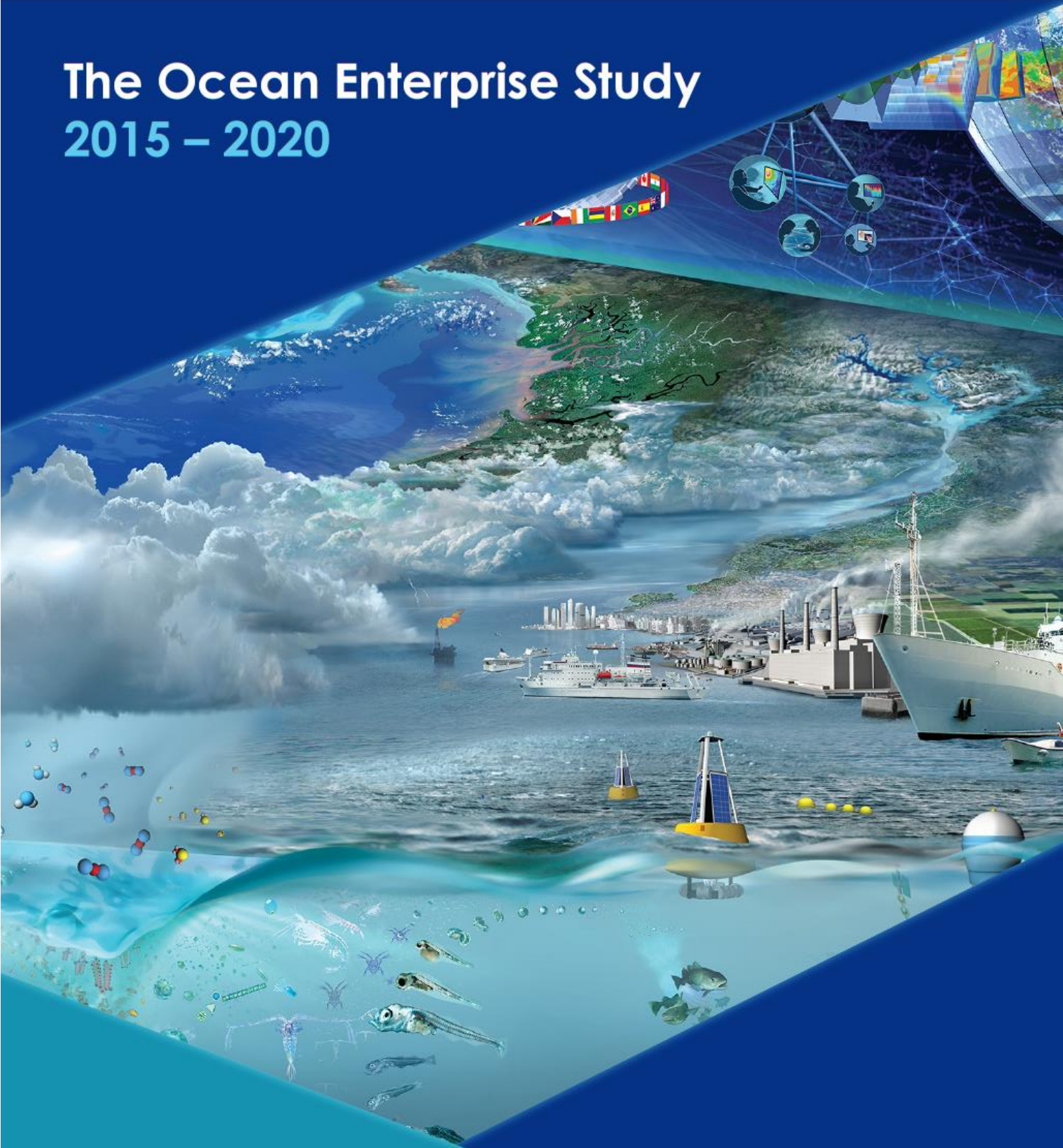
The Ocean Enterprise Study
2015 – 2020



A study of U.S. New Blue Economy business activity

FOREWORDS

Dr. Richard W. Spinrad, Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator

It is often said that you cannot manage what you do not measure.

As we move forward with the opportunities for growing the Blue Economy, it is data, information, and knowledge about the ocean that will underpin managing the delivery of the bounty of the sea, while protecting the ocean environment and the essential natural capital and ecosystem services that it provides. This knowledge-based New Blue Economy, looking to the sea for data and information to address societal challenges and inspire their solutions, is critical to delivery of the future Blue Economy.

Delivering an effective New Blue Economy requires partnership across the triple helix of government, academia, and industry. It is specialized businesses that provide the technological means to observe and measure the ocean and who act as intermediaries, leveraging NOAA's public data and delivering much of the customized ocean information needed for a wide variety of end-uses.

This "Ocean Enterprise" is a key partner for NOAA. Ocean Enterprise businesses provide technologies essential to achieving NOAA's mission and are important users of NOAA's public good data, translating it into actionable information for use by a vast and growing array of end-uses and end-users.

This Ocean Enterprise 2015 – 2020 report provides an important update on this vital industry cluster.

Nicole LeBoeuf, Assistant Administrator, NOAA National Ocean Service

The NOAA National Ocean Service (NOS) is at the cutting edge of delivering ocean observations, measurements, and models in support of NOAA's mission. NOS works at global, national, and regional scales to provide the ocean data and information needed to facilitate the Blue Economy and ensure the protection of coastal communities, infrastructure, and the marine and coastal environment.

A specialty area of expertise within the National Ocean Service is engagement with stakeholders to assess needs and translate science and data into information to support decisions at many timescales from now into the distant future. NOS strives to provide insights about changes in the environment that impact our lives every day. The Ocean Enterprise complements NOAA and NOS by enabling and advancing our collective capabilities to provide such insights. The success of the Ocean Enterprise and the businesses therein benefits the Blue Economy. It is an important part of the solution to meeting societal needs for ocean, coastal, and Great Lakes information and provides critical components of the value chain delivering insightful information to those who need it.

Through public private partnerships, Cooperative Research and Development Agreements, and other partnership mechanisms, NOS works with industry to find new ways to observe and measure the ocean and to make most effective use of ocean data and information for the benefit of the nation.

This Ocean Enterprise 2015 – 2020 report will help to raise the profile of recent changes in this important business cluster and will support the exploration of further opportunities for NOAA and NOS to play a role in its continued development.

Carl Gouldman – Director, IOOS Program Office

The U.S. Integrated Ocean Observing System (IOOS®) is a unique New Blue Economy partnership of federal agencies, academia, and industry. IOOS is the nation's "eyes on the ocean, coasts, and Great Lakes;" an integrated network of people and technology gathering data and developing tracking and predictive tools to benefit the economy, the environment, and public safety at home, across the nation, and around the globe.

IOOS works closely with the Ocean Enterprise business cluster in the testing and deployment of new ocean observation and measurement technologies applied to stakeholder needs. IOOS partners with many Ocean Enterprise technology Providers and Intermediaries through the IOOS Regional Associations who are working to deliver decision support services every day, engaging with stakeholders to ensure alignment with end-user needs.

This Ocean Enterprise 2015 – 2020 report is another important step in our engagement with the ecosystem of businesses providing ocean observation and measurement products and services. I am excited to see the growth and expansion in the number of companies in this important business cluster and look forward to continuing to strengthen the dialogue amongst the players to accelerate our ability to meet the ever-growing needs for ocean and Great Lakes information.

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Project Leads:

Steven Tally, PhD, ERISS Corporation
Ralph Rayner, PhD, NOAA IOOS

Contributors from ERISS Corporation:

Jim Wheeler, PhD
Justin Heet
Barbara Nyegaard

Contributors from the U.S. IOOS Program Office:

Carl Gouldman
Michelle Harris
Catherine Tobin
Kate Culpepper

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Table of Contents

Figures

Tables

EXECUTIVE SUMMARY

ES1.1 Introduction

In 2015, the U.S. Integrated Ocean Observing System (IOOS) Office and the National Ocean Service (NOS) commissioned the *2015 Ocean Enterprise Study* (NOAA, 2017 Rayner et al., 2019). This study sought to assess the size and characteristics of the U.S. "Ocean Enterprise." The Ocean Enterprise comprises two main categories of businesses: "Providers" of the technological means to undertake ocean observations and measurements and "Intermediary" businesses that add value to ocean[1] data and information, tailoring it to address the needs of specific end-uses.

The Ocean Enterprise is the business component of the "New Blue Economy" (Hotaling and Spinrad, 2021); knowledge-based activities that support harnessing ocean resources for economic growth, while protecting ocean health and ensuring social equity.

The contribution of ocean-based activities to the overall economy is significant and is growing. A study conducted by the Organisation for Economic Co-operation and Development (OECD) estimated the size of the ocean economy at around US$1.5 trillion in 2010 (around 3% of global gross domestic product) and predicts that the ocean's contribution will have doubled in size relative to 2010 levels, to US$3 trillion by 2030 (OECD, 2016). The OECD study also recognized that this economic potential can only be delivered if use of the ocean and ocean resources is balanced with protecting the natural capital and ecosystem services that the ocean provides. This "Blue Economy", coupling economic growth, social inclusion, and the preservation or improvement of livelihoods with ensuring environmental sustainability of the ocean and coastal waters, depends upon New Blue Economy data, information, and knowledge for its effective delivery.

Ocean Enterprise businesses that contribute to the New Blue Economy thus play a vital role in supporting the wider Blue Economy. Looking to the future, these businesses will play an increasingly important role in delivering product and service innovation underpinning capacity to meet many of the challenges facing the planet; from food security and climate change to the provision of energy and natural resources, while also ensuring protection of the ocean environment.

The 2020 Ocean Enterprise study identified how U.S. Ocean Enterprise businesses are responding to the opportunities afforded by the growth and changing composition of the Blue Economy, and how the scale and scope of this important industry cluster has changed since 2015.

[1] For the purposes of this report, the term 'ocean' encompasses the open ocean, continental shelves, coasts, and the Great Lakes.

ES1.2 Methodology

As with the 2015 study, the methodology used in the 2020 study comprised a combination of a web-survey of businesses identified as being Ocean Enterprise Providers or Intermediaries, and secondary analysis of the Ocean Enterprise cluster based on public and proprietary business information sources. The use of secondary analysis was expanded in the 2020 study to provide a more comprehensive assessment of the breadth and depth of the Ocean Enterprise, as well as to compensate for the difficulties of securing web-survey responses during the Covid-19 pandemic. In addition, the study provided an opportunity to assess the impact of the pandemic on Ocean Enterprise business activity.

In total, the study screened over 2,000 U.S. businesses with potential involvement in Ocean Enterprise activities. Survey responses were received from 15% of the businesses identified as being part of the Ocean Enterprise cluster. Detailed secondary analysis allowed the survey results to be put into the context of the overall population of 814 identified Ocean Enterprise businesses.

ES1.3 Key findings

Figure ES. 1 provides summary details of the number of Ocean Enterprise businesses, their geographical distribution, their total employment, and the revenue they derive from Ocean Enterprise activities as determined by the 2015 and 2020 studies.

Figure ES. 1. U.S. Ocean Enterprise businesses: their geographical locations, employment, and Ocean Enterprise revenue.

The 2020 Ocean Enterprise Study identified 814 U.S. businesses active in provision of Ocean Enterprise products and services, in 49 states, the District of Columbia, and two overseas U.S. territories. Total employment for these companies was some 325,000 and their Ocean Enterprise revenue was estimated at $8 billion.

Between 2015 and 2020, the U.S. Ocean Enterprise experienced real dollar growth of 7% (as measured by 2015 Producer Price Index dollars) with the number of businesses in the Ocean Enterprise cluster increasing by almost 60%, to a total of 814. A significant proportion of this total growth in numbers of businesses was the result of the founding of 112 new Ocean Enterprise businesses since 2015 (36% of the total growth), of which 46 were new independent businesses. The balance of the overall 300 increase in numbers represents established businesses that entered the Ocean Enterprise space after 2015, or whose Ocean enterprise revenues reached a discoverable level after this date.

The U.S. Ocean Enterprise cluster is highly export-driven with approximately 22% of businesses' Ocean Enterprise revenue being from export sales, which is substantially above the 12% national average for the export-share of GDP (BEA, 2021a). Businesses in the cluster export to all regions of the world, with Asia-Pacific and Europe being the most important markets, and with both regions increasing their significance since 2015.

Surveyed businesses were generally more optimistic than might be expected given the survey period's macroeconomic context. Thirty-six percent of surveyed businesses expected employment increases over the coming year, compared to only 10% expecting decreases. Revenue increases over the same period were expected by 40% of respondents, while decreases were expected by 26%.

Businesses reported substantially increased market diversification. In 2015, three market sectors were targets for at least half of respondents; by 2020, six sectors were targets for at least half of respondents, and an additional six were targets for at least 40% of U.S. Ocean Enterprise businesses. Businesses reporting offshore renewable energy as one of their chief market sectors more than doubled to 57%, compared with 27% in 2015. The maritime security and water quality sectors also reported significant growth in importance.

The five years since the last study has seen a large growth in the provision of autonomous systems as platforms for ocean observations and measurements. Between 2015 and 2020, the share of technology Providers that delivered ocean data platforms, including autonomous underwater and surface vehicles, nearly doubled.

Amongst Intermediaries, businesses that provided ocean information services involving physical oceanographic information, already the most important sector in 2015, grew in importance with nearly three-quarters of survey respondents using physical oceanographic information in their service offerings. The next most commonly cited data categories were hydrographic and

bathymetric surveys, navigation and positioning, geophysical information and biological information.

Survey respondents provided information concerning their awareness of IOOS and its future plans, as well as perceived barriers to working with IOOS. The pattern of responses was very similar to 2015 with 70% of respondents indicating awareness of IOOS and with limited knowledge about future investments and developments being cited as the most common barrier to working with IOOS.

The survey provided a unique opportunity to ask about the impact of the Covid-19 pandemic. The Ocean Enterprise business cluster remains optimistic about the future despite the impact of the pandemic on business activity. Sixty-seven percent reported plans to enter new geographical markets, 72% plan to enter new market sectors, and 55% are intending to increase research and development investments, despite the impact of the pandemic.

ES1.4 Conclusions and next steps

Set against the opportunities afforded by expected overall growth in the Blue Economy, the Ocean Enterprise cluster has had to contend with major challenges over the 2015 to 2020 period. The most notable of these has been the impact of large reductions in activity related to its key market in support of offshore oil and gas exploration and production. Despite these challenges, the cluster has grown by 7% since 2015, indicating that growth in other market opportunities more than compensated for the decline in offshore oil and gas related activity.

The coming years can be expected to see further decline in the market for Ocean Enterprise products and services provided to offshore oil and gas and perhaps some other established markets. At the same time, rapid growth is expected to occur in areas such as offshore renewable energy and sustainable aquaculture, as well as supporting the growing need for information to manage ocean health and ensure climate change resilience.

In parallel with these changes in markets for Ocean Enterprise products and services, there will be an accelerating impact from new technological and scientific means to make ocean observations and measurements and to utilize them in the generation of actionable information. Examples are increased use of autonomous systems and the application of new analytical tools (such as artificial intelligence and machine learning, as well as the application of sophisticated modeling techniques).

This combination of a large shift in markets and in the technological means of servicing them creates an uncertain business environment and fosters innovation. Established businesses are forced to adapt to changing market opportunities and the threat of disruptive technologies. The combination of market and technological change creates an ideal environment for the emergence of new startup businesses delivering disruptive solutions to end-user needs. The growth opportunities in developing markets also attract established businesses not previously active in the Ocean Enterprise space. These trends are clearly in evidence in the changes seen since 2015.

The results of the 2020 study indicate that the U.S. Ocean Enterprise business cluster will emerge from the Covid-19 pandemic well positioned to exploit opportunities associated with further growth of the Blue Economy. It will, however, face a challenging transition, as businesses navigate fundamental changes in markets and in the technological means to deliver innovative solutions to meeting their ocean information needs. The coming decade will therefore be a period of great change for Ocean Enterprise businesses. In the energy sector, achieving net zero by 2050 will demand enormous growth in the capture of offshore renewable energy. If the projections recently made by the International Energy Agency in its *Net Zero by 2050 Roadmap* (IEA, 2021) report hold true, demand for Ocean Enterprise products and services to support the offshore wind component of the energy transition will probably exceed the current capacity of the cluster. Similarly, changes in the use of ocean living resources and delivering a target of designating 30% of the ocean as marine protected areas, as well as monitoring enhanced natural and engineered use of the ocean as a carbon sink, will all demand new capacity in ocean observation and measurement and information services. To add to this list are the growing information needs of ensuring ocean health and the protection of coastal communities, infrastructure and environments from rising sea-levels.

Delivering these growing and changing demands for New Blue Economy products and services requires partnerships across the triple helix of government, academia, and industry. It is specialized businesses that provide the technological means to observe and measure the ocean and who act as Intermediaries, leveraging NOAA's public data and delivering much of the customized ocean information needed to support the rapidly changing and growing needs of the Blue Economy. The "Ocean Enterprise" business cluster is thus a key partner for NOAA, providing technologies essential to delivery of NOAA's mission and serving as key users of NOAA's public good data, translating it into actionable information for use by a vast and growing array of end-uses and end-users. The 2020 Ocean Enterprise study will help to guide and inform NOAA's relationship with the Ocean Enterprise business cluster as a critical New Blue Economy partner.

The results of this study are intended to be widely disseminated by IOOS and NOAA, helping to raise the profile of the Ocean Enterprise cluster as a critical enabler of the Blue Economy and an important business sector in its own right. Study outputs will also help to inform and guide the work of NOAA, IOOS and the Department of Commerce in delivering initiatives that foster innovation and business success for U.S. companies engaged in the New Blue Economy.

It is expected that this and future studies will help guide and support the Ocean Enterprise business cluster as it navigates the challenges and opportunities associated with changing use of the ocean and its resources, protection of the ocean and coastal environment, and maintenance of the ocean's natural capital and ecosystem services upon which we all depend.

1. INTRODUCTION

The ocean[2] is a key and growing source of food, energy, and minerals, and the majority of world trade relies on ocean transportation. Approximately 40% of the world's population live in coastal regions, and three-quarters of the world's large cities are located on the coast (United Nations, 2017). Coastal waters and regions are the predominant location of the global tourism and recreational industries. Coastal regions are also the location of a large proportion of global economic activity.

The economic importance of the ocean has led to a number of countries creating subsets of their national income accounts (called satellite accounts[3]) that measure ocean-related economic activity at a national or regional level (Fenichel et al., 2020; Jolliffe et al., 2021).

NOAA and the Bureau of Economic Analysis released the first official U.S. Marine Economy Satellite Account (MESA) in June 2021 (BEA, 2021b). The MESA statistics offer national estimates for ocean, coastal, and Great Lakes-related economic activity by major industry. These national-level statistics covering 2014 to 2019 are the most comprehensive and accurate produced to date.

The U.S. marine economy accounted for 1.9%, or $397 billion, of the nation's gross domestic product (GDP) in 2019, and it grew faster than the U.S. economy from 2018 to 2019, growing by 4.2% (compared with 2.2% U.S. GDP growth). The U.S. marine economy supported 2.4 million jobs in 2019.[4]

In addition, the U.S. National Ocean Economics Program has been tracking the ocean components of the U.S. economy contained in the databases of the U.S. Bureau of Labor Statistics since 1990. Data for all years beyond 2004 have been generated by the National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management, leading to production of the *NOAA Report on the U.S. Ocean and Great Lakes Economy for 2016* (NOAA, 2019) and corresponding results for 2019 (BEA, 2021).

It is increasingly recognized that the ocean provides vital natural assets and ecosystem services that play a pivotal role in human society (Spalding et al., 2016). Hundreds of millions of people depend directly on the oceans for their food and livelihoods. We all depend on the oceans for provision of much of the oxygen that we breathe and for their controlling and moderating role in weather and climate.

The recognition of the need to balance the economic use of the ocean and ocean resources with the protection of the natural assets and ecosystem services that the ocean provides is embodied in the concept of the "Blue Economy." The Blue Economy couples the promotion of economic growth, social inclusion, and the preservation or improvement of livelihoods, while ensuring

[2] For the purposes of this report, the term 'ocean' encompasses the open ocean, continental shelves, coasts, and the Great Lakes.
[3] Satellite accounts (BEA, 2020) are supplementary statistics that allow analysis of a particular aspect of the economy, such as spending on travel and tourism. The data are presented in a satellite account supplement and are designed to be consistent with Bureau of Economic Analysis (BEA) core economic statistics (BEA. 2017).
[4] https://www.bea.gov/data/special-topics/marine-economy.

environmental sustainability of the ocean and coastal areas (World Bank and United Nations Department of Economic and Social Affairs, 2017).

In contrast to the terrestrial environment, the ocean represents a difficult and unfamiliar environment in which to operate. As a consequence, much of the economic activity around, on, and under the ocean would not be possible were it not supported by information and knowledge derived from ocean observations, measurements, and forecasts.

Balancing delivery of the economic potential of the ocean with protecting the essential natural assets and ecosystem services that the ocean provides, is similarly dependent on knowledge and information derived from ocean observations, measurements, and forecasts. Ocean observations, measurements, and forecasts also deliver important benefits far inland given their critical role as an input to weather forecasting and climate projection.

1.1 The New Blue Economy

The means to undertake observations, measurements, and forecasts in order to map, explore, characterize, and forecast the ocean, and the utilization of the resulting information to underpin the delivery of socioeconomic benefits has been described as the "New Blue Economy" (Hotaling and Spinrad, 2021). The New Blue Economy is described as "a knowledge-based economy, looking to the sea not for extraction of material goods, but for data and information to address societal challenges and inspire their solutions." It is an economy founded on emerging capabilities for acquiring data and developing knowledge that supports harnessing ocean resources for economic growth, while protecting ocean health and ensuring social equity.

The development of the New Blue Economy is analogous to the development of the "*Weather Enterprise*." The Weather Enterprise comprises a relatively mature ecosystem of technology providers, public meteorological agencies (such as the NOAA National Weather Service) and public and private organizations delivering information services to a wide range of end-uses (National Research Council, 2003; Spiegler, 2007).

As the requirements for ocean data and information have grown in scale, the research, development, manufacturing, and distribution of the technological means to conduct ocean observations and measurements have become important economic activities in their own right.

The growth in the use of the ocean and ocean resources, coupled with the need to sustain ocean natural capital and ecosystem services, has driven the development of an important and growing service industry. Specialist businesses add value to ocean data and information, tailoring it for specific end-uses. Where the necessary information cannot be obtained from public sources, these businesses may also conduct the specific ocean observations and measurements needed to support a particular end-use.

Business New Blue Economy activity thus comprises two main components. The first component is industry provision of the technological means to make ocean observations and measurements with businesses acting as product and infrastructure "Providers." The second component is businesses that act as "Intermediaries," translating ocean information into service offerings in support of the specific needs of end-uses and end-users. These business product and service activities comprise the "Ocean Enterprise," and are the subject of this report.

1.2 The Scope of the United States Private Sector Ocean Enterprise

As defined above, for the purposes of this study, the private sector Ocean Enterprise is defined as U.S.-based businesses that are Providers of the technological means to undertake ocean observations and measurements, or who act as Intermediaries adding value to ocean observations, measurements, and forecasts for sale to public and private "end-users."

These private sector activities are key components of value chains connecting the means to make ocean observations and measurements to the delivery of socioeconomic benefits associated with their use.

Although understanding and quantifying the specific benefits derived from end-use of ocean information does not form a part of this study, it is important to understand the broad categories of end-use that are supported by New Blue Economy activity.

End-users of ocean information derive societal or economic benefits from New Blue Economy products and services. They include the science community and marine and maritime industry sectors, such as offshore oil and gas, marine renewable energy, ports, shipping, fishing, and aquaculture. They also include federal, state, and local government bodies and agencies who utilize ocean information for regulatory purposes, for ensuring the safety of life or property, or for protection of the environment. The general public are also end-users of ocean information, primarily in support of their leisure and recreational activities.

By virtue of the contribution of ocean information to improve weather forecasting and climate prediction, end-user benefits extend inland to include weather- and climate-dependent activities such as agriculture, air and ground transportation, and retailing.

Understanding and quantifying the end-use benefits derived in whole or in part from ocean data and information is the focus of the *NOAA IOOS Benefits of Ocean Observing Catalog* (BOOC) project (NOAA, 2021).

Supporting end-uses are the technological means to make ocean observations and measurements, the production of the observations and measurements themselves, and the capacity to turn the resulting data into useful actionable information. These are the key elements of the New Blue Economy:

- Providers of ocean observing and measurement tools and infrastructure
- Producers of core public-good ocean observations, measurements and forecasts
- Intermediaries who tailor ocean data or information for a specific end-use

Providers of observing system technological components are predominantly private sector businesses and include manufacturers of sensors, instruments, and platforms; providers of the data infrastructure that manage and communicate ocean data; and organizations that develop and maintain the data management systems, software tools, and models that are used to help turn ocean data into useful information.

While Providers technically include satellite-based observing technology, as with the 2015 study, the Ocean Enterprise 2020 study excluded commercial Providers of satellite-based ocean observing technology because of the difficulty of separating activities associated with the construction, launch, and operation of satellite-based ocean observation from more general satellite remote sensing.

Producers of ocean observations are primarily public organizations delivering ocean observations, measurements, and modeled data and information on a free-of-charge or cost-of-distribution basis as a public good.[5] They encompass a wide range of national, regional, and international institutions and initiatives operating at different spatial scales (Moltmann et al., 2019).

Many countries have installed marine research infrastructure and ocean observatories. Regions have combined their efforts to observe different parts of the ocean on a collective basis, sharing and combining the collected data and derived information.

Globally, frameworks have been developed to foster the growth of existing ocean observing systems and implement observing capability in regions that are under-observed.

Most national and regional ocean observing systems contribute to the Global Ocean Observing System (GOOS). GOOS operates under the auspices of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO-IOC) in partnership with the World Meteorological Organization (WMO). It provides coordination for global ocean observation, and links with the Global Earth Observing System of Systems (GEOSS).

Today, GOOS comprises a Steering Committee; three discipline-based GOOS Expert Panels that provide scientific oversight on physics and climate, biogeochemistry and biology and ecosystems; and thirteen GOOS Regional Alliances (GRAs). The GRAs are coalitions of national or regional ocean observation initiatives that follow GOOS principles. The GRAs support marine research and operational oceanographic services to different degrees, depending on the extent of development of each of the systems. They also promote national, regional and local collaboration and capacity building.

Within the GOOS framework, efforts to establish national ocean observing systems have been continually increasing. Almost every coastal country is involved in marine research and activities related to ocean observation and measurement, although systems are not equally developed. Whereas some countries demonstrate strong expertise in observing activities, others are in the process of gaining experience. Examples of developed ocean observing systems include the Australian Integrated Marine Observing System (IMOS), Canadian Ocean Networks and the Canadian Integrated Ocean Observing System (CIOOS), the Japan Oceanographic Data Center, the European Global Ocean Observing System (EuroGOOS), the European Union Copernicus Marine Environment Monitoring Service (CMEMS), the European Marine Observation and Data Network (EMODnet), the NOAA Global Ocean Monitoring and Observing Program (GOMO) and, of course, U.S. IOOS.

The U.S. Integrated Ocean Observing System (IOOS®) Program is a national-regional partnership including 17 federal agencies, 11 regional associations (RAs), and a technology verification and validation organization (the Alliance for Coastal Technologies).

In addition to public sector producer activity, end-users of ocean observation, measurement, and forecast information products and services commission their own data collection to support

[5] In economics, a public good is a good that is both non-excludable and non-rivalrous. For such goods, users cannot be barred from accessing or using them for failing to pay for them. Use by one person or organization neither prevents access of others nor reduces availability to others.

operational needs that cannot otherwise be supported through use of public good ocean data and information sources. In these instances, end-users generally place contracts with specialist commercial Intermediaries, who undertake such work on their behalf. In some cases, these single end-use data are also incorporated into public good data repositories, either because of legal obligations to do so (often when the data are collected as part of a regulatory requirement) or through voluntary provision.

In some instances, a single Intermediary will undertake all of the measurements required, as well as generating the information needed to satisfy the specific end-user need. In others, contracts for measurement, data analysis, modeling and the generation of specific tailored information may be let to multiple organizations, each delivering a component of the Intermediary activity to meet the specific end-user need.

Less common are instances where end-users procure the technological means to make ocean observations and measurements directly. A more recent development is the move toward public-private partnerships, in which Ocean Enterprise businesses undertake ocean data collection in their own right, licensing the resulting data to public sector End-User partners.

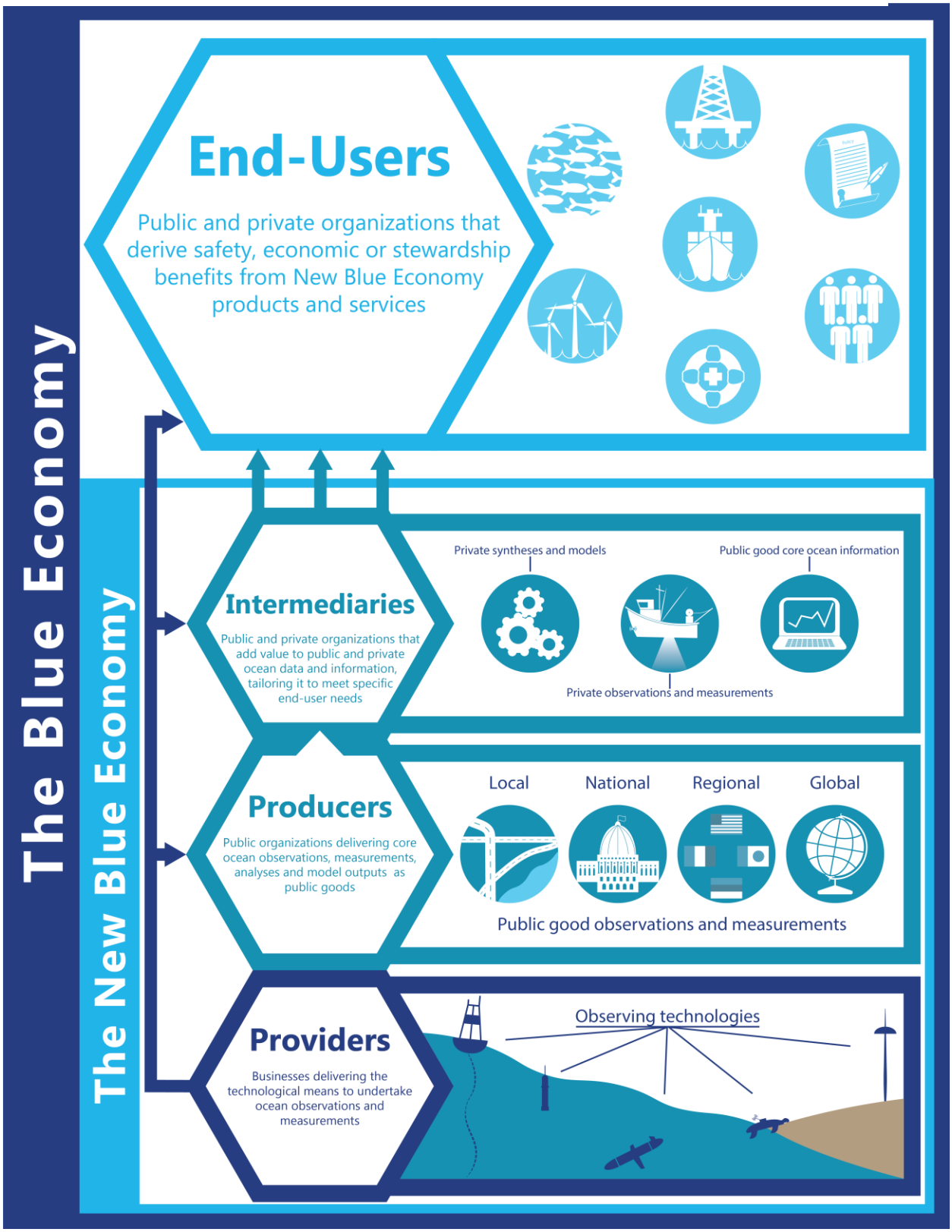
For the purposes of this study, business Intermediary activity comprises all commercially contracted work in conducting ocean observations and measurements, analyzing and interpreting ocean information, and generating information products and services specifically tailored to meeting the needs of particular end-uses and end-users.

Examples of such Intermediary activity are site characterization, design and operating criteria for offshore installations (such as oil and gas production platforms or offshore wind turbines delivered to an offshore energy end-user), preparation of ocean forecasts in support of shipping or recreational end-users, or the generation of coastal flood risk assessments for an insurance provider or a coastal municipality.

1.3 IOOS and the Ocean Enterprise

In March 2009, President Obama signed the *Integrated Coastal and Ocean Observation Act* (PLN 111-11, 2009) establishing statutory authority for the development of the U.S. Integrated Ocean Observing System (IOOS®). This Act and its subsequent reauthorization in December 2020 (PLN 116-271, 2020) mandates the establishment and maintenance of a national integrated system of ocean, coastal, and Great Lakes observing systems coordinated at the federal level with the mission "to produce, integrate, and communicate high quality ocean, coastal and Great Lakes information that meets the safety, economic, and stewardship needs of the Nation."

Figure 1.1. The principal components of the New Blue Economy.



As part of their missions, NOAA[6] and IOOS seek to engage with U.S. businesses that are Providers of the technological means to gather ocean data; act as Intermediaries in producing value-added services based on ocean information; or are end-users deriving safety, economic, or stewardship benefits from use of ocean information.

In 2015, IOOS and the NOAA National Ocean Service (NOS) commissioned the *2015 Ocean Enterprise Study* (NOAA, 2016; Rayner et al., 2019), a first of its kind evaluation of the scale and scope of U.S. Provider and Intermediary business activity.

A core objective of the 2015 study was to raise visibility and awareness of this industry cluster's importance and to improve the understanding of its engagement with NOAA and the IOOS Program.

In the period since the publication of the *2015 Ocean Enterprise Study*, there has been increasing recognition of the growth potential of the Blue Economy and, in turn, the Ocean Enterprise business activities that will be essential to support delivery of this potential.

To better understand how U.S. Ocean Enterprise businesses are responding to the opportunities afforded by a growing Blue Economy, and to help guide how NOAA might best support U.S. Ocean Enterprise activity, NOAA IOOS commissioned a repeat Ocean Enterprise study in early 2020.

1.4 The Ocean Enterprise in 2020

Soon after publication of the 2015 Ocean Enterprise study report, the Organisation for Economic Co-operation and Development (OECD) published *The Ocean Economy in 2030*, (OECD, 2016). This report highlighted the use of the ocean and ocean resources as the "new economic frontier." According to the OECD report, by 2030 ocean-based industries will "have the potential to outperform the growth of the global economy as a whole, both in terms of value added and employment."

The OECD projections suggest that between 2010 and 2030, a "business-as-usual" scenario could see the ocean economy more than double its contribution to global value added, reaching over U.S. $3 trillion. Particularly strong growth is expected in marine aquaculture, offshore wind energy, fish processing, and shipbuilding and repair. As a result, ocean industries will make an important contribution to employment growth. In 2030, they are anticipated to employ 40 million full-time equivalent jobs in the OECD business-as-usual scenario. The fastest growth in employment is expected to occur in offshore wind energy, marine aquaculture, fish processing, and port activities.

As well as recognizing the immense potential of the ocean in terms of resource wealth, economic growth, employment and innovation, the OECD report also recognizes the role of the ocean in many of the global challenges facing the planet in the decades to come—from food security and climate change to the provision of energy, natural resources, and improved medical care.

[6] As an Agency of the Department of Commerce, engagement with industry is an important part of NOAA's mission. All NOAA Line Offices interact with Ocean Enterprise businesses to a lesser or greater degree. NOAA programs such as the Office of Coastal Management (OCM), the Center for Operational Oceanographic Products and Services (CO-OPS), the National Data Buoy Center (NDBC), the Global Ocean Monitoring and Observing program (GOMO), the NOAA Office of Coast Survey (OCS), and the NOAA IOOS Program are closely engaged with Ocean Enterprise Provider businesses and with Intermediary businesses that make use of NOAA data and information in developing products and services with a wide range of end-uses and end-users.

While the potential of the ocean to help meet these challenges is considerable, this potential faces an array of threats; the report describes current and growing stresses from overexploitation, pollution, declining biodiversity, and climate change, among others. Realizing the ocean's potential to support economic growth will demand responsible, sustainable approaches to its economic development. Growth in sustainable ocean economic activity is expected to drive a corresponding growth in the New Blue Economy. An increased demand for the technological means to conduct ocean observations and measurements and the use of the resulting data to support creation of the ocean information services that underpin the Blue Economy present an important opportunity for U.S. Ocean Enterprise businesses.

Science and technology developments are also expected to play a key part in shaping the future New Blue Economy, as new scientific understanding and emerging technologies enable new approaches to meeting ocean information needs. U.S. Ocean Enterprise businesses need to be positioned to capture the innovation opportunities associated with connecting new scientific understanding and emerging technologies to the developing information needs of the Blue Economy. They also need to connect with the sectoral and geographical markets where their products and services are best able to deliver benefits to end-uses and end-users.

Set against the longer-term changes identified by the OECD and others, there are also shorter-term factors, which have significant impact on Ocean Enterprise business activity. Most notable in the period since the 2015 Ocean Enterprise study has been the historic fall in oil prices. Over the period from late 2014 to mid-2016, oil prices fell by 70%. This fall was mostly driven by the boom in cost-competitive shale oil production (World Bank, 2018). The subsequent decline in higher-cost offshore oil exploration and production has had a significant negative impact on a key market for Ocean Enterprise products and services.

Coincident with work on the 2020 study has been the impact of the Covid-19 pandemic. The pandemic has had impacts on all businesses, and the Ocean Enterprise sector has been no exception. To gain some insights into the pandemic's effects on the sector, a set of supplementary survey questions were added to the Ocean Enterprise 2020 study, aimed at helping to understand the impact of the Covid-19 pandemic on Ocean Enterprise businesses.

The Covid-19 pandemic also had very direct impacts on how the 2020 study was conducted. Business disruptions, furloughs, and the general difficulties of contacting companies during a pandemic made the use of a web-based business survey more challenging than would normally be the case. As a result, the study included more expansive use of secondary research to describe and measure U.S. Ocean Enterprise activity.

This Ocean Enterprise 2015 - 2020 report leverages and adds to the information gathered in the 2015 study. It provides contemporary information about changes in the scale and scope of the businesses comprising the U.S. Ocean Enterprise, as well as description of key market, technology and exporting trends. Looking to the future, the report examines how NOAA and NOAA IOOS might facilitate and support the future success of U.S. businesses engaged in Ocean Enterprise activities.

METHODOLOGY

2.1 Background

While the primary goal of the 2020 study was to provide an update on the 2015 work, it also provided an opportunity to improve on methods and apply lessons that were learned during the 2015 study. To compensate for the challenges of conducting an industry survey during the pandemic, the scope of the 2020 study was expanded to include additional secondary research efforts to create a comprehensive multi-method design that generated a uniquely detailed profile of the U.S. Ocean Enterprise.

The overall approach was to create a database of all known U.S. businesses that are Ocean Enterprise Providers and/or Intermediaries, and to survey a representative sample of these utilizing a web-survey. Results of the web-survey were combined with detailed secondary analysis on all businesses contained in the database. The analyses that are presented in this report draw on data from these two main sources:

- **A database of web-survey responses:** Survey respondent data supported a sample-based analysis, which could then be generalized to an overall Ocean Enterprise population level.
- **Secondary Ocean Enterprise information:** "Secondary" data sources refer to data sources that do not rely on direct reporting from individuals within a target company, such as through a survey or an interview. However, the value of this information for the purposes of this report are anything but secondary. Analysis of public and proprietary information allowed the development of a database of the universe of U. S. Ocean Enterprise businesses and their economic details. This database of Ocean Enterprise businesses was generated from sources such as annual reports, Dun & Bradstreet listings, Securities and Exchange Commission (SEC) filings, company websites, and other publicly available information. This not only provided Ocean Enterprise businesses' detailed corporate structures, but also their locations, employment, revenue, industry foci and a variety of other indicators. A more detailed description of the methodology employed for secondary analysis is provided in Appendix 1.

2.2 Creation of a Database of Ocean Enterprise Businesses

An initial database of businesses was compiled from multiple sources. First, lists of businesses that might provide Ocean Enterprise activities were obtained from professional and industry associations, industry-specific email and contact lists, and lists provided by federal agencies and an array of IOOS stakeholders. As it was initially unknown if any individual business on these lists conducted activities that would classify them as belonging to the Ocean Enterprise cluster, it represented a "wide net" approach that required further screening. Initially, the aggregated list was screened to eliminate any businesses obviously uninvolved in Ocean Enterprise Provider and/or Intermediary activities, as well as those with no operating locations in the United States. The final database of included businesses for the web-survey comprised 3,087 individual contacts at 2,198 companies.[7] Given this large and purposely overly inclusive list, the survey

[7] Multiple contacts were often obtained for individual companies.

design relied upon screening questions to ensure only businesses who conducted Ocean Enterprise activities were asked to respond to the full survey instrument.

2.3 Outreach and Survey Administration

Initial outreach efforts designed to inform businesses of the upcoming survey were conducted through announcements in industry publications, information posted on the NOAA website, social media and through announcements at relevant industry meetings and conferences. Due to the large database of potential Ocean Enterprise businesses, survey invitations were sent in waves of 100 to 300. Prior to each wave of survey invitations, an information email was sent from IOOS informing the recipient of the upcoming survey, providing links to further information and offering the option to go directly to the survey. The first survey invitations were sent out on April 4, 2020, with survey activities continuing through September 2020. Succeeding waves of invitations were sent out weekly. Reminder emails were sent out after two weeks with no response, and weekly for up to 10 weeks. In total, 11 waves of invitations were sent out with accompanying reminders following. In total, approximately 18,000 emails were sent including informational outreach, invitations and reminders. Survey responses were received from nearly 15% of the businesses identified by secondary analysis as having Ocean Enterprise activities.

The full survey instrument can be found in Appendix 2.

2.4 Data Collection and the Covid-19 Pandemic

The commencement of survey activities closely corresponded with the onset of the Covid-19 pandemic, which resulted in worldwide disruption to normal business activities. After much discussion, the decision was made to proceed with the survey despite the likely impact of the pandemic. This decision balanced the need for new information and the knowledge that the ability to collect data on the pre-Covid timepoint was rapidly diminishing, against the knowledge that regular survey processes and the ability to contact and obtain responses from Ocean Enterprise businesses might be compromised.

The most pronounced impact of the Covid-19 pandemic was the greatly increased difficulty in obtaining survey responses. At the start of survey work, the majority of businesses were either transferring to conducting business operations remotely, with no centralized presence, or were temporarily suspending business operations (usually smaller businesses). Furthermore, many executives and other high-level individuals were not always monitoring email or were de-prioritizing all but the most urgent communications for response. “Gatekeepers” such as administrative assistants or those screening and forwarding emails sent to group email addresses (such as *info@abcwidgets.com*) were not always monitoring or responding to emails while the remote working transfer and adjustment period was taking place. All told, this resulted in unprecedented difficulty obtaining survey responses and a longer survey period than initially planned.

Some modifications to survey questions and processes were made to respond to and accommodate the unique circumstances that resulted from the Covid-19 pandemic. These were:

- **The addition of Covid-19-related survey questions:** To gain some insight into the impact of the pandemic, additional questions were added asking about how businesses were responding to Covid-19 in terms of changes in investment strategies supporting new research and development, changes in plans to enter new geographical markets, and changes in plans to enter new market sectors.

- **Modification of questions that asked for past business information:** To remove the impact of the pandemic from as much information as possible and obtain pre-pandemic datapoints, questions asking about such areas as recent revenue and employment were reworded to refer to the most recent complete business or fiscal year, or to provide estimates up to the end of calendar year 2019.

- **Expansion of survey period:** Although initial project plans had projected a three-month survey period, this period was expanded to six-months to allow multiple contacts with businesses as they transitioned to predominantly remote working.

The web-survey obtained responses from 128 individual businesses engaged in Ocean Enterprise activities. This compared with 159 responses to the 2015 survey.

2.5 Secondary Data Analysis and Representativeness of the Survey Sample

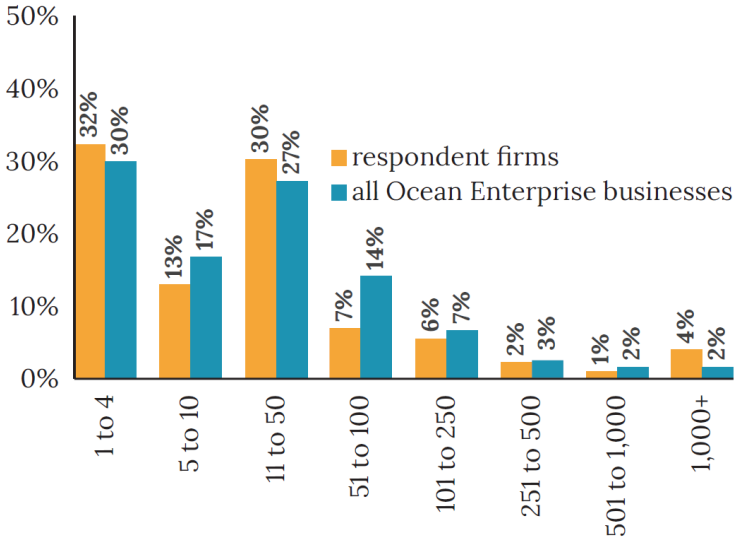
Secondary analysis of the initial database of potential businesses that might be engaged in Ocean Enterprise activities proceeded in parallel with the web-based survey.

Initial screening of all businesses in the full database identified 814 as having Ocean Enterprise activities. Based on this total, the web-survey response rate comprised nearly 16% of the total population of Ocean Enterprise businesses.

A key goal of the web-survey was to obtain responses that were representative of the overall population of Ocean Enterprise businesses, especially with respect to company size.

As shown in Figure 2.1, the employment size categories for the survey sample and the overall Ocean Enterprise population, determined from secondary analysis, closely correspond. The biggest differences lie within some of the mid-sized employment categories, with the "11 to 50" category slightly over-represented in the sample and the "51 to 100" category slightly under-represented. It is notable that the proportion of businesses with 1,000 or more employees is greater in the survey sample than the overall universe of businesses (4% and 2%, respectively), while obviously being a small minority in both.

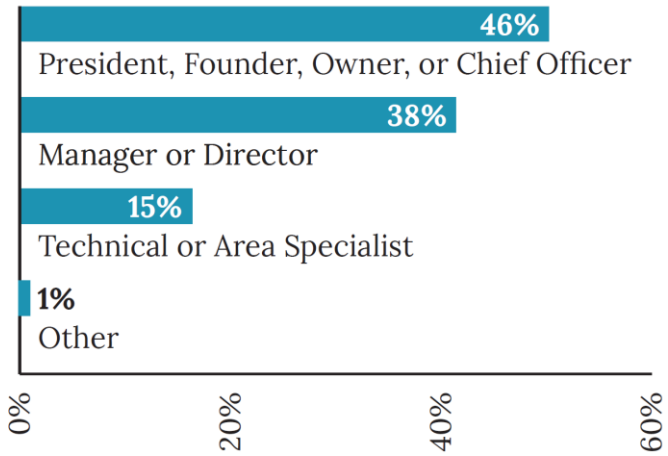
Figure 2.1. Size of survey respondent and total Ocean Enterprise businesses.



2.6 Function of Survey Respondents

For any survey, collected information is only as good as its source. An indicator of the reliability and validity of the collected information is the appropriateness and knowledge of the individuals who responded to the web-survey. Figure 2.2 profiles the job categories of the individuals who provided full survey responses. As individuals were allowed free-text entry of their job titles, responses were coded into the three categories shown. Of particular interest was the high share of respondents, 84%, who were executives or managers of their respective businesses; this gives the responses particular merit as representative of the overall, strategic view that corporate executives tend to reflect. This is not to say that technical specialists' views would not have been of interest, only that the survey should be understood as reflecting an executive/managerial perspective rather than a technical one.

Figure 2.2. Function of survey respondents.



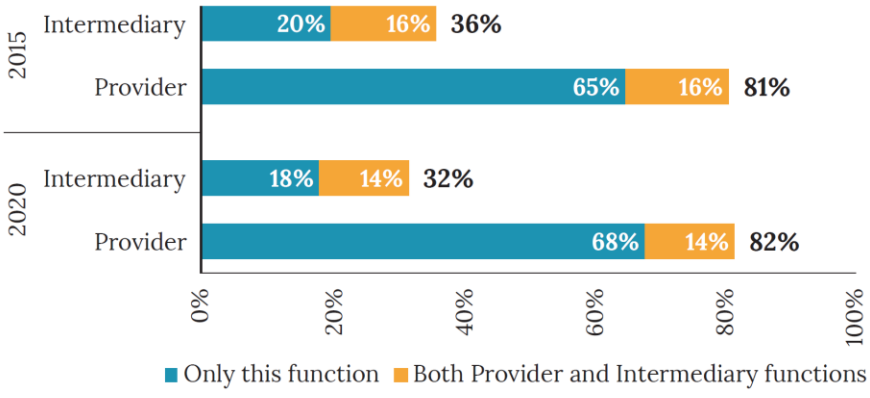
2.7 Organization Function

The survey's screening question categorized Ocean Enterprise respondents' activities between:

- Providers of sensors, instruments, platforms, and associated infrastructure for ocean observation and measurement.
- Intermediaries that make use of ocean, coastal and Great Lakes measurements, observations, and models as an input to the creation of value-added information products in support of specific end-uses.

In 2020, the majority of respondent businesses (68%) identified themselves as Providers, 18% of respondents identified themselves as performing activities as an Intermediary, and 14% indicated they performed both functions. This yielded a combined 82% of respondents that were Providers and a combined 32% that were Intermediaries (Figure 2.3).

Figure 2.3. Business function of respondents.



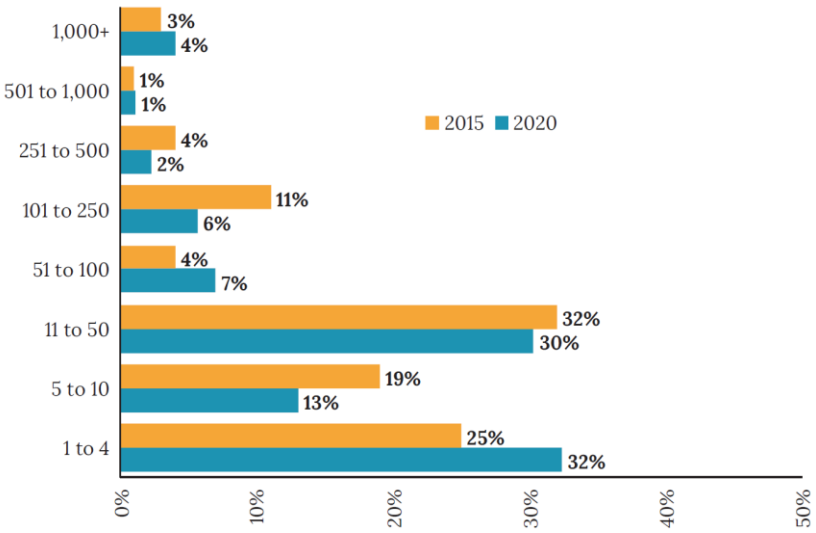
3. STUDY FINDINGS

3.1 Company Size

3.1.1 Business size of survey respondents

Figure 3.1 shows the total employment of respondent businesses for 2020 and 2015. In 2020, almost one-third of respondent businesses reported fewer than five employees, an increase of 7% from the 2015 study. For both survey periods, there was a large proportion of respondent businesses with between 11 and 50 employees, reflecting a tendency for many Ocean Enterprise businesses to be small-to-medium size businesses.

Figure 3.1. Business size of survey respondents.



3.1.2 Comparative size of all Ocean Enterprise businesses, survey respondents, and all U.S. businesses

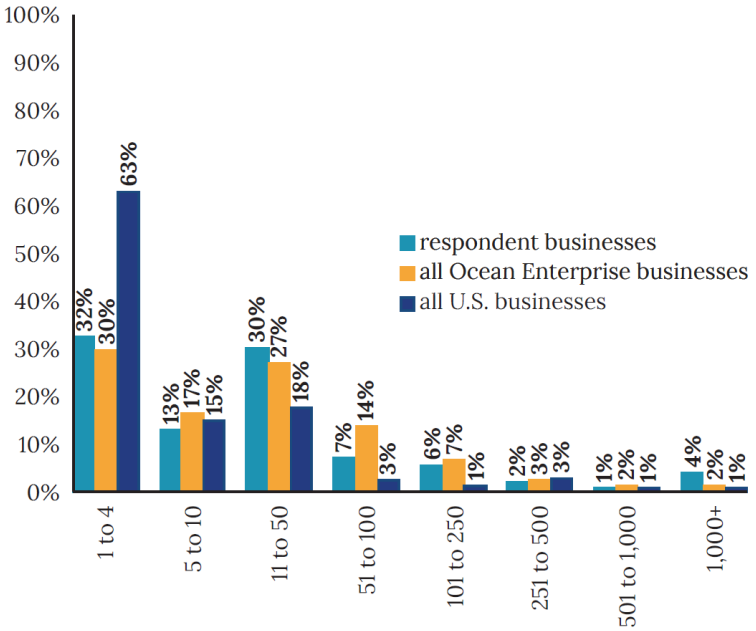
Figure 3.2 shows the distributions of business count by employment size for three groups:

- The 2020 survey respondents.
- The larger universe of businesses identified as conducting Ocean Enterprise activities.
- Businesses in the U.S. economy, as a whole.

As shown, when compared with the U.S. distribution, small businesses (those with more than 10 and fewer than 500 employees) are more prevalent in the Ocean Enterprise sector compared to the overall economy, while micro businesses (those with fewer than 10 employees) are less common.

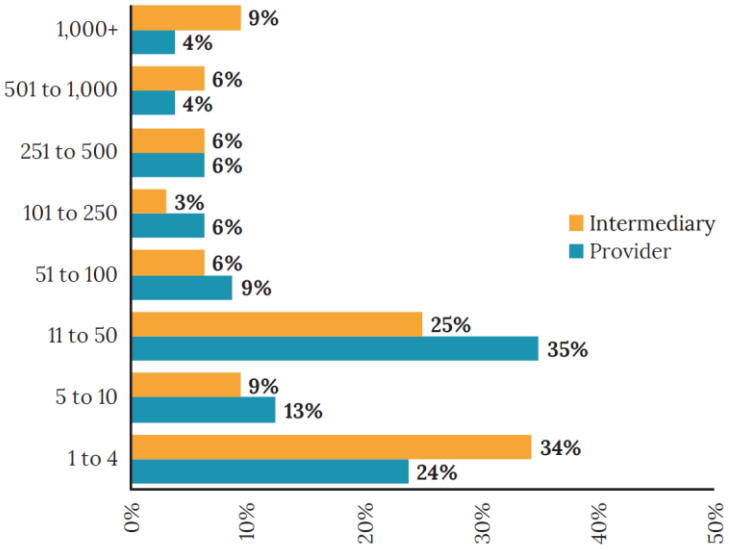
The survey also allowed examination of key issues by Ocean Enterprise function. For employment size, an examination by function (Figure 3.3) reveals that Intermediaries were more likely to be in both the very smallest and also the largest employment categories

Figure 3.2. Total employment of respondent businesses compared to U.S.



as compared to Providers. For example, 34% of Intermediaries reportedly had between one and four employees, compared to 24% for Providers. Further, 9% of Intermediaries had greater than 1,000 employees, compared to less than 4% of Providers.

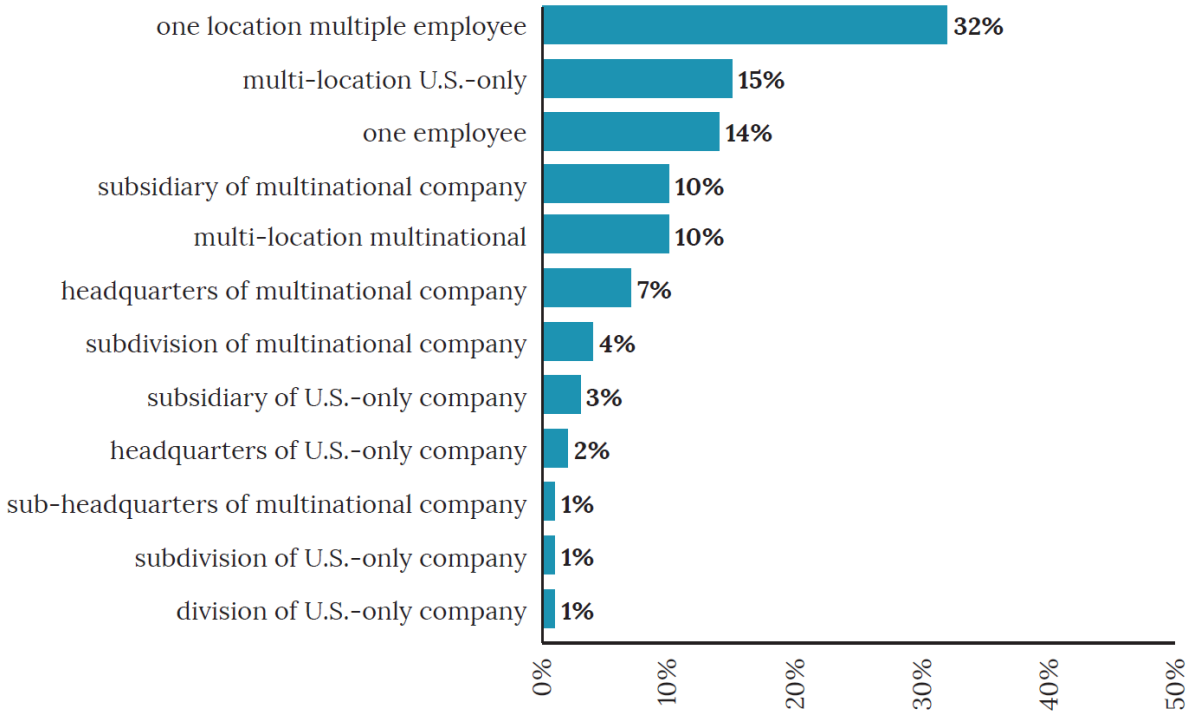
Figure 3.3. Total employment of respondent businesses by function.



3.2 Corporate Structure

The 2020 survey asked, in very precise terms, about the structure of respondent businesses. As shown in Figure 3.4, the most common structural type was "one location, multiple employees" (32%). This is not surprising given the large number of small businesses that are contained in the Ocean Enterprise population.

Figure 3.4. Structure of respondent businesses.



3.3 Location Dynamics

3.3.1 Number of locations

The number of respondent discrete locations is displayed in Figure 3.5. Relative to 2015, a far larger proportion of businesses operate from a single location (67% in 2020; 45% in 2015). Conversely, a much smaller proportion of participant businesses reportedly operated from 10 or more locations.

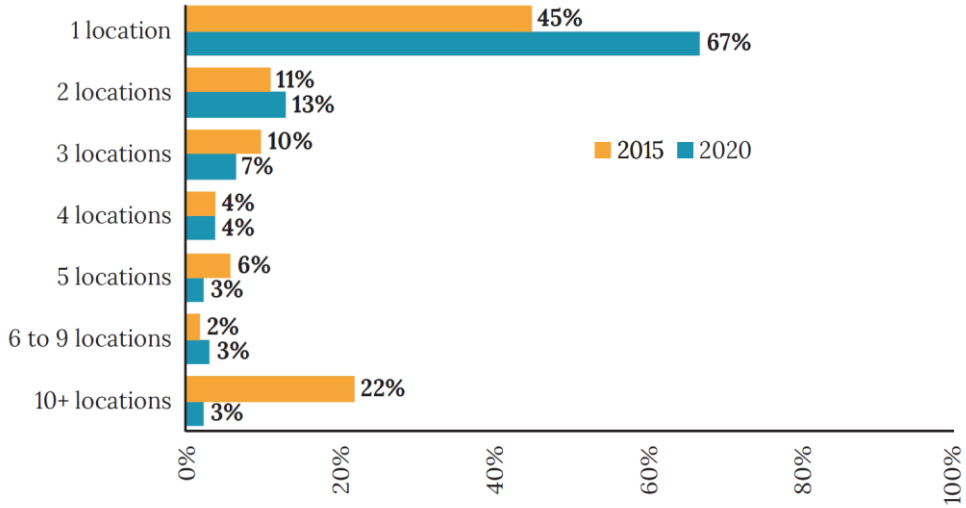


Figure 3.5. Number of discrete locations operated by respondent businesses.

3.3.2 Number of foreign locations

Figure 3.6 shows the number of non-U.S. locations operated by respondents' businesses for the 2015 and 2020 survey periods. With 67% of respondents indicating they are one-establishment businesses, it is not surprising that the great majority (80%) of respondents report their business as operating solely within the U.S. This reflects an increase in U.S.-only businesses compared with 2015. Similarly, a comparatively smaller proportion of businesses reportedly had 10 or more foreign locations in 2020 as compared with 2015.

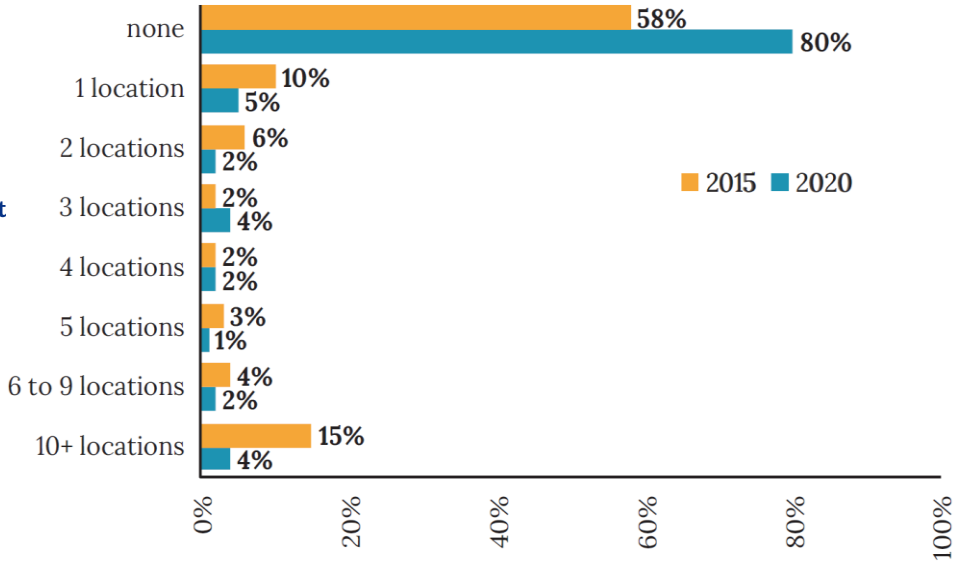
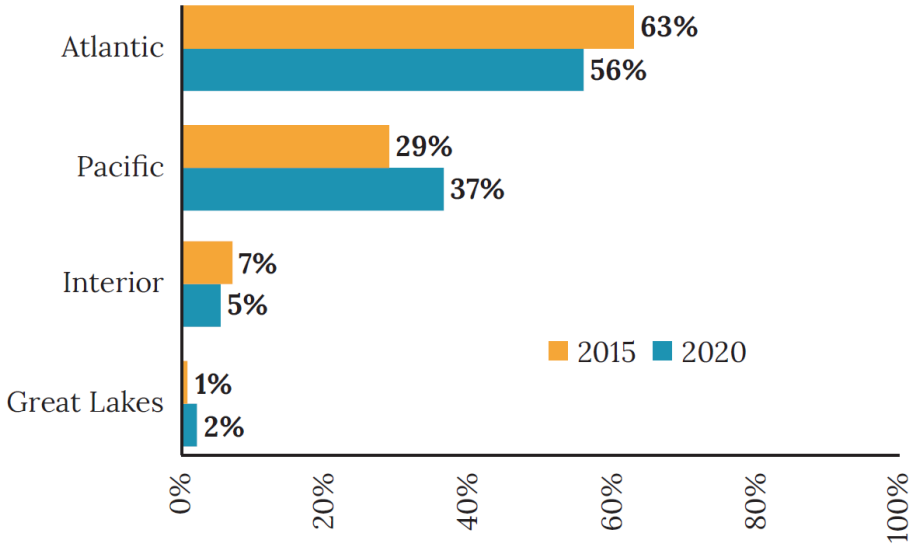


Figure 3.6. Number of foreign locations operated by respondent businesses.

3.3.3 Proximity to the ocean

Figure 3.7 examines the location of respondents slightly differently, by proximity to an ocean basin (or the lack thereof). This was determined by the respondent's state (see Appendix 3 for further details of respondent locations by state) as opposed to their metropolitan area. The Ocean Enterprise community is most concentrated in states that border the Atlantic Ocean,[8] with over half of respondents in such locations. There were some slight shifts among oceans-of-access between the 2015 and 2020 survey periods. The proportion of respondents in states bordering the Pacific Ocean increased by 8 percentage points, while the proportion of businesses that bordered the Atlantic went down proportionally by 7 percentage points. Five percent of respondents were from the interior of the nation in states that did not border the ocean.[9]

Figure 3.7. Ocean of access of respondent businesses.



[8] Businesses located in any state along the Mississippi river or its tributaries were classified as belonging to the Atlantic region.
[9] Being classified as belonging to the "interior" category does not necessarily indicate that a respondent's state had no waterborne access to the ocean, as many included river systems that support ocean-related shipping. However, for the purposes of this report, these states were considered interior.

3.3.4 Ocean Enterprise business locations

In total, the survey and secondary analyses identified 814 U.S. businesses conducting Ocean Enterprise activities located in 49 states, the District of Columbia, and two overseas U.S. territories. This compares with 410 businesses located in 36 states in 2015.

Figure 3.8 shows two dimensions of company location dynamics. The overall size of the circles represents the number of operations per U.S. Office of Management and Budget Statistical Area, using an entity's Combined Statistical Area, Metropolitan Statistical Area, Micropolitan Statistical Area, or non-metropolitan U.S. city, as appropriate. The smallest dots represent one operation. The largest circle represents a metropolis with 341 Ocean Enterprise businesses. The second dimension, color density of the circles, depicts non-branch locations (e.g., headquarters operations or legal subsidiaries). A colorless circle includes no headquarters or subsidiaries, while the darkest blue circles are regions with non-branch company operations in the triple digits.

Figure 3.8. Locations of Ocean Enterprise businesses.

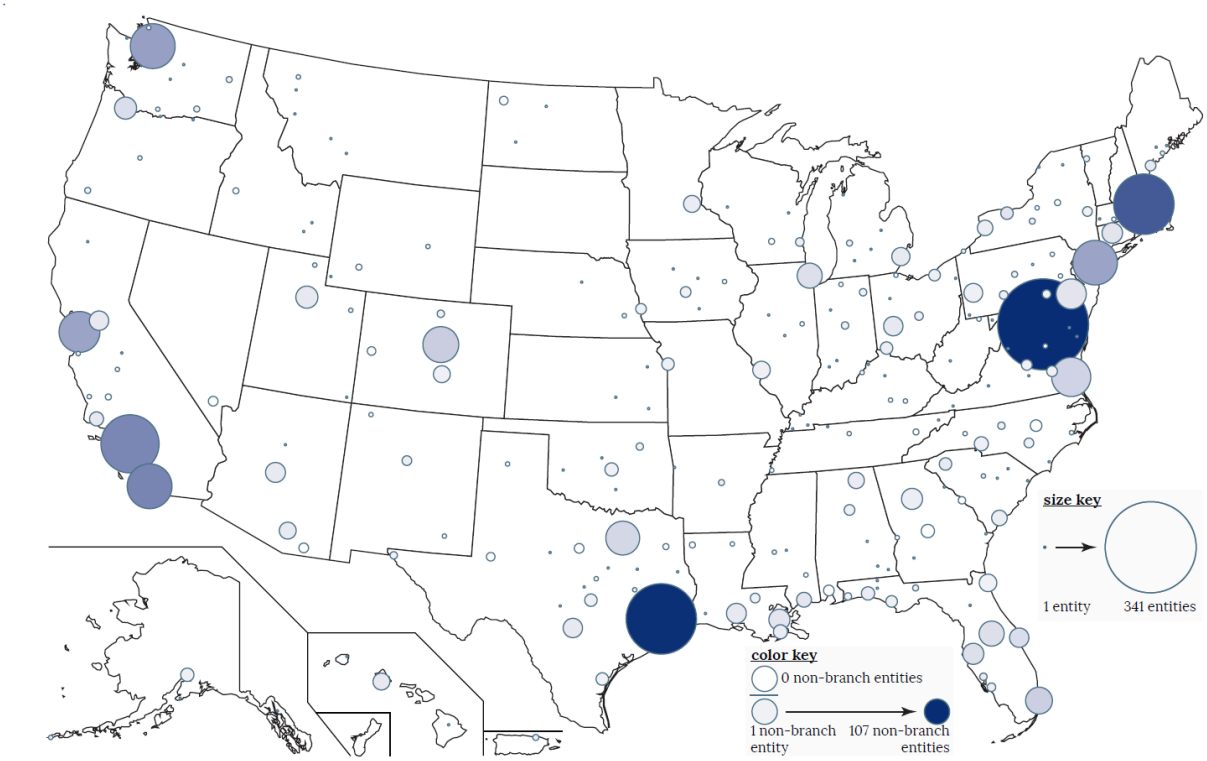
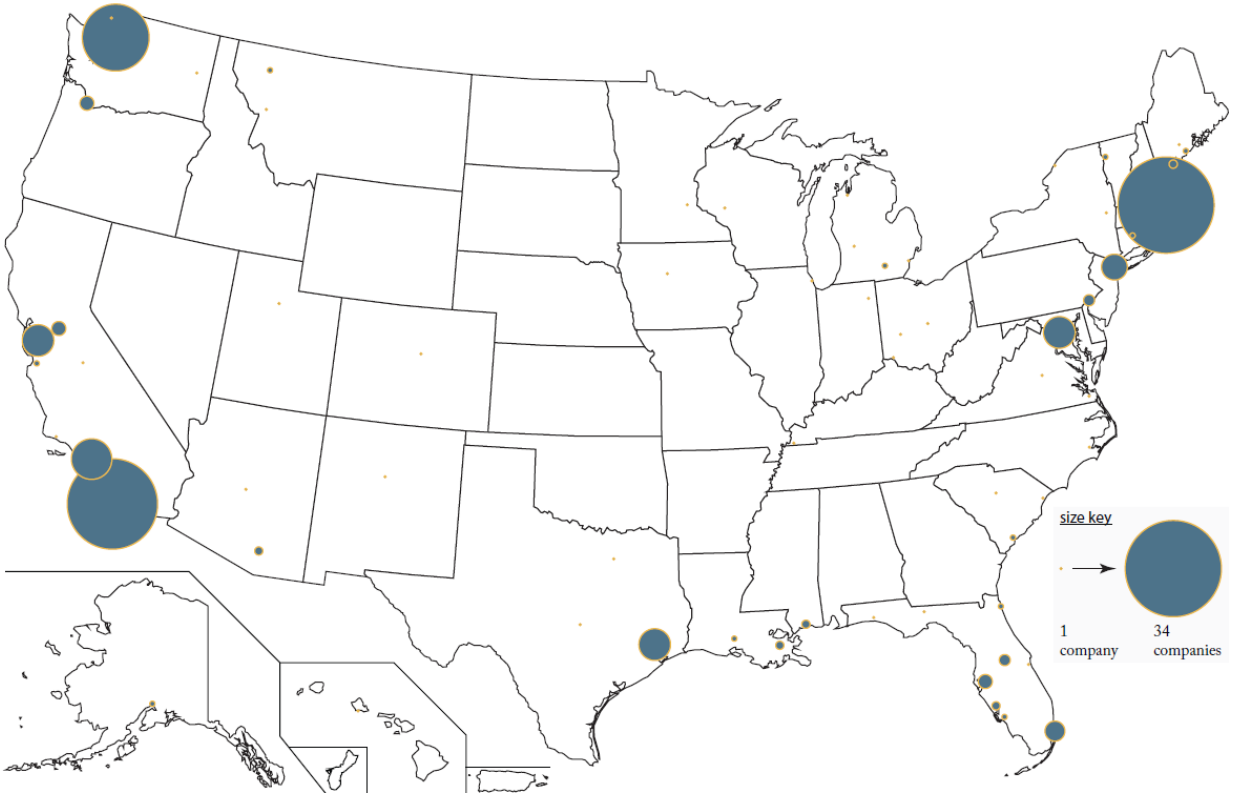


Figure 3.9 focuses on the location dynamics of a critical subset of the Ocean Enterprise: independent businesses.[10] In a strict sense, the major overall U.S. centers of the Ocean Enterprise are also its home for independent businesses in the Ocean Enterprise space. However, relative dominance is somewhat different. The Mid-Atlantic is de-emphasized when corporate families are subtracted from the New York-to-Hampton Roads/Virginia Beach corridor. The Gulf Coast was no doubt impacted by the post-2014 collapse in oil and gas prices and its effect on the survival of independent businesses and the creation of new businesses. However, Southern and Central Coast California and the Pacific Northwest become much more dominant when only independent companies are considered.

Figure 3.9. Locations of independent Ocean Enterprise businesses.



[10] An independent business is a business that is free from outside control. It usually means a privately owned establishment, as opposed to a public limited company, the latter of which is owned by investment shares traded in the stock market. In many cases, independent businesses are sole proprietorship companies.

3.4 Organizational Experience in Ocean Enterprise Activities

3.4.1 Survey findings

On average, businesses reported relatively extensive experience in Ocean Enterprise activities. Almost nine in ten respondents reported at least five years' experience in the market (Figure 3.10). Five percent were new to the market (1 year or less of experience). Providers tended to have been in Ocean Enterprise-related business longer than Intermediaries. It should be noted that organizations that had conducted Ocean Enterprise activities for a very short time would be less likely to have been identified and may not have participated in the survey. This particular dynamic would of course be equally true for the 2015 and 2020 surveys.

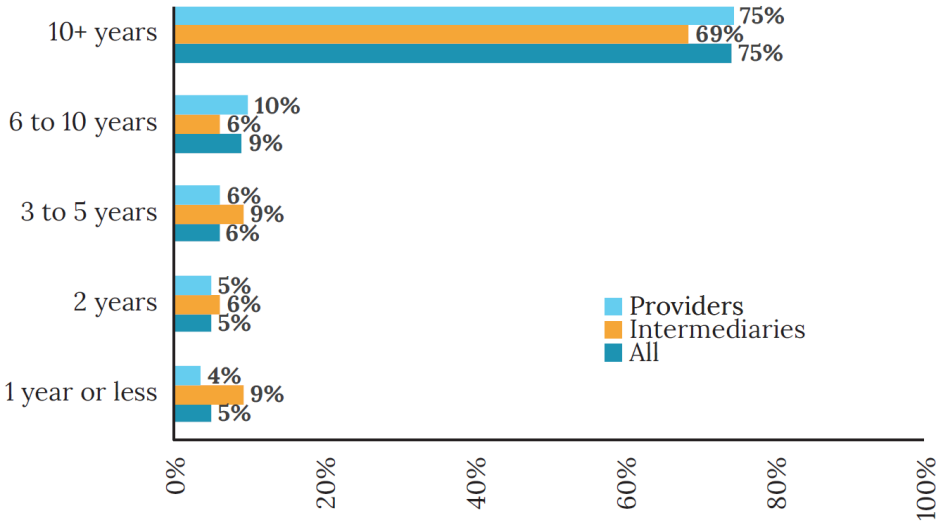


Figure 3.10. Organizational experience in the Ocean Enterprise.

3.4.2 Growth in number of Ocean Enterprise businesses since the 2015 study

During the 2015 study, 410 Ocean Enterprise businesses were identified through industry lists, commercial databases, and associated research. For the purposes of determining 2015 Ocean Enterprise revenue estimates, it was assumed that up to 20% of Ocean Enterprise businesses were unidentified in the 2015 study's source databases. Assuming that the 2015 survey results were representative of the then total Ocean Enterprise universe, this adjustment would mean that approximately 500 businesses were involved in Ocean Enterprise activities in 2015.

Detailed secondary analysis of the 2020 population of businesses conducting Ocean Enterprise activities identified that 104 businesses that were not part of the 2015 study population were judged to have been engaged in Ocean Enterprise activities prior to 2015. This indicates an actual revised 2015 study population total of 514, which is very close to the 500 businesses estimated above.

Using available data of founding information and other secondary sources, 112 businesses were identified as founded since the 2015 study. Of these new entrants, 66 were part of existing corporate families, and 46 were independent businesses. An additional 140 businesses were identified that had been deemed out of scope during the 2015 study, having no identifiable Ocean Enterprise activities at this time, but which now had activities qualifying them as belonging to the

Ocean Enterprise sector. Finally, there were 48 businesses counted that were the result of previously existing Ocean Enterprise businesses expanding through the creation or acquisition of new legal entities after the 2015 study.

All told, the 2020 study identified an increase of 300 businesses in the total population of Ocean Enterprise businesses over a revised 2015 total of 514, an increase of almost 60%.

A full description of the methodology utilized to determine the growth in Ocean Enterprise business count is provided in Appendix 1.

3.5 Revenue and Employment Estimates

The information presented in this section is based primarily on secondary research on the population of businesses that engage in Ocean Enterprise activities. The critical conceptual framework for these estimates is that they are for businesses engaged in Ocean Enterprise activities only and are not for these businesses' larger corporate families where they are subsidiaries. Location counts, employment and revenue of the full corporations involved in the Ocean Enterprise would be much larger than the estimates that follow.

In similar fashion, all estimates are only for U.S. Ocean Enterprise businesses' U.S. operations. Any foreign locations, overseas employment, and overseas revenue not consolidated into the accounts of a U.S. parent organization are excluded from the estimates.

A final note of context concerns the time-period for which data were requested. While the survey and the secondary estimates focused on FY2019, the interruptions from the pandemic and the diversity of start and end points for corporate fiscal years inevitably mean that the estimates blend individual businesses' annual revenue estimates from a period greater than a common 12 months. However, given the large number of businesses involved in the Ocean Enterprise, relatively early-starting fiscal years are probably balanced by relatively late-starting fiscal years.

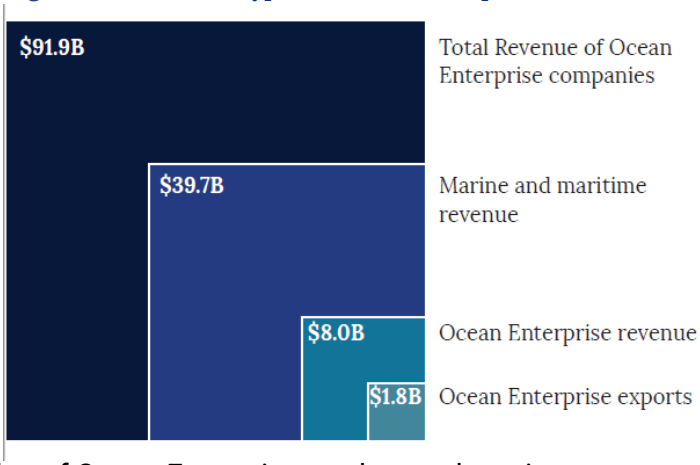
As described in the detailed methodology provided in Appendix 1, total revenue and employment for Ocean Enterprise businesses were collected primarily through secondary research conducted on the database of Ocean Enterprise businesses using sources such as Dun & Bradstreet and publicly available records found through web-searches and review of Annual Reports and Securities and Exchange Commission filings. This provided population-based revenue and employment figures, which have the advantage of not suffering from survey and sample related limitations.

It is undoubtedly the case that, like the 2015 study, the 2020 study will have failed to identify the entire population of U.S. businesses conducting Ocean Enterprise activities. However, the more robust 2020 approach to compilation of target businesses and secondary analysis can be expected to have significantly reduced the likelihood of missing all but the very smallest recently formed businesses with the result that no assumptions have been made regarding revenue from businesses not identified in the 2020 study in the revenue and employment estimates in Section 3.5 below.

3.5.1 2020 Ocean Enterprise revenue estimates

Figure 3.11 shows the total revenue of U.S. businesses in the Ocean Enterprise sector at an estimated $91.9 billion. Total marine and maritime revenue of these businesses was just over 43% of total revenue and was estimated at $39.7 billion.

Figure 3.11. Revenue types of Ocean Enterprise businesses.



Total Ocean Enterprise revenue was estimated to be $8 billion. This represented 20% of overall marine and maritime revenue, and 9% of total revenue of businesses in the Ocean Enterprise cluster.

The final revenue measure calculated for the U.S. Ocean Enterprise sector was the value of Ocean Enterprise product and service exports. This was estimated at approximately $1.8 billion, with just over one-fifth, or 22%, of Ocean Enterprise revenue resulting from export activity.

Aggregate Dun & Bradstreet data revealed that the Ocean Enterprise cluster growth between 2015 and 2020 saw much higher growth in numbers of businesses than in Ocean Enterprise revenues. This trend is indicated by average Ocean Enterprise revenue per business (Table 3. 1 below) for entities founded before and after the 2015 study. Not surprisingly, Ocean Enterprise revenue per business is smaller for newer businesses than established ones. On average, established independent businesses generated over four times more revenue than new independent businesses, while the comparative ratio for corporate family members is approximately three to one.

Table 3. 1. Average Ocean Enterprise sales of businesses, by type, pre-2014 and 2014-20 founding date periods.

Founding period	All businesses	Corporate family businesses	Independent businesses
Through 2015 study	$8.2M	$10.7M	$1.7M
Post-2015 study	$2.0M	$3.5M	$0.4M

3.5.2 Ocean Enterprise revenue comparison 2015 – 2020

One of the key objectives of the 2020 study was determining the revenue growth of the Ocean Enterprise sector in the period since the 2015 study.

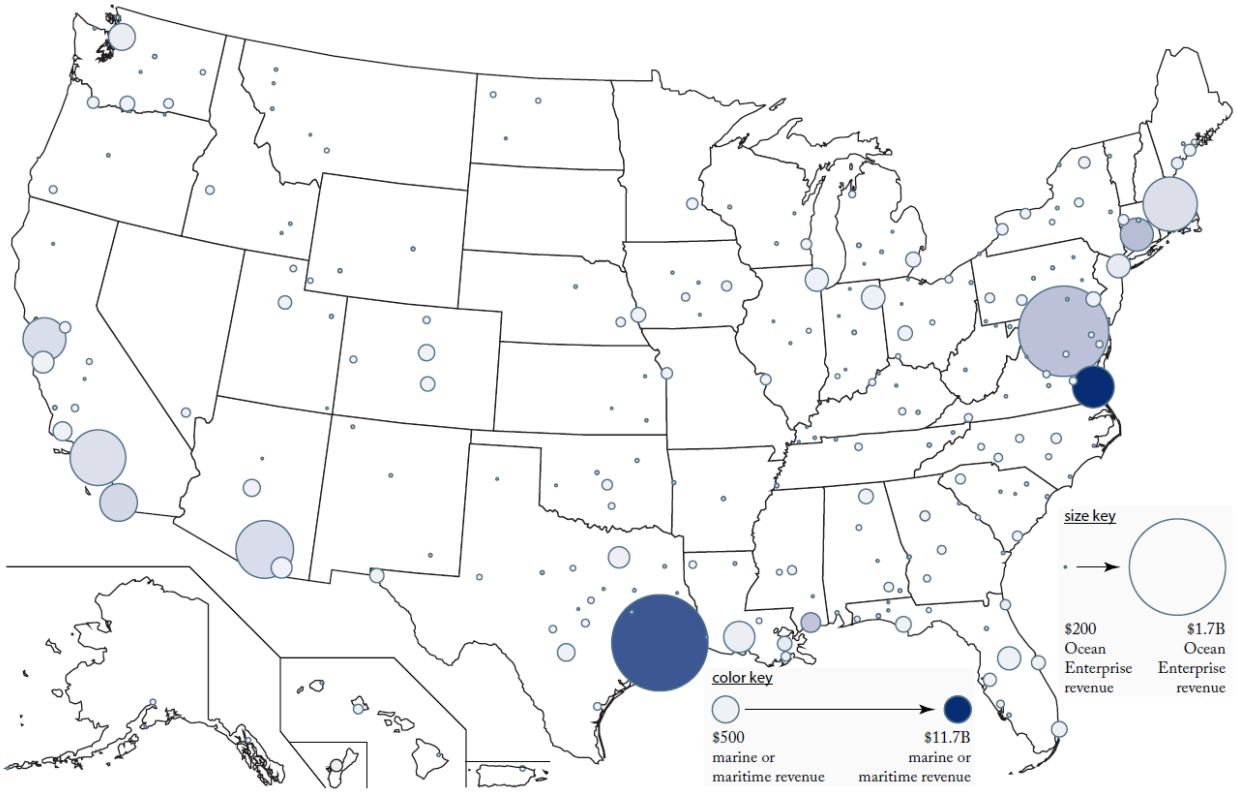
In order to conduct comparisons of estimated revenues for the 2015 and 2020 study periods, the estimates must first be converted to a common time period. This was done on basis of the detailed Producer Price Indices generated by the Bureau of Labor Statistics as best representing the price changes in the various components of the Ocean Enterprise cluster. Converting the 2020 Ocean Enterprise revenue estimate of $8 billion into 2015 values results in an adjusted 2020 value of $7.5 billion. The total revenue estimate for the sector in 2015 was $7.1 billion, including an adjustment to account for businesses unaccounted for in the lists and other sources used to

create the 2015 database. The $0.4 billion increase between 2015 and 2020 equates to an 7% revenue growth.

3.5.3 Ocean Enterprise business revenue by location

Figure 3.12 explores the geographic distribution of businesses' marine/maritime and Ocean Enterprise revenue. The darkest blue represents nearly $12 billion in marine/maritime revenue from the region's Ocean Enterprise businesses, and the two darkest blue circles, for Houston (offshore oil and gas) and Virginia Beach-Newport News (shipbuilding and defense), show how the size of a region's marine/maritime activity is a general but imperfect predictor of the size of its Ocean Enterprise cluster. The Ocean Enterprise revenue is depicted by the size of the circles, with the highest-earning region being the location of businesses earning almost $2 billion from Ocean Enterprise activities.

Figure 3.12. Geographic distribution of Ocean Economy and Ocean Enterprise revenue of Ocean Enterprise businesses.



3.6 Ocean Enterprise Industry Code Description and Analysis

In any analysis of industry clusters, it is normal to find a discussion of economic activity by North American Industry Classification System (NAICS) codes. There is no such analysis in this report. Neither the NAICS code schema nor the former Standard Industrial Classification (SIC) schema fit the complex and rapidly evolving Ocean Enterprise cluster. This same challenge, writ large, faces NOAA (and the Department of Commerce) in defining the Blue Economy.[11] Standard industry definitions do not capture Ocean Enterprise activity with any accuracy or granularity, as the Ocean Enterprise has a focus and function that cut across standard industry code structures.

Appendix 3 provides a summary of the allocation of identifiable Ocean Enterprise activity across NAICS and SIC industry classifications. A more detailed analysis of the complex industry relationships in the cluster is being developed as a separate report.

3.6.1 Economic impact analysis

Economic Impact analysis (often referred to as "multiplier analysis") is a process used to estimate the total economic effects of a selected economic change within a defined region. It is an effort to capture how a dollar of spending in a focused industry or business ripples through a local, regional, or national economy. This study included such an analysis of the impact of the Ocean Enterprise cluster on the U.S. economy.

Traditional Economic Impact Analysis has multiple components:[12]

- **Direct effects** refer to U.S. Ocean Enterprise revenue of all businesses in the Ocean Enterprise cluster.
- **Indirect effects** measure the value of additional economic demands that businesses in the Ocean Enterprise cluster place on supplying industries in the U.S.
- **Induced effects** accrue when workers in the Ocean Enterprise cluster and their indirect supplying industries spend their earnings on goods and services in the U.S. (often called "Type II multiplier" effects).
- **Total economic effects** are the sum of these three direct, indirect, and induced effects. They are all the transactions attributable, either directly or indirectly, to the activities being measured.

Using the U.S. Bureau of Economic Analysis Industry-by-Industry product accounts, an aggregate economic impact analysis was calculated for the Ocean Enterprise sector with respect to Ocean Enterprise revenue.

Since the Ocean Enterprise cluster is composed of companies across the supply chain that purchase from one another, an economic impact assessment faces risks of double counting.

[11] There are multiple dimensions of this effort. One of the most critical ongoing activities involves defining the Marine Economy Satellite Accounts for the U.S., which are supplementary statistics that allow analysis of a particular aspect of the economy, such as spending on travel and tourism. The data presented in a satellite account supplement are designed to be consistent with Bureau of Economic Analysis (BEA) core statistics such as gross domestic product (BEA, 2021).

[12] A vast literature, as well as multiple government and private modeling systems, are focused on economic impact analysis. The U.S. Bureau of Economic Analysis provides one that is in wide use, RIMS II. More detailed information on economic impact and the use of the RIMS II system can be found at this website. (https://apps.bea.gov/regional/rims/brfdesc.cfm).

Available data does not permit easy sorting of indirect spending along the supply chain. Three especially conservative estimation modifications were used to avoid double-counting.

- Rather than use an existing Economic Impact model, very conservative multipliers using U.S. Bureau of Economic Analysis Industry-by-Industry product accounts were generated. These industry-specific coefficients for indirect impacts were applied for only one round of spending.

- This analysis estimated only direct and indirect effects; it did not include the impacts from the compensation of employees within the supply chains of Ocean Enterprise businesses (i.e., the "Induced" or "Type II" multiplier effects).

- As a further effort to be conservative, a downward adjustment was applied to reduce indirect spending based on consideration of industry mix in the cluster.[13]

Using these highly conservative assumptions, the direct and indirect economic impact of Ocean Enterprise-specific business activities is estimated to be $14.5 billion. The implicit sector-wide multiplier for the Ocean Enterprise is thus 1.80 (i.e., $1.00 of Ocean Enterprise sales generates an additional $0.80 of sales among suppliers).

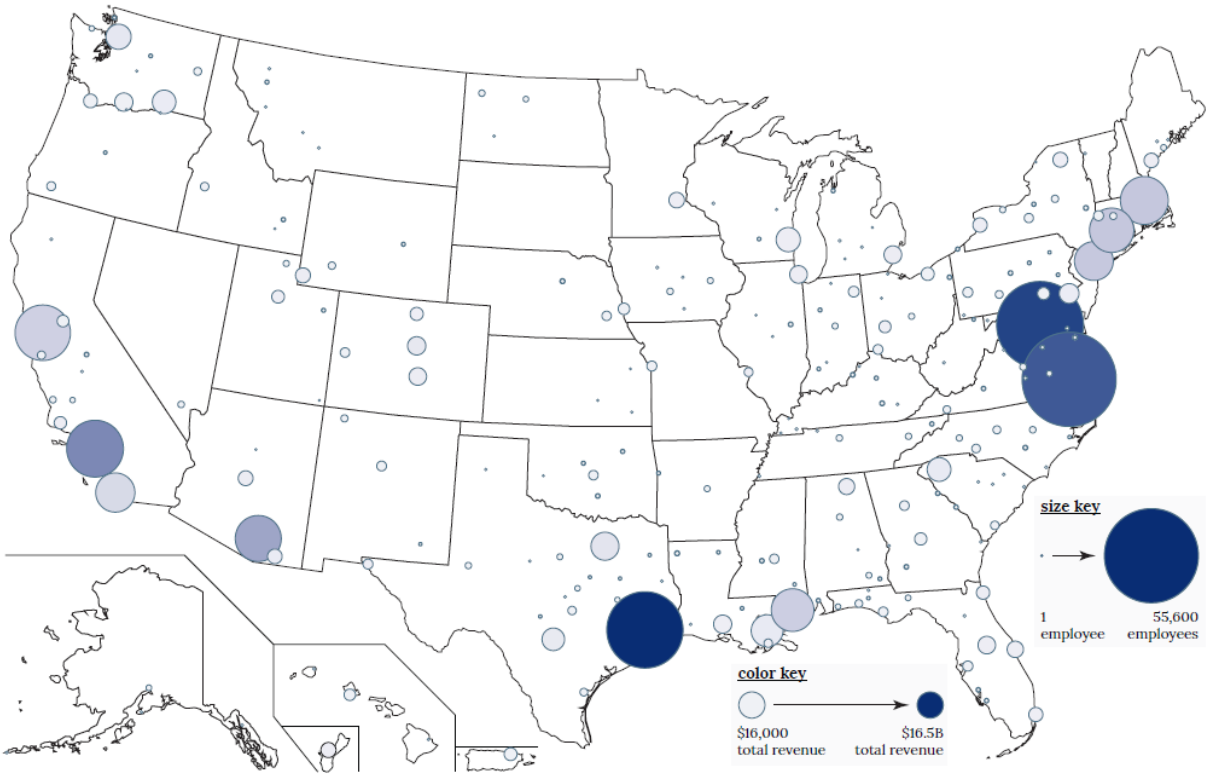
3.7 Employment Estimates

Respondents were asked to report the employment of their organization. A similar methodology as used for revenues was utilized, whereby the employment data from the survey respondents and secondary sources was used to project employment for all businesses thought to be involved in the Ocean Enterprise. The Total U.S. Employment of Ocean Enterprise businesses in 2019 was an estimated 324,000 employees. This represents an increase of between 21% and 45% from estimates obtained in the 2015 study, which estimated between 223,000 and 268,000 employees for businesses engaged in Ocean Enterprise activities. It should be recognized that this figure represents total employment by businesses engaged in Ocean Enterprise activities rather than employment specific to the production of Ocean Enterprise products and services.

[13] While a detailed discussion of the effort is available in the methodology, the basis of the technique extended from the total share of an industry's U.S. Gross Industry Product associated with Ocean Enterprise businesses. The smaller that share, the more "specialized" the Ocean Enterprise aspect of an industry was assumed to be, and thus the more likely to be associated with spending *from* other Ocean Enterprise businesses. To reflect this assumption and increase the conservatism of the estimates, a sliding adjustment was applied to the calculated share of total industry Gross Industry Product, and the resulting ratio was subtracted from each businesses' sales as representative of spending by other Ocean Enterprise businesses.

Figure 3.13. explores the geographic distribution of revenue and employment for Ocean Enterprise businesses. The size of each circle represents concentrations of employment, with larger circles indicating higher employment numbers. The color of the circle indicates total revenue with darker circles representing higher revenue. Although employment and revenue are strongly related, in some cases, such as the northeast and west coasts, there are regions with average concentrations of employment that indicate higher revenue (medium sized circle with medium blue shading). This may be indicative of high technology businesses, which can require relatively few staff, to generate high revenue.

Figure 3.13. Geographic distribution of total employment and revenue of Ocean Enterprise businesses.

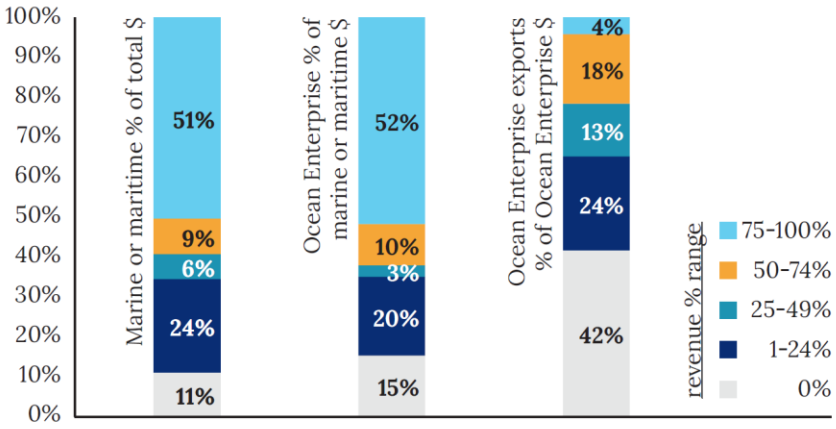


3.8 Proportion of Respondent Businesses' Revenue Associated with Marine/Maritime and Ocean Enterprise Activities

Surveyed businesses were asked a series of questions to determine how much of their total business was attributable to marine/maritime and Ocean Enterprise activities, and what proportion of their Ocean Enterprise activities were due to exports sales. A summary of survey responses to these questions is shown in Figure 3.14.

Over half of survey respondents reported that the majority of their revenues were from marine/maritime business. When asked what proportion of their marine/maritime revenue was due to Ocean Enterprise activities, just over half reported that Ocean Enterprise revenues accounted for the majority of their overall marine/maritime activity.

Figure 3.14. Marine/maritime, Ocean Enterprise, and Ocean Enterprise exports shares of total revenue.

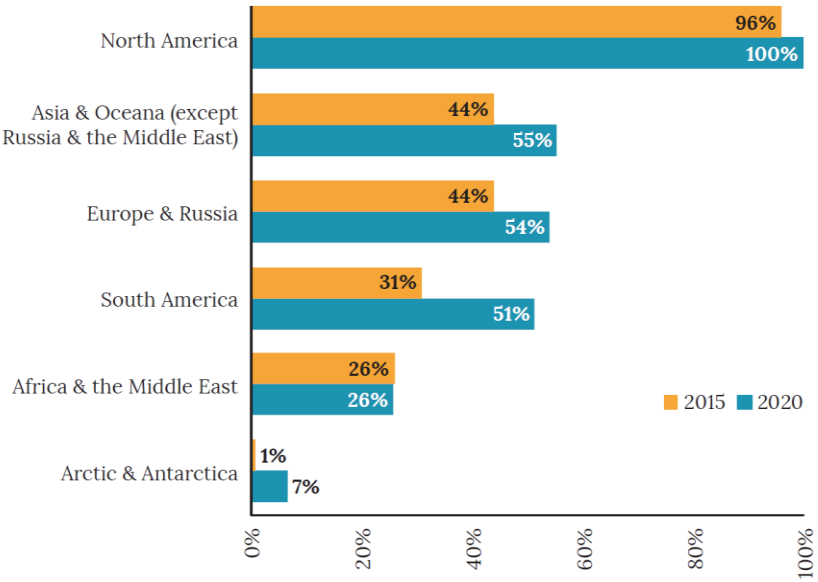


Respondents were finally asked to report what proportion of their Ocean Enterprise-related revenue was from export sales. Twenty-two percent of respondents reported that exports accounted for at least half of their Ocean Enterprise-related revenues, while a combined 66% reported that exports contributed to less than one-quarter of their total Ocean Enterprise-related business. Forty-two percent reported that export sales accounted for none of their Ocean Enterprise-related revenue.

3.9 Export Markets

Given the inherently international nature of a product suite focused on the ocean and therefore extending beyond U.S. borders, the nature of the U.S. Ocean Enterprise sector's export markets is an obvious interest. Respondents were asked to identify various national or regional markets (including the U.S.) that were a source of at least 5% of revenues. Respondents were allowed to select as many markets as applied. Unsurprisingly, given the inclusion of the U.S., the most cited market was North America. In 2020, every

Figure 3.15. Foreign markets that represent at least 5% of respondents' sales.



surveyed business reported customers in North America, with 99% of these reporting customers in the U.S. (Figure 3.15). This was similar to the 2015 survey findings, when a comparably high proportion (96%) reported customers in North America.

Of particular interest in the responses about export markets is the relatively equal importance of the European, Asian and Pacific Rim regions, with over 50% of respondents reporting sales for both areas. This echoes the 2015 survey in terms of the two regions being comparable, but with 2015-20 growth in the proportion of businesses exporting to these areas. Also of interest is the notable increase in the proportion of surveyed businesses that reported export markets in South America, increasing from 31% in 2015 to 51% in 2020.

3.10 Business Dynamics

The survey asked a series of questions that related to Ocean Enterprise businesses' expectations about the future trajectory of their business, as well as an overall product profile of their activities.

3.10.1 Business outlook: 2015-2020 employment projection comparison

Respondents were generally optimistic about employment growth over the next 12 months. As shown in Figure 3.16, 36% expect their businesses' employment to increase during this time period. Only one in ten expected their employment numbers to decline. However, the largest proportion (48%) anticipate the *status quo* holding for the next year, while 6% were unsure. These expectations were markedly different to those seen in 2015. Specifically, a smaller proportion of employers reported plans to grow, while relatively more businesses plan to downsize. The proportion expecting to stay at current employment levels was similar in both years.

These more conservative growth projections for 2020 are not surprising given the macroeconomic context over the survey period. The start of data collection coincided almost exactly with the Covid-19 pandemic lockdown and spanned the period through fall of 2020 when the impact of the pandemic remained an unknown to many employers. Moreover, for many businesses, the pandemic inevitably interacted with additional market challenges. Viewed through this lens, the projections can be seen as remarkably optimistic, especially given that only 10% of employers anticipate decreasing their staffing levels in the next year.

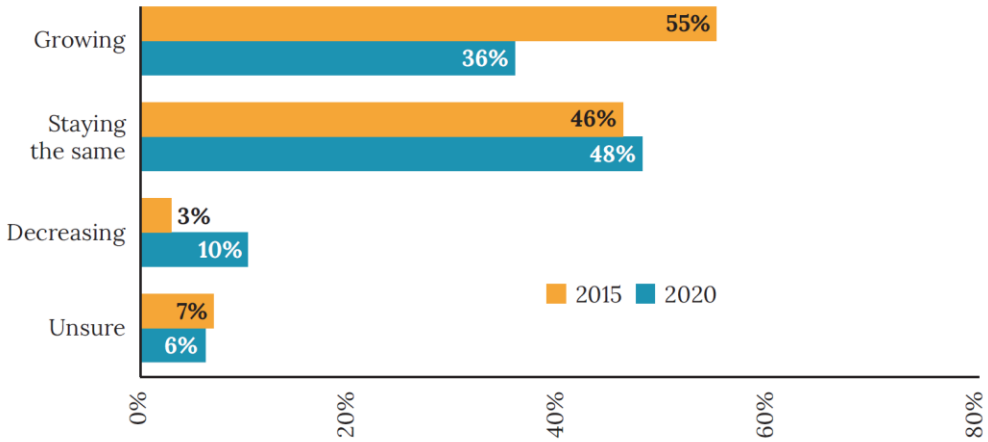


Figure 3.16. Employment projections for the next 12 months comparison.

3.10.2 Business outlook: Employment projection by company function

The outlook differed slightly when examined by company function. As shown in Figure 3.17, Providers were more likely to report that they anticipate growth, while Intermediaries were more likely to report staying the same or were uncertain about future employment expectations.

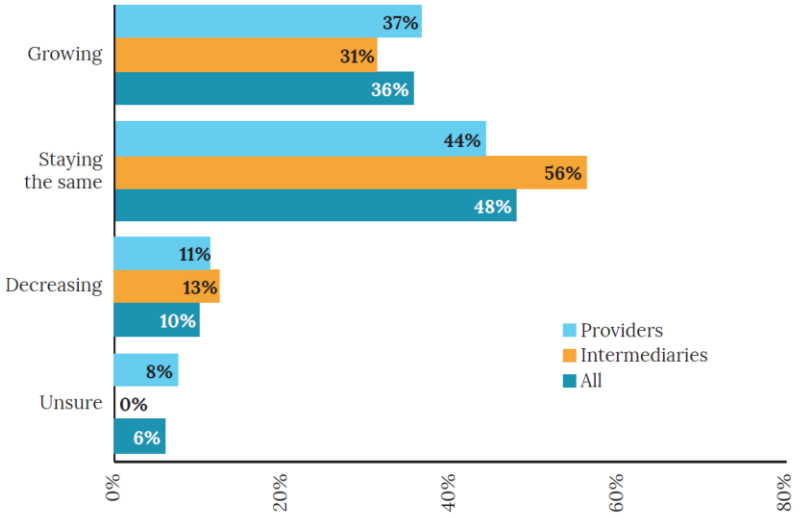


Figure 3.17. Employment projections for the next 12 months by function.

3.10.3 Business outlook: 2015-2020 revenue projection comparison

As with employment, respondents were generally optimistic about revenue growth in the next 12 months. As shown in Figure 3.18, 40% expected their business revenue to grow during that time period. However, compared to employment expectations, businesses were significantly more likely to anticipate decreased revenue levels, with 26% expecting business revenues to decrease in the next 12 months. These projections highlight a more conservative revenue outlook as compared to that seen in 2015, when over half of respondents predicted revenue growth in the next 12 months, and only 11% expected revenue decline. As with employment, these revenue projections undoubtedly reflect the projected impact of the pandemic and other external challenges discussed earlier.

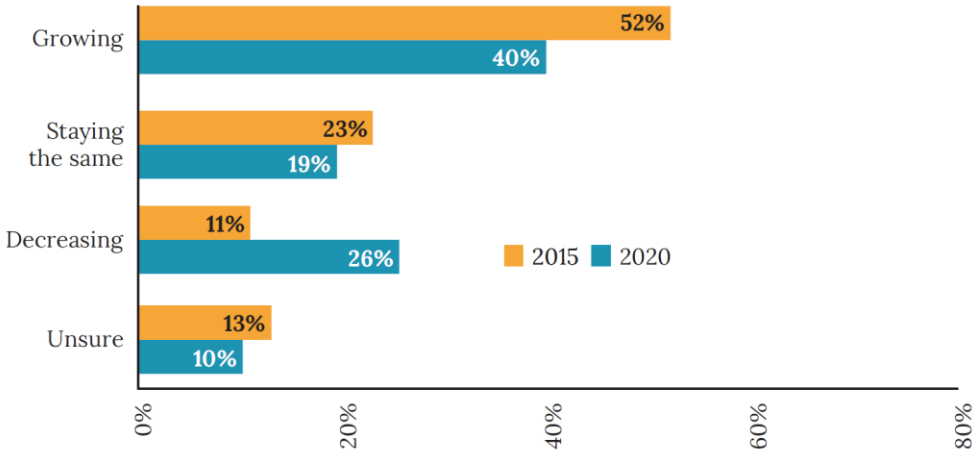
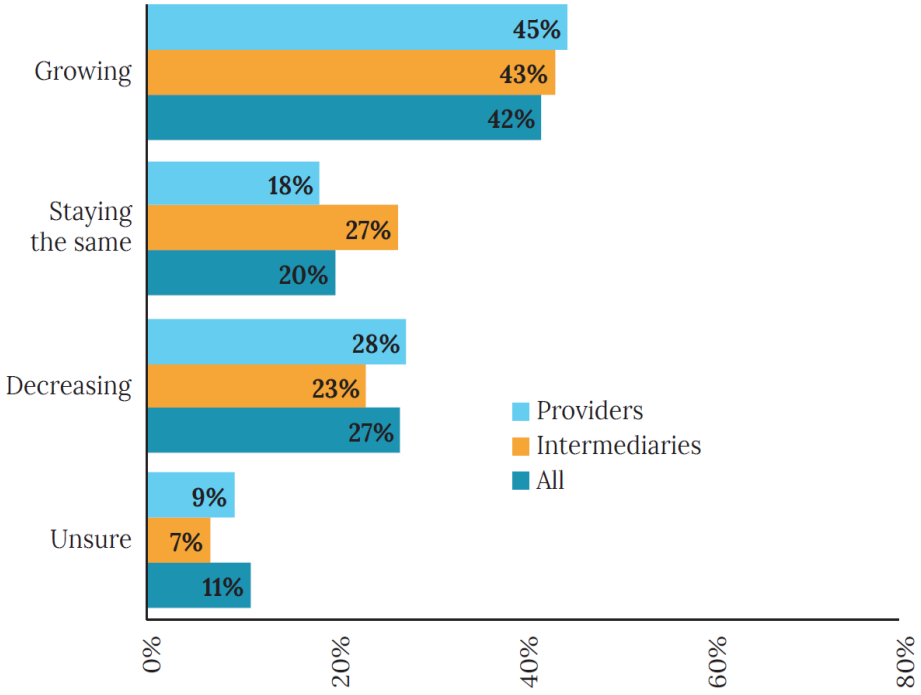


Figure 3.18. Revenue projections for the next 12 months timepoint comparison.

3.10.4 Business outlook: Revenue projections by business function

As with employment projections, the outlook differed slightly when examined by business function. Figure 3.19 shows that Providers and intermediaries reported roughly equal expectations of revenue growth in the next 12 months. Intermediaries were more likely to predict static revenue than were Providers.

Figure 3.19. Revenue projections for the next 12 months by business function.

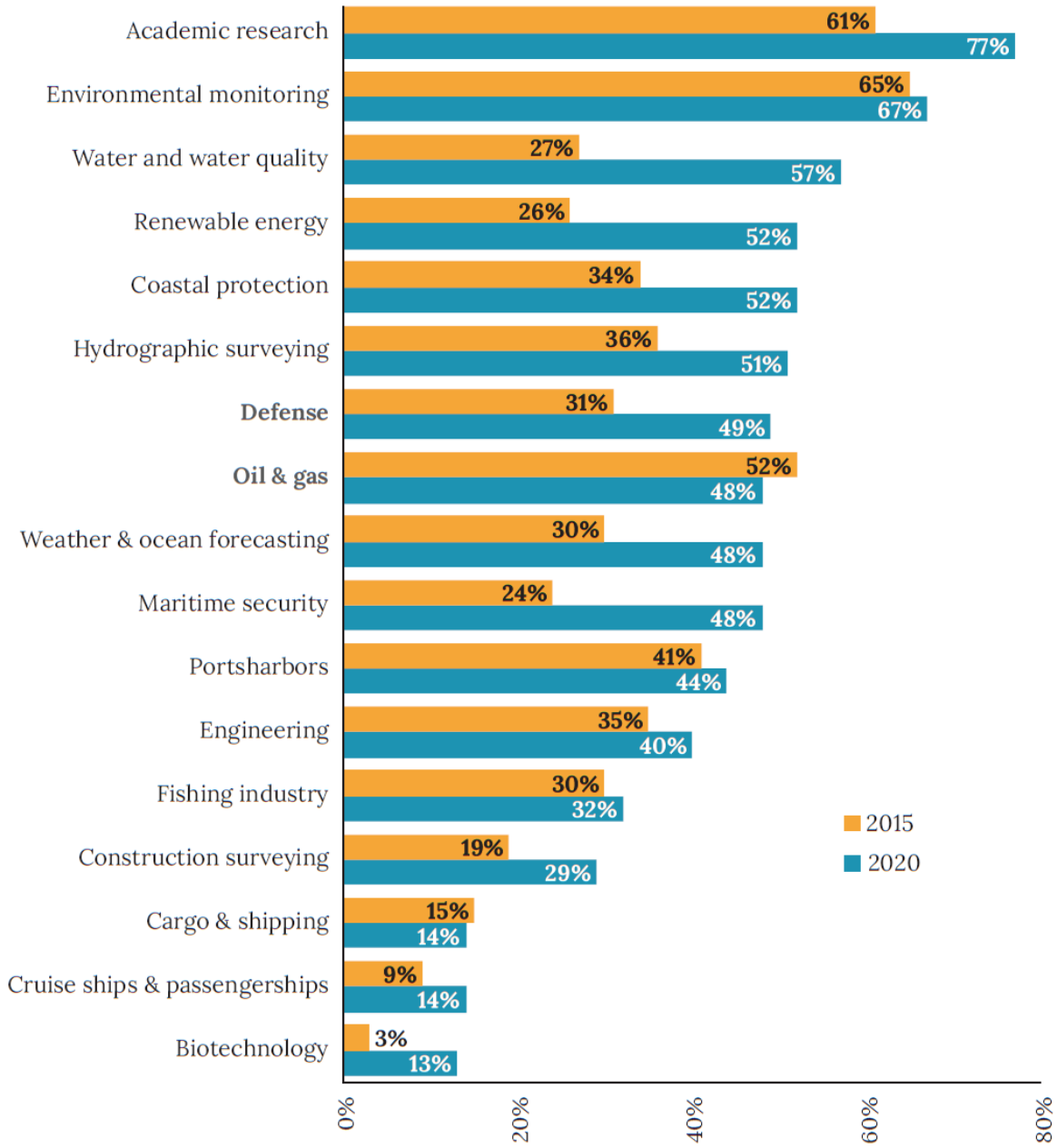


3.11 Market Sectors

3.11.1 Chief market sectors: 2015 comparison

Figure 3.20 indicates respondents' main market sectors for the 2015 and 2020 survey periods. For both survey periods, academic research and environmental monitoring were among the top two sectors endorsed. However, the respondents to the 2020 survey were much more diverse. For example, in the 2015 survey, only three sectors were endorsed by 50% or more respondents, while in 2020 six sectors were endorsed by more than half of respondents, and an additional six sectors were endorsed by 40% or more of respondents.

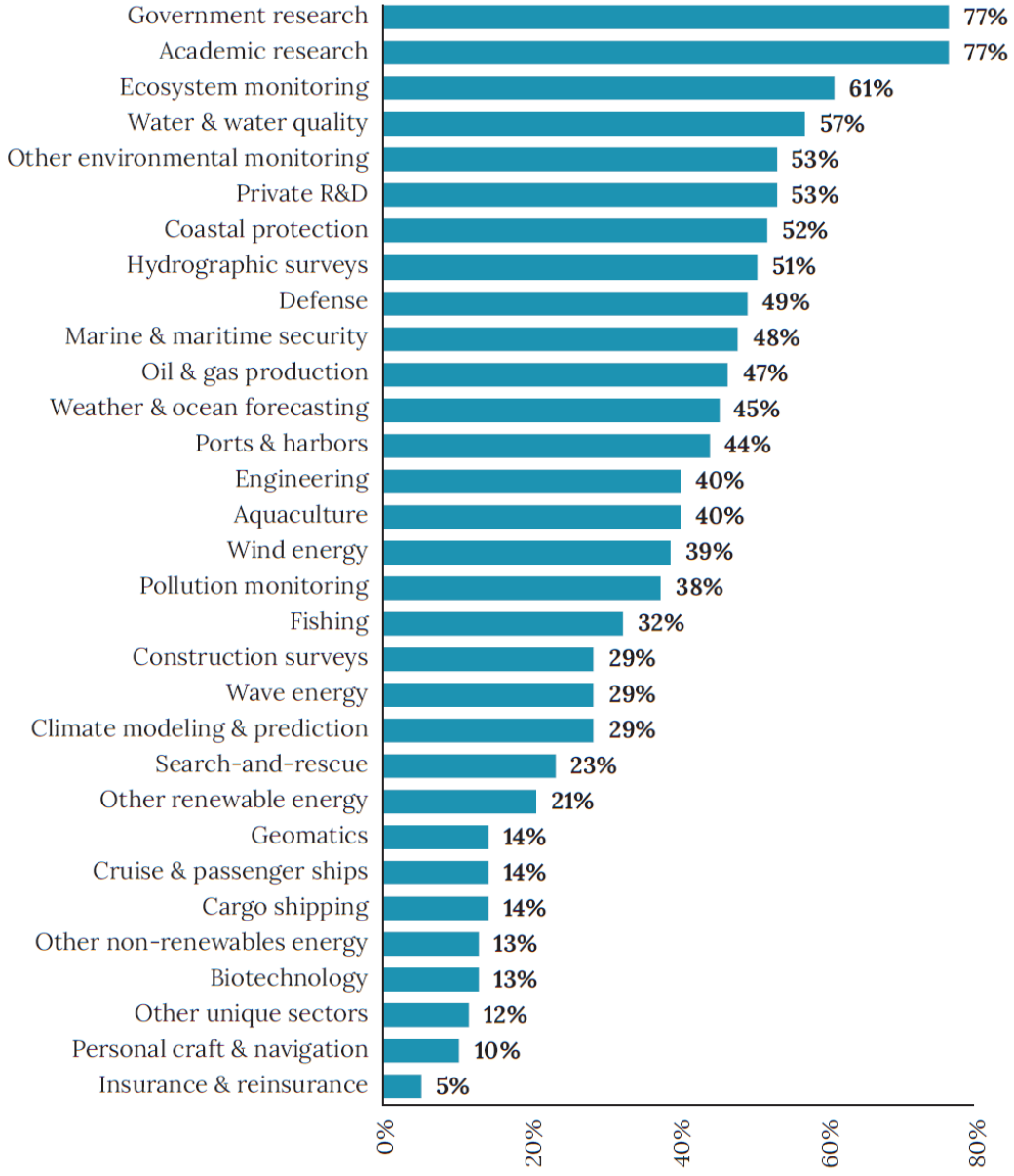
Figure 3.20. Respondents' chief market sectors 2015 and 2020.



3.11.2 Chief market sectors: All categories

The 2020 survey allowed for a more granular analysis of market sectors, with some of the 2015 sectors being broken down into subsidiary components. Responses inclusive of these are shown in Figure 3.21. In 2020, eight separate end-uses were a target for at least half of the respondents, and a further ten were targets for at least one-third of respondents.

Figure 3.21. Chief market sectors of survey respondents.



3.11.3 Number of market sectors served

The number of market sectors chosen by respondents provides an indicator of diversity of function. Figures 3.22 and 3.23 show the number of market sectors endorsed by survey respondents. A combined 50% of respondents reported their business was engaged in at least ten of the listed market sectors. Only 3% reported that their business was engaged in only a single listed sector.[14]

Nineteen percent of the respondents focus on less than 5 different market sectors, while more than 65% of respondents selling to between 6 to 15 market sectors. Fourteen percent of respondents focus on more than 16 sectors.

Analysis of the gross number of businesses engaged in certain market activities does not necessarily reflect employment or Ocean Enterprise revenue. For example, a hypothetical business engaged in the defense market sector could potentially represent more gross employment than all businesses engaged in environmental monitoring combined.

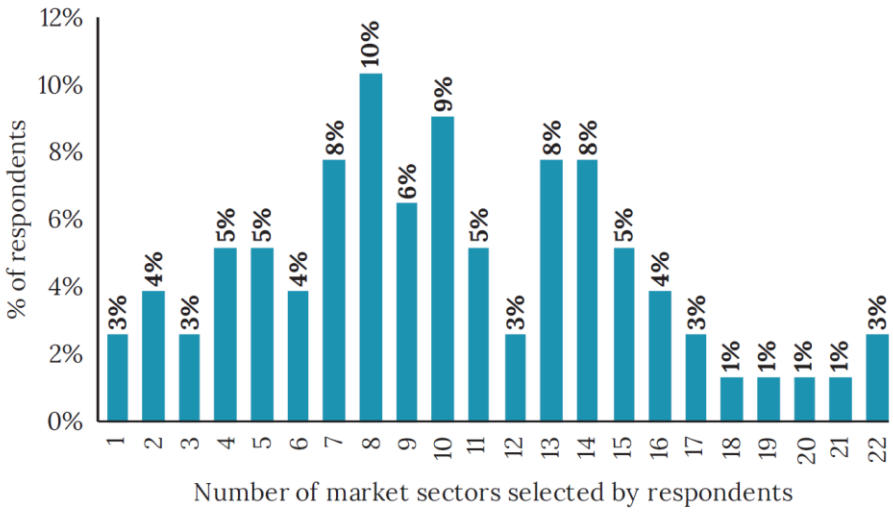


Figure 3.22. Proportion of market sectors endorsed by respondents.

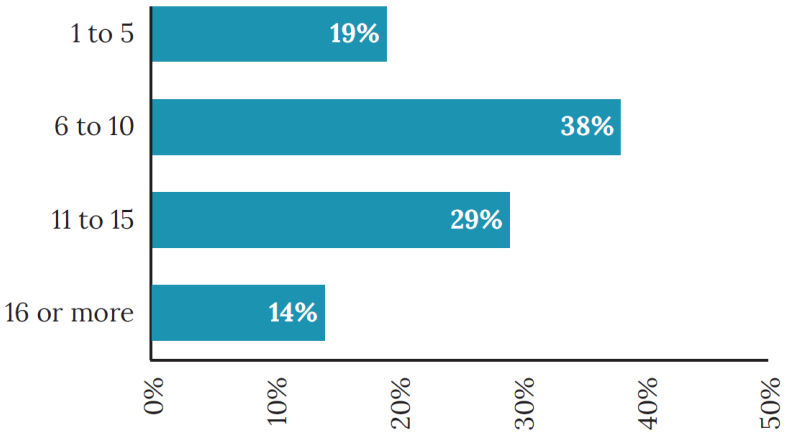


Figure 3. 23. Number of market sectors endorsed by respondents.

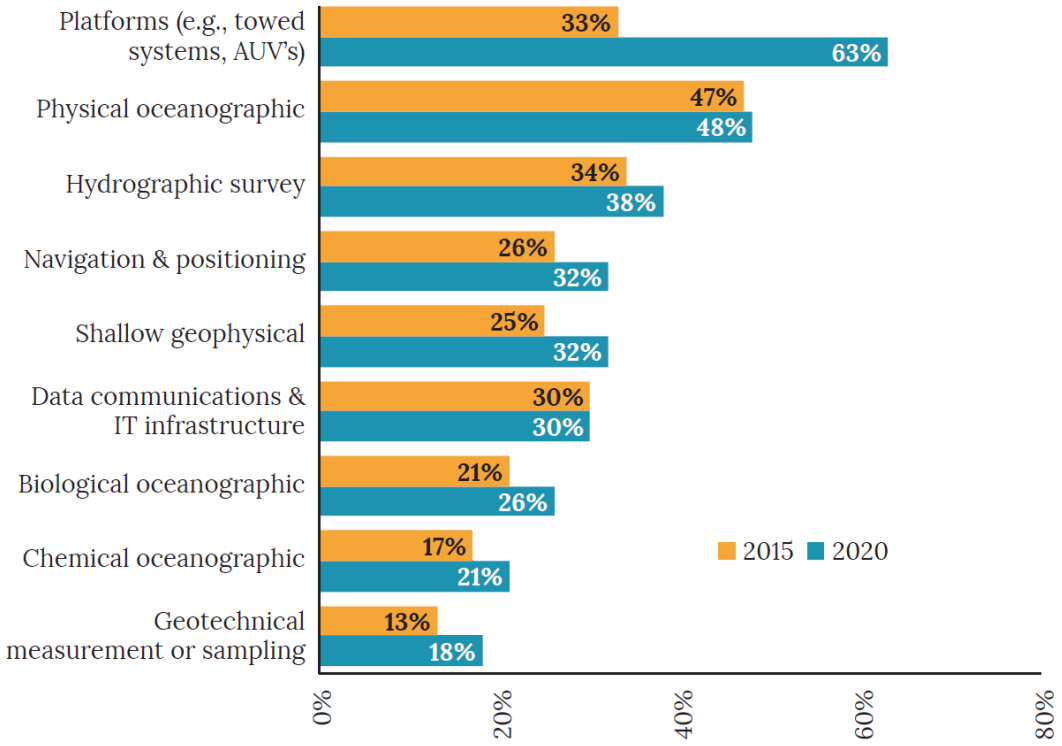
[14] Respondents were permitted to choose as many categories as applied; therefore, percentages can sum to more than 100%.

3.12 Types of Ocean Enterprise Product Sales

3.12.1 Types of Product Sales: 2015-2020 comparison

Respondents who indicated that they were a Provider of ocean observation and measurement products were asked a question regarding the types of products they sold. Figure 3.24 shows a comparison of types of products sold for the 2015 and 2020 survey periods. The greatest change was a near doubling of the proportion of businesses that sold platforms, such as towed systems or autonomous surface/underwater vehicles.

Figure 3.24. Types of Ocean Enterprise Product Sales in 2015 and 2020.

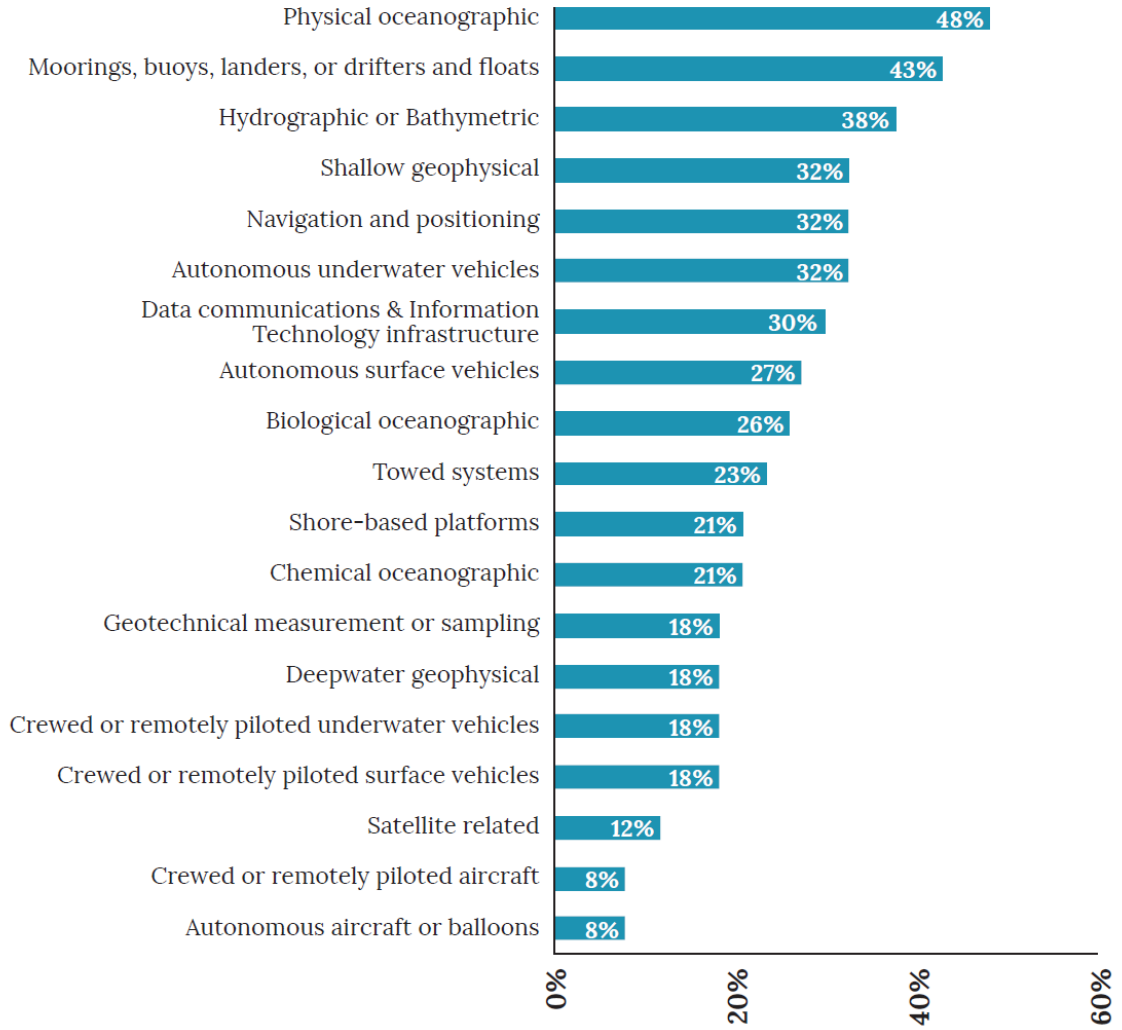


3.12.2 Types of product sales: All categories

The multi-year comparisons presented above represent categories common to both survey years. Where necessary, these comparative categories were compiled based on combining the responses to the more detailed list of product types used in the 2020 survey. These more detailed categories are shown in Figure 3.25.

When considering the percentages shown in Figures 3.24 and 3.25, it is important to remember that they relate to the number of businesses active in each product type, rather than the employment of revenue generation related to each. This cannot be determined from the survey or secondary analysis data.

Figure 3.25. Types of Ocean Enterprise product sold.



3.13 Use of Ocean Observation Information

Businesses that indicated they were Intermediaries were asked a series of questions regarding their use of different types of ocean observation, measurement, and forecast information in the generation of the information services that they sell to end-users.

3.13.1 Use of In Situ information

Figure 3.26 shows a comparison of reported types of information used for both the 2015 and 2020 survey periods.[15] In 2020, Intermediaries were generally more likely to report use of information types from all listed categories, compared to the 2015 survey. Usage of physical oceanographic information was the most commonly selected category for both survey years.

Figure 3.26. Use of *In Situ* information by use type.

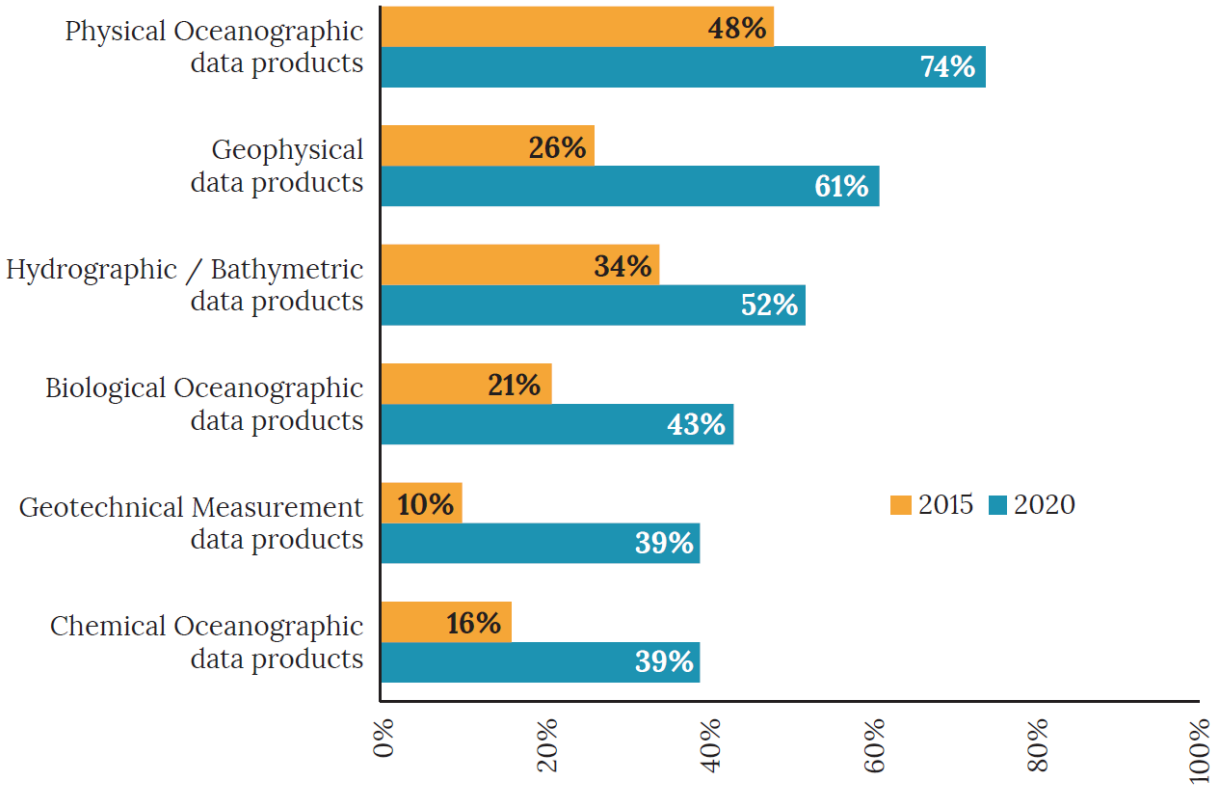
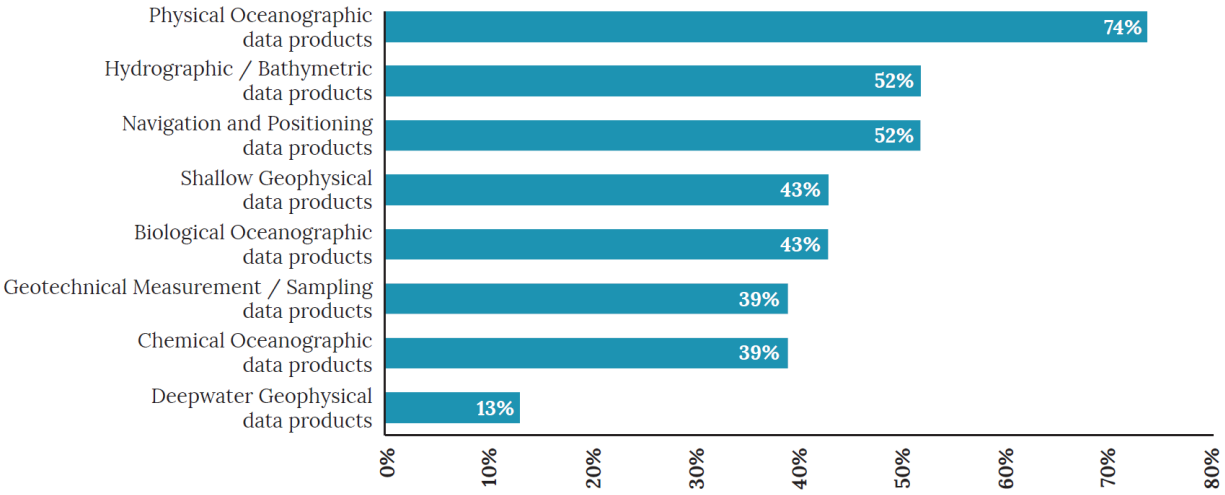


Figure 3.27 shows the detailed categories offered as possible information types in the 2020 survey. As shown, the great majority of users (74%) use physical oceanographic information, with about half using hydrographic/bathymetric information and navigation/positioning information. This is consistent with the findings from other value chain studies, for example a recent OECD use case study of use of UK public good ocean data (Jolly et al., 2021).

[15] Respondents were permitted to choose as many categories as applied; therefore, percentages can sum to more than 100%.

Figure 3.27. 2020 use of information by *in-situ* type.

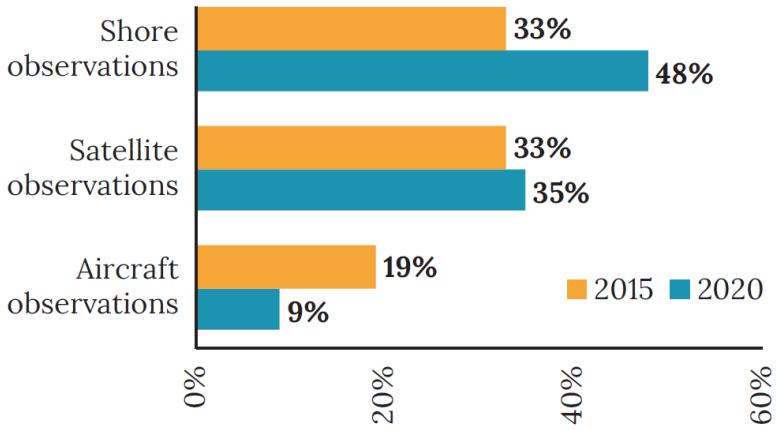


3.13.2 Intermediary use of remotely sensed information

Intermediary use of remotely sensed data and information is shown in Figure 3.28.[16] In general, remotely sensed observations are used less frequently than *in-situ* data products. However, it must be recognized that remotely sensed data, and especially satellite observations, are a key enabler of public good ocean predictive models. The resulting public good ocean forecasts are widely utilized by Intermediaries as in input to their customized information services. These indirect uses of remotely sensed data would generally not be recognized in the survey responses.

Shore and satellite observations are the most commonly used type of remotely sensed information for both survey periods. Almost half of respondents (48%) reported use of shore observations, representing a substantial change from the 2015 study (33%). The next most commonly used type of remotely sensed information was satellite observations (35%), which was comparable to the 33% found in the 2015 study. As in 2015, observations taken from aircraft were the least commonly used, although the 9% usage rate is markedly less than the 19% reported by respondents for 2015.[17]

Figure 3.28. Use of remotely sensed information by use type.



[16] Satellites, airplane observations, high frequency radar

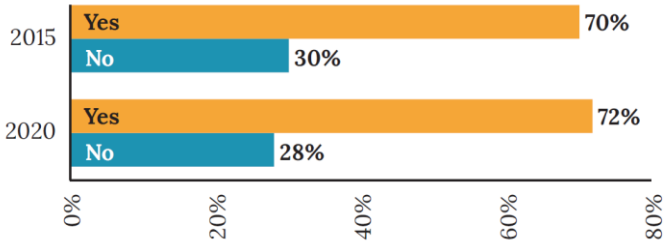
[17] Respondents were permitted to choose as many categories as applied; therefore, percentages can sum to more than 100%.

3.14 IOOS Business Dynamics

3.14.1 Awareness of IOOS and future plans

One purpose of this study was to assess respondents' awareness of the U.S. Integrated Ocean Observing System (IOOS). Familiarity with IOOS was very similar for the 2020 and 2015 studies (Figure 3.29).

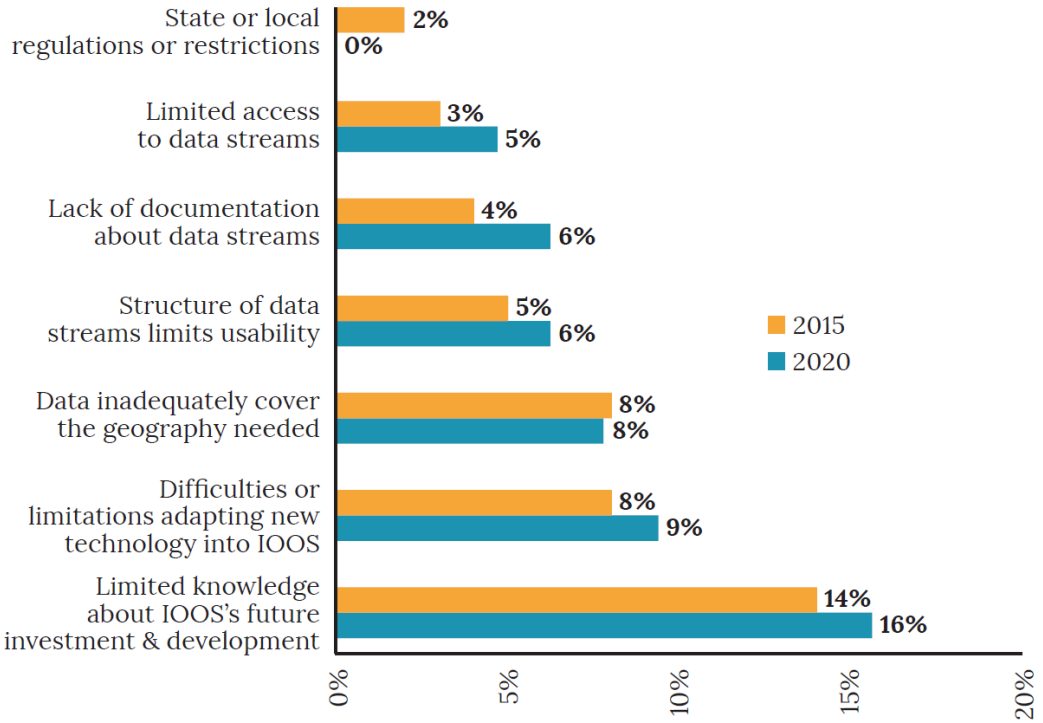
Figure 3.29. Awareness of IOOS.



3.14.2 Barriers and suggested improvements for working with IOOS

Reported barriers to working with IOOS are shown in Figure 3.30.[18] The pattern of responses from respondents to the 2020 survey were similar to those in 2015. In both study years, limited knowledge about future investments and development plans for the IOOS system was the most commonly cited barrier.

Figure 3.30. Barriers to working with IOOS.



[18] Respondents were permitted to choose as many categories as applied; therefore, percentages can sum to more than 100%.

3.15 The Impact of the COVID-19 Pandemic on Ocean Enterprise Businesses

Surveyed businesses were asked to report how the COVID-19 pandemic was impacting their future plans. Specifically, these questions asked about their plans to enter new geographical markets, or new market sectors, as a response to the COVID-19 pandemic.

As shown in Figure 3.31, there was little expectation of exiting from current geographical markets due to the business disruption impacts of the COVID-19 pandemic, with only 17% of surveyed businesses reporting such plans. Instead, the expectations were strikingly optimistic: 67% reported plans to enter new geographical markets.

A similarly optimistic picture was seen for plans to enter new market sectors despite the COVID-19 pandemic. Seventy-two (72%) of businesses reported plans to enter new sectors, while only 8% plan to leave current market sectors (Figure 3.32).

Businesses were slightly more conservative when asked to describe how the COVID-19 crisis was expected to impact their research and development investment. However, it is notable that over half of surveyed respondents still intend to increase their research and development activities (Figure 3.33).

Figure 3.31. Plans for geographical markets given the COVID-19 pandemic.

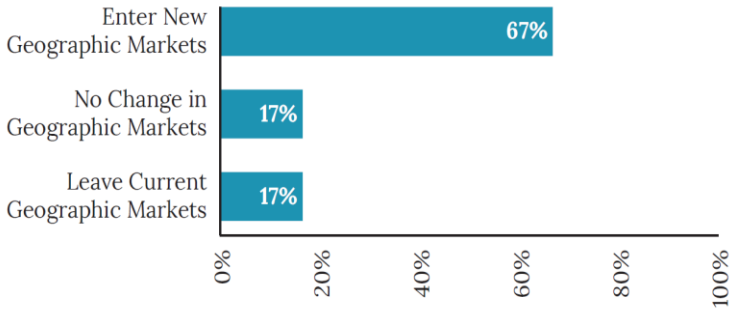


Figure 3.32. Plans for market sectors given the COVID-19 pandemic.

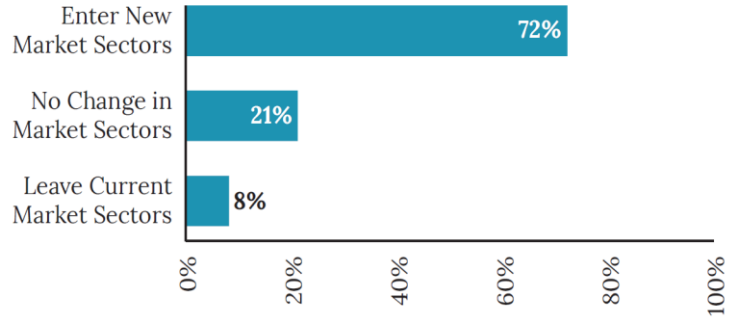
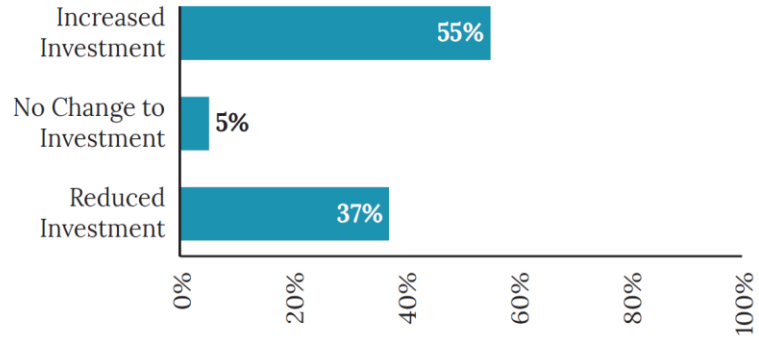


Figure 3.33. Plans for research and development investment strategies given the COVID-19 pandemic.



4. Conclusions and Next Steps

4.1 Growth and Change

The projected doubling of Blue Economy value-added over the period 2010 to 2030 would be expected to result in corresponding growth in the New Blue Economy, and, in turn, Ocean Enterprise business activity. Set against the opportunities afforded by this expected overall growth in the Blue Economy, the Ocean Enterprise cluster has had to contend with major challenges over the 2015 to 2020 period. The most notable of these has been the impact of large reductions in activity related to its key market in support of offshore oil and gas exploration and production. Despite these challenges, the cluster has grown by 7% since 2015, indicating that growth in other market opportunities more than compensated for the decline in offshore oil and gas related activity. While modest in absolute terms, this 7% growth in revenues is remarkable given the macroeconomic headwinds faced by much of the U.S. Ocean Enterprise business cluster since 2015.

As well as projecting overall growth in the Ocean Economy, the OECD and others predict a shift in the geographical and sectoral markets for Ocean Enterprise businesses. As levels of activity in developing end-uses of the ocean and ocean resources increases, there is a corresponding demand for Ocean Enterprise products and services to serve these developing markets. The offshore wind and aquaculture markets provide good examples. Both of these end-use market segments are growing rapidly (FAO, 2020; GWEC, 2020); creating corresponding growth in opportunities for existing Ocean Enterprise products and services, as well as demand for new products and services tailored to meeting the specific needs of these markets. The number of U.S. Ocean Enterprise businesses engaged in the renewable energy sector has more than doubled since the 2015 study despite the predominant geographical markets for these services currently being outside of the United States.

An increased focus on the importance of sustaining ocean natural capital and ecosystems is a vital component of the Blue Economy; this focus would be expected to drive an increase in the provision of Ocean Enterprise products and services in support of understanding and protecting ocean and coastal environments. Such an increase is reflected in the change in the importance of water quality monitoring as a key market, with the number of businesses regarding this as a primary market more than doubling since the 2015 study.

Over the period since the 2015 study, there have been significant developments in the technological means to make ocean observations and measurements and in the analytical and modeling tools used to convert the resulting data into actionable information. The most significant of these has been the trend toward increased use of autonomous and robotic systems as platforms for ocean observations and measurements. The number of companies engaged in delivery of such systems has nearly doubled since 2015.

Although not easily determined from the results of the study, the trend toward increased use of autonomous and robotic systems will drive corresponding innovation in novel sensors and the low power instruments, navigation and control systems needed for integration into such systems. Increased use of autonomous and robotic systems will also create demands for new tools and techniques to analyze, interpret, and present the data that they collect.

The combination of a shift in markets and changes in the scientific and technological means of servicing them creates an uncertain business environment. Established businesses are forced to adapt to changing market opportunities and the threat of disruptive technologies. Such an environment provides fertile ground for innovation, especially by new start-up businesses, who

see opportunities to provide novel solutions to emerging market needs. The 2020 study identified 46 such new independent businesses.

Growth opportunities in new markets can also be expected to attract established businesses to enter the Ocean Enterprise space. One of the most striking findings of the 2020 study was the overall growth in numbers of established businesses that have become active in provision of Ocean Enterprise products and services or have focused their activity through creation of new legal entities since 2015. The study also identified a significant level of both domestic and cross-border acquisition activity over the five-year period, with a number of the businesses identified in the 2015 study having been consolidated into larger organizations. It is likely that some of the new members of corporate families identified as being established after 2015 were also acquisitions of independent businesses established after this date. This consolidation process has been particularly evident in the autonomous and robotic systems space, where relatively young independent businesses have been acquired and integrated into larger corporate families, including those more traditionally associated with the aerospace and defense sectors.

Results from questions concerned with the relationship with IOOS indicate that little has changed in this regard since the 2015 study. In general, there is a high level of awareness of IOOS, although more needs to be done to reach out to those businesses that are unaware of IOOS' activities. It is perhaps surprising that the number of businesses experiencing barriers to working with IOOS has not significantly changed since 2015 in percentage terms, although this result needs to be considered alongside the large increase in absolute numbers of businesses engaged in Ocean Enterprise activities.

The Covid-19 pandemic has presented an obvious challenge to many industry sectors. The supplementary survey questions concerning Covid-19 have provided a useful insight into the impact of the pandemic on Ocean Enterprise businesses. The results of analysis of the responses to the supplementary Covid-19 question indicate that the Ocean Enterprise business cluster remains optimistic about the future and is weathering the business impacts of the pandemic well.

It is expected that U.S. Ocean Enterprise businesses will emerge from the Covid-19 pandemic well positioned to exploit the opportunities presented by further growth in the Blue Economy. It will, however, face a challenging transition, as businesses navigate fundamental changes in markets and in the technological means to deliver innovative solutions to meeting their ocean information needs. The coming decade will therefore be a period of great change for Ocean Enterprise businesses. In the energy sector, achieving net zero by 2050 will demand enormous growth the ability to capture offshore renewable energy. If the projections recently made by the International Energy Agency in its *Net Zero by 2050 Roadmap* (IEA, 2021) report hold true, demand for Ocean Enterprise products and services to support the offshore wind component of the energy transition will probably exceed the current capacity of the cluster. Similarly, changes in the use of ocean living resources and delivering a target of designating 30% of the ocean as marine protected areas, as well as monitoring enhanced natural and engineered use of the ocean as a carbon sink will all demand new capacity in ocean observation and measurement and information services. To add to this list are the growing information needs of ensuring ocean health and the protection of coastal communities, infrastructure and environments from rising sea levels.

Delivering these growing demands for New Blue Economy products and services requires partnership across the triple helix of government, academia, and industry. It is specialized businesses that provide the technological means to observe and measure the ocean and who act as Intermediaries, leveraging NOAA's public data and delivering much of the customized ocean information needed to support the rapidly changing and growing needs of the Blue Economy. The

"Ocean Enterprise" business cluster is thus a key partner for NOAA, providing technologies essential to delivery of NOAA's mission, and serving as key users of NOAA's public good data, translating it into actionable information for use by a vast and growing array of end-uses and end-users. The 2020 Ocean Enterprise study will help to guide and inform NOAA's relationship with the Ocean Enterprise business cluster as a critical New Blue Economy partner.

4.2 Next Steps

The results of the 2020 Ocean Enterprise study provide a picture of the changes that have occurred since the first study in 2015.

Communication of the results of the 2020 study, through this report and associated workshops and other outreach, will serve to further raise the profile of the Ocean Enterprise business cluster as a key component of the New Blue Economy and a critical enabler of the wider Blue Economy.

The result of this study will help to inform the work of NOAA, IOOS and the Department of Commerce in their efforts to sustain and support the development of the U.S. Ocean Enterprise ecosystem of New Blue Economy businesses. This support includes engagement with new ocean observing technologies and continued efforts to support the effective provision of public data and information to business Intermediaries engaged in meeting end-user needs. The results will also help to target support for U.S. Small and Medium Enterprises, the fostering and testing of novel Ocean Enterprise technologies and information products, and the encouragement of export activities.

It is expected that this and future studies will help guide and support the Ocean Enterprise business cluster as it navigates the challenges and opportunities to support the use of the ocean and its resources, while protecting the ocean and coastal environment and the ocean's natural capital and ecosystem services upon which we all depend.

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Appendices

Appendix 1. Non-Survey Revenue and Employment Methodology.

The 2015 study relied on two key components of the Ocean Enterprise universe: 1) an identifiable population of businesses that emerged from research and review, and 2) research that informed assumptions about the number of Ocean Enterprise businesses that were not captured in this way, as well as these businesses' employment, total revenue, Ocean Economy revenue, and Ocean Enterprise revenue. With some exceptions, we assumed the undercounted entities were distributed in a similar way to the survey sample responses. This approach had been informed by and followed other efforts that had been made to understand the Ocean Enterprise universe.

The current study utilized an updated process informed by the lessons learned since the 2015 study.

Population Identification:

1. We first reviewed the entire Ocean Enterprise-related population identified for the 2015 study, including those deemed out-of-scope in 2015. We scanned websites and other materials to determine if they were still in business and, if so, if they appeared to be in the Ocean Enterprise cluster. We also identified if the listed businesses were part of a larger corporate family and explored if other parts of that corporation also might be in the Ocean Enterprise cluster.[19]
2. The next effort (run concurrently) was to expand upon the efforts of 2015 and collect information on as many entities as possible from:
    - Memberships of Ocean Enterprise related organizations;
    - Participants in and exhibitors at Ocean Enterprise related conferences;
    - Referrals from IOOS staff and other knowledgeable experts;
    - Knowledge of the ERISS research team;
    - Businesses identified as selling Ocean Enterprise related products and services to the U.S. Government, based on a detailed search of federal contracts data (collected and reported in USASpending.gov);
    - A detailed search of the Thomas Network data at Thomasnet.com (formerly *Thomas Register)* using maritime and Ocean Enterprise related search criteria;
    - Searches of Ocean Enterprise relevant market and analyst reports;
    - Generalized web research.
3. As with the 2015 population, websites were scanned to determine if businesses were active in areas relevant to the Ocean Enterprise and, when appropriate, the Ocean Enterprise relevance of the companies' larger corporate families.
4. The third identification effort was continual throughout the project: referrals, press reports and generalized research generated a small but useful list of potential candidates.

[19] A detailed discussion of our analysis of corporate families is provided in a separate methodological report.

5. The fourth identification effort resulted from email blasts and newsletter and website mentions by Ocean Enterprise relevant organizations, social media placements on NOAA and IOOS sites, and presentations by IOOS at relevant events.

Secondary Research

For the 2020 study, a more comprehensive assessment of the identified Ocean Enterprise sector than was possible from a survey was obtained using secondary sources of information. These secondary sources do not have the level of context at the individual business level that was captured in the survey, but do provide information, especially economic data, that permitted the development of a more refined picture of the scope and scale of U.S. Ocean Enterprise activity.

For the 2020 analysis, a manual effort was initiated to collect Ocean Enterprise-relevant data for every business in the identification database focused on: verification of in or out of scope; total revenue; total employment, marine and maritime revenue; and Ocean Enterprise revenue.

During the identification process above, businesses were tentatively identified as: In scope, out of scope, or Indeterminant. Out of scope entities were dropped. Indeterminant entities, if located in the U.S., and if Dun & Bradstreet or other data were available, were assigned to the relevant but still unknown population. For in-scope entities, an effort was made to assign conservative estimates of marine and maritime and Ocean Enterprise shares of total revenue, based on web research, annual reports, and other materials. Scores were assigned to each entity:

- Point or range estimates for shares of Maritime and Ocean Enterprise, if possible (survey responses and interviews were included in the data collection);
- Small Ocean Enterprise activity but shares indeterminate;
- Relevant but still unknown (no basis for direct estimates);
- Unknown (no data or no U.S. location).

Corporate families had many subsidiaries and branches that did not have a unique web identity that could be researched. However, each entry did have unique NAICS and SIC codes reported in the Dun & Bradstreet (Hoovers) data set. A detailed NAICS/SIC analysis of all businesses for which we were able to generate point estimates (including those scored as “small but shares indeterminate”, and “relevant but still unknown”) generated a range of potential shares of total revenue attributable to marine and maritime and Ocean Enterprise.

With these estimates in hand, a further process reviewed the point estimates generated by this process for Ocean Enterprise-relevant entities that were previously identified. The general bias was to assign the range minimum, or to exclude the entity from the analysis.

Follow-up manual scans were pursued to flag entities that might deserve some additional attention.

The resulting database, including survey and interview participants, represented the study’s identified U.S. Ocean Enterprise population for further analysis.

Estimation Biases

Throughout the non-survey analysis, we sought to use conservative assumptions regarding "in-scope/out of scope" assignments, point estimates of maritime and Ocean Enterprise revenue shares and statistical estimates of maritime and Ocean Enterprise revenue shares.

Aerospace and especially satellite observation-related Providers were excluded unless specific Ocean Enterprise-relevant activities were identifiable, or an aerospace business responded to the survey and provided its own data. Similarly, satellite communication Providers were excluded because of the difficulty of separating specific Ocean Enterprise activities from their terrestrial business.

Advanced Electronics supply chain companies were included only if detailed research identified specific Ocean Enterprise products, services, and markets as critical and estimable.

As noted, an analytical process was used to identify branches of large corporate families as potentially in the Ocean Enterprise cluster, based on common NAICS/SIC codes with entities in the Ocean Enterprise cluster. We excluded many of these and assigned minimum marine/maritime and Ocean Enterprise shares to those retained.

Despite our wide net to identify entities potentially in the Ocean Enterprise cluster, it is probable we have missed some Ocean Enterprise businesses. Most likely to be omitted are branches of large corporations, which are not separate legal entities, and very young start-ups that are not yet visible in the sources used to identify target businesses.

In general, the non-survey analysis was designed to yield conservative estimates, understating total Ocean Enterprise revenue.

Ocean Enterprise Business Count

During the 2015 study, 410 Ocean Enterprise businesses were identified through industry lists, commercial databases, referrals, and associated research. It was estimated that some 20% of Ocean Enterprise businesses were unidentified in the 2015 study, suggesting nearly 500 businesses involved in Ocean Enterprise activities in 2015. This compares with 815 businesses identified in 2020: an increase of over 300. The 2015 to 2020 growth in the number of businesses that make up the Ocean Enterprise is one of the study's most striking findings. However, this headline finding is not matched by a single headline cause.

As noted above, one goal of the 2020 study was to develop a much more comprehensive database of Ocean Enterprise participants, reaching out into key parts of the value chain and exploring industrial sectors only recently becoming visibly active in the Ocean Enterprise. The result was a substantially improved, more precise and comprehensive understanding of the 2020 Ocean Enterprise population. Even so, the Ocean Enterprise remains underestimated. Identification challenges have been magnified by the dynamic nature of the cluster since 2015.

Multiple dynamics are at play and estimates of their impact on the growth of the Ocean Enterprise population since 2015 for the 2020 study are necessarily somewhat speculative.

- A business may well be decades old, but still be "new" in the Ocean Enterprise population. If a hypothetical mid-20th century electronics business launched a new hydrographic sensor as its first Ocean Enterprise product two years ago or adapted an existing sensor for marine use,

it would certainly be classified as an established company, but it would still be a new entrant to the Ocean Enterprise and Ocean Enterprise business count.

- A closely related issue results from a notion of "estimably Ocean Enterprise:" the point at which a businesses' share of total revenue from Ocean Enterprise products or services rises to a level that can be confidently estimated from secondary research. The 2015–20 period saw this become true for shipbuilders and aerospace businesses (see Appendix 4), while the role of the Ocean Enterprise in other industries' revenue, such as satellites, remains too opaque to be estimated. Critically for this project, whenever a business' share of total revenue from the Ocean Enterprise was deemed inestimable, the business was excluded from the Ocean Enterprise count.
- A third key factor reflects the incredible dynamism in the Ocean Enterprise corporate sector since 2015. Foreign investments, mergers, acquisitions, spin outs, and internal restructurings have radically changed the configuration of the Ocean Enterprise corporate landscape.
    - A particularly important unknown is the churn at the branch level. Acquisitions, new product introductions, or new market segment entries are often bundled into branches underneath an existing legal corporate entity. Even if an Ocean Enterprise-related branch can be clearly identified, branches do not report a founding date. Therefore, revenue from an Ocean Enterprise branch is rolled into their immediate parent corporate entity, which results in allocating that revenue to the founding date of the immediate parent and thus obscuring whether the action was before or after the 2015 study. Unfortunately, available data does not readily permit sorting the timing of branch dynamics.
    - This dynamism extends to the structure of the legal entities (headquarters, sub-headquarters and subsidiaries) within each corporation. As products, services, markets, and technologies evolve, whether organically or through merger and acquisition, sub-headquarters and subsidiaries are established or restructured to better manage overall corporate activity.
    - Finally, the US Ocean Enterprise is a very international cluster, some 24% of the 2020 population has an ultimate parent outside the United States. These range from simple representative offices to large manufacturing and service companies. We don't have a comparable estimate for 2015, but foreign parent firms have been key players in terms of new U.S. Ocean Enterprise product and services offerings.

We cannot measure precisely how these various dynamics are directly reflected in the growth of the Ocean Enterprise, but it is possible to generate reasonable estimates using available data.

Of the 814 legal entities identified as belonging in the Ocean Enterprise population, information regarding year of business founding revealed 92 companies founded since the 2015 study. Additional research raised that total to 112.

The next step was to identify companies explicitly excluded as out of scope in the 2015 study, but that were determined to be in scope in 2020. These businesses were re-examined to determine if some companies' status had changed in the intervening years. This review identified 140 businesses, either independent companies or companies within corporate families, that were assessed as out of scope in 2015, but had become a part of the Ocean Enterprise by 2020.

A high-level review of the 2020 Ocean Enterprise database also identified those Ocean Enterprise members linked in some way to the 410 in-scope 2015 companies (e.g., acquisition, spinout, merger). Available data provides limited insight into judging which of the above dynamics were responsible for this expansion except for startups defined by founding date. Some companies went out of business, some were acquired, others restructured adding new ocean enterprise

subsidiaries. After a detailed assessment, this group of 2015 in-scope companies experienced a net growth by 2020 of 48 businesses (excluding start-ups included above).

The final step involved identifying businesses that were not included in the above categories but had founding dates prior to the 2015 study or had no identifiable founding date. This process accounted for 104 total businesses. Available sources do not tell us when and how these remaining 104 entered the Ocean Enterprise cluster. Some companies that likely had growth were missed in the 2015 business compilation and analysis. It is useful to note that this is roughly the same magnitude as the assumed undercount in the 2015 study.

Overall, the process estimated that the Ocean Enterprise grew by a net 314 companies from the assumed 2015 population of 500. Of course, the actual number of 2020 businesses that are new to the universe must be larger than the net difference between the 2015 and 2020 business counts. Some of the 2015 businesses have inevitably since closed, have remained in business but exited the Ocean Enterprise space, or were independent businesses that have been absorbed into corporate families by acquisition or merger (or were businesses within corporate families whose status changed due to internal restructuring or other merger and acquisition activity).

Of the total growth, it is uncertain when or how all of them entered the Ocean Enterprise. The estimates above attempt to quantify the change between 2015 and 2020 to the extent reasonably supportable by the data. The study inevitably encounters limitations in further untangling of these cluster dynamics between 2015 and 2020.

Table A. 1. Dynamics of business growth in the Ocean Enterprise, 2015-2020.

Ocean Enterprise business population	Count
2015 Ocean Enterprise businesses	
Original 2015 report Ocean Enterprise businesses	410
Newly discovered pre-2015 Ocean Enterprise businesses	104
Total 2015 Ocean Enterprise businesses	**514**
2015-20 Ocean Enterprise dynamics of growth	
Ocean Enterprise businesses founded since 2015	112
Pre-2015 businesses entering the Ocean Enterprise since 2015	140
Other net growth within 2015 corporate families	48
Total 2015-20 net growth in Ocean Enterprise businesses	**300**
Total 2020 Ocean Enterprise business population	**814**

Appendix 2: The Survey Instrument

The Ocean Enterprise Study 2020 electronic survey instrument built upon the 2015 survey effort to both update and improve NOAA's and IOOS's understanding of the Ocean Enterprise business community.

As detailed in this report, the survey's questions promoted a direct comparison to the 2015 project's findings. However, the 2020 survey was by no means a carbon copy of the original instrument. More attention was paid to the possible differences among organizational types. The list of choices in many questions were expanded to reflect the changed context faced by the Ocean Enterprise in terms of technologies, markets, and activities. Finally, while this report focuses on the Ocean Enterprise and IOOS business communities and their survey answers, parallel data was often collected on respondents that identified themselves as outside those core audiences. All changes were approved in accordance with U.S. government human subject protocols and paperwork reduction priorities.

The new survey also relied significantly on advanced survey skip, piping, and branching functionality to minimize the time investment required of respondents.

The logic flow determinants were as follows:

- National location
- U.S.-only or multinational structure
- Business or corporate structure type
- Ocean Economy contribution
- Export activity
- IOOS familiarity
- IOOS or other Ocean Enterprise data system contribution

The survey began with an introductory expression of gratitude for the respondent's time and attention. The introductory page also featured an explanation of the survey's purpose and structure, its relationship to the Ocean Enterprise Study 2020 project, and key concepts and terms. In addition, the survey questions and options regularly included detailed explanations of concepts and terms, such as definitions for Ocean Enterprise Provider, Intermediary, and End-User, and also included a number of clickable, in-survey, hyperlinked definitions of various terms.

With a few exceptions at the beginning of the survey, each survey question was optional; any required questions were indicated as such.

The survey instrument clearly expressed that all responses would be kept confidential.

Survey Questions:

1. Please select the answer choice(s) below that best describes your business: (select all that apply)
   - ❑ We provide infrastructure for ocean measurement, observation, or forecasting purposes (e.g., platforms, instruments, sensors, data communications, IT infrastructure, instruments for navigation and positioning, etc.)
   - ❑ We use ocean measurements, observations or forecasts to create or enhance a value-added data product offered for commercial sale (e.g. to provide a survey product, power a weather or surf forecast service, evaluate ocean hazards, support fish locating, etc.)
   - ❑ We don't provide ocean measurement, observation, or forecasting infrastructure or use ocean measurements, observations or forecasts <SURVEY WILL GO TO THANK YOU/EXIT SCRIPT>

2. How long has your business provided ocean measurement, observation or forecast infrastructure or related value-added services?
   - ❑ Less than 1 year
   - ❑ 1 through 3 years
   - ❑ Through 5 years
   - ❑ More than 5 years
   - ❑ Unknown

3. Currently, how many employees in your business are located in the U.S.?
   - ❑ 1-4
   - ❑ 5-9
   - ❑ 10-24
   - ❑ 25-49
   - ❑ 50-99
   - ❑ 100-249
   - ❑ 250-499
   - ❑ 500-999
   - ❑ 1000 or more

4. Currently, how many employees in your business are at your current location?
   - ❑ We only have one location
   - ❑ 1-4
   - ❑ 5-9
   - ❑ 10-24
   - ❑ 25-49
   - ❑ 50-99
   - ❑ 100-249
   - ❑ 250-499
   - ❑ 500-999
   - ❑ 1000 or more

5. In the next 12 months do you anticipate your company:
   - ❑ Growing
   - ❑ Staying the same
   - ❑ Decreasing
   - ❑ Not sure

6. Is your company a subsidiary, and if YES, what is the name of the holding company and in which country is it registered?
   - ❑ Not a subsidiary

   Yes, we are a subsidiary of_____, and based in (Country) .

7. How many discrete locations does your company or your parent company have? (multiple buildings on a single campus counts as one location)
   - ❑ 1
   - ❑ 2
   - ❑ 3
   - ❑ 4
   - ❑ 5
   - ❑ 6-9
   - ❑ 10 or more

8. How many of these locations are outside the U.S.?
   - ❑ All
   - ❑ None
   - ❑ 1
   - ❑ 2
   - ❑ 3
   - ❑ 4
   - ❑ 5
   - ❑ 6-9
   - ❑ 10 or more

9. What were your company's gross revenues for the past year?
   a) Subsidiary revenues (if subsidiary)_____
   b) Overall company revenues _____

10. What share of your revenue is due to Maritime activities or business?
    - ❑ 0% or None
    - ❑ 1% to 24%
    - ❑ 25% to 49%
    - ❑ 50% to 74%
    - ❑ 75% to 100%
    - ❑ Don't Know

11. What share of your maritime revenues is due to business or activities associated with providing ocean observation, measurement or forecasting infrastructure or provision of value-added data products based in whole or in part on ocean observation, measurement or forecast data?
    - ❑ 0% or None
    - ❑ 1% to 24%
    - ❑ 25% to 49%
    - ❑ 50% to 74%
    - ❑ 75% to 100%
    - ❑ Don't Know

12. What percentage of your ocean observation, measurement or forecasting related revenues from Question 10 is from sales outside the U.S.?
    - ❑ 0% or None
    - ❑ 1% to 24%
    - ❑ 25% to 49%
    - ❑ 50% to 74%
    - ❑ 75% to 100%
    - ❑ Don't Know

13. In the next 12 months, do you anticipate your ocean observation, measurement and forecasting related business revenue:
    - ❑ Growing
    - ❑ Staying the same
    - ❑ Decreasing
    - ❑ Not sure

14. From which of these market areas does your company, or your parent company (if it is U.S. registered) receive significant ocean observation, ocean measurement or ocean forecasting business related revenue (greater than 5%) (Select all that apply):
    - ❑ Australia/New Zealand
    - ❑ Other Asia-Pacific
    - ❑ Japan
    - ❑ China
    - ❑ Taiwan
    - ❑ South Korea
    - ❑ Africa
    - ❑ Middle East
    - ❑ East Europe/Russia
    - ❑ Continental Europe
    - ❑ UK/Ireland
    - ❑ USA
    - ❑ Canada
    - ❑ Mexico/Central America
    - ❑ Non-U.S. Caribbean
    - ❑ South America
    - ❑ Other: _____

15. What are your main market sectors? (select all that apply)
    - ❑ Academic research
    - ❑ Defense
    - ❑ Maritime security
    - ❑ Ports/harbors
    - ❑ Coastal protection
    - ❑ Environmental monitoring
    - ❑ Renewable energy
    - ❑ Oil/gas
    - ❑ Maritime security
    - ❑ Fishing industry
    - ❑ Hydrographic surveying
    - ❑ Construction surveying
    - ❑ Water and water quality
    - ❑ Biotechnology
    - ❑ Engineering
    - ❑ Weather and ocean forecasting
    - ❑ Cargo shipping
    - ❑ Cruise ships/passenger ships

    Other: _____

16. (Providers only) What kind of ocean measurement, observation, or forecasting infrastructure (e.g., platforms, instruments, sensors, data communications, Information Technology infrastructure etc.) do you sell? (select all that apply)
    - ❑ Hydrographic survey sensors/instruments/systems
    - ❑ Shallow geophysical survey sensors/instruments/systems

- ❑ Geotechnical measurement/sampling, sensors/instruments/systems
- ❑ Physical oceanographic sensors/instruments/systems
- ❑ Chemical oceanographic sensors/instruments/systems
- ❑ Biological oceanographic sensors/instruments/systems
- ❑ Navigation and positioning sensors/instruments/systems
- ❑ Platforms such as towed systems, remote or autonomous underwater vehicles
- ❑ Data communications and Information Technology infrastructure
- ❑ Other _____

17. (Intermediaries only) If you utilize "*IN SITU*" ocean observations or measurements in your data products (i.e., data generated from observations or measurements conducted within or upon the ocean) what kind of data do you use? (select all that apply)
    - ❑ Bathymetric data
    - ❑ Geophysical data
    - ❑ Geotechnical data
    - ❑ Physical oceanographic data
    - ❑ Chemical oceanographic data
    - ❑ Biological oceanographic data
    - ❑ Other _____
    - ❑ We do not utilize *IN SITU* data

18. (Intermediaries only) If you utilize "REMOTELY SENSED" ocean observations in your product (e.g., satellites, airplane observations, high frequency radar), what kind of data do you use? (select all that apply)
    - ❑ Aircraft observations
    - ❑ Satellite observations
    - ❑ Shore observations
    - ❑ Other _____
    - ❑ We do not utilize REMOTELY SENSED data

The following questions relate specifically to your interaction with the U.S. Integrated Ocean Observing (IOOS).

19. Are you aware of the Integrated Ocean Observing System (IOOS) and, if so, do you contribute to IOOS infrastructure or utilize IOOS coordinated data? (Select all that apply)
    - ❑ We are unaware of the IOOS <SURVEY WILL GO TO THANK YOU/EXIT SCRIPT>
    - ❑ We are aware of IOOS
    - ❑ We contribute to IOOS infrastructure
    - ❑ We make use of IOOS coordinated data

20. Which of the following do you consider issues or barriers to working with IOOS that impact your business? (select all that apply)
    - ❑ Local regulations or restrictions
    - ❑ Limited access to data streams
    - ❑ Structure of IOOS data streams limits usability
    - ❑ Lack of documentation on IOOS data streams
    - ❑ Difficulties or limitations with adapting new technology into the existing ocean observing system
    - ❑ Limited knowledge about future investment and development plans for the IOOS system
    - ❑ Data does not adequately cover the geographical needed
    - ❑ Hard to find employees who can work with the IOOS data
    - ❑ Hard to find employees who can work with the IOOS infrastructure

- ❑ Other: _____
- ❑ None of the above
- ❑ Don't know

21. In the future, we plan to: (select all that apply)
    - ❑ Develop new products that utilize IOOS data
    - ❑ Expand the capabilities of our current product that utilizes IOOS data
    - ❑ Provide additional infrastructure for IOOS
    - ❑ Provide additional services for IOOS
    - ❑ Eliminate some products or services we provide
    - ❑ None of the above

22. What areas do you think could be improved with regard to working with IOOS? (select all that apply)
    - ❑ Better information and data stream standardization
    - ❑ More openness to opportunities for new innovations
    - ❑ Greater focus on the interests of small or new enterprises engaged in ocean observation, measurement, and forecasting or the use of ocean data
    - ❑ Greater focus on the interests of large or established enterprises
    - ❑ Other: (please describe) _____
    - ❑ None of the above

23. Do you feel your current or future workforce could benefit from specific training related to working with IOOS data or providing IOOS infrastructure?
    - ❑ Yes: please explain:
    - ❑ No
    - ❑ Don't know

24. Is there anything that would make it easier to provide services, products, or infrastructure to NOAA and the IOOS system?
    - ❑ Yes: please explain:
    - ❑ No
    - ❑ Don't know

25. Is there anything that would make it easier to utilize the IOOS data and incorporate it into a product?
    - ❑ Yes: please explain:
    - ❑ No
    - ❑ Don't know

Appendix 3: Location of Targeted Businesses by State.

State or territory	Businesses and branch operations count	Businesses count
Total	**2,227**	**814**
California	311	151
Texas	297	114
Virginia	227	69
Florida	143	67
Massachusetts	120	62
Maryland	102	35
Washington	98	46
Colorado	78	21
Louisiana	62	18
New York	60	28
New Jersey	58	22
Pennsylvania	58	12
Georgia	39	3
Arizona	36	8
Ohio	34	8
Connecticut	30	12
Illinois	30	4
North Carolina	29	5
Utah	28	8
Alabama	28	6
Oregon	27	11
District of Columbia	24	3
Michigan	23	9
Rhode Island	18	7
South Carolina	18	7
Hawaii	17	6

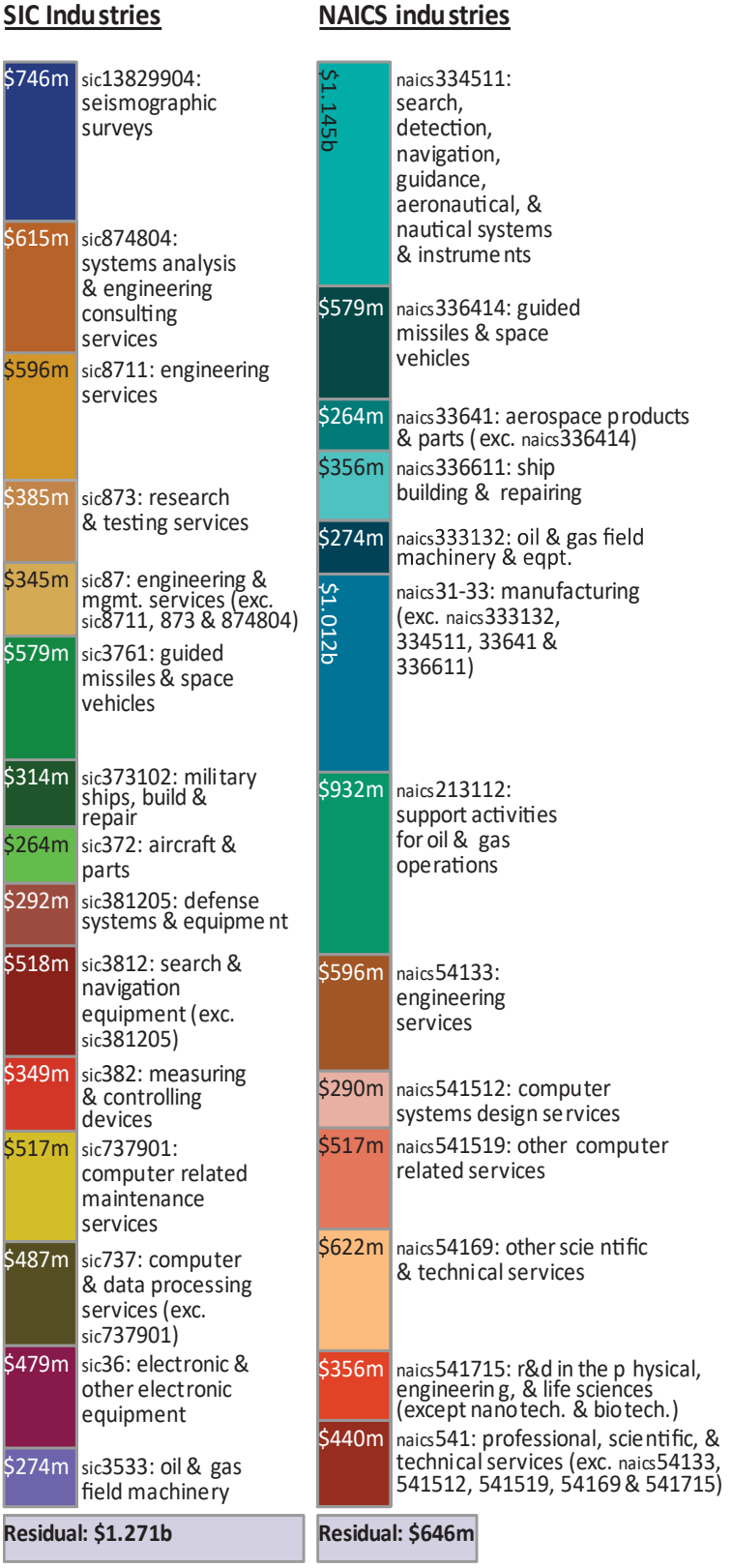
State or territory	Businesses and branch operations count	Businesses count
Oklahoma	17	2
Mississippi	16	7
New Hampshire	15	6
Minnesota	15	4
Kentucky	12	3
New Mexico	12	3
Maine	11	8
Alaska	11	5
Nebraska	11	3
Missouri	11	2
Indiana	10	4
Kansas	10	1
Wisconsin	7	4
Idaho	7	0
North Dakota	7	0
Tennessee	7	0
Montana	6	4
Iowa	6	1
Wyoming	6	1
Nevada	6	0
Delaware	4	1
West Virginia	4	0
Vermont	3	2
Arkansas	3	1
Puerto Rico	3	1
Guam	1	1
Other	3	3

Appendix 4. Industry Code Classification Comparison.

The Ocean Enterprise cluster is a complex and rapidly evolving array of economic activity. Standard national data collection systems do not offer the level of detail required to analyze and monitor this cluster. In the process of identifying and estimating Ocean Enterprise revenue at the individual legal entity level for this project, we used the Dun & Bradstreet/Hoovers database to capture detailed North America Industry Classification System (NAICS) and Standard Industry Classification (SIC) codes for each business with a D-U-N-S (a unique number allocated to each legal entity reported by Dun & Bradstreet). The more detailed eight-digit Dun & Bradstreet SIC schema is based on the U.S. SIC methodology.

Ocean Enterprise revenue was allocated to the most detailed NAICS and SIC codes available for each specific entity. The results of this analysis are shown in the industry composition chart opposite. This describes the share of the Ocean Enterprise revenue driven by critical primary Dun & Bradstreet SIC and NAICS industries and industry aggregations. So, for example, in the NAICS column, the largest single detailed primary industry was NAICS 334511, which was associated with approximately 10% of Ocean Enterprise revenue.

In total, this stepwise technique accounts for about 89% of the total Ocean Enterprise in the case of the more detailed Dunn & Bradstreet SIC schema, and approximately 92% of the total in the case of each entity's primary NAICS assignment.



IOOS
Integrated Ocean Observing System

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Department of Commerce
United States of America

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