



THE OCEAN ECONOMY IN LOS ANGELES COUNTY

ECONOMIC IMPACT ANALYSIS

2020



LOS ANGELES COUNTY
ECONOMIC DEVELOPMENT CORPORATION

Collectively Advancing Opportunity and Prosperity for All



INSTITUTE FOR APPLIED ECONOMICS

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This report was commissioned by County of Los Angeles under the directive of the Los Angeles County Board of Supervisors, led by Supervisor Janice Hahn.

The Los Angeles County Economic Development Corporation (LAEDC) together with AltaSea at the Port of Los Angeles prepared this report in response to the Ocean Economy's promise and potential in Los Angeles County. We thank our colleagues from AltaSea for their valuable insight and expertise.

The LAEDC Institute for Applied Economics offers objective economic and policy research for public agencies and private firms. The group focuses on economic impact studies, regional industry analyses, economic forecasts and issue studies, particularly in water, transportation, infrastructure and environmental policy.

Every reasonable effort has been made to ensure that the data contained herein reflect the most accurate and timely information possible and they are believed to be reliable.

The report is provided solely for informational purposes and is not to be construed as providing advice, recommendations, endorsements, representations or warranties of any kind whatsoever.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	4
1. INTRODUCTION	10
Defining the Blue/Ocean Economy	11
Industry Composition	11
Ocean Based Industries.....	12
Ocean Economies Along the California Coast	14
2. ECONOMIC ANALYSIS OF THE OCEAN ECONOMY	16
California.....	16
Los Angeles County.....	18
Dynamic Impacts	18
3. WORKFORCE NEEDS ASSESSMENT	20
California.....	21
Los Angeles County.....	21
Employment Forecast by Sector	21
Occupational Analysis	23
4. TRENDS & BARRIERS	25
5. OCEAN ECONOMY CASE STUDIES	28
Case Study: Bangladesh	30
Case Study: Indonesia.....	32
Case Study: Massachusetts	36
Case Study: San Diego	40
Case Study: Washington	42
6. IMPACT OF CLIMATE CHANGE ON THE OCEAN ECONOMY IN LOS ANGELES	46
Overview: Global Climate Change	46
Impacts of Climate Change on California	47
Sea Level Rise.....	49
Ocean Warming and Acidification	53
Temperature Change, Extreme Heat, Air Quality	56
7. CREATING NEW POLICIES	61
CONCLUSION.....	68
APPENDIX	69
Relevant NAICS Codes	69
Ocean Economy Sector Descriptions	70
Local Talent Development	71
Methodology	73

EXECUTIVE SUMMARY

The ocean is essential to our everyday lives. Not only do we rely on its fundamental ecological functions, but the impacts of ocean-based industries are critical to trade and the global economy.

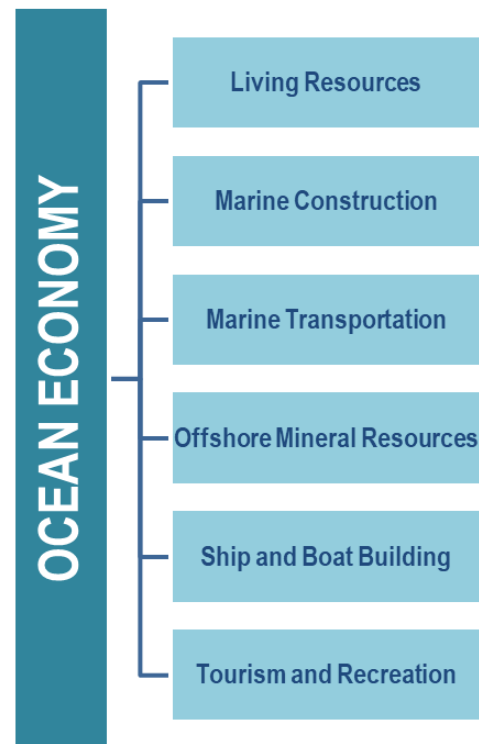
The true value of the ocean and its multitude of resources and promising opportunities is difficult to quantify and cannot be overstated. However, the ocean is facing unprecedented pressures, from pollution and overfishing to climate change. In order to mitigate these pressures and sustainably utilize available resources for both economic and ecological gain, more decision makers are placing a strong and focused emphasis on blue economy development.

The blue economy is defined by the World Bank as the "sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem." The term ocean economy is often used interchangeably with blue economy, though it sometimes refers to only economic activities. In this report, both terms are used and intended to encompass the economic and ecological aspects of the ocean.

Conservative estimates indicate that the value of the blue economy will double over the next decade, with a **projected global value of \$3 trillion by 2030**. Across the world, municipal and national entities are investing in the sustainable development of their own blue economies and reaping significant economic and ecological rewards. Tangible opportunities exist for California and Los Angeles (L.A.) County to follow in their footsteps.

California is well known for its striking coastline. The nearly one thousand distinct beaches, pockets of surf and sand in each coastal neighborhood serve as both calming oases and centers of bustling activity.

Figure 1: Existing ocean economy sectors



However, the connections that Californians have with the water go far beyond ocean views and beachside adventures. California's ocean has fostered the development of a burgeoning blue economy, **currently providing over 660,000 direct jobs and over \$143 billion in total economic output in the state.**

Looking to the future, there are ample opportunities to harness the full potential of the blue economy and usher in a new era of innovation in Los Angeles. A 'sea change' is taking place, focused on developing sustainable solutions and contributing to emerging industries. The county's 75 miles of coastline coupled with unique location-based resources including world-class research institutions and technology companies will lead to new discoveries and the creation of well-paying jobs.

The current ocean economy consists of maritime-based economic activities in the following six distinct sectors (Figure 1):

- ❖ Tourism and recreation;
- ❖ Ship and boat building;
- ❖ Offshore mineral extraction;
- ❖ Marine transportation;
- ❖ Marine construction; and
- ❖ Living resources.

While some of these sectors contribute more to the state and regional economies than others, they each play a vital role in the existing ocean economy. In both California and Los Angeles County, tourism and marine transportation currently make up over 90 percent of ocean economy employment, with all other industries contributing less than four percent each. Similarly, tourism and recreation contribute the most jobs to the ocean economies in Orange County, San Diego County, San Francisco County and Ventura County.

Over the next decade, tourism and marine transportation (specifically shipping) will remain important contributors to the blue economy, along with several new emerging sectors that have been identified and classified by their potential for long-term growth (Figure 2). Industries with the best prospects for high long-term growth include offshore wind, surveillance and safety, and marine aquaculture. In addition, industries that have long-term potential but are not yet at commercial scale —such as ocean renewable energy, marine biotechnology, marine robotics,

and carbon capture and storage— will present new opportunities for innovations in technology and resource management.

The blue economy will increase employment and support the development of solutions to key environmental challenges. This report features an analysis of the current ocean economy in L.A. County, as well as projections, case studies, and promising areas of focus for a prosperous blue economy.

ECONOMIC ANALYSIS OF THE OCEAN ECONOMY

This section of the report presents a cross sectional analysis of the current and potential future economic impacts of the ocean and blue economies.

The LAEDC estimates that in 2018, the ocean economy in **California** generated:

- ❖ 1.035 million total jobs (direct, indirect and induced)
- ❖ over \$143 billion in output,
- ❖ \$84 billion in gross state product (GSP), and
- ❖ over \$53 billion in total labor income.

During the same year in **Los Angeles County**, the ocean economy produced:

- ❖ 200,400 total jobs (direct, indirect and induced)
- ❖ over \$34 billion in output,
- ❖ \$20 billion in gross county product (GCP),
- ❖ over \$12 billion in labor income, and
- ❖ \$1.7 billion in local taxes (2018).

Globally, the ocean economy is currently valued at \$1.5 trillion, an amount projected to double to \$3 trillion over the next decade. In L.A. County, the LAEDC forecasts that by 2023 the ocean economy will produce more than 126,000 direct jobs and pay \$37.7 billion in wages, an increase from the 2018 direct jobs total of 117,900. Over the same five years, LAEDC predicts the ocean economy will generate at least \$80.1 billion in regional output, \$49.8 billion in GCP and \$69.2 billion in personal income.

Figure 2: Emerging ocean economy sectors

Industrial marine aquaculture
Deep- and ultra-deep water oil and gas
Offshore wind energy
Ocean renewable energy
Marine and seabed mining
Maritime safety and surveillance
Marine biotechnology
High-tech marine products and services
Others

5-Year Contribution Forecast of the Ocean Economy
Los Angeles County, 2019-2023

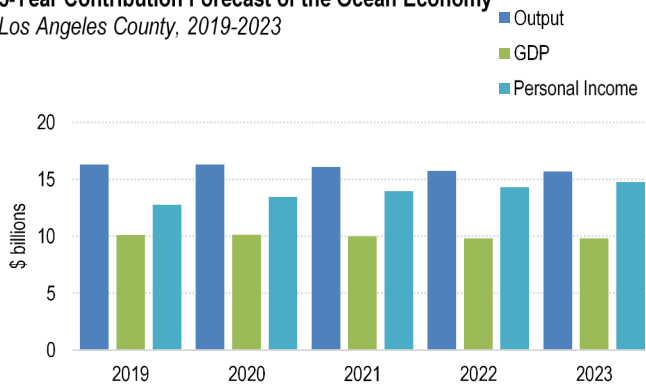


Figure 3: Ocean economy contribution forecast

As the focus shifts to an integrated blue economy, economic impacts are expected to be considerably bolstered by emerging industries.

WORKFORCE NEEDS

Developing a robust blue economy in Los Angeles will require the expansion of existing workforce needs to include new jobs, training and education opportunities spanning a wide range of skills and knowledge.

There is significant promise within the blue economy, not only for next generation jobs in both tourism and marine transportation — which make up the vast majority of our current blue economy— but also in new industries with perceptibly high job growth potential. Some of these new industries will provide avenues to sustain and grow our livelihoods while also addressing the serious issues of climate change, pollution and overfishing as well renewable energy and cutting-edge biotechnology.

Total employment in existing industries of the blue economy across the state of California is expected to grow 10.3 percent by 2023, largely within the marine transportation industry.

In Los Angeles County, employment in existing industries within the blue economy is expected to increase at least seven percent (7%) by 2023. The county’s marine construction industry is driving this employment growth, with

a projected increase of 47.7 percent during the forecast period.

Within emerging industries, it is anticipated that job growth will be tied to the development and implementation of technologies that improve the effective utilization of ocean resources. In some industries, such as marine aquaculture, job growth will be closely tied to government policies and regulations.

In L.A. County, there are several universities and community colleges that provide pathways into the current and emerging sectors of the blue economy. Furthermore, there are programs on the horizon to train and educate the L.A. workforce in the innovative technologies that are being developed in the coming years.

TRENDS AND BARRIERS

As part of its analysis of the California and L.A. County ocean economies, LAEDC facilitated discussions and interviews with representatives from ocean economy-related industries located in the Southern California region to obtain their assessments of the current ocean economy in Los Angeles County.

LAEDC proposed two broad questions to the firms and organizations interviewed:

- 1. How can government, science, and business best collaborate to support a shared vision for Los Angeles County’s ocean economy that maximizes environmental and economic co-benefits?**
- 2. What elements are needed to create a rich innovation and entrepreneurial environment that accelerates new firm creation and growth, as well as an in-flow of investment capital, such as “seed” and venture capital, into the L.A. County’s ocean economy?**

Overall, there is growing consensus that industry representatives in the ocean economy

would benefit from greater collaboration and participation in legislative, public policy and regulatory processes at the outset and throughout.

LAEDC interviewed start-up companies engaged in the ocean economy to discuss the opportunities and challenges of operating and scaling sustainable firms in L.A. County.

Competitive advantages that are igniting innovation within related industries and attracting entrepreneurs include access to two of the world's largest ports; extensive coastal access points; partners committed to ocean excellence such as the Southern California Marine Institute and AltaSea; and state and local legislative bodies that are committed to addressing the negative impacts of climate change.

To create a world-leading blue economy, these advantages must be leveraged and combined with other facets of production and inputs, such as greater access to proof-of-concept, seed, venture and development-stage capital.

LAEDC's interview with NOAA revealed that the organization is interested in partnering with economic development corporations, incubators, accelerators, and educational institutions to develop and implement programs to expedite commercialization in the region. This type of collaboration will help Los Angeles further develop its blue economy to reach its full potential and reap the economic and ecological rewards, much like the other cities and nations that have invested in this promising sector.

OCEAN ECONOMY CASE STUDIES

Countries and cities that have invested in the growth of their blue economies are on the cutting edge of research and development (R&D), modernization, and sustainability. These governments and the economies they support are realizing the benefits of their

investments with increased GDP, employment, and improved natural resource management.

Since the designation of its specific ocean territory, Bangladesh has prioritized the ocean and blue economy as an important factor in future growth. The government has invested heavily in maintaining coastal and marine ecosystems to create a vibrant and successful blue economy. Meanwhile, favorable policies and funding support in Indonesia have led the island nation to become the second-largest fish producer in the world (after China), with 2.7 million and 3.3 million workers employed by wild-catch fisheries and aquaculture, respectively. In the United States, the state of Washington has seen the public and private sector collaborate to grow its blue economy to a value of \$37.6 billion a year, while San Diego serves markets in Asia and Latin America as one the world's largest port cities, with many jobs directly or indirectly connected to the blue economy. These case-studies and others can serve as models for Los Angeles.

Five different locales and the impacts of their blue economies are reviewed in detail in this report:

- ❖ Bangladesh;
- ❖ Indonesia;
- ❖ Massachusetts;
- ❖ San Diego; and
- ❖ Washington State.

Case studies were selected with an aim to reflect global and national trends in the development of a blue economy. The studies provide information on what steps have been taken to ensure the sustainability of the ocean economy and to offer recommendations on next steps.

While the case studies differ in nuances, all coalesce around many of the same topics, and each provides recommendations on paths forward in the ocean economy. Most studies provide important recommendations for supportive government policies; framework for R&D cooperation, commercialization, and

incubation; and development of a sustainable workforce, including training and education programs.

Other common recommendations include modernization of current techniques, investing in infrastructure, and increasing efforts to protect natural resources.

IMPACT OF CLIMATE CHANGE ON THE OCEAN ECONOMY IN LOS ANGELES COUNTY

Globally, climate change has already created observable effects – glaciers have melted, plants and animals have shifted territories, and trees are blooming at different times. In California, increasing ocean temperature and acidification, sea level rise, frequent heat waves, extreme fires, and other storm events are becoming the new normal. The signs of environmental change are noticeable, and climate change does indeed have a role in shaping the blue economy.

There are five broad and interconnected climate change forces most likely to impact the ocean and ocean-related activities in Los Angeles County: **Sea Level Rise, Ocean Warming, Ocean Acidification, Temperature Change, and Extreme Heat**. The potential economic impacts of these climate forces are examined in detail in the report.

While climate change will have an impact on the blue economy, investing in the blue economy gives our region the opportunity to have measurable impacts on climate change. This is perhaps one of the greatest opportunities that a blue economy presents to Los Angeles.

Feedback from ocean-based businesses to the changing environment has the potential to not only be profitable, but also play a role in reducing impacts. A 2019 report from the U.N. Secretary General's Climate Action Summit highlighted five key solutions that would help limit effects of climate change and contribute to

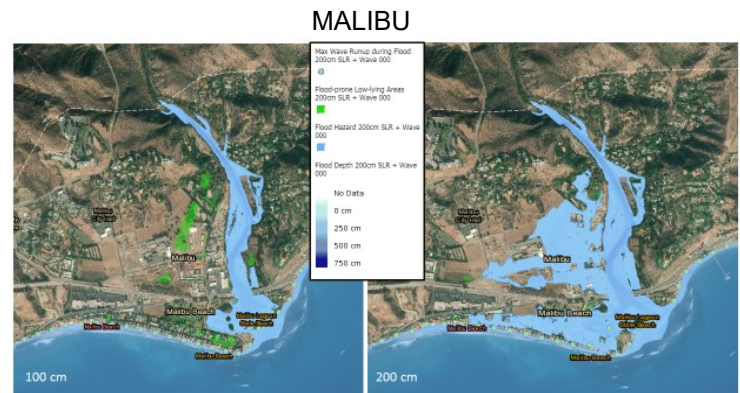


Figure 4: Projected sea level rise impact in Malibu at 100cm and 200 cm

a sustainable ocean economy while protecting coastal communities from storms, providing jobs, and improving food security. These solutions include:

- ❖ Increasing the use of ocean-based renewable energy.
- ❖ Decarbonizing domestic and international shipping and transport.
- ❖ Increasing the protection and restoration of “blue carbon” ecosystems—mangroves, seagrasses, and salt marshes.
- ❖ Utilizing low-carbon sources of protein from the ocean, such as seafood and seaweeds, to help feed future populations in a healthy and sustainable way, while easing emissions from land-based food production.
- ❖ Carbon storage in the seabed.

Complete implementation of these ocean-based climate solutions could deliver one-fifth (up to 21%) of the annual greenhouse gas emissions cuts outlined in the Paris Agreement to help keep global temperature rise below 1.5 degrees Celsius. Emission reductions of this magnitude are equivalent to eliminating the annual emissions from all coal-fired power plants worldwide or taking 2.5 billion cars off the road.

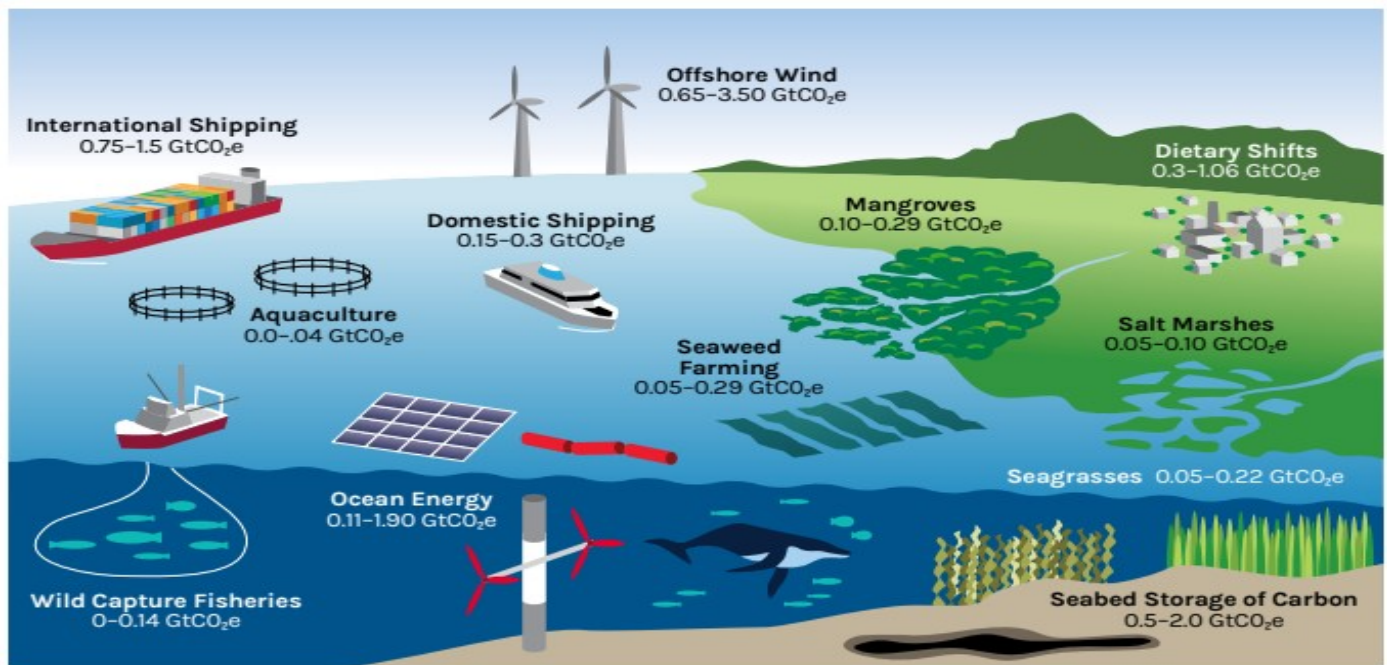


Figure 5: Contribution of Five Ocean-based Climate Action Areas to Mitigating Climate Change in 2050⁹⁶

CREATING NEW POLICIES

An essential aspect to realizing the full potential of the blue economy is employing a more integrated approach to policy development. Policy recommendations intended to strengthen and grow the blue economy in Los Angeles County fall into three different categories:

ENVIRONMENTAL POLICY RECOMMENDATIONS

- ❖ Preserve the local waterfront, ocean, and their resources
- ❖ Promote utilizing the ocean for renewable energy
- ❖ Continue to combat climate change and lead the nation in climate change policy
- ❖ Continue to promote recycling of plastics and other long-life products

WORKFORCE/INDUSTRY CLUSTER POLICY RECOMMENDATIONS

- ❖ Increasing throughput of local ports by eliminating trade hurdles and promoting trade with trans-pacific partners
- ❖ Invest in local development programs for maritime workers

- ❖ Grow ecotourism in Los Angeles

GOVERNMENTAL POLICY RECOMMENDATIONS

- ❖ Communicate potential legislation to small and large firms and trading partners involved in the ocean economy in order to prepare them for upcoming legal changes

The recommendations act to preserve a renewable, clean, ocean economy while upholding California's image as a key trading partner and the nation's leader in environmental issues.

CONCLUSION

The total impact of California's shoreline transcends the economic and ecological impacts defined by this study. In addition to over one million workers in the state for whom the shoreline and coastal waters are a source of economic opportunity, California's 26 million coastal residents also depend on the shoreline in some form or fashion. In the face of growing threats such as climate change, our state must capitalize on its unique position to create and employ innovative ways to protect its most prized resource: the ocean.

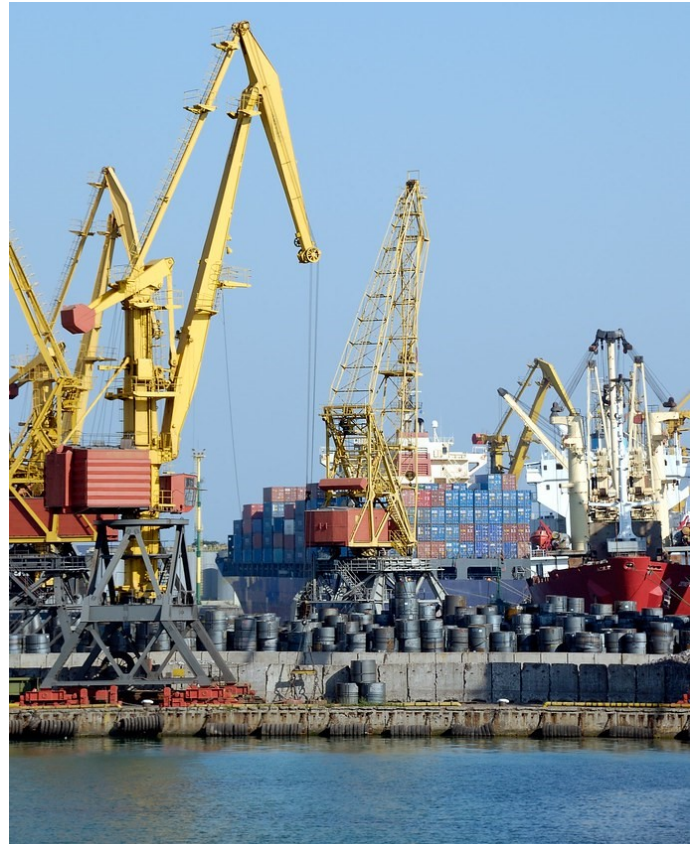
1. INTRODUCTION

The ocean covers 71 percent of the Earth's surface, yet only five percent of it has been explored. A myriad of unknown species, activities and potential new industries await discovery in the azure depths. Measuring the breadth of economic activities that are dependent on the Earth's oceans is essential to understanding what's at stake when discussing regulations, use of ocean-related resources, and the promise of the blue economy.

Conservative estimates indicate that the value of the blue economy will double over the next decade, with a **projected global value of \$3 trillion by 2030**. Across the world, municipal and national entities are investing in the sustainable development of their own blue economies and reaping significant economic and ecological rewards. Tangible opportunities exist for California and Los Angeles (L.A.) County to follow in their footsteps.

This report presents a cross sectional analysis of the economic impact of the existing ocean economy, its social and environmental role in the lives of Californians and Los Angeles residents, and the potential for growing a robust blue economy. The concept of the blue economy transcends a one-dimensional vision of business opportunity, and instead thrives on a synthesis of extraction, conservation, husbandry and recreation. Prior to addressing the consequential effects of the ocean, this report first offers a comprehensive definition of the blue economy and its key sectors.

Next, the economic impact and size of the current ocean economy is presented. The LAEDC Institute for Applied Economics (IAE) has quantified the economic impact of the ocean economy in the State of California and in the County of Los Angeles.

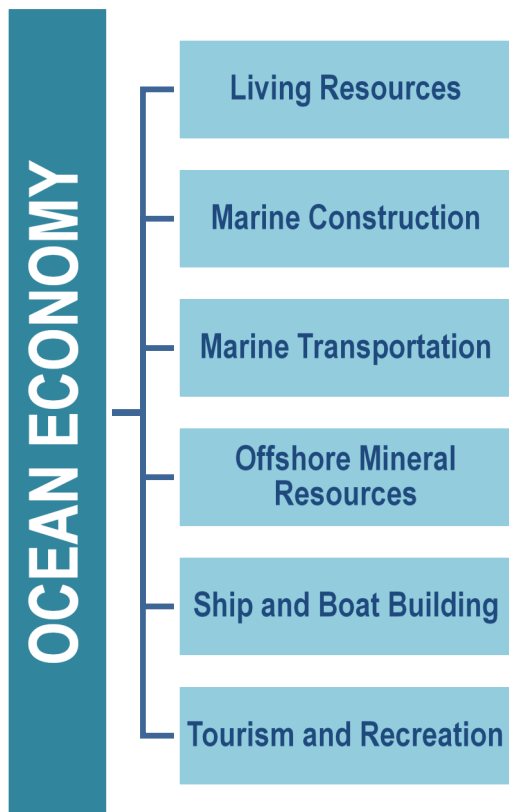


In Section 3, key occupations are identified and forecasted, along with an analysis of current community college and university programs that have direct impacts on the blue economy workforce.

Trends and barriers within the blue economy are discussed in Section 4, while case studies are presented in Section 5. A comprehensive review of the impacts that climate change poses to the economy is presented in Section 6.

Finally, detailed policy recommendations are provided to guide decision makers in their efforts to grow and strengthen our “home grown” blue economy.

Exhibit 1-1: Ocean Economy Taxonomy

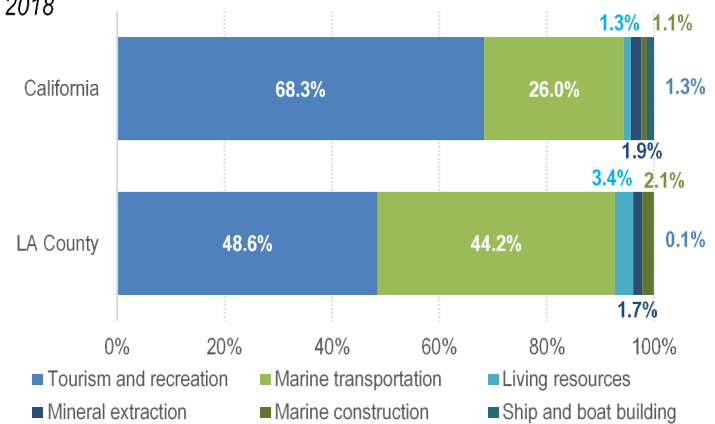


DEFINING THE BLUE / OCEAN ECONOMY¹

The blue economy is defined by the World Bank as the "sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of ocean ecosystem." The term ocean economy is often used interchangeably with blue economy, though it sometimes refers to only economic activities. An internationally agreed-upon definition for the ocean economy does not yet exist; thus, IAE reviewed comparable case studies and found the definitions used by the National Ocean Economics Program (NOEP) and the Organization for Economic Cooperation and Development (OECD) as acceptable baselines for measuring all activities encompassed within the ocean economy.

In this report, both terms are used as descriptors. The use of the term 'blue economy' in this report generally refers to the

Exhibit 1-2
Employment Distribution of the Ocean Economy
2018



integrated ecological and economical aspects of the ocean, including emerging markets, while the use of the term 'ocean economy' in this report generally refers to the combined economic activities of the six existing ocean-based industries displayed in Exhibit 1-1².

- ❖ Tourism and recreation;
- ❖ Ship and boat building;
- ❖ Offshore mineral extraction;
- ❖ Marine transportation;
- ❖ Marine construction; and
- ❖ Living resources.

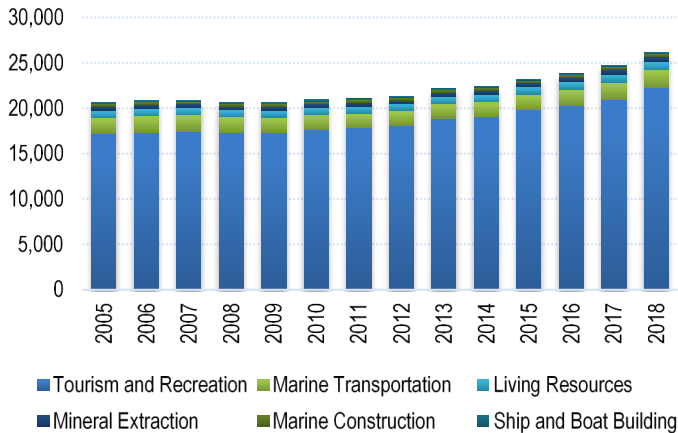
INDUSTRY COMPOSITION

While some of sectors contribute more to the state and regional economies than others, they each play a vital role in the existing ocean economy.

In both California and Los Angeles County, tourism and marine transportation currently make up over 90 percent of ocean economy employment, with all other industries contributing less than four percent each. Similarly, tourism and recreation contribute the most jobs to the ocean economies in Orange County, San Diego County, San Francisco County and Ventura County.

¹Note: the definition used by the LAEDC is not immutable, as impacts and measurements of the ocean economy have room to shift and adapt over time. With only a portion of our oceans explored, many opportunities remain to build upon existing sectors and develop entirely new ones. Moreover, industry codification is always evolving, meaning the definition of the ocean economy is subject to revision in future research.

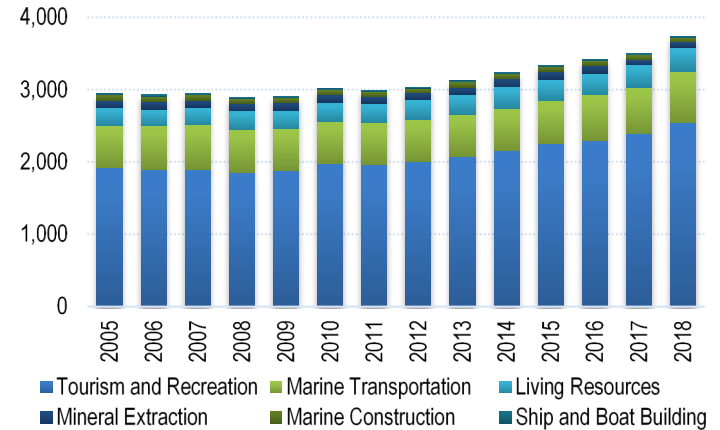
²NOAA; Economics: National Ocean Watch, 2016

Exhibit 1-3**Distribution of Ocean Economy Establishments**
California, 2005-2018

Marine transportation is a close second behind tourism and recreation in California and L.A. County, accounting for 26 percent of jobs in the state and 44 percent of current ocean economy jobs in L.A. County. The significant difference in employment share in transportation is largely due to the impact of trade at the San Pedro Bay Port complex, one of the busiest ports in the world. The Living Resources sector also contributes more to the L.A. County ocean economy than it does to California's.

The breakdown of ocean economy establishments in California and Los Angeles County from 2005 to 2018 are shown in Exhibits 1-3 and 1-4.

Employer establishments in the ocean economy have a similar distribution, with the tourism and recreation industry boasting the largest number of establishments out of all six sectors in 2018. Over 22,200 and 2,500 tourist establishments are in operation in California and L.A. County, respectively. Marine transportation ranks next with the second largest number of establishments in the state and county; almost 20 percent of establishments in Los Angeles County and almost eight percent (8%) in California are in the marine transportation industry. These establishments are largely made up of

Exhibit 1-4**Distribution of Ocean Economy Establishments**
L.A. County, 2005-2018

warehouses, cargo handling services, port operations and support services in transportation.

Over the next decade, tourism and marine transportation (specifically shipping) will remain important contributors to the blue economy, along with several new emerging sectors that have been identified and classified by their potential for long-term growth. Industries with the best prospects for high long-term growth include offshore wind, surveillance and safety, and marine aquaculture. In addition, industries that have long-term potential but are not yet at commercial scale—such as ocean renewable energy, marine biotechnology, and carbon capture and storage—will present new opportunities for innovations in technology and resource management. These industries are discussed in more detail in Section 2 of this report.

OCEAN-BASED INDUSTRIES

Each of the sectors in the existing ocean economy are comprised of unique ocean-based industries. Here we identify what industries and activities these sectors include and briefly discuss why they are important to our state and our region.

Living Resources includes fish hatcheries and aquaculture; fishing; seafood processing; and seafood markets.

Marine aquaculture has the potential for significant growth, given that the ocean currently produces two percent (2%) of global food supply despite covering 71 percent of the Earth's surface³. Creating policy to bolster this industry, while also continuing to adhere to California's rigorous environmental standards, could increase protein production at a much lower carbon footprint than other forms of farming. Marine aquaculture of some species such as seaweeds and bivalves can also help to remediate pollutants in water and supply other industries, such as biofuels.

Marine Construction refers to heavy and civil engineering related to the ocean. Developments in coastal communities are built specifically to withstand a harsh marine environment, using "hard" infrastructure elements such as sea walls, breakwaters and various wave-deflecting structures.

Beach nourishment -adding large quantities of sand or sediment to the beach- is also a common activity in this sector intended to help combat issues with erosion and stabilize shorelines. As sea levels continue to rise in the face of climate change, the practice of beach nourishment is likely to increase. The coastal beach restoration and erosion control program led by the state seeks to conserve the state's shorelines and minimize social and economic losses associated with beach erosion.

Marine Transportation encompasses warehousing, passenger transportation, deep sea freight, search and navigation equipment, and marine transportation services. With 11 ports operating throughout the state, marine transportation is a significant component of the state's economy and represents more than 25 percent of employment within the state's ocean economy and more than 40 percent of



employment within L.A. County's ocean economy (Exhibits 1-2).

Offshore Mineral Resources include activities such as oil and gas extraction, with supporting roles inclusive of drilling, geophysical exploration and mapping, and sand mining.

The state of California is the fourth largest producer of crude oil in the nation and has the fourth-largest share of proven oil reserves⁴, which generate significant revenue. Currently, 19 offshore oil and gas agreements are operated in California waters; however, since 1994, California's coastline has remained off limits to any new oil and gas leases⁵.

Despite its relatively small direct impact on employment, geophysical exploration and mapping services are of great importance throughout the state. Earthquake-prone and geologically diverse, California benefits from increased research and development in geology and seismology, which allows our infrastructure to be built to withstand potential natural disasters.

Ship and Boat Building encompasses activities primarily occurring in shipyards, boatyards, and manufacturing facilities. Ships are defined as watercraft for non-recreational use, while boats are defined as watercraft intended for personal use.

³Seafood for the Future; Marine Aquaculture 2019

⁴EIA; California State Profile and Energy Estimates, 2018

⁵California State Lands Commission, 2019

In 2018, ship and boat building contributed over 8,400 jobs in California in 2018. While it is the only sector out of the six ocean-based sectors with a forecast for a decline in employment, it remains a significant contributor to the ocean economy. Ship and boat building also support the bustling freight and cruise ship industries, which are essential components of California's ocean economy. The modest employment and direct impact of this industry contributes an essential supporting role to the state's other ocean related sectors.

Tourism and Recreation includes activities that illustrate the iconic image of California's beaches, such as surfing, snorkeling, camping and beach volleyball. California beaches and the recreational activities they support are key factors in the state's global position as a top tourist destination.

Predictably, this sector is the largest driver of the ocean economy within both Los Angeles County and California, employing about 50 percent and two-thirds of the workers within their ocean economies, respectively.

Other activities in this sector include sightseeing operations, ocean-related botanic gardens and zoos, aquariums, recreational boat dealers and many food and accommodation services located along the coast.

OCEAN ECONOMIES ALONG THE CALIFORNIA COAST: A COMPARISON

As previously discussed, the tourism and recreation sector currently leads in the number of jobs and establishments in the ocean economy throughout California. However, as to be expected, the prominence of each industry varies across different regions.

To understand and measure the uniqueness of the ocean economy in Los Angeles County in comparison with other coastal regions in California, we analyze the employment distribution of our ocean-based sectors along with four other counties located along California's coast: Orange County; San Diego County; San Francisco County; and Ventura County.

Similar to the Los Angeles County and state-level data already presented, tourism and recreation contribute the most ocean economy jobs in each of these four counties.

Orange County has the highest share of employment in marine transportation of all four coastal counties presented in this section, due to its close proximity to the ports of Los Angeles and Long Beach. (Exhibit 1-5)

Exhibit 1-5

Employment Distribution of the Ocean Economy
Orange County

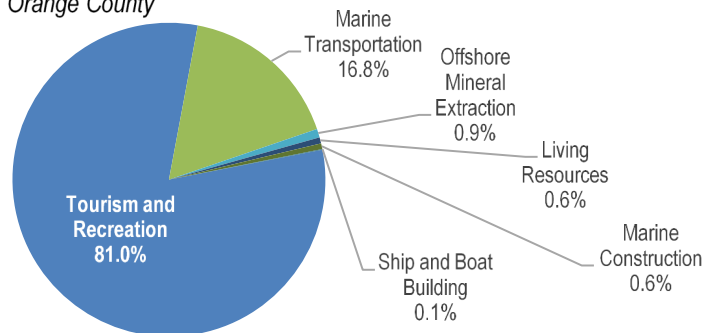
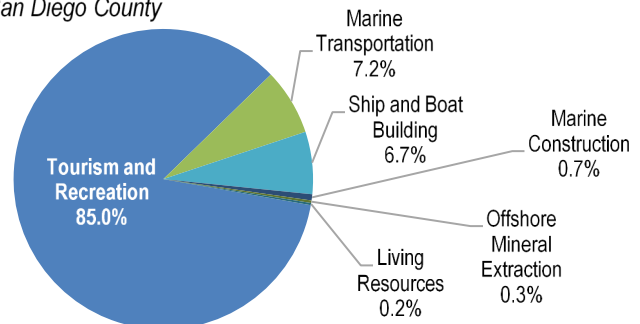


Exhibit 1-6

Employment Distribution of the Ocean Economy
San Diego County



The prominence of the U.S. Navy in San Diego County illustrates why it is the only county to have more than two percent (2%) of its ocean economy employment in the ship and boat building sector. (Exhibit 1-6)

In San Francisco County, tourism and recreation accounts for nearly all ocean economy-related jobs at 97.1 percent. (Exhibit 1-7)

Among the selected counties, Ventura County has the greatest share of ocean-related employment in mineral extraction, at 4.2 percent. (Exhibit 1-8)

BLUE ECONOMY PROSPECTS

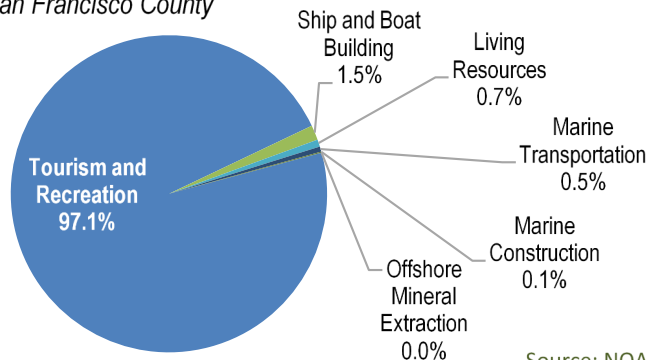
Looking to the future, there are favorable circumstances to harness the full potential of the blue economy and usher in a new era of innovation in Los Angeles. A 'sea change' is turning the tides, and stakeholders are focusing more on developing sustainable solutions and contributing to emerging industries.

The county's 75 miles of coastline coupled with unique location-based resources including world-class research institutions and technology companies will lead to new discoveries and the creation of well-paying jobs.

Exhibit 1-7

Employment Distribution of the Ocean Economy

San Francisco County

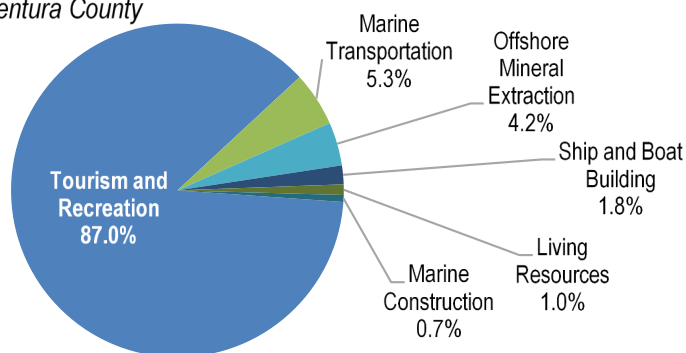


Source: NOAA

Exhibit 1-8

Employment Distribution of the Ocean Economy

Ventura County





2. ECONOMIC ANALYSIS OF THE OCEAN ECONOMY

The ocean economies of California and Los Angeles County have impacts on other macro economies beyond ocean-related jobs. Direct industry activity creates indirect and induced effects that ripple through the state and regional economy (Exhibit 2-1). These effects are related to the spending of ocean economy firms in their supply chain and the household spending of the ocean economy workforce. Together, these economic activities generate billions in output, value added impact, income and various tax revenues, and many jobs.

CALIFORNIA

The current economic impact of the ocean economy in California is presented in Exhibit 2-2.

Exhibit 2-1: Direct, Indirect and Induced Effects

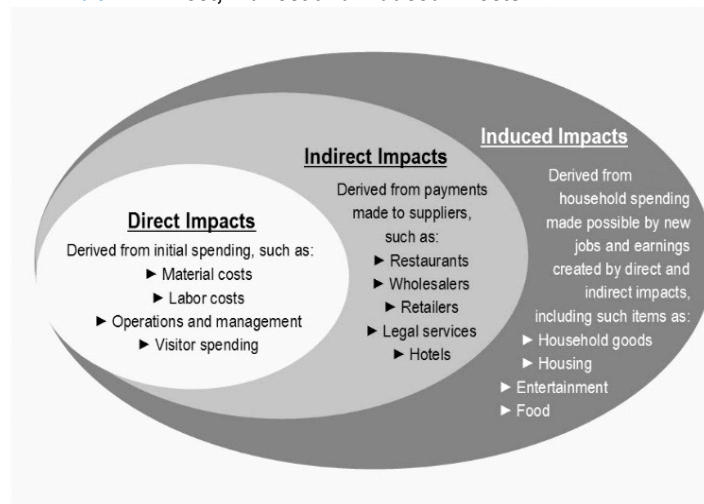


Exhibit 2-2

Economic and Fiscal Impact of the Ocean Economy in California

Total Economic Impact

Total Output (\$ billions)	\$143.4
Gross State Product (\$ billions)	\$84.4
Total Employment	1,035,200
<i>Direct</i>	660,200
<i>Indirect and Induced</i>	375,000
Total Labor Income (\$ billions)	\$53.3
Total State and Local Taxes (\$ billions)	\$8.0

Source: Estimates by LAEDC

Exhibit 2-3

Employment Impact of the Ocean Economy in California

	Jobs	Labor Income (\$ millions)	Output (\$ millions)
Ag and Mining	16,590	\$1,211	\$3,184
Utilities	1,170	\$208	\$964
Construction	5,440	\$397	\$994
Manufacturing	61,440	\$6,657	\$26,587
Wholesale trade	20,140	\$1,755	\$5,066
Retail trade	36,570	\$1,601	\$3,905
Transportation and warehousing	183,420	\$10,271	\$21,971
Information	7,210	\$1,538	\$4,804
Finance and insurance	22,190	\$1,935	\$5,637
Real estate and rental	26,790	\$1,275	\$12,407
Professional, scientific technical	32,030	\$2,894	\$4,722
Management of companies	10,120	\$1,409	\$2,637
Administrative and waste services	41,300	\$1,887	\$3,552
Educational services	13,260	\$527	\$792
Health and social services	39,760	\$2,552	\$4,315
Arts, entertainment and recreation	17,300	\$680	\$1,530
Accommodation and food services	469,540	\$14,736	\$37,154
Other services	28,240	\$1,434	\$2,321
Government	2,660	\$296	\$868
Total	1,035,200	\$53,263	\$143,410

Source: Estimates by LAEDC

The LAEDC estimates that the ocean economy in California (2018) generates:

- ❖ over \$143 billion in output,
- ❖ \$84 billion in gross state product (GSP),
- ❖ and over \$53 billion in total labor income.

In terms of GSP, the ocean economy comprises roughly 3 percent (3%) of the state's overall economy.

In addition to the ocean economy's **direct employment of over 660,000** California workers, indirect and induced activity sustains an additional 375,000 jobs in the state. In total, this equates to **1.035 million California jobs directly and indirectly buoyed by the ocean economy**, which equates to roughly seven percent (7%) of state's total workforce.

The jobs created by the ocean economy and supported by its indirect and induced activity encompass all major industry groups. However, industries that benefit most from the

Exhibit 2-4

Economic and Fiscal Impact of the Ocean Economy in LA County

Total Economic Impact

Output (\$ billions)	\$34.3
Gross County Product (\$ billions)	\$20.0
Employment	200,400
<i>Direct</i>	117,900
<i>Indirect and Induced</i>	82,500
Labor Income (\$ billions)	\$12.8
Total Local Taxes (\$ billions)	\$1.7

Source: Estimates by LAEDC

Exhibit 2-4b

Employment Impact of the Ocean Economy in LA County

	Jobs	Labor Income (\$ millions)	Output (\$ millions)
Ag and Mining	2,080	\$197	\$395
Utilities	310	\$54	\$233
Construction	970	\$62	\$165
Manufacturing	19,750	\$2,999	\$9,715
Wholesale trade	5,930	\$451	\$1,394
Retail trade	7,970	\$361	\$850
Transportation and warehousing	47,110	\$3,192	\$7,210
Information	1,670	\$288	\$978
Finance and insurance	4,490	\$398	\$1,192
Real estate and rental	5,120	\$274	\$2,563
Professional, scientific technical	7,010	\$652	\$1,085
Management of companies	2,440	\$293	\$583
Administrative and waste services	10,470	\$434	\$839
Educational services	2,370	\$108	\$161
Health and social services	9,840	\$598	\$1,037
Arts, entertainment and recreation	2,260	\$100	\$227
Accommodation and food services	63,720	\$2,000	\$5,018
Other services	6,550	\$311	\$506
Government	370	\$59	\$153
Total	200,400	\$12,831	\$34,303

Source: Estimates by LAEDC

ocean economy in terms of employment impacts are accommodation and food services, which is a result of the ocean economy's reliance on tourism, and transportation and warehousing (Exhibit 2-3). These two industries support over 469,000 and 183,000 jobs, respectively. The state's

manufacturing industry is also a significant beneficiary, with over 61,000 California manufacturing jobs supported (directly and indirectly) by the ocean economy.

LOS ANGELES COUNTY

In Los Angeles County, the ocean economy is no less significant in terms of its economic and fiscal contributions. The economic impact of the ocean economy in the County is presented in Exhibit 2-4.

In total, Los Angeles County's ocean economy produces:

- ❖ 200,400 total jobs,
- ❖ over \$34 billion in output,
- ❖ \$20 billion in gross county product (GCP),
- ❖ over \$12 billion in labor income, and
- ❖ \$1.7 billion in local taxes (2018).

As a proportion of GCP, the ocean economy currently contributes 2.5 percent to the Los Angeles County total. In addition to **directly employing over 117,000 workers**, the county's ocean economy sustains an additional 82,500 jobs.

Similar to the statewide ocean economy, Los Angeles County's overall ocean economy job impacts are largest in accommodation and food services and in transportation and warehousing. The overall employment impacts in these two industries are 63,700 and 47,100 jobs, respectively. Manufacturing is third, in terms of ocean economy-related employment impact, with over 19,700 jobs.

DYNAMIC IMPACTS

The LAEDC forecasts that by 2023 the ocean economy in LA County⁶ will directly employ

Exhibit 2-5

Dynamic Impacts of the Ocean Economy, 2019-2023

Direct effects

Employment (2023)	126,170
Wages Paid (2019-2023, \$ billions)	\$ 37.7

Forecasted Impacts (aggregate, 2019-2023)

Output	\$ 80.1
GDP	\$ 49.8
Employment (5-year average)	105,800
Personal Income	\$ 69.2

Source: REMI; Estimates by LAEDC

Exhibit 2-6

5-Year Contribution Forecast of the Ocean Economy

Los Angeles County, 2019-2023

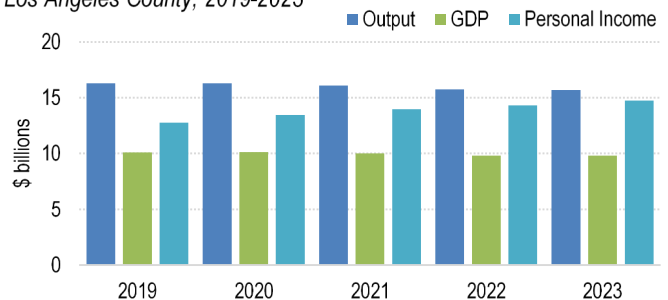
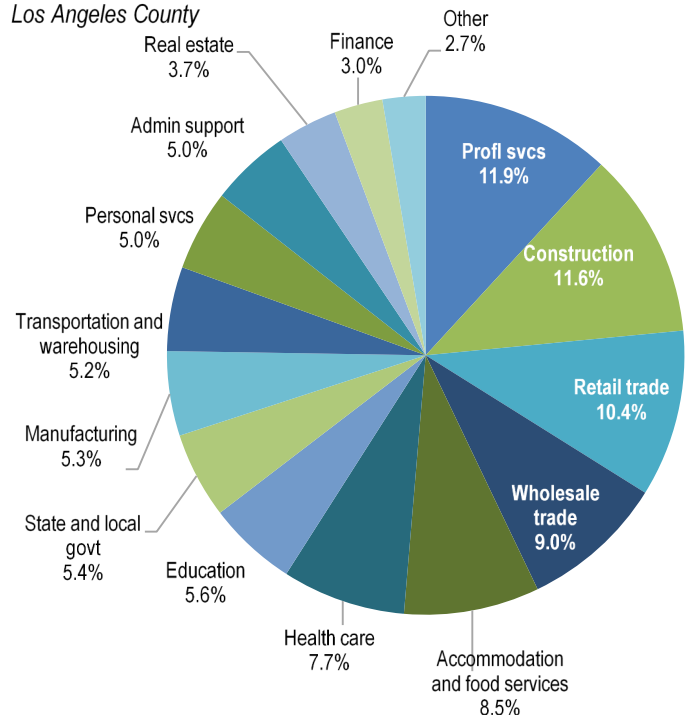


Exhibit 2-7

Average Indirect Employment Contribution, by Industry

Los Angeles County



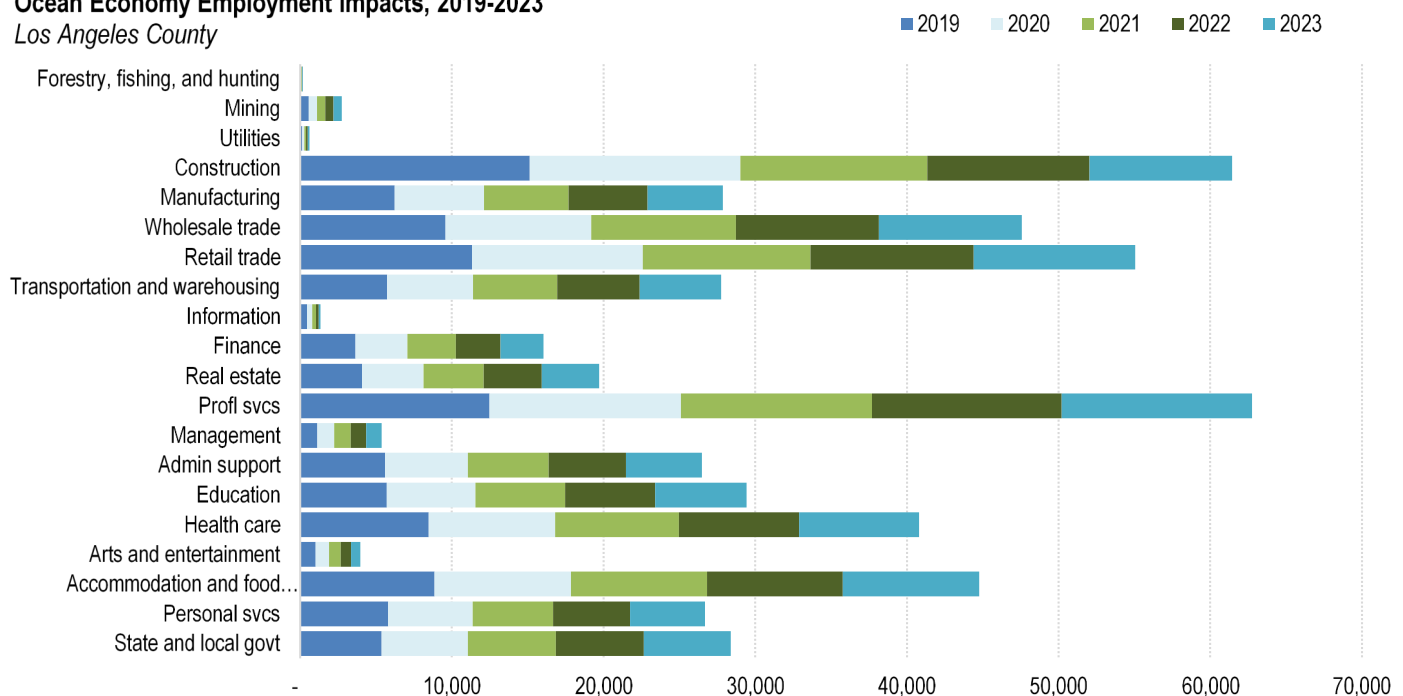
⁶The REMI model is only limited to Los Angeles County and therefore state-level impacts are not presented in this report.

⁷Wages refer to monetary compensation given to an employee or independent contractor for work done, while personal income encompasses both cash and non-cash payments / benefits that are subject to local, state and federal

Exhibit 2-8

Ocean Economy Employment Impacts, 2019-2023

Los Angeles County



over 126,000 people and will pay \$37.7 billion in wages⁷ between 2019 and 2023.

Using REMI to forecast the ocean economy's contribution to the county between 2019 and 2023, it is estimated that the ocean economy's activity will sustain an average of **105,800 indirect and induced jobs per year** over the forecast period.

Over the five years, it is predicted the ocean economy will generate:

- ❖ \$80.1 billion in regional output,
- ❖ \$49.8 billion in GCP and
- ❖ \$69.2 billion in personal income.

On an annual basis over the forecast period, this would equate to an average of:

- ❖ \$16.0 billion in output,
- ❖ \$10.0 billion in GDP and
- ❖ \$13.8 billion in personal income annually.

The ocean economy's indirect and induced employment contribution over the forecast period is estimated to spread across all industries. The industries benefiting the most from the ocean economy include professional services, construction, retail trade and wholesale trade (see Exhibit 2-7 for complete breakdown). The distribution of employment indirectly sustained by the ocean economy is expected to be relatively constant over the forecast period.

3. WORKFORCE NEEDS ASSESSMENT

Developing a robust blue economy in Los Angeles will require expansion of existing workforce development systems to address new job opportunities with training and education, spanning a wide range of skills and knowledge.

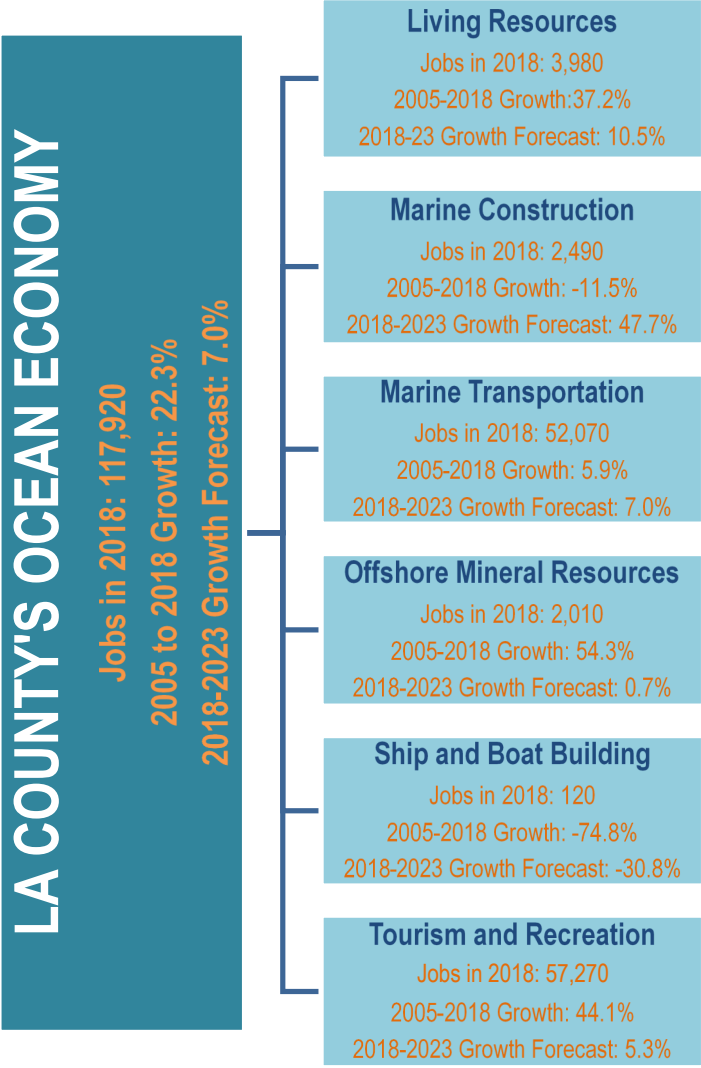
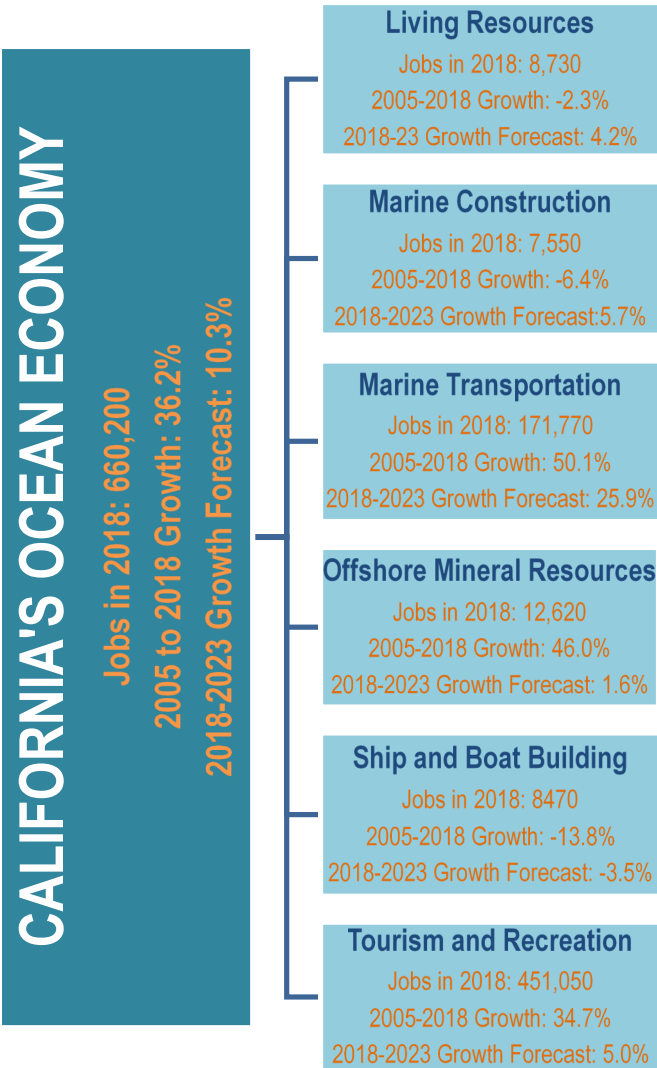
There is significant promise for growth within the blue economy, not only for next generation jobs in both tourism and marine transportation, but also in new industries with perceptibly high job growth potential. Some of these new industries will provide avenues to sustain and grow our livelihoods while also addressing the serious issues of climate change, pollution and

overfishing as well renewable energy and cutting-edge biotechnology.

For the purposes of this report, the LAEDC created an employment forecast for existing ocean economy-related jobs through 2023. In addition, this section contains a forecast for emerging industries over the next decade using data from the OECD Ocean Economy 2030 report. Figures 3-1 and 3-2 show the LAEDC projected employment growth across the existing sectors of the ocean economy in California and Los Angeles County, respectively.

Figure 3-1: Projected employment growth across sectors of the ocean economy in California

Figure 3-2: Projected employment growth across sectors of the ocean economy in LA County



CALIFORNIA

Total employment for the ocean economy across the state is expected to grow 10.3 percent by 2023, largely within the marine transportation industry.

LOS ANGELES COUNTY

In Los Angeles County, employment in the ocean economy is expected to grow seven percent (7%) between 2018 and 2023. Despite comprising only two percent (2%) of the overall ocean economy in L.A. County (2018), employment within the county's marine construction industry is expected to grow by 47.7 percent over the forecast period.

EMPLOYMENT FORECAST BY SECTOR

Tourism and Recreation

Stable growth expected in the tourism and recreation industry at both the state and county levels by 2023. At both levels, the industry can anticipate an employment growth around five percent (5%). Restaurants and other food establishments are expected to enjoy the bulk of this growth, with occupations such as cooks, servers and hosts expected to increase. More than 3,000 jobs are expected to be added in Los Angeles County in this sector over the period.

3,010

*Jobs Added
2018-23*

Marine Construction

The state's marine construction industry is forecasted to sustain stable growth of over 5 percent, with significantly more growth projected in Los Angeles County, where the industry is forecasted to grow over

1,190

*Jobs Added
2018-23*

45 percent and add over 1,100 jobs by 2023. As mentioned, beach nourishment as a result of rising sea levels will be a contributing factor to this growth. Likewise, additional project developments within county coastal neighborhoods are a contributing factor as well. Close to 1,200 jobs are projected to be added in this sector in Los Angeles County over the period.

Marine Transportation

Employment in marine transportation, already a significant factor in the Los Angeles County ocean economy, is expected to grow an additional seven percent (7%) by 2023, adding over 3,600 jobs in the county. In the state overall, employment in this industry is expected to grow by more than 25 percent over the forecast period, equivalent to over 44,000 jobs, which is more than any other ocean economy industry in the state. This sector is forecast to add 3,650 job in Los Angeles County over the period.

3,650

*Jobs Added
2018-23*

Offshore Mineral Resources

The forecasted growth of the mineral extraction industry is expected to have little change from 2018 to 2023. Over 12,000 jobs in this industry exist in California, over 2,000 of which are in Los Angeles County. Environmental regulations, along with further developments in and adoption of alternative energy sources, are expected to restrain the activities associated with this industry, such as drilling, petroleum and gas extraction, from significant growth rates. Only 20 jobs are expected to be added in this sector in Los Angeles County over the period.

20

*Jobs Added
2018-23*

Living Resources

From 2018 to 2023, employment in living resources is forecasted to increase 4.2 percent in the state, from 8,700 jobs in 2018 to nearly 9,100 jobs in 2023. In L.A. County, employment in the industry is expected to increase over 10 percent, adding roughly 420 jobs. Marine fishing and farming, seafood markets and seafood production and packaging are a few of the key activities related to this industry. Over 400 jobs are projected to be added in this sector in Los Angeles County over the period.

420

Jobs Added
2018-23

Ship and Boat Building

Employment in the ship and boat building industry is forecasted to decrease in both Los Angeles and the state over the coming years. This industry is the smallest job contributor to the ocean economy, both in L.A. County and California; employment within this industry has been steadily decreasing since its peak of over 450 jobs in L.A. County in 2005 and over 10,000 jobs across the state in 2008. This sector is forecast to lose 40 jobs in Los Angeles County over the period.

-40

Jobs Lost
2018-23

EMERGING INDUSTRIES

To assess the potential for job growth opportunities and challenges in the blue economy in the longer term, the Organization for Economic Co-operation and Development (OECD) researched and published the report “The Ocean Economy in 2030: The Ocean as a Sustainable Source of Economic Growth.”



Figure 3-3: Marine robotics is one of several emerging industries in the blue economy

The OECD report identified the following emerging industries:

- ❖ Deep- and ultra-deep water oil and gas
- ❖ Offshore wind energy
- ❖ Ocean renewable energy
- ❖ Marine and seabed mining
- ❖ Maritime safety and surveillance
- ❖ Marine biotechnology
- ❖ High-tech marine products and services
- ❖ Others

According to the report, above-average job growth is expected in almost all sectors listed, with especially rapid employment growth occurring in marine aquaculture, fish processing, offshore wind and port activities.

Within these emerging industries, it is anticipated that job growth will be tied to the development and implementation of technologies that improve the effective utilization of ocean resources. In some industries, such as marine aquaculture, job growth will be closely tied to government policies and regulations, which is discussed in detail in Section 7 of this report.

OCCUPATIONAL ANALYSIS

Los Angeles County

The LAEDC has identified the occupations within L.A. County's ocean economy that are forecasted to have the greatest growth by 2023; they are reflective of the opportunities for growth in the construction and transportation sectors of the ocean economy.

Within the forecasted growth of the marine construction industry as a whole, the bulk of job growth is expected for construction laborers, projected to grow from 860 workers in 2018 to 1,250 by 2023. Additionally, occupations in transportation are projected to increase, especially those related to port activity.

California

In California's ocean economy, transportation industry occupations are expected to grow the fastest. Marine transportation employment is

forecasted to grow by 25 percent between 2018 and 2023. The shipping and receiving, truck driving and labor workforces, among others listed in Figure 3-4, can anticipate nearly 25 percent growth by 2023.

Local Workforce Development

A wide range of post-secondary education options are available for those interested in joining the ocean economy's workforce. Universities and community colleges in Los Angeles County provide pathways into all key sectors of the ocean economy, from degrees to certificate programs for those who are unable to complete a full degree program. A selection of educational programs in LA County that train students to work in ocean-related industries can be found in the appendix. In addition, work-based learning opportunities are available, including in emerging industries where startups are seeking to scale.

Figure 3-4

LAEDC Projections of Top 10 Growing Occupations in the Ocean Economy,
Los Angeles County - 2018-2023

Occupation	SOC Code	Los Angeles Employment 2018	Los Angeles Employment 2023	Growth Rate
1. Construction Laborers	47-2061	860	1,250	45.2%
2. General and Operations Managers	11-1021	1,640	1,780	8.2%
3. Heavy and Tractor-Trailer Truck Drivers	53-3032	2,210	2,380	7.6%
4. Packers and Packagers, Hand	53-7064	2,780	2,980	7.4%
5. First-Line Supervisors of Office and Admin Support Workers	43-1011	960	1,030	7.3%
6. Light Truck or Delivery Services Drivers	53-3033	1,040	1,120	7.2%
7. Shipping, Receiving, and Traffic Clerks	43-5071	2,260	2,420	7.1%
8. Laborers and Freight, Stock, and Material Movers	53-7062	12,530	13,410	7.1%
9. Transportation, Storage, and Distribution Managers	42-8005	1,340	1,440	7.1%
10. First-Line Supervisors of Transportation & Material Moving Workers	53-1048	2,940	3,150	7.0%

Figure 3-5**LAEDC Projections of Top 10 Growing Ocean Economy Occupations,
California - 2018-2023**

Occupation	SOC Code	California Employment 2018	California Employment 2023	Growth Rate
1. Laborers; Freight, Stock, & Material Movers	53-7062	41,374	51,806	25.2%
2. Industrial Truck and Tractor Operators	53-7051	18,031	22,657	25.7%
3. Stock Clerks and Order Fillers	43-5081	12,717	15,818	24.4%
4. First-Line Supervisors of Transportation & Material Moving	53-1048	9,750	12,225	25.4%
5. Packers and Packagers, Hand	53-7064	8,867	11,031	24.4%
6. Shipping, Receiving, and Traffic Clerks	43-5071	7,441	9,301	25.0%
7. Heavy and Tractor-Trailer Truck Drivers	53-3032	7,371	9,106	23.5%
8. Transportation, Storage, and Distribution Managers	42-8005	4,408	5,541	25.7%
9. General and Operations Managers	11-1021	6,764	7,844	16.0%
10. First-Line Supervisors of Food Preparation and Serving Workers	35-1012	21,247	22,314	5.0%

4. TRENDS AND BARRIERS

As California accelerates its transition to a low-carbon future, one of the main challenges is to implement policies that maximize environmental *and economic* co-benefits⁸ in a way that cuts emissions and also spurs economic prosperity, creates quality jobs and lifts communities. Indeed, policies that simply focus on cutting emissions will only guarantee California's role as a profligate *consumer* of the products and services needed to cut emissions, and will not ensure its global leadership as a researcher, designer, builder and exporter of them.

There are already numerous firms and supporting partner organizations in Southern California that are developing, commercializing and selling products, technologies and processes to address growing concerns about a range of issues including climate change, the protection of coastal ecosystems from rising sea levels, the environmental impacts of oceangoing shipping, the collapse of fisheries, the growth of ocean mining and the alarming growth in ocean plastic pollution and other debris. As part of its analysis of the California and L.A. County ocean economies, LAEDC facilitated discussions and interviews with a number of these organizations -including representatives from ocean economy-related industries, the science and technology sector, regional government agencies, non-governmental organizations, and entrepreneurs located in the Southern California region- to obtain their assessments of the current ocean economy in Los Angeles County.

LAEDC interviewed established firms such as Teledyne Marine with over 1,600 global employees (a subsidiary of Teledyne Scientific, which is headquartered in Thousand Oaks, California), as well as start-ups, some with fewer than five employees. A majority of the organizations interviewed were engaged in the following industries:

- ❖ Marine aquaculture
- ❖ Ocean renewable energy
- ❖ Marine manufacturing and construction
- ❖ High-tech marine products and services
- ❖ Southern California Ports

LAEDC proposed two broad questions to the firms and organizations interviewed:

1. *How can government, science, and business best collaborate to support a shared vision for Los Angeles County's ocean economy that maximizes environmental and economic co-benefits?*
2. *What elements are needed to create a rich innovation and entrepreneurial environment that accelerates new firm creation and growth, as well as an in-flow of investment capital, such as "seed" and venture capital, into the L.A. County's ocean economy?*

The following is a summary of the responses:

- ❖ A multitude of respondents stated that a major challenge is with governmental agencies that are often slow to adopt and/or deploy new technologies that increase efficiency, especially if the new process or technology is perceived as reducing labor requirements. For example, representatives from the shipping industry identified challenges with adoption of new vessel designs and technologies. Industry representatives said that outdated

⁸The express language of AB 32 reads, in part: *It is the intent of the Legislature that the State Air Resources Board design emissions reduction measures to meet the statewide emissions limits for greenhouse gases established...in a manner that minimizes costs and maximizes benefits for California's economy, improves and modernizes California's energy infrastructure and maintains electric system reliability, maximizes additional environmental and economic co-benefits for California, and complements the state's efforts to improve air quality. (Health and Safety Code § 38501(h); Emphasis added).*

technologies will remain in use until regulatory or other incentives create increased market demand.

❖ Several small to medium sized firms expressed the need for increased state and federal funding to support early-stage innovations and to coordinate government agencies. For example, there are a multitude of thermal and mechanical energy sources produced by the ocean, including tidal rise and fall, tidal and ocean currents, waves, submarine geothermal, and offshore wind. However, most industry activities require access to sea space, integration of multiple agencies in governance, coordination with government policies, and negotiation with a range of other users of sea space and resources. This level of coordination markedly increases the cost of doing business relative to other regions, states and nations. As a result, much of the energy produced by the ocean is not cost-effectively accessible in Southern California, as compared to other renewable energy sources.

❖ Firms engaged in seafood production identified their main priority as reducing barriers to the expansion of seafood production in Southern California through streamlined aquaculture permitting and regulatory reform. For example, Catalina Sea Ranch, located in San Pedro, is the first offshore aquaculture facility in federally regulated waters of the United States. However, the lack of U.S. Food and Drug Administration-approved biotoxin testing labs to test shellfish safety, and regulatory setbacks, delayed the mussel farm's commencement of commercial operations for several years.

❖ Mature firms engaged in the development of marine instruments expressed an interest in developing and

securing local suppliers for items that are currently manufactured in China and other foreign countries. The uncertainty of tariffs and other international events have disrupted their once stable and moderately priced supply chains.

Overall, there is growing consensus that industry representatives in the ocean economy would benefit from greater collaboration and participation in legislative, public policy and regulatory (i.e. rulemaking) processes at the outset and throughout, both at the regional, state and federal levels rather than waiting for draft regulations to be proposed and then attempting to amend or overturn them, or, worse, try to mitigate their effects after their adoption.

LAEDC interviewed several start-up companies engaged in the ocean economy to discuss the opportunities and challenges of operating and scaling sustainable firms in L.A. County. The county has many competitive advantages, including two of the world's largest ports, extensive coastal access points, the Southern California Marine Institute⁹, and state and local legislative bodies that are committed to addressing the negative impacts of climate change. These advantages are igniting innovation within related industries and attracting entrepreneurs; yet, these advantages aren't sufficient to catalyze a world-leading ocean economy on their own. They must be leveraged and combined with other facets of production and inputs, such as greater access to proof-of-concept, seed, venture and development-stage capital.

A number of the ocean economy start-up firms interviewed suggested that VC engagement in L.A. County remains a challenge, with much of the investment capital flowing to other regions of the state or country. The National Oceanic

⁹A strategic alliance of 23 major universities, colleges, and foundations in Southern California committed to providing marine expertise and hands-on experience to students at all levels, to achieve the highest and most efficacious level of research, to monitor the marine environment and to increase public awareness.

and Atmospheric Administration (NOAA), whose main goal is to increase private-sector commercialization of innovations derived from Federal research, is actively seeking to invest in Southern California firms in the context of three funding phases:

- ❖ Phase I – Feasibility stage, \$120,000 for 6 months
- ❖ Phase II – R&D, \$400,000, two years
- ❖ Phase III – Commercialization (non-SBIR funds)

LAEDC's interview of NOAA revealed that the organization is interested in partnering with economic development corporations, incubators, accelerators, and educational institutions to develop and implement programs to expedite commercialization in the region. Currently, there are only two incubators in Southern California focused exclusively on the ocean economy: AltaSea at the Port of Los Angeles and Port of San Diego Blue Economy incubator. A maturing system of ocean-related incubators and accelerators in the region would accelerate the development and retention of newly formed ocean-related firms, supporting more direct jobs. As these firms grow, there will be amplified multiplier effects, resulting in additional direct and indirect jobs, increased productivity and output, and positive fiscal impacts.

5. OCEAN ECONOMY CASE STUDIES

INTRODUCTION

Climate change, limited resources, and overfishing continue to threaten various economies throughout the globe. Countries and cities that have invested in the growth of their blue economies are on the cutting edge of research and development (R&D), modernization, and sustainability. These governments and the economies they support are realizing the benefits of their investments with increased GDP, employment, and improved natural resource management.

This focus on the economic benefits of the ocean is not new; however, there has been an increase in efforts to make the Blue Economy more fruitful and profitable while adhering to environmental guidelines. The case studies reviewed outline five different places (Bangladesh; Indonesia; Massachusetts; San Diego; Washington State) and their connection to a Blue Economy. The studies provide information on what steps have been taken to ensure the sustainability of the blue economy and offer recommendations on next steps.

Case studies were selected with an aim to reflect global and national trends in the development of a Blue Economy. Bangladesh and Indonesia have large ocean economies supported by governments that value the increasing importance of this type of economy. Selected areas in the United States (San Diego, Washington State, Massachusetts) reflect different parts of the country and highlight measures that are currently being taken from east to west. The U.S. locations aspire to be Blue Economy leaders.

Since the designation of its specific ocean territory, **Bangladesh** has prioritized the ocean and Blue Economy as an important factor in future growth. By maintaining coastal and marine ecosystems, the country hopes to

create a vibrant and successful Blue Economy. Efforts in **Indonesia** largely center on the Seafood Sector with a focus on aquaculture production (seaweed and fish production), creating a sustainable workforce, and developing government policies that benefit this sector. Stateside, **Massachusetts** has a Maritime Economy dating back to the 1600s and is home to the esteemed Woods Hole Oceanographic Institute. Comprised of six sectors, Massachusetts' Maritime Economy is attempting to address challenges in aquaculture, tourism and recreation. Money is currently being spent on the state's innovation economy to help with those challenges. Serving markets in Asia and Latin America, **San Diego** is one of the world's largest port cities with many jobs directly or indirectly connected to the Blue Economy. Lastly, **Washington** has a maritime industry that employs workers from every county of the state. With five subsectors of the Maritime Economy, Washington is looking towards long term sustainability through a growing economy, healthy ecosystems, and resilient communities.

While the case studies differ in nuances, all coalesce around many of the same topics, and each provides recommendations on paths forward in the burgeoning ocean economy. Most studies provide recommendations for supportive government policies; cooperation for Research and Development (R&D), commercialization, and incubation; and a sustainable workforce, including training and education programs. Other common recommendations include modernization of current techniques, investing in infrastructure, and increasing efforts to protect natural resources.

RECOMMENDATIONS FOR A BLUE ECONOMY

	Bangladesh	Indonesia	Massachusetts	San Diego	Washington
Supportive Government Policies	✓	✓	✓	✓	✓
Support R&D Commercialization Incubators	✓		✓	✓	✓
Workforce Training	✓		✓	✓	✓
Invest in Infrastructure		✓	✓		✓
Modernization	✓	✓			✓
Simplify Regulations			✓	✓	✓
Sustainability (protect existing resources)	✓	✓	✓		
Encourage Collaboration				✓	✓
Public/Private Funding			✓		✓

CASE STUDY: BANGLADESH

Publication: *Toward a Blue Economy: A Pathway for Sustainable Growth in Bangladesh* (World Bank Group, 2018)

Information (participants, dates, and purpose of study):

Following the peaceful resolution of maritime boundary disputes with its neighbors in 2010 and 2014, the Government of Bangladesh has defined ocean space under its jurisdiction. The country's ocean space is now almost equivalent in size to its land mass, resulting in the government prioritization of the ocean economy as a key source of future growth. The World Bank and European Union, along with academic and institutional partners, created this report to assist the Government of Bangladesh and support the nation's blue economy goals. This report defines an ocean economy and how it relates to a blue-economy; attempts to explain the current state of the nation's ocean-economy; and outlines how to apply the blue economy concept in Bangladesh.

BACKGROUND

The Bay of Bengal Large Marine Ecosystem (LME) is bordered by eight countries and contains 6.2 million square kilometers of highly productive waters. Bangladesh has approximately 710 kilometers of coastline measured in a line from its westernmost to easternmost points. The coast contains the world's largest delta, formed by the Padma and Meghna Rivers,¹⁰ and 32 percent of the

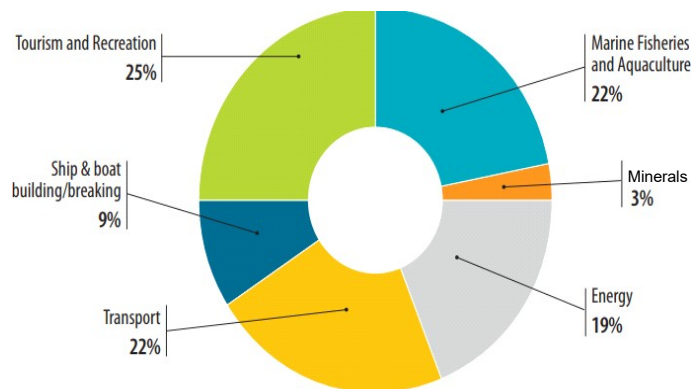


Figure 5-1: Composition of the Ocean Economy in Bangladesh, Percent of Gross Value Added (2014-15)¹³

terrestrial area in Bangladesh is defined as coastal zone.¹¹

Following decisions in 2012 and 2014 by the International Tribunal for the Law of the Sea (ITLOS), which resolved maritime boundary disputes, Bangladesh now exercises jurisdiction over the use of ocean resources in an area estimated to cover 121,110 square kilometers – equivalent to more than 80 percent of the country's total land area.¹³

OCEAN ECONOMY

The current ocean economy in Bangladesh consists mainly of tourism and recreation (25%); marine capture fisheries and aquaculture (22%); transport (22%); and offshore gas and oil extraction (19%). In 2015, ocean economy industries and services accounted for roughly 3.33 percent of the total Bangladesh Gross Value Added.¹⁴

¹⁰BOBLME. 2015. Strategic Action Programme (SAP).

¹¹Iftekhhar, M.S. 2006. "Conservation and management of the Bangladesh coastal ecosystem: overview of an integrated approach." *Natural Resources Forum*. Vol. 30 Wiley Online Library. P. 230-237

¹²Toward a Blue Economy: A Pathway for sustainable Growth in Bangladesh (2018)

¹³Food and Agriculture Organization (FAO). 2014. "FAO Fisheries & Aquaculture: Fishery and Aquaculture Country Profiles – The People's Republic of Bangladesh." <http://www.fao.org/fishery/facp/BGD/en#CountrySector-SectorSocioEcoContribution>. Accessed December 19, 2017.

¹⁴P.G. Patil, J.Virdin, C.S. Colgan, M.G. Hussain, P. Failler, and T. Vegh (2018). *Toward a Blue Economy: A Pathway for Sustainable Growth in Bangladesh*. Washington, DC: The World Bank Group.

BLUE ECONOMY

Following the resolution of its maritime boundaries in 2014, the Government of Bangladesh stated its interest in pursuing the blue economy concept as part of the country's growth strategy. Prime Minister Sheikh Hasina characterized the blue economy as a window of opportunity for the country's sustainable development. She also advanced an objective of turning the Bay of Bengal into a hub of economic development and prosperity that would contribute to poverty reduction, food security, and climate resilience.¹⁵

The coastal and marine ecosystems in Bangladesh provide services to society and can be characterized as natural capital assets. The status of these ecosystems will be a major determinant of the future growth of the country's economy, and its success in creating a blue economy. The Bay of Bengal provides natural capital in the form of non-renewable resources and ecosystem assets that flow into Bangladesh's ocean economy. However, benefits of these ecosystem assets are inherently difficult to measure because their values are not determined by market exchanges.¹⁰

POLICY RECOMMENDATIONS

Five Year Plan. The Government defines the blue economy concept as a sustainable pathway forward for growth of the ocean economy. This concept appears throughout their seventh five-year plan (FYP), completed in 2015. The FYP emphasizes that growth in the country's ocean economy is contingent upon the status of ocean ecosystems and natural capital.¹⁶ The seventh FYP outlines

twelve actions needed to create and maintain a prosperous and sustainable blue economy:

- ❖ Protecting and managing the fisheries for the present and the future generations;
- ❖ Developing a strong renewable energy sector using ocean and atmospheric forces;
- ❖ Maintaining existing (e.g., ship building) and developing new maritime industries;
- ❖ Extending fishing areas using new technologies and methods even beyond the exclusive economic zone in the international waters;
- ❖ Developing a strong human resources base for domestic utilization, and export to foreign job markets;
- ❖ Substantially increasing fisheries production and export earnings through improved aquaculture and introduction of mariculture;
- ❖ Creating a competitive tourism industry, including ecotourism and marine cruises;
- ❖ Increasing revenue from shipping, commerce by expansion of domestic fleet, destinations, trans-shipment, transit provisions, and linking seaports;
- ❖ Giving special priority to anticipated Climate Change impacts on all relevant matters, and adjust policies and plans;
- ❖ Maintain the inland river systems and ecosystems for fishery, sediment transport, and inland shipping;
- ❖ Building a solid science, research and education base; and
- ❖ Along with other coastal areas, establishment of a marine academy in Khulna.

These twelve national action areas are supported by the following three strategic

¹⁵Alam, M.K. 2014. "Ocean/Blue economy for Bangladesh." Proceedings of International Workshop on Blue Economy. Dhaka, Bangladesh: Bangladesh Ministry of Foreign Affairs. <http://mofa.gov.bd/content/about-blue-economy>. Accessed December 18, 2017.

¹⁶General Economics Division (GED). 2015. "Seventh Five Year Plan (FY2016-2020): Accelerating Growth, Empowering Citizens." Dhaka, Bangladesh: Planning Commission, Government of the People's Republic of Bangladesh.

policies, strategies, and plans currently under development:

- ❖ Bangladesh's Integrated Coastal and Ocean Management Policy (ICOMP)
- ❖ Bangladesh's National Sustainable Development Strategy (NSDS)
- ❖ Bangladesh's Climate Change Strategy Action Plan

The Government of Bangladesh has articulated a policy objective to apply the blue economy concept to the ocean economy in the Bay of Bengal. It has identified several initial activities and programs to begin, and is in the process of preparing an integrated policy as well as reviewing or developing related policies.

Create consistent policy and set measurable goals. The FYP report suggests

a coordinated policy planning process to help guide a strategic long-term transition to a blue economy in Bangladesh. This process should set measurable targets and consistently monitor progress. Benefits would include lower costs for shared common infrastructure, support for cross fertilization of technologies and innovation, and broadly, a more effective use of shared ocean space.

Because the blue economy falls under the responsibility of numerous sectors and regulatory agencies, a high-level committee was formed to coordinate efforts and develop policies and strategies.¹¹ However, questions still remain including how to better measure the current economic uses of the ocean space, identify clear targets for sustainable growth, and set policy pathways to get there.

CASE STUDY: INDONESIA

Publication: Trends in Marine Resources and Fisheries Management in Indonesia – A 2018 Review (California Environmental Associates, 2018)

Information (participants, dates, and purpose of study):

Commissioned by the David and Lucille Packard Foundation, and assembled by California Environmental Associates (CEA), this report responds to a need for data to inform future decisions. The report follows a baseline report issued by the Packard Foundation in 2016, “Indonesia Fisheries: 2015 Review.” Results of both reports are made available to any and all stakeholders who can benefit from comparable statistics to aid in understanding of emerging patterns. However, due to the sprawling geography of Indonesia (including roughly 17,000 islands) and decentralized institutional management, reliable information on catch-reporting and tracking of trends is difficult to ascertain on a community level.

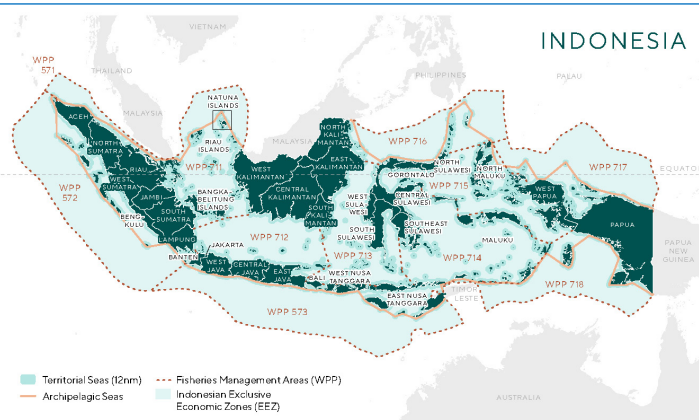


Figure 5-2: Map of Indonesia's Territorial Waters and Fisheries Management Areas (WPP)¹⁷

BACKGROUND

Located along the path of many major maritime trade routes, Indonesia has a territorial sea area four times larger than its land area. Additionally, the country boasts some of the highest levels of marine biodiversity and is home to several marine

¹⁷Trends in Marine Resources and Fisheries Management in Indonesia – A 2018 Review, 2018.

reserves. Naturally, the ocean is of primary importance to Indonesia.

Like many other countries, Indonesia faces pressures due to overfishing, climate change, coastal development, and pollution.

FUNDING AND INVESTMENTS

Aside from public funding and private sector investments, funding from private foundations and development aid organizations (including both bilateral and multilateral donors) provides important resources for marine and fisheries issues in Indonesia. Between 2007 and 2015, the philanthropic sector provided 113 million USD in funding, and the development aid sector provided 84 million USD in ocean-related grants in Indonesia.

A number of important investment funds are specifically targeting Indonesian “sustainable” fisheries. The Althelia Sustainable Ocean Fund and the Meloy Fund are the two main impact investment vehicles currently doing so.

SEAFOOD SECTOR

The fisheries sector contributes significantly to national food security and employment in Indonesia. A recent study ranked Indonesia as the eighth-most fish-dependent nation in the world, measured by dependence on fish-derived animal protein (52.68%).^{18,19} Furthermore, Indonesian fish consumption has increased every year since 2012.²⁰

Indonesia is the second-largest fish producer in the world after China. In 2015, the country produced 21.6 million tons of seafood – 5.9

million tons through wild-catch fisheries; 4.4 million tons through aquaculture; and 11.3 million tons through seaweed. While growth in wild catch has remained relatively steady since 2000, aquaculture has quadrupled between 2000 and 2015.²¹ In 2015, aquaculture accounted for about 42 percent of fisheries production (excluding seaweed).²²

Seaweed production has increased at an even faster rate. In 2000, it was the smallest contributor to the seafood production sector; in 2015 at 11.3 million tons, it became larger than aquaculture and wild catch combined, and propelled Indonesia to become the second largest seaweed producer in the world.

With regard to employment, 2.7 million and 3.3 million workers are employed by wild-catch fisheries and aquaculture, respectively. An additional 1 million workers process and market fisheries products, and most workers throughout the industry operate in small-scale businesses. In fact, 80 percent of aquaculture farms in 2014 were small operations that required simple technology to function.

Indonesia’s fisheries sector, as measured by gross domestic product, grew 7.3 percent in 2014, and 6.8 percent in 2017 through Q3. The sector’s direct contribution to GDP averages between 2.0 and 2.5 percent from 2010 to 2016.

Aquaculture is projected to become the leading source of fish production in Indonesia between 2026 and 2030.²³ The government set national fisheries production targets for aquaculture and wild-catch combined at 22.32 million tons (MT) by 2019.²⁴ This amount doubles the 12.2 MT production level from

¹⁸Pudjiastuti, Susi, “Challenges in Public Policy: Lessons Learned from Indonesia’s Fisheries Sector,” Presentation for Harvard Kennedy School, Cambridge, MA, USA, March 12, 2018.

¹⁹Dhina, O., “Eating Fish Campaign” in Kupang: Improving Indonesian Women’s Health and Nutrition,” MAMPU, May 15, 2017, <http://www.mampu.or.id/en/news/eating-fish-campaign-kupang-improvingindonesian-women%E2%80%99s-health-and-nutrition>.

²⁰Badan Pusat Statistik (Statistics Indonesia) (BPS), 2017

²¹Seafood Intelligence Trading Portal, “Country Profile: Indonesia,” 2018, <https://seafood-tip.com/sourcing-intelligence/countries/indonesia/>.

²²FAO Fisheries and Aquaculture Department, “FishStat J.”

²³Bennett, Abigail, Pawan Patil, Kristin Kleisner, Doug Rader, John Virdin, and Xavier Basurto, “Contribution of Fisheries to Food and Nutrition Security: Current Knowledge, Policy, and Research,” 2018, NI Report 18-02, Durham, NC: Duke University.

²⁴Baruna Nusantara Foundation, “A Brief Review of Policy and Regulatory Reforms.”

²⁵“Exploring Indonesian Aquaculture Futures.”

2014. Most of this increase came from aquaculture as a result of limits in wild-catch species.²⁵

POLITICS

In 2014, Joko Widodo was elected President of Indonesia, representing a turning point for the country. He is the first president from outside the political and military elite—a small-town businessperson and man of the people. One of his early acts as president was instituting a Global Maritime Axis via the Indonesian Ocean Policy. Formally launched in June 2017 as Presidential Decree No. 16/2017, this policy aims to²⁶:

- ❖ Restore Indonesia's maritime culture.
- ❖ Protect and manage marine resources, including sustainable fishing industries.
- ❖ Prioritize maritime infrastructure by constructing deep seaports and logistical networks and developing shipping and maritime tourism.
- ❖ Engage diplomatically to reduce conflicts, to resolve border claims, and to halt illegal fishing, marine piracy, and pollution.
- ❖ Strengthen naval defense capabilities.

In addition, President Widodo has instituted a number of policy changes that impact the ocean economy. Of note:

- ❖ In 2015, the government established the National Illegal, Unreported and Unregulated (IUU) Fishing Task Force. IUU fishing is estimated to have caused the country to lose between 4 and 20 billion USD a year.²⁷

- ❖ Indonesia placed a moratorium on foreign-owned and -built boats and transshipments, which reduced foreign fishing boats in Indonesia by 90 percent.²⁸ This moratorium has resulted in a 25-35 percent reduction in total fishing effort and has led to increases in local catch.
- ❖ The Coordinating Ministry for Maritime Affairs (CMMA) was established to centralize and align the many overlapping maritime-related government agencies in Indonesia.
- ❖ The CMMA issued a ban on trawling. This ban has been controversial for several reasons including the need for small fishers to purchase alternative fishing gear, though efforts have been made to provide the required equipment for free.²⁹
- ❖ Indonesia is the second-largest contributor to marine plastic pollution after China.³⁰ Indonesia plans to spend up to 1 billion USD per year to reduce the amount of plastic and other waste in its waters by 70 percent by 2025.³¹

POLICY RECOMMENDATIONS

Consideration of land use policies and intensification in land use practices will be necessary. The government's national fisheries production targets are ambitious and seem unlikely given the available land and water. Assuming business-as-usual, Indonesia would need an area of roughly 95,000 square kilometers by 2030 to support this growth, which is approximately 20 percent of Indonesia's total land mass.

²⁵Dwinanda, Reiny, "Indonesia Committed to Cracking Down on Crimes at Sea," *Republika*, January 24, 2017, <http://en.republika.co.id/berita/en/national-politics/17/01/24/okades414-indonesia-committed-to-cracking-down-on-crimes-at-sea-minister>.

²⁷Indonesia: Fisheries minister goes from strength to strength, *Asian Correspondent*, May 18, 2017, <https://asiancorrespondent.com/2017/05/indonesia-fisheries-minister-goes-strengthstrength/#R19phwq5J7R5RoLU.97>

²⁸Cabral R.B. et al., "Rapid and Lasting Gains from Solving Illegal Fishing," *Nature Ecology and Evolution* 2 (April 2018): 650-58.

²⁹Government to Distribute Fishing Equipment to Replace 'Cantrang,'" *The Jakarta Post*, July 13, 2017, <http://www.thejakartapost.com/news/2017/05/03/jokowi-tells-minister-to-extend-use-of-fishingtrawlers.html>.

³⁰"How Can Indonesia Win Against Plastic Pollution?" *The Conversation*, September 5, 2017, <https://theconversation.com/how-can-indonesia-win-against-plastic-pollution-80966>.

³¹"Indonesia Pledges \$1bn a Year to Curb Ocean Waste," *The Guardian*, March 2, 2017, <https://www.theguardian.com/environment/thecoral-triangle/2017/mar/02/indonesia-pledges-us1-billion-a-year-to-curb-ocean-waste>; "Indonesia to Reduce Plastic Waste 70% by 2025," *Jakarta Globe*, February 24, 2017, <http://jakartaglobe.id/news/indonesia-to-reduce-plastic-waste-70-by-2025/>.

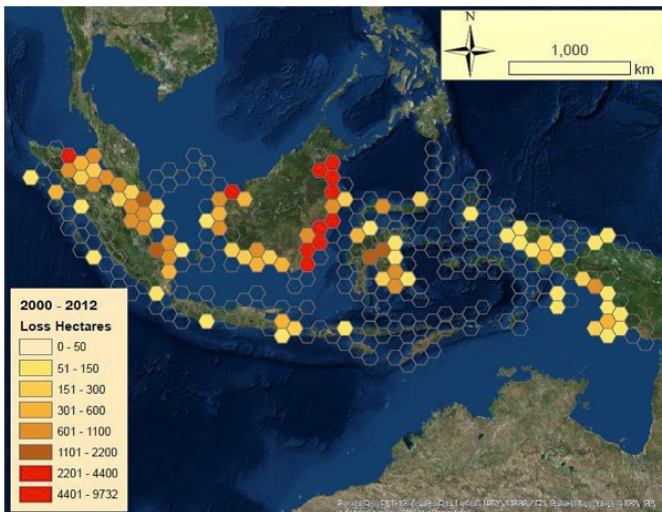


Figure 5-3: Map of Indonesia's Mangrove Forest Loss³⁶

Investment in infrastructure. As of 2017, the government was working on plans to invest in infrastructure by developing 12 maritime and fisheries centers, which would provide boats and gear, storage and cold chain infrastructure, floating docks, and other facilities.^{32,33} President Widodo's development plan also includes the "sea-toll" project, the goal of which is to facilitate development and connect outlying regions, especially in eastern Indonesia.³⁴

Establish and enforce sustainable farming practices. In 2016, most if not all of MMAF funding was provided in the form of capital assets (e.g., boats) instead of funds for developing governance systems or other sustainable fisheries management components. Given that IUU fishing by foreign vessels has essentially been

eliminated, a key question is whether MMAF will be able to design and implement effective measures to limit illegal fishing by Indonesian vessels and also enact preconditions for sustainable management of legal domestic fishing. Further growth will require the mitigation of financial, logistical, and capacity challenges, such as those associated with poor transportation infrastructure, variability in seed quality, and substandard practices.³⁵

Investments and public policy should be made to manage environmental impacts of growth in aquaculture. Aquaculture has already had an impact on Indonesia's mangrove forests. Along with agriculture, coastal development, and urbanization, Indonesia is home to about 28 percent of the world's mangroves. Roughly 30 million tons of carbon emissions could be reduced though mangrove conservation annually in Indonesia.

Invest in technology and knowledge that can increase efficiency in aquaculture production. While aquaculture production can be ecologically efficient in theory, its sustainability is dependent on species, production systems, and the intensity of production methods.

³²Japan Helps Indonesia Develop Fishery Business Center, Tempo.co, August 8, 2017, <https://en.tempo.co/read/news/2017/08/08/056898186/Japan-Helps-Indonesia-DevelopFishery-Business-Center>

³³Indonesia to Build Maritime, Fisheries Center in Nunukan: Minister," The Jakarta Post, March 24, 2017, <http://www.thejakartapost.com/news/2017/03/24/indonesia-to-build-maritime-fisheries-center-in-nunukan-minister.html>.

³⁴Jokowi Says Progress on Maritime Infrastructure Insufficient," Jakarta Globe, March 30, 2016, <http://jakartaglobe.id/news/jokowi-saysprogress-maritime-infrastructure-insufficient/>.

³⁵Harkell, Louis, "Nine million tons of farmed fish in Indonesia by 2019? Maybe not" Undercurrent News, August 18, 2017, <https://www.undercurrentnews.com/2017/08/18/nine-million-tons-offarmed-fish-in-indonesia-by-2019-maybe-not/>

CASE STUDY: MASSACHUSETTS

Publication: Navigating the Global Economy: A Comprehensive Analysis of the Massachusetts Maritime Economy (Public Policy Center, University of Massachusetts, Dartmouth, 2017)

Information (Participants, dates, and purpose of study):

This study was funded by the Seaport Economic Council (SEC), which works with Massachusetts' 78 coastal communities to increase economic development. The SEC desired to understand the current Massachusetts Maritime Economy and determine strategies for growth. The Public Policy Center at University of Massachusetts Dartmouth assisted the study by conducting an in-depth analysis of the Massachusetts Maritime Economy including the establishment of an Industry Advisory Group to help guide research, focus groups, and key informant interviews. Secondary data was taken from the NOAA's Office for Coastal Management.³⁷

BACKGROUND

Massachusetts has a long history with maritime economic activity. In the early 1600s, as colonists first began arriving, the harvesting of local shellfish and fishing became an important source of food. In the pre-revolutionary colony, shipbuilding quickly became the leading industry due in part to easy access to the ocean with many sheltered bays and deep harbors.³⁸ Success in shipbuilding led to growth in supporting industries such as warehouse and wharf construction, while also supporting the development of innovation.³⁴ By the end of the eighteenth century, fish was the most important export in New England. In fact, during the American Revolution, many of these

fishing vessels were converted to form the American navy.³⁹

During the nineteenth and early twentieth centuries, the maritime sector in Massachusetts was led by the whaling and fishing industries. As wild stocks became harder to find, ships required innovations in design and supporting technologies (such as freezing storage).

The two world wars of the twentieth century increased investment and research in new maritime technologies. The Second World War was a significant factor in the founding of Woods Hole Oceanographic Institution as well as other research organizations in the state.⁴⁰ In the post-war era, technological progress was made in the fishing industry through such developments as mechanization and trawling. New England fisherman increasingly faced competition from foreign vessels and fish stocks continued to decline. In 1976, the Magnuson-Stevens Fishery Conservation and Management Act gave control of coastal fishing to the US, which limited foreign competition. Still, fish stock depletion continued.

MASSACHUSETTS MARITIME ECONOMY

The study defines the Maritime Economy as those economic activities whose inputs are derived, in whole or in part, from the ocean. This economy includes six major sectors:

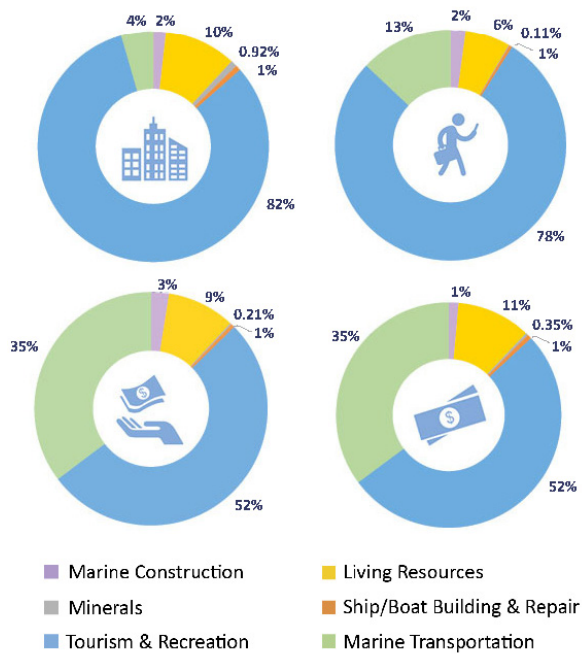
- ❖ Living Resources
- ❖ Marine Construction
- ❖ Offshore Minerals
- ❖ Ship and Boat Building and Repair
- ❖ Tourism and Recreation (Coastal)
- ❖ Transportation

³⁷<https://coast.noaa.gov/digitalcoast/tools/enow.html>

³⁸Perunko, J. Bisher, K., & Davis, S. (2007). "Maritime History of Massachusetts." Nation Park Service. Washington D.C. Retrieved from: <https://www.nps.gov/nr/travel/maritime/index.htm>

³⁹Magra, C.P. (2006). "The New England Cod Fishing Industry and Maritime Dimensions of the America Revolution." University of Pittsburgh

⁴⁰Woods Hole Oceanographic Institution (2016). "History and Legacy: Over 80 Years of Ocean Research, Education, and Exploration."



Source: ENOW; NOEP; Authors' calculations.

Figure 5-4: Massachusetts Maritime Economy Establishments, Employment, Total Wages, and GSP by Sector⁴¹

The Massachusetts Maritime Economy includes 5,555 establishments, employs 90,482 workers, pays \$3.4 billion in total wages, and produces \$6.4 billion in Gross State Product (GSP). It represents 2.6 percent of the State's direct employment and 1.3 percent of its gross produce.

Maritime Economic growth was greater when compared to the state economic growth as a whole from 2005 to 2015 in terms of GSP (48.0% vs. 32.1%) and real GSP (36.7% vs. 11.4%), though the number of establishments grew at a slower pace (6.1% vs. 16.5%).

Tourism & Recreation is the largest sector in terms of employment and has grown 16.7 percent from 2005 to 2013, outperforming the nation and New England. It accounts for a smaller but still significant share of total wages and gross state product. There are limits to growth, however. Coastal communities that benefit from scenic tourism must maintain their natural resources in order to draw visitors. As a result, constraints on development coupled with industry wages below the statewide

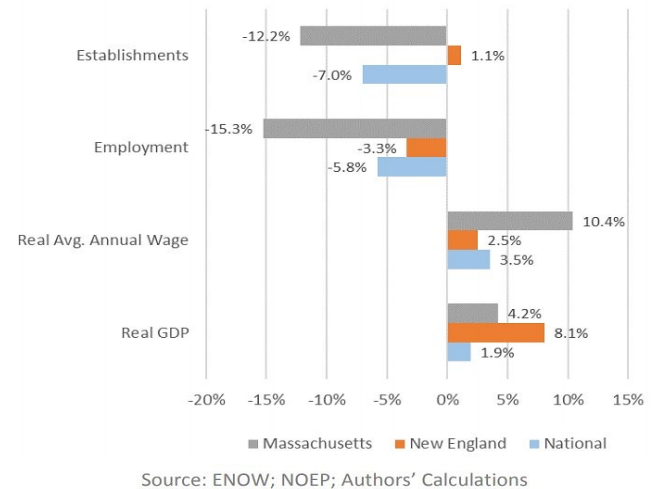


Figure 5-5: Changes in the Living Resources Sector, 2005 – 2013

average have made housing affordability an issue.

Living Resources accounts for 6 percent of Maritime Economy employment. This sector has been declining since 2009, particularly in the fishing industry, which accounts for 62 percent of the establishments in the sector. This decline is primarily due to federal catch regulations, which have caused the industry to consolidate around larger fishing operations that enjoy economies of scale. The number of employees has also declined 15.3 percent from 2005 to 2013, primarily due to industry consolidation as well as increased automation in processing. Average wages and real GDP have both increased during this same period (10.4% and 4.2%). The Living Resources sector in Massachusetts has followed regional and national trends, at a slightly exaggerated rate.

Aquaculture. In the Living Resources sector of the Maritime Economy, opportunity exists for domestic aquaculture to fill seafood demand currently supplied by imports. Half of seafood the US imports comes from aquaculture,⁴² but only 7.8 percent of seafood produced in the US comes from aquaculture.⁴³ This production represents less than one percent of the world's

⁴¹Navigating the Global Economy: A Comprehensive Analysis of the Massachusetts Maritime Economy, 2017.

⁴²National Oceanic and Atmospheric Administration. Fisheries of the United States (FUS) Report. (2013)

aquaculture sales and volume.⁴⁴ Fulfilling domestic seafood demand with US aquaculture is supported by the Massachusetts Division of Marine Fisheries, which has a goal to develop sustainable marine aquaculture.⁴⁵ However, growth in this sector is limited by complicated federal, state, and local permitting requirements. Additionally, growers face challenges due to workforce issues, funding, marketing, competition, and insurance coverage, among other things.⁴⁶

Other Maritime Economy

Sectors. Offshore Minerals is mostly made up of oil and gas production companies and is a relatively small industry.

Though once a dominant industry in Massachusetts, Boat & Ship Building & Repair makes up a small portion of the Maritime Economy due to the almost total absence of major ship and boat builders in the area. Marine Construction only represents 2 percent of the Maritime Economy employment and is mostly dependent on government-supported projects. Marine Transportation is mostly comprised of Warehousing (49% of employment) and Search & Navigation Equipment (44%). Most of this sector's GSP in Massachusetts is in the Search & Navigation subsector (74%). Marine Transportation accounts for 4 percent of the Massachusetts Maritime Economy in terms of establishments and 35 percent in terms of GSP.

Emerging Sectors. The Marine Technology Cluster is a significant contributor to the state's Innovation Economy. This cluster

Sector	Establishments	Employment	GSP (\$M)	Real GSP (\$M)
Living Resources	-10.9%	-13.4%	34.3%	2.6%
Marine Construction	0.0%	140.5%	5.1%	-21.2%
Offshore Minerals	-23.9%	-58.1%	12.7%	-32.8%
Boat & Ship Building & Repair	-14.8%	-16.2%	-15.2%	-15.2%
Tourism & Recreation	11.4%	22.4%	45.6%	14.5%
Marine Transportation	-16.1%	9.5%	64.0%	118.3%

Table 5-1: Sector change from 2005 to 2015³⁷

encompasses fields such as robotics, oceanography, renewable and non-renewable energy, biotechnology, communications hardware, information technology, advanced materials, and civil engineering. Federal defense spending has been the largest driver of growth.

Other federal funding for marine renewable energy, adaptation to sea level rise, and other technical fields has also been of great importance to the state's Marine Technology cluster. For example, institutions of higher education in Massachusetts spent a total of \$164.8 million on oceanographic R&D in 2014. The majority of these activities were federally financed, accounting for 76 percent of all oceanographic R&D expenditures.

Due to the broad contributions to this category, it is difficult to portray detailed data points; however, by any measure, Massachusetts has a competitive advantage. The state is home to

⁴³National Oceanic and Atmospheric Administration. Fisheries of the United States (FUS) Report. (2015)

⁴⁴Food and Agriculture Organization of the United Nations. Fishery Statistics-Global Aquaculture Production.

⁴⁵Massachusetts Department of Fish and Game, Division of Marine Fisheries. 2015 Annual Report.

⁴⁶Lapointe, George. White Paper: Overview of the Aquaculture Sector in New England. Northeast Regional Ocean Council. March 2013 (revised).

the Woods Hole Oceanographic Institute, which, in addition to being the largest oceanographic research organization in the country, also has enormous offshore wind potential. The state is also a leader in the Marine Robotics Industry, a market expected to grow from \$2.2 billion in 2015 to 4.6 billion in 2020.⁴⁷

POLICY RECOMMENDATIONS

❖ ***Preservation and protection of ocean and coastal resources.*** A number of University of Massachusetts survey respondents cited “preserving and protecting ocean resources” as a critical or very critical issue to the success of their business. On the other hand, increased maritime activities put stress on limited resources. Policies should balance growth with sustainability.

❖ ***Maintenance of a stable and predictable business cost and regulatory environment.*** 69 percent of respondents said that “reducing business costs related to taxes” was the most critical policy issue affecting the success of their business.

❖ ***Advocacy for continued federal research funding to support technologies surrounding the Marine Technology cluster.*** Massachusetts’ higher education institutions reported \$165 million in R&D expenditures related to oceanography in 2014, 76 percent of which was federal. Massachusetts companies were awarded 81 maritime SBIR/STTR grants in 2015, amounting to an investment of \$204 million.

❖ ***Addressing port infrastructure constraints to promote growth.*** Massachusetts ports are turning away ships because of limited water depths or space. Dredging and other capital improvements could address these

challenges. Additional port investments could also support emerging industries, such as offshore wind.

❖ ***Capacity of specialized sector specific training programs.*** 36 percent of survey respondents indicated that specific educational credentials or technical certifications were necessary in their area of business. Most of them also asked “Where are my future workers going to come from?”

❖ ***Flexibility in harbor area zoning, particularly in Designated Port Areas.*** Massachusetts has ten Designated Port Areas designed to promote water-dependent industrial uses. Some port cities are transitioning toward innovation-oriented maritime industries, such as research and education, or mixed-used developments which include public spaces. If Massachusetts is to make this transition, zoning requirements will need to be more flexible.

❖ ***Strengthening connections within the Marine Technology cluster.*** The state can assist by strengthening connections in the Marine Technology to not only support research and development, but also seek capital and develop a cohesive industry strategy.

❖ ***Capacity development for technology commercialization and transfer.*** The state should create programs to assist commercial development of marine-related technologies.

❖ ***Capitalizing on the Ocean-to-Table Movement.*** The state should expand efforts to promote locally sourced and fresh seafood. This expansion would benefit the Living Resources and Tourism & Recreation sectors.

⁴⁷ABI Research. 2016. The Massachusetts Robotics Cluster. Massachusetts Technology Collaborative. See <http://www.masstech.org/roboticscluster>. 39

CASE STUDY: SAN DIEGO

Publication: San Diego Maritime Industry Report (San Diego Workforce Partnership, The Maritime Alliance, San Diego Regional Economic Development Corporation, 2012)

Information (participants, dates, and purpose of study):

This report was sponsored by the San Diego Workforce Partnership (SDWP), the San Diego Regional Economic Development Corporation (SDREDC), and the Maritime Alliance (TMA). During a period of four weeks in May and June 2012, over 230 San Diego-based employers participated in a survey to better understand the maritime industries within the Blue Economy, and from there determine:

- ❖ The Maritime Industry’s overall contribution to the local economy;
- ❖ The Industry’s subcategories and respective percentages of the overall total;
- ❖ The Industry’s business and workforce development needs; and
- ❖ The Industry’s interest in engaging with strategic industry partnerships and intermediary collaborations to further business retention, expansion, and new business recruitment.

BACKGROUND

San Diego is a world-class port city with a Maritime Industry that represents one of the most unique regional economies in the world. San Diego’s location makes it an axis of the Pacific Ocean, the largest and deepest ocean in the world, and ties the city intellectually and physically to the growing markets of Asia and Latin America.⁴⁸ One of the largest traditional maritime entities, the Port of San Diego is the fourth largest of California’s eleven public ports and has jurisdiction over approximately 5,500 acres of land and water.⁴⁹

Total employment (September, 2011)	45,778
Traditional maritime exclusive industries	8,176
Maritime technology industries	18,948
Other maritime	18,654
Total estimated revenue (September, 2011)	\$14,034,085,362
Traditional maritime exclusive industries	\$ 1,403,082,257
Maritime technology industries	\$ 6,165,840,257
Other maritime	\$ 6,465,162,848
Source: ERISS; Info-USA; U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; Dun and Bradstreet; Corporation Wiki	

Figure 5-6

SAN DIEGO MARITIME INDUSTRY

This report refers to the collective maritime industries as the Blue Economy or the Maritime Industry, and the maritime technology sub-set as Blue Tech. The Blue Economy in San Diego includes three types of industries:

- ❖ Traditional Maritime “Core” Industries
- ❖ Related “Traditional” Maritime Industries
- ❖ Maritime Technology Industries

Figure 5-6⁵⁰ displays how and which types of maritime industries make up the Blue Economy in San Diego. **Traditional Maritime “Core” Industries** deal, more or less, exclusively with maritime activity (fishing, ocean shipping, ports, etc.). **Related “Traditional” Maritime Industries** include maritime activities but are also associated with non-maritime goods and customers (construction, etc.). Lastly, **Maritime Technology Industries** includes businesses that are central to Maritime Technology activity. While jobs may not be specifically maritime related, they are reliant on their company’s inclusion in the Blue Economy.

Figure 5-6 breaks down key industry diagnostics for the San Diego Maritime Industry. The maritime industry is comprised of more than 1,400 companies producing over

⁴⁸ERISS; San Diego Maritime Industry Report, 2012
⁴⁹Port of San Diego Economic Impact Study, ERA 2007
⁵⁰San Diego Maritime Industry Report, 2012.

\$14 billion of direct sales and almost 46,000 jobs. The projected total employment growth between 2011 and 2020 is for nearly 6,000 new jobs.

POLICY RECOMMENDATIONS

❖ **Connect Local/Smaller Businesses with Industry Connections and Resources.** Of these 1,400 companies, a significant amount have large customer bases outside the region. There is concern that unless the region strengthens industry connections, it may be at risk of losing successful companies with weak local business ties. Thus, there is a need to focus on attracting and promoting high wage, high value-added, capital and R&D intensive companies and operations.

There is also concern that stronger collaboration is needed, as some of the most attractive deals are seen as too large or too complex for small companies to pursue by themselves. There was a general lack of knowledge about the San Diego Workforce Partnership (SDWP), the San Diego Regional Economic Development Corporation (SDREDC), and The Maritime Alliance (TMA), all of which are resources intended for smaller companies to utilize to take advantage of large or complex deals.

❖ **Assist with California Policy Requirements.** Companies in the San Diego Ocean Economy have also expressed concern about California's regulatory burden, as well as that of the U.S. Environmental Protection Agency. The belief is that regional organizations are not aggressive enough in helping deal with local regulatory concerns or in providing

Graphic 1. Visualizing the San Diego Maritime Industry

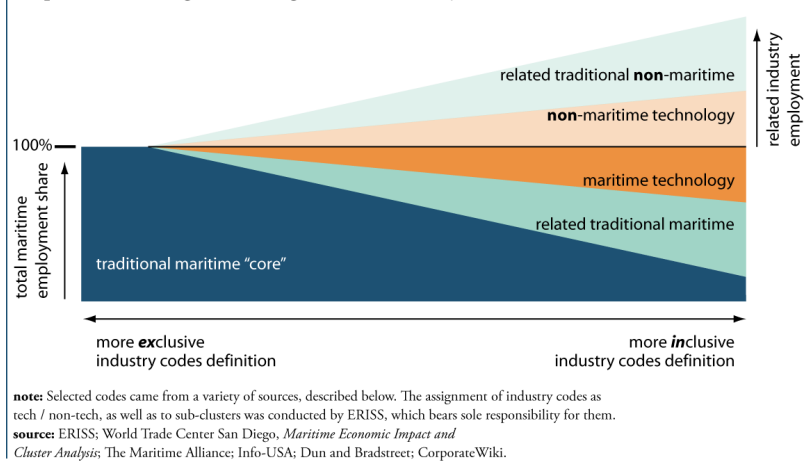


Figure 5-7

advocacy support in state and federal arenas.

❖ **Invest in a Maritime Workforce.** Additionally, while there is an abundance of individuals with college or advanced degrees, there is a lack of talent with maritime-specific experience or training. One potential solution is organizing sector working groups to identify workforce needs, and working with secondary vocational programs, community colleges, and four-year and graduate institutions to help design curricula and programs. The issue of finding qualified talent with maritime knowledge and experience proposes exploration of creative alternatives such as maritime-specific modules inserted into existing courses. Also, the high cost of living in San Diego is making it more difficult to attract qualified individuals.

❖ **Protect the Waterfront.** Residential and tourism interests have eclipsed industrial and commercial uses, resulting in concern for “protecting the working waterfront.” Although this is primarily the responsibility of the port and port tenants, it has been expressed that various maritime organizations were not doing enough collectively.

CASE STUDY: WASHINGTON

Publication: Washington Maritime Blue: Washington State’s Strategy for the Blue Economy (Washington State Department of Commerce, 2019)

Information (participants, dates, and purpose of study):

Washington State’s maritime sector has emerged as a model for environmental performance and best practices. The Maritime Innovation Advisory Council was formed by Governor Jay Inslee in December 2017 to ensure Washington State remains a home to a world-class, thriving, and sustainable maritime industry through 2050 and beyond. The Council developed this comprehensive plan for all stakeholders to accelerate and support technology innovation and best practices throughout the state’s maritime industry. This report outlines pathways and projects developed by and for Washington’s maritime stakeholders – industry, government, Tribes, research universities, and NGO’s.

Washington Maritime Blue is a cluster organization built on broad participation and strong new partnerships. It is committed to the development of maritime business, technology, and practices that promote a sustainable future, contributing to economic growth, ecological health, and thriving communities.

BACKGROUND

Washington State is the most trade-dependent state in the US, with 1 in 4 jobs tied to international trade. Washington’s maritime industry directly employs workers in every county of the state.⁵¹ Additionally, the state is recognized for its stewardship in sustainability. Washington is part of a coalition of 15 states and territories that has committed to reaching

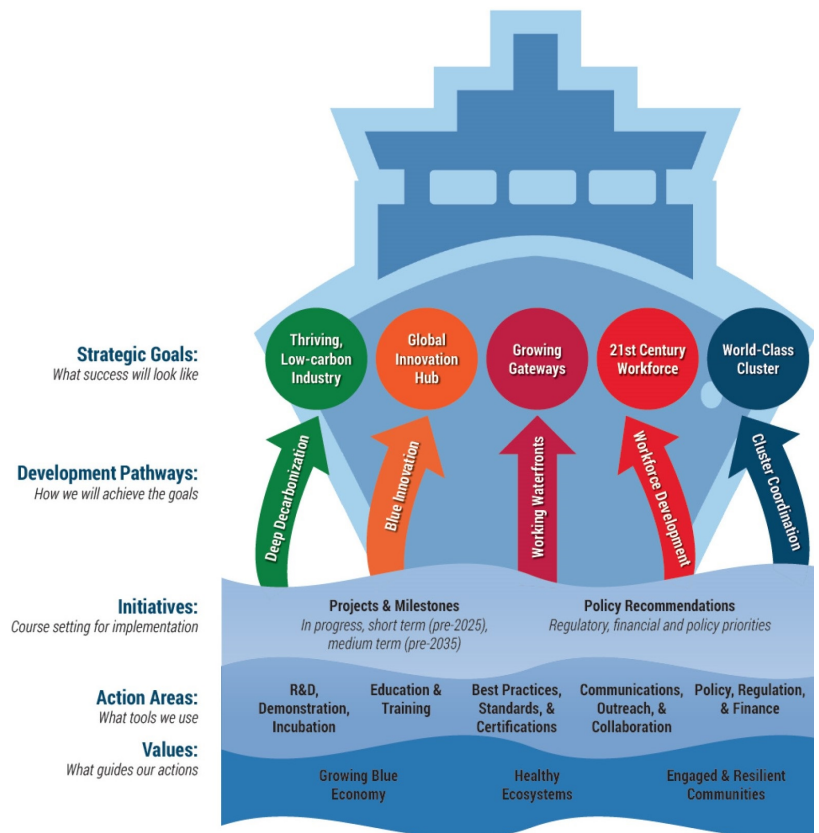


Figure 5-8

the climate goals of the Paris Agreement. The state also shares regional goals for reducing greenhouse gas emissions at least 80 percent by 2050 as part of the Pacific Coast Collaborative.⁵²

WASHINGTON MARITIME ECONOMY

Washington’s maritime economy has a culture of competitive advantage through innovation and sustainability. The economy boasts world-class research institutions and capabilities in ocean science and marine energy. Assets include a diverse and interdependent maritime industry with strong leadership in environmental best practices and technology investment. It is also one of the nation’s strongest tech sectors with leadership and support for advanced manufacturing in

⁵¹Community Attributes Inc. 2017. The Puget Sound Regional Economy 2017.

⁵²Pacific Coast Collaborative Homepage. <http://pacificcoastcollaborative.org/>

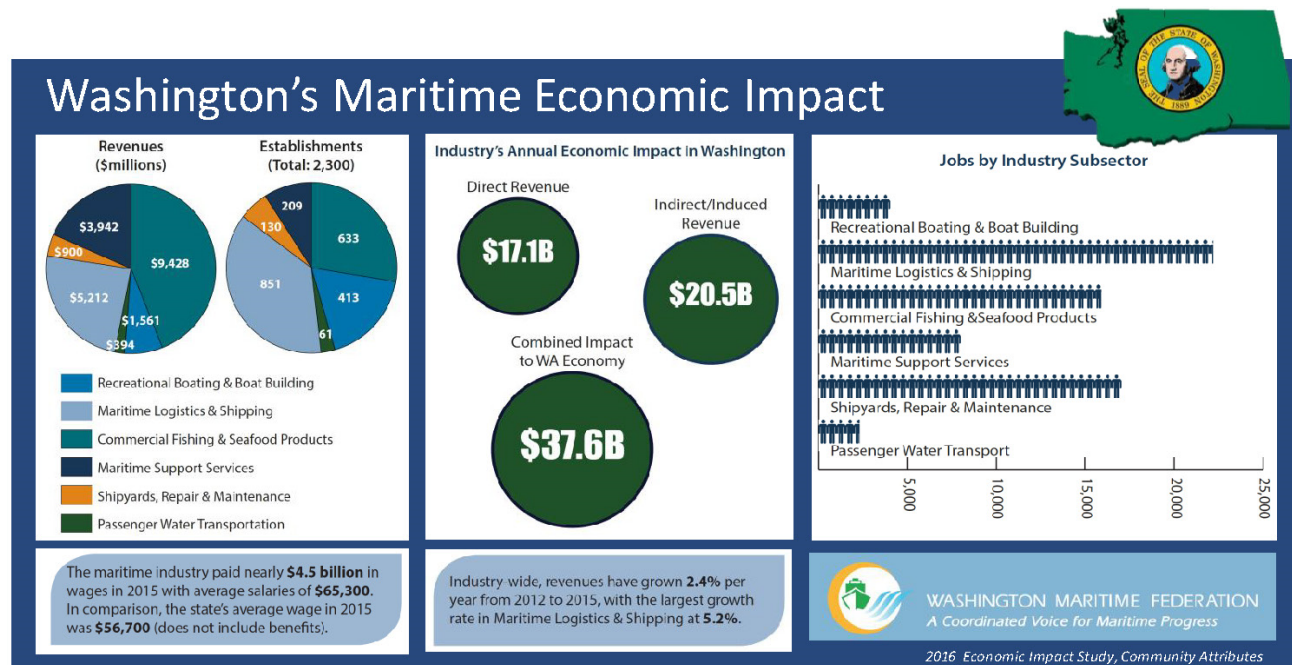


Figure 5-9

aerospace, military and defense, clean technology, and ship building industries. The fishing and seafood sector manages productive and sustainable fishing grounds, and the Port's shipping and logistics sectors exceed environmental impact goals.

Maritime activity has long been a pillar of Washington State's economy with \$17.1 billion in gross business income and 69,500 good-paying jobs. The average pay for a job in Washington is \$56,900, while maritime workers are paid an average of \$67,000. This sector continues to grow at an average of 6.4% a year and has the potential for a much greater impact on the state's economy.⁴⁷

Other key statistics include:

- ❖ The maritime industry is worth more than \$37 billion to state economy.
- ❖ Washington's maritime sector includes 2,300 companies that employ almost 70,000 people. The industry is responsible for \$4.7 billion in wages annually. Historically, the annual growth rate has been between three percent and six percent.

❖ Statewide, for every direct job in Maritime, an additional 1.6 jobs were supported elsewhere in the state economy. Likewise, every million dollars of sales by Maritime companies supported almost ten jobs throughout the state economy.

WASHINGTON'S MARITIME SUBSECTOR ANALYSIS

Washington State's maritime sector is comprised of five subsectors:

- ❖ **Commercial Fishing & Seafood Processing** includes wild capture fishing, aquaculture/fish farming, and seafood processing. This subsector contributed 44 percent of the total maritime industry revenue for 2015 and supported 23 percent of the total maritime jobs.
- ❖ **Maritime Logistics & Shipping** includes transportation, warehousing, and support firms and services. This subsector contributed 23 percent of the total maritime industry revenue for 2015 and 32 percent of total maritime jobs.
- ❖ **Passenger Water Transportation** includes deep sea water transportation, coastal and inland water transportation,

and support activities. This subsector contributed 2 percent of the total maritime industry for 2015 and supported 3.3 percent of total maritime jobs.

❖ **Ship and Boat Building, Repair, and Maintenance** includes the Puget Sound Naval Shipyard, boat and ship building, and repair and maintenance. This subsector contributed 12 percent of the total maritime industry for 2015 and 30 percent of total maritime jobs.

❖ **Maritime Support Services** includes naval architecture and marine engineering, geotechnical and environmental, and other professional services. This subsector contributed 19 percent of the total maritime industry revenue for 2015 and 12 percent of total maritime jobs.

❖ **Ocean Science Technology** includes ocean technology, robotics and submarines, water technology, and marine biomedicine/biotechnology. Washington is a leader in clean water science, ocean research, and data collection and processing, as well as clean energy technologies research development and commercialization.

WASHINGTON BLUE ECONOMY

Economic growth and ocean health are mutually dependent for long-term sustainability in the Washington Blue Economy. For Washington Maritime Blue, the definition of sustainability is three-fold:

- ❖ **A Growing Economy:** build a strong business climate, attract talent and investment, and develop an efficient regulatory structure that supports innovation and infrastructure.
- ❖ **Healthy Ecosystems:** commit to restoring and sustaining the health of coastal and marine ecosystems.

❖ **Resilient Communities:** apply a social justice lens to ensure thriving and resilient communities across the maritime sector.

POLICY RECOMMENDATIONS

❖ **Government Support.** Support from local, state, and federal governments is key to the success of the Washington Maritime Blue strategy, particularly in their roles as stakeholder convener and as creators of policies and regulations. These branches of government can impact the rate at which industry can accelerate innovation and living-wage job creation.

❖ **Fund and Develop Clean Energy Technology and Spaces.** To accelerate the transition of Washington's maritime industry to a low-carbon future, it is imperative to secure funding in order to develop and support both vessels and shore-side infrastructure for electric operation and cleaner low-carbon fuels. Policies and incentives need to be adopted in order to create discernible conditions that reduce carbon (and other) emissions from maritime applications. Lastly, public funds for clean energy and carbon mitigation should be directed towards maritime, clean technology applications.

To drive commercialization of emerging blue technologies, incentives and finance mechanisms for maritime innovation in shipbuilding and manufacturing should be established. There also needs to be a designated maritime innovation validation zone to perform R&D testing and evaluation of safety and operational performance. Funding and developing incubation, R&D, and commercialization of platforms for maritime innovation facilities and research centers would also be beneficial.

❖ **Invest in Infrastructure.** To lead the nation in efficient, clean, and safe maritime practices across industries, it is

recommended to invest in port and maritime infrastructure to maintain and increase modernization and competitiveness. Aligning and simplifying regulatory and permitting processes would improve speed, efficiency, and predictability in maritime infrastructure projects. Regional collaborations and partnerships could promote competitiveness and reduce ecological impact.

❖ ***Develop a Maritime Workforce Based in New Technologies.*** The next generation of an inclusive and diverse maritime workforce with technological expertise and access to clean, healthy, living wage jobs is on the horizon. Thus, dedicated funding for maritime specific training, education, and workforce development is needed; this development includes the expansion of registered apprenticeships and youth programs. Support also needs to be demonstrated for statewide workforce development that encourages alignment and efficiency of programs according to community and industry sector-based priorities. Finally, adopting Career Connect Washington recommendations in conjunction with regional efforts would define and support maritime career pipeline development.

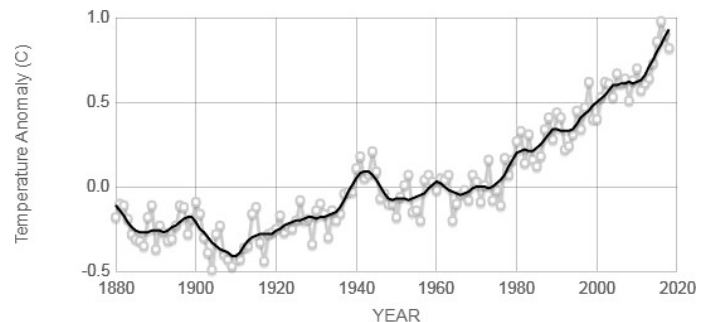
6. IMPACT OF CLIMATE CHANGE ON THE OCEAN ECONOMY IN LOS ANGELES COUNTY

OVERVIEW: GLOBAL CLIMATE CHANGE

In December 2015, 195 countries signed the Paris Agreement to endorse a long-term goal of limiting global temperature rise to 2 degrees Celsius, with an aspirational goal of 1.5 degrees Celsius. According to a report by the world's leading scientists in a recent Intergovernmental Panel on Climate Change (IPCC), the world has until 2030 to reduce emissions by 45 percent and three decades (until 2050) to reach net zero emissions in order to stop global warming at 1.5 Celsius. The world has already warmed by 1 degree and, assuming business-as-usual, is expected to exceed the 1.5-degree Celsius limit before 2040.⁵³

In short, climate change is already upon us. According to NASA, 18 of the 19 warmest years ever recorded have occurred since 2000.⁵⁴ In fact, the last five years have been the hottest since record-keeping began in 1880. Evidence of current climate change and future scenarios consistently point to significant and increasing risks during the coming decades.

Volumes of scientific studies indicate that an increase in greenhouse gases is one of the primary drivers of global climate change. More research to determine causality amongst various climate elements would aid development of mitigation strategies, particularly when examining a local area. Due to the interconnected nature of the climate, one environmental factor may overlap and amplify others; impacts in one geographic area often influence other locations. In 2018, a group of scientists published a study using 91 climate risks and 253 causal relationships



Source: climate.nasa.gov

Figure 6-1: Global Land-Ocean Temperature Index⁵⁵

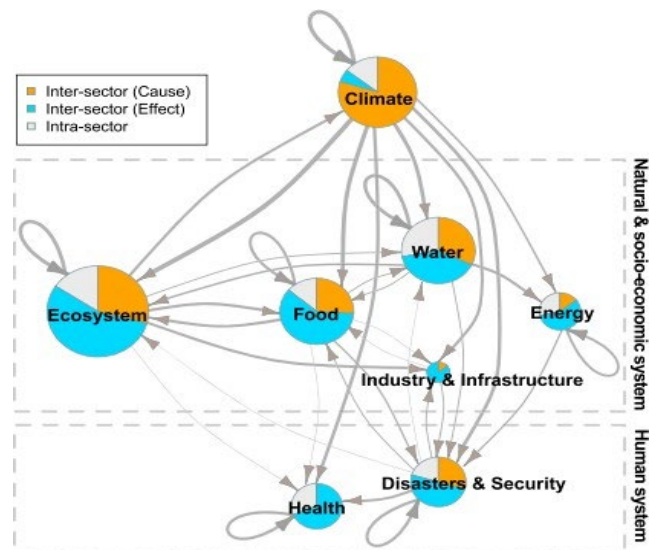


Figure 6-2: Climate risks and their cause-effect relationships⁵⁶

to provide a visualization of the interconnections of these elements. As the figure above illustrates, every climate change factor is part of a highly complex and connected system. While it is important to isolate specific areas such as Los Angeles County or even cities within the county for

⁵³Intergovernmental Panel on Climate Change. (2015). Global warming of 1.5 C: Summary for Policymakers. Retrieved from https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf

⁵⁴National Aeronautics and Space Administration (NASA). (2018). Global Climate Change: Global Temperature. Retrieved from <https://climate.nasa.gov/vital-signs/global-temperature/>

⁵⁵National Aeronautics and Space Administration (NASA). (2018). Global Climate Change: Global Temperature. Retrieved from <https://climate.nasa.gov/vital-signs/global-temperature/>

⁵⁶Yokohata, T., Tanaka, K., Nishina, K., Takahashi, K., Emori, S., Kiguchi, M., et al. (2019). Visualizing the interconnections among climate risks. *Earth's Future*, 7, 85–100. Retrieved from <https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1029/2018EF000945>



Figure 6-3: Historical and contemporary photographs of the Dana Glacier

analysis and policy action, it is important to remember that localities are part of a much larger system. Ultimately, climate change is a challenge that must be addressed by all.

IMPACTS OF CLIMATE CHANGE ON CALIFORNIA

Globally, climate change has already created observable effects – glaciers have melted, plants and animals have shifted territories, and trees are blooming at different times. In California, increasing ocean temperature and acidification, sea level rise, frequent heat waves, unusual fires, and other storm events are becoming the new normal.

The signs of environmental change are noticeable:

- ❖ Since 1895, when records were first taken, California's annual mean temperature has increased by about 2.2 degrees Fahrenheit. The greatest increase has been in the South Coast region (over 2.5 degrees Fahrenheit).
- ❖ In a little over a century, California's largest glaciers located in the Sierra Nevada Mountains have lost an average of 70 percent of their area.
- ❖ From 1987 to 2016, extreme heat days and nights have increased from 7 to 21 days per year. The greatest increase

PORT OF LOS ANGELES SEA LEVEL RISE ADAPTATION STUDY

September 2018

The Port of Los Angeles has 27 terminals, 43 miles of waterfront, and has created approximately 1.6 million jobs nationwide and 150,000 locally.

The Port based their study on the National Research Council 2012 projections following State Guidance from the Ocean Protection Council and California Coastal Commission.

The Port discovered multiple areas of potential vulnerability including threats to cargo wharves, critical facilities and utilities, transportation networks (rail and roadway), community and commercial assets, and natural habitats.

To mitigate these risks, the study recommended three strategies:

- ❖ Governance – add sea level rise language into planning documents, guidelines, and current project plans.
- ❖ Initiative – collaborate with organizations beyond the Port, fill information gaps, conduct feasibility studies, and seek additional funding.
- ❖ Infrastructure – create temporary and permanent structures to protect critical assets.

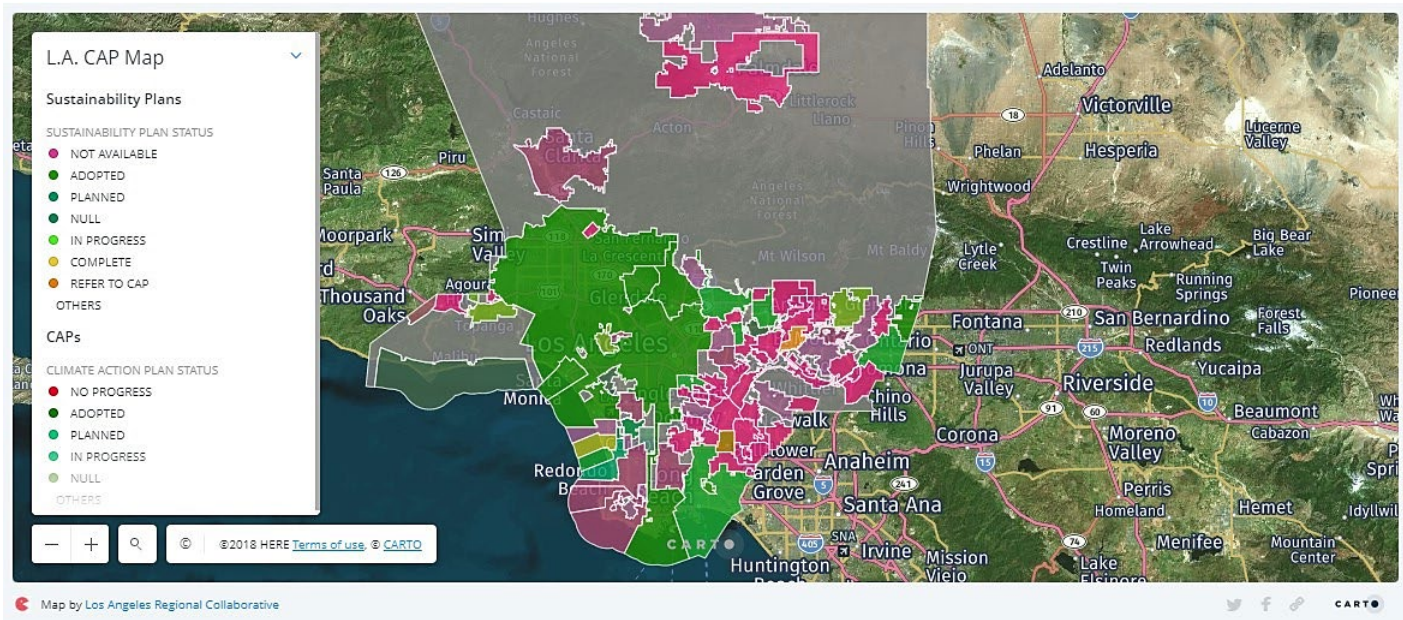


Figure 6-4: Sustainability Plans in the County of Los Angeles⁵⁷

- ❖ during this period has been in Southern California.
- ❖ Sea levels have risen by 1.51 mm (0.06 inches)/year in Santa Monica (1933 - 2016) and 0.96 mm (0.04 inches)/year in Los Angeles (1923 – 2016).⁵⁸
- ❖ Since 1932, 15 of the top 20 largest wildfires in California occurred after 2000.⁵⁹ Three of the five largest fires in Los Angeles County history have occurred since 2007.⁶⁰

California's Response to Climate Change

Political intervention plays an increasingly important role in planning for the future and, hopefully, mitigating outcomes. California has been a leader in terms of climate change policy, resulting in measurable and positive effects. Due largely to state legislation, California's emissions fell by 9 percent from 2000 to 2016 despite a growing economy and population.⁶¹

The State has enacted a large number of policies to address climate change and assist in preparing the State and local communities for anticipated impacts.

- ❖ Governor Brown issued Executive Order B-30-15 setting a greenhouse gas (GHG) emissions target for 2030 at 40 percent below 1990 levels. Senate Bill 32 (Pavley, 2016) and Assembly Bill 32 (Nunez, 2006) support this goal.
- ❖ Executive Order S-13-08, signed by Governor Schwarzenegger, directs state agencies to plan for sea level rise and climate impacts through coordination of the State Climate Adaptation Strategy.
- ❖ Assembly Bill 691 (Muratsuchi, 2013) requires holders of public trust lands to assess the impacts of sea level rise and report the results to the State Lands Commission.
- ❖ Assembly Bill 1482 (Gordon, 2015), Senate Bill 246 (Wieckowski, 2015), Senate Bill 379 (Jackson, 2015), and Assembly Bill 2800 (Quirk, 2016) all require preparation of climate adaptation strategies; local

⁵⁷LARC. L.A. CAP Map. Retrieved October 2019 from <http://www.laregionalcollaborative.com/la-cap-map>

⁵⁸Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (May 2018). Indicators of Climate Change in California. Retrieved from <https://oehha.ca.gov/media/downloads/climate-change/report/2018caindicatorsreportmay2018.pdf>

⁵⁹California Department of Forestry & Fire Protection. (August 8, 2019). Top 20 Largest California Wildfires. Retrieved from https://www.fire.ca.gov/media/5510/top20_acres.pdf

⁶⁰Los Angeles Almanac. Fires in Los Angeles County. Retrieved from <http://www.laalmanac.com/fire/fi07.php#largest>

⁶¹"Environmental policy: The great divide." The Economist, 29 June 2019, pp. 21-22.

governments are required to include adaptation and resiliency strategies in general plans, and state agencies are required to account for climate change when planning new infrastructure.

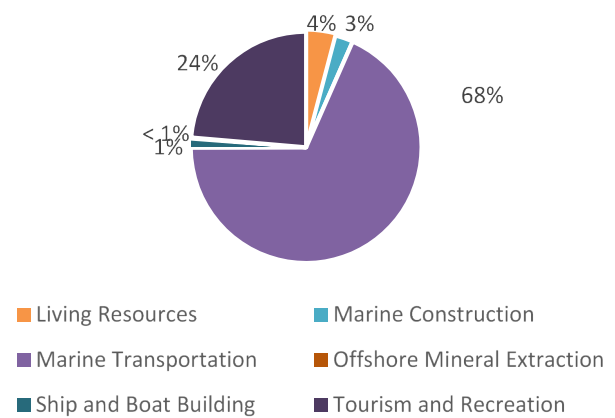
Regional and city-level planners have taken steps to reduce environmental impacts and create strategies for climate change in their localities. Many cities within Los Angeles County have made admirable efforts to develop and enact local Sustainability Plans and the efforts are ongoing. For example, in 2018, the Port of Los Angeles completed a detailed study on the local impacts of sea level rise, and the City of Long Beach produced a climate change vulnerability assessment. Others are in process following the adoption of new state policy requiring consideration of climate impacts in city plans.

Ocean Economy in Los Angeles County

Los Angeles is situated along the coast and is home to two of the nation's busiest ports. Six economic sectors directly depend on ocean resources: Marine Construction, Living Resources, Offshore Mineral Extraction, Ship and Boat Building, Tourism and Recreation, and Marine Transportation.⁶² In Los Angeles County, 2.1 percent of the economy was derived from ocean-related activities in 2016, contributing \$14 billion in GDP. Marine Transportation is, by far, the dominant sector, due mostly to port traffic. Tourism and Recreation also significantly contributes to the county's GDP.

There are five broad and interconnected climate change forces most likely to impact the ocean and ocean-related activities in Los Angeles County: Sea Level Rise, Ocean Warming, Ocean Acidification, Temperature Change, and Extreme Heat. The potential

Percentage of GDP (millions)



*Figure 6-5: Los Angeles County Ocean Economy by Sector (2016)*⁶³

economic impacts of these climate forces are examined in greater detail below.

SEA LEVEL RISE

Sea Level Rise will unquestionably affect the coastal areas of Los Angeles County, which encompass 4,084 square miles of land including Santa Catalina and San Clemente Islands; in fact, 75 miles of coast run along the western border of the county. In addition to sea level rise, climate change promises an increase in coastal storm events. Together, these factors will exacerbate the impacts of high tides, storm surges, and beach erosion.⁶⁴

Many different models project sea level rise. *Our Coast Our Future*, a collaborative project designed to provide coastal California planners with relevant information on sea level rise, has collected results from the most commonly cited studies. The project concluded that sea level rise projections for the year 2100 range from a low of 18 cm (0.59 feet) using Intergovernmental Panel on Climate Change (IPCC) 2007 assumptions⁶⁵ to a high of 288 cm (9.45 feet) using assumptions from the

⁶²NOAA Office for Coastal Management. (2015). The National Significance of California's Ocean Economy. Retrieved from <https://coast.noaa.gov/data/digitalcoast/pdf/california-ocean-economy.pdf>

⁶³NOAA Office for Coastal Management. ENOW Explorer. Retrieved October 2019 from <https://coast.noaa.gov/digitalcoast/tools/enow.html>

⁶⁴Los Angeles Regional Collaborative for Climate Action and Sustainability. Ocean & Coastal Resources. (12 December 2016). Retrieved from <http://climateaction.la/ocean-and-coastal-resources/>

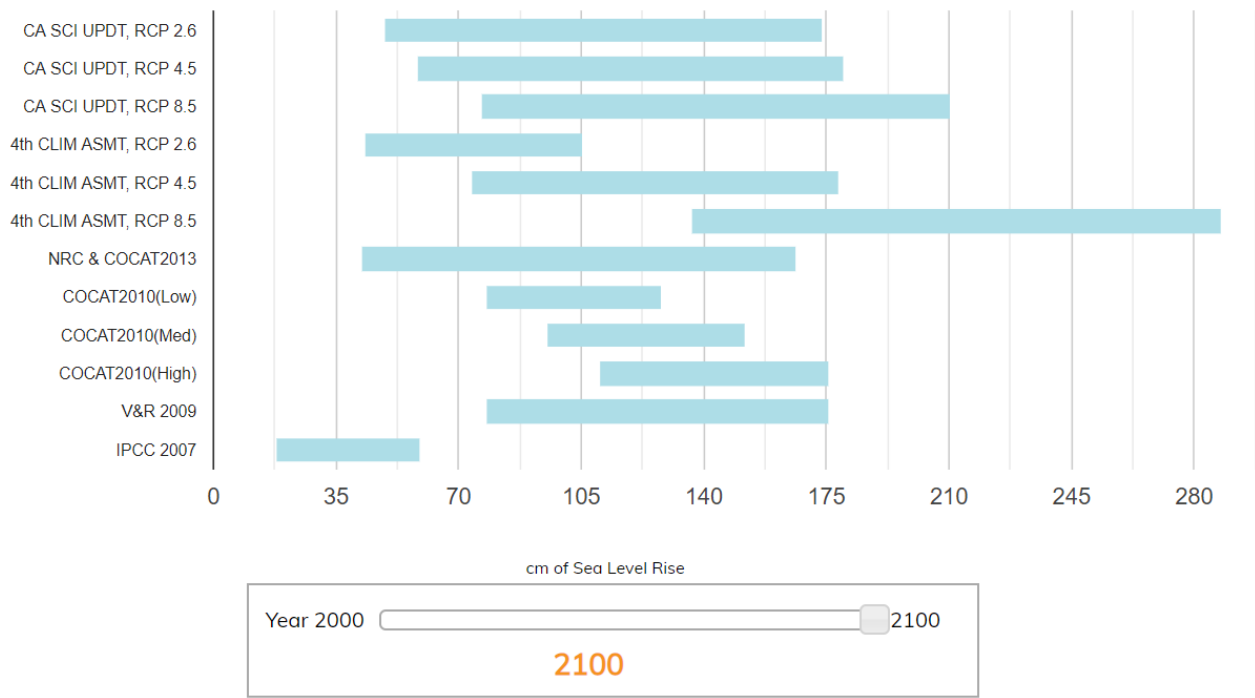


Figure 6-6: Comparing Sea Level projections

extreme ranges determined by the 4th California Climate Assessment.⁶⁶

Recent reports produced by the California Ocean Protection Council (OPC) project that by the year 2100, sea levels in the state may rise by approximately 2.4 feet (73 cm) to 6.9 feet (210 cm); the potential for ice-loss results in an extreme scenario with 10.2 feet of sea level rise.⁶⁷

These projections have been adopted by the State of California through the OPC's Sea Level Rise Guidance Document as well as by the California Coastal Commission's 2018 Sea Level Rise Policy Guidance.

Using these assumptions and looking at tide gauges in Santa Monica, sea level rise is projected between 1.1 feet to 2.6 feet (33.53 cm to 79.25 cm) by 2050 and 3.3 feet to 10.0 feet (100.58 cm to 304.8 cm) by 2100. In Los Angeles, sea levels will rise between 1.0 foot to 2.6 feet (30.48 cm to 79.25 cm) by 2050 and

3.2 feet to 9.9 feet (97.54 cm to 301.75 cm) by 2100.⁶⁴

By any measure, it is clear sea levels are rising and action must be taken. A study by Moser showed that the cost of doing nothing to prepare for sea level rise exceeds the costs of adapting to changes by 4 to 10 times.⁶⁴

Sea Level Rise: Economic Challenges

Sea level rise and the changing climate creates qualitatively different challenges with the potential to significantly threaten many coastal resources, including beachfront development, transportation, coastal recreation, habitats, and cultural and scenic assets. Part of the challenge for business and government lies in the uncertainty of determining sea level outcomes. It is difficult to anticipate the impact on the ocean economy precisely, but potential damage to coastal areas is projected to be significant, with

⁶⁵IPCC. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp., 2007. Retrieved from <https://www.ipcc.ch/report/ar4/syr/>

⁶⁶Cayan, D. R., J. Kalansky, S. Iacobellis, D. Pierce, and R. Kopp Kopp. Creating Probabilistic Sea Level Rise Projections to support the 4th California Climate Assessment. Prepared for the California Energy Commission. 2016.

Retrieved from <https://efiling.energy.ca.gov/GetDocument.aspx?tn=215428-7&DocumentContentId=17339>

⁶⁷California Coastal Commission. (August 12, 2015 and updated November 7, 2018). California Coastal Commission Sea Level Rise Policy Guidance. Retrieved from https://documents.coastal.ca.gov/assets/slr/guidance/2018/0_Full_2018AdoptedSLRGuidanceUpdate.pdf

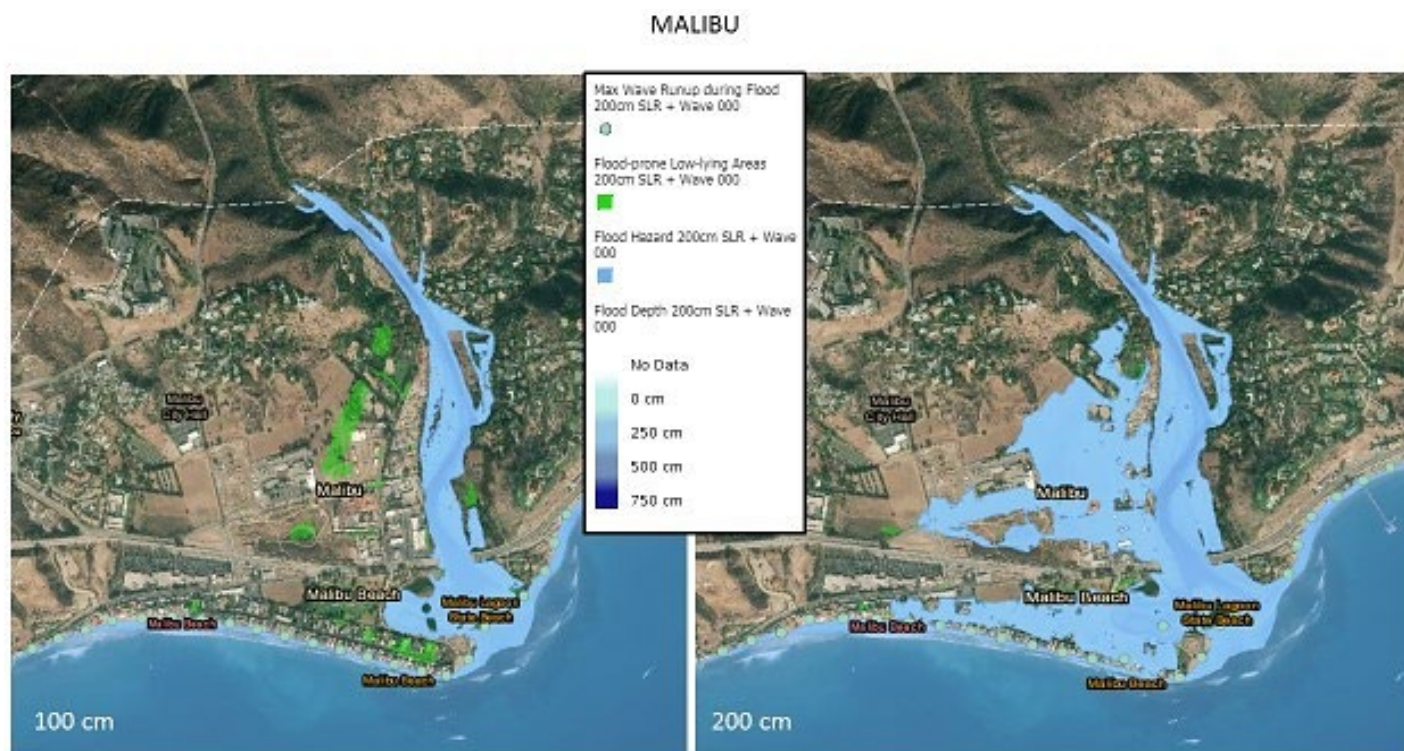


Figure 6-7: Projected sea level rise impact at 100cm and 200 cm⁶⁸

cascading effects on any business that depends on coastal land or resources.

Climate Central provides a risk analysis tool based on the latest current data available. Based on assumptions of a 5-foot (152.4 cm) sea level rise:

- ❖ 11,506 people living below 5 feet in Los Angeles County would be directly affected.
- ❖ 7,139 homes and 6 square miles of land would be at risk (an estimated property value of \$2.5 billion).
- ❖ 62 miles of roads, 6 passenger stations, 5 heliports, 4 power plants, and 2 Amtrak stations would be under threat.
- ❖ 111 EPA listed sites could be flooded risking contamination to the wider area.⁶⁹

Sea Level Rise: Impact on Living Resources, Marine Construction, and Marine Transportation Sectors

Our Coast Our Future mapping tools display possible scenarios given a 100 cm and 200 cm sea level rise, roughly corresponding with the projection made by the California Ocean Protection Council (OPC). Impacts vary depending on the natural coastal structure and on man-made protections, such as sea walls. Likely areas of risk at these levels in Los Angeles County include:

- ❖ **Living Resources Sector.** The fishing community depends on functioning infrastructure, which includes ports, docks, fish processing facilities, and fuel docks. Sea level rise between 100 cm and 200 cm threatens to flood or inundate many of these important assets.⁷⁰ The Living Resources sector, which represented 4 percent of Los Angeles County's ocean economy in 2016, would be impacted by the need to repair, relocate, or make other adjustments to changing sea levels and unusual tides and storms.

⁶⁸Our Coast Our Future. Interactive Map. Retrieved October 2019 from <http://data.pointblue.org/apps/ocof/cms/index.php?page=flood-map>

⁶⁹Climate Central. Data retrieved October 2018 from <https://riskfinder.climatecentral.org/>

⁷⁰State of California, Governor's Office of Planning and Research; California Natural Resources Agency; State of California Energy Commission. (2018). California's Fourth Climate Change Assessment – California's Coast and Ocean Summary Report. Retrieved from <https://www.energy.ca.gov/sites/default/files/2019-07/Statewide%20Reports-%20SUM-CCCA4-2018-011%20OceanCoastSummary.pdf>

❖ **Marine Construction and Marine Transportation Sectors.** Projected damage to the Port of Los Angeles and neighboring Port of Long Beach which comprise the San Pedro Bay port complex is extensive under the 100 cm to 200 cm sea level rise scenarios. Together, these ports handle more containers per ship call than any other port complex in the world. The Port of Los Angeles ranks seventeenth worldwide, and the San Pedro Bay port complex ranks ninth.⁷¹ Sea level rise will present clear challenges to these ports, especially if flooding affects staging areas next to the dock and surrounding roadways and railways from which goods are distributed; this is projected to occur if there is no intervention.⁷² According to the National Oceanic and Atmospheric Administration's (NOAA) Economics: National Ocean Watch (ENOW) data set, the Marine Transportation sector in Los Angeles County (most of which utilizes these ports) produced \$8.3 billion in GDP in 2016 and employed 46,451 people in 622 establishments. This sector accounts for 68 percent of the county's ocean economy by GDP and 21 percent of its employment. The Marine Construction sector accounted for an additional 3 percent of the county's Ocean Economy by GDP in 2016. Its activities are also closely tied to the San Pedro Bay port complex. This sector includes heavy construction firms involved in building port and other marine structures such as piers, offshore oil platforms, and harbor dredging.⁷³

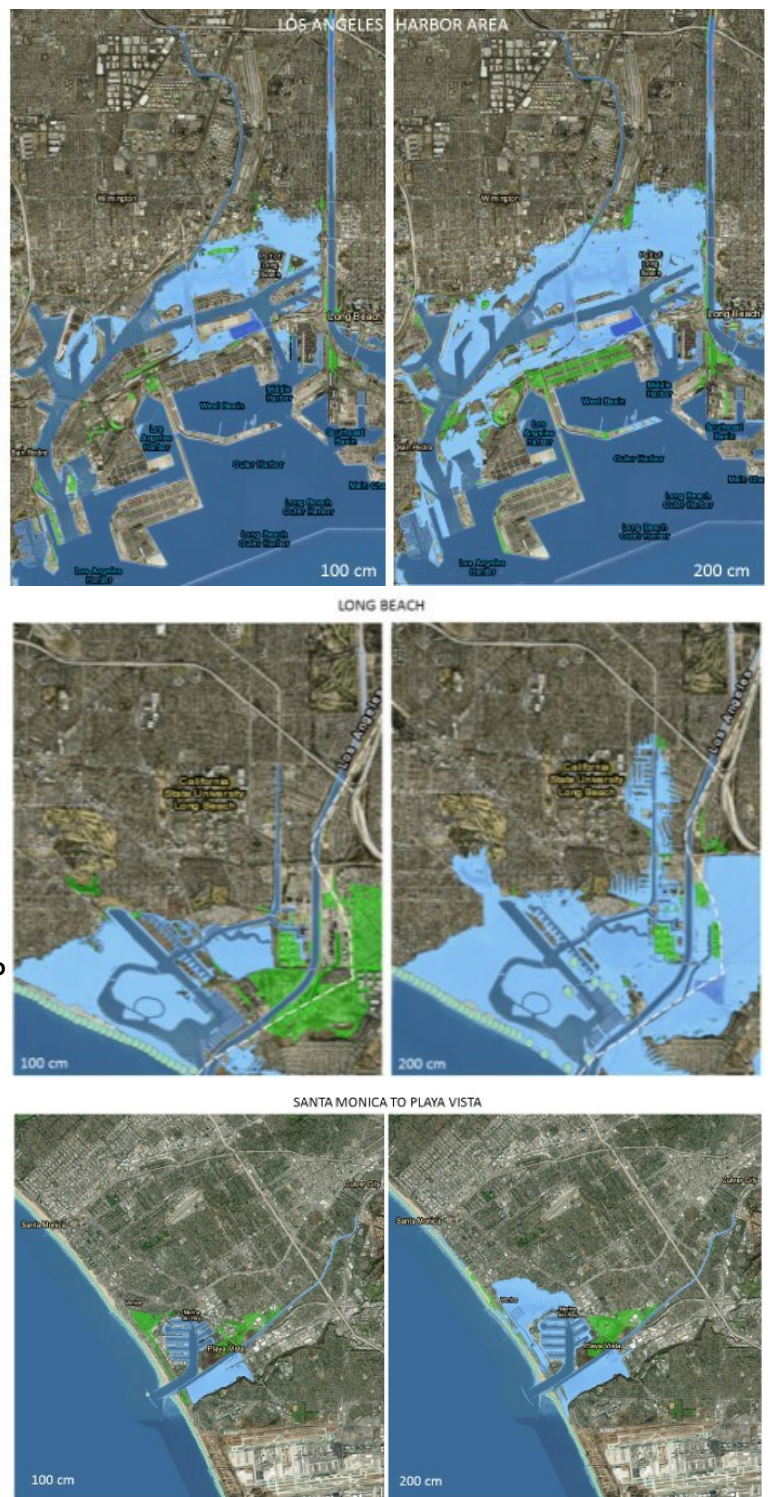


Figure 6-7: Projected sea level rise impact at 100cm and 200 cm

⁷¹The Port of Los Angeles. 2018 Facts and Figures. Retrieved October 2019 from <https://www.portoflosangeles.org/business/statistics/facts-and-figures>
⁷²State of California, Governor's Office of Planning and Research; California Natural Resources Agency; State of California Energy Commission. (2018). California's Fourth Climate Change Assessment –

⁷³California's Coast and Ocean Summary Report. Retrieved from <https://www.energy.ca.gov/sites/default/files/2019-07/Statewide%20Reports-%20SUM-CCCA4-2018-011%20OceanCoastSummary.pdf>
 NOAA Office for Coastal Management. (2015). The National Significance of California's Ocean Economy. Retrieved from <https://coast.noaa.gov/data/digitalcoast/pdf/california-ocean-economy.pdf>

Sea Level Rise: Impact on the Tourism and Recreation Sector

Los Angeles County beaches span approximately 25 miles and attract more than 50 million annual visitors. The Los Angeles County Department of Beaches and Harbors has 19 public beaches under its jurisdiction. Loss or damage to these areas would impact ocean-related tourism and recreation.

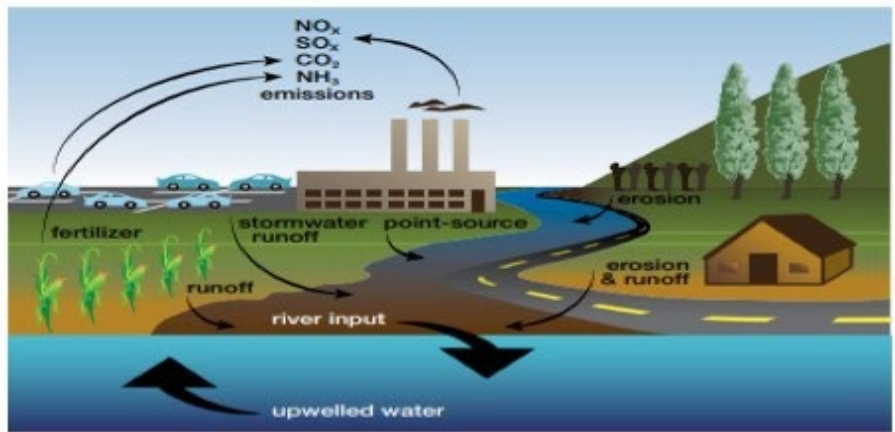


Figure 6-8: Contributors to Ocean Acidification

Beach-related tourism plays a major role in the region's economy. According to NOAA ENOW, Tourism and Recreation in Los Angeles County produced \$2.9 million in GDP in 2016 and employed 54,170 people in 2,304 establishments. This sector accounts for 21 percent of the county's ocean economy by GDP and 48 percent of its employment.⁶⁹

Coastal tourism is not likely to disappear in the face of sea level rise, but climate-associated changes will cause loss of property and income, economic instability, and pressure to relocate. It will certainly pose new challenges to the tourism and recreation sectors.

A 2011 study commissioned by the California Department of Boating and Waterways⁷⁴ indicated that popular seaside tourist areas in California could lose a total of \$530 million between now and 2100 if sea levels rise by 4.6 feet (140 cm). This total includes:

- ❖ \$51.6 million in damages caused by a 100-year coastal flood capable of destroying homes, commercial buildings, and contents;
- ❖ \$439.6 million in tourism spending and local and state tax revenue losses (accumulated between 2011 and 2100),

assuming that an eroded beach would attract fewer visitors; and

- ❖ \$38.6 million in habitat and recreation losses from erosion, assuming a 16 percent reduction in beach area.

According to a more recent study conducted as part of California's Fourth Climate Change Assessment, 31 to 67 percent of Southern California beaches may completely erode by 2100 without intervention. Given a projected 50 cm rise in sea level by 2050, \$17.9 billion worth of residential and commercial buildings could be inundated statewide. A 100-year coastal flood, on top of this level of sea level rise, would almost double these costs.⁷⁵ Even a more moderate rise of 35 cm would increase the risk to life and property due to flooding by 25 percent.⁷⁶

OCEAN WARMING AND OCEAN ACIDIFICATION

Ocean warming and ocean acidification are two climate change factors with a destructive influence on the health and productivity of the coastal ocean environment.

⁷⁴California Department of Boating and Waterways and San Francisco University. (2011). The Economic Costs of Sea-Level Rise to California Beach Communities. Retrieved from <https://dbw.parks.ca.gov/pages/28702/files/CalifSeaLevelRise.pdf>

⁷⁵State of California, Governor's Office of Planning and Research; California Natural Resources Agency; State of California Energy Commission. (2018). California's Fourth Climate Change Assessment – Overview. Retrieved from <http://www.climateassessment.ca.gov/state/overview/>

⁷⁶State of California, Governor's Office of Planning and Research; California Natural Resources Agency; State of California Energy Commission. (2018). California's Fourth Climate Change Assessment – Los Angeles Region Report. Retrieved from <https://www.energy.ca.gov/sites/default/files/2019-07/Reg%20Report-%20SUM-CCCA4-2018-007%20LosAngeles.pdf>

The ocean serves as a natural sink for global heat and greenhouse gases, but human-caused changes to the climate have begun to outpace what the ocean can absorb. From 1900 to 2016, California's coastal ocean warmed by approximately 0.7 degrees Celsius. Every indication is that this warming trend will continue. Under a high-end greenhouse gas emissions scenario (Representative Concentration Pathway - RCP 8.5), California Current waters (current that moves southward along the western coast of North America) are expected to be 2 to 4 degrees Celsius above the 1920–2016 average by 2100.⁷⁷

Oceans worldwide have become 30 percent more acidic since the Industrial Revolution as a result of chemical byproducts of modern industrial activity, such as carbon dioxide.⁷⁸ The longest running publicly available data on carbon dioxide absorption in seawater in California is from Point Conception, near Santa Barbara. This monitoring started in 2010 and has not provided enough data to determine independent trends. However, values are similar to those measured in Hawaii at similar times. Since the 1980s, the average pH of the world's oceans have dropped from 8.16 to 8.05, and in general the ocean's chemistry is changing 100 times faster than the 650,000 years preceding the Industrial Revolution.⁷⁹

Other climate change forces along California's coast include acidic runoff, erosion, and non-carbon dioxide emissions. For example, most sulfur oxide (SOx) and nitrogen oxide (NOx) emissions are generated where California's human population is most concentrated: along the coast. In 2014 (the latest year reported), Los Angeles County accounted for 21.45

percent of California's SOx and NOx emissions.⁸⁰

Pollutants can cause ocean ecosystems to use more oxygen than they produce, causing low oxygen "dead zones." High acidity and low oxygen waters can lead to decreased biological productivity.⁸¹

Ocean Warming and Acidification: Economic Challenges

Ocean warming and acidification have significant implications for Southern California's aquatic wildlife. In addition to an increase in low-oxygenated sections, warmer water temperatures may lead to more stratification of coastal waters and reduced upwelling of nutrients from deeper in the ocean. Scientists have correlated these changes with impacts on marine life. Ocean acidification is damaging plant and animal life, and is changing the chemistry of the ocean environment in ways that are altering ecosystem structures.

Ocean Warming and Acidification: Impact on the Living Resources Sector

The Living Resources sector in Los Angeles County produced \$498,269,000 in GDP in 2016 and employed 4,024 people. This sector accounts for 4 percent of the county's ocean economy by GDP and employment. It includes commercial fishing, aquaculture and seafood processing.⁸² Due to the extractive nature of these activities, Living Resources are particularly reliant on the condition of the coast and coastal ocean, and the sector is susceptible to economic impacts from ocean warming acidification.

⁷⁷State of California, Governor's Office of Planning and Research; California Natural Resources Agency; State of California Energy Commission. (2018). California's Fourth Climate Change Assessment – California's Coast and Ocean Summary Report. Retrieved from <https://www.energy.ca.gov/sites/default/files/2019-07/Statewide%20Reports-%20SUM-CCCA4-2018-011%20OceanCoastSummary.pdf>

⁷⁸Doney, Scott. "The Growing Human Footprint on Coastal and Open-Ocean Biogeochemistry." *Science*. (2010). 328, 1512. Retrieved from <https://pdfs.semanticscholar.org/2c5e/ee92ea7e6dfa80966efc8744fb13af8b045a.pdf>

⁷⁹Ocean Acidification." Scripps Institution of Oceanography, UC San Diego. Retrieved from <https://scripps.ucsd.edu/news/ocean-acidification>.

⁸⁰Environmental Protection Agency. (2014). 2014 National Emissions Inventory Report. Retrieved from <https://gispub.epa.gov/neireport/2014/>

⁸¹Center for Ocean Solutions. (2012). Why Ocean Acidification Matters to California, and What California Can Do. Retrieved from https://oceansolutions.stanford.edu/sites/default/files/2012%20Why%20Ocean%20Acidification%20Matters%20to%20California_0.pdf

⁸²World Ocean Initiative. (27 September 2019). Climate change report highlights risks and opportunities for the blue economy. Retrieved from <https://www.woi.economist.com/climate-change-report-highlights-risks-and-opportunities-for-the-blue-economy/>

Globally, the world's oceans are projected to absorb two to four times more heat by 2100 than they have in the past 50 years if global warming is limited to 2 degrees Celsius and emissions levels increase by five to seven times. Based on these dismal assumptions, there would be a 15 percent decline in the total mass of marine animals, and a drop of up to 25 percent in fish catches worldwide. If these scenarios come to pass, global revenue in the fishing industry could fall by around 10 percent by 2050.⁸³

In Southern California, researchers have linked warmer waters with an 80 percent reduction in zooplankton since 1951. Zooplankton are microscopic organisms that are the source of food for higher trophic level species, such as fish. Scientists have also found evidence of negative impacts on kelp forest ecosystems as a result of warmer water.⁸⁴ Like zooplankton, kelp is at the bottom of the food chain for many aquatic species. It also serves as habitat for a number of animals such as garibaldi and kelp bass.⁸⁵ Due to kelp's significance to nearly 700 species in the California coastal waters, it plays an important role in supporting commercial and recreational fisheries. Though efforts are being made locally to protect kelp forests, they are under threat due to climate change. The Palos Verdes Peninsula has lost 75 percent of its kelp forest over the last 100 years.⁸⁶

Warmer ocean temperatures have also been linked to an increase in harmful algal blooms. While some algae blooms are not harmful,

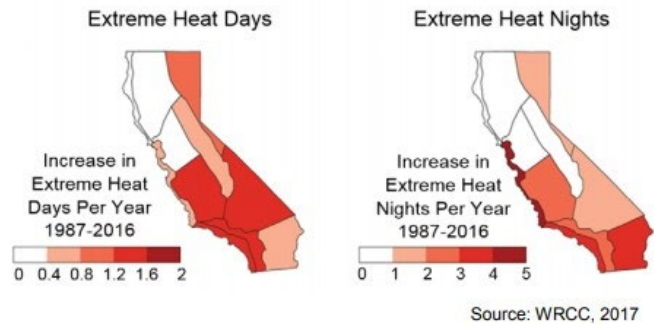


Figure 6-9: Regional trends in extreme heat days and nights⁸⁷

many are extremely dangerous to human and animal life. These have the potential to impact fisheries, such as the massive algal bloom in 2015 that closed fisheries along the West Coast.⁸⁸

By directly affecting species, ocean acidification has a direct impact on fisheries. Rockfish, a popular species with local commercial fisheries, has been found to be affected by changes in acidity.⁸⁹ Scientists have also found that an increase in low-oxygen zones off the southern California coast could reduce rockfish habitat by one-fifth to one-half.⁹⁰ In laboratory tests, acidifying ocean waters impose ecological challenges to marine species, especially species such as shell-forming organisms.⁸¹ Known impacts to species of state interest include decreases in shell size and/or thickness in oysters and mussels, increased mortality in Dungeness crab, and shell dissolution in small plankton (pteropods and foraminifera) that form the base of the food web for many organisms.⁹¹

⁸³Los Angeles Regional Collaborative for Climate Action and Sustainability. Ocean & Coastal Resources. (December 19, 2016). Retrieved from http://climateaction.la/wp-content/themes/larc/report/AGreaterLA_ClimateActionFramework_Dec-19-2016-ocean-and-coastal-resources.pdf

⁸⁴NOAA: National Marine Sanctuaries. Kelp Forest – A Description. Retrieved October 2019 from <https://sanctuaries.noaa.gov/visit/ecosystems/kelpdesc.html>

⁸⁵Cabrillo Marine Aquarium. Kelp Forests. Retrieved October 2019 from <https://www.cabrillomarinaquarium.org/exhibits/socal-marine-habitats/kelp-forests.asp>

⁸⁶KCET. Restoring Southern California's Kelp Forests. Retrieved October 2019 from <https://www.kcet.org/shows/socal-connected/restoring-southern-californias-kelp-forests>

⁸⁷Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (May 2018). Indicators of Climate Change in California. Retrieved from <https://oehha.ca.gov/media/downloads/climate-change/report/2018caindicatorsreportmay2018.pdf>

⁸⁸Serna, Joseph. "Toxic algae bloom shuts down West Coast fisheries." The Los Angeles Times. (19 June 2015). Retrieved from <https://www.latimes.com/local/lanow/la-me-ln-toxic-algae-bloom-shuts-down-west-coast-fisheries-20150618-story.html>

⁸⁹Barboza, Tony. "Rise in ocean acidity makes fish anxious, study finds." The Los Angeles Times. (6 December 2013). Retrieved from <https://www.latimes.com/science/sciencenow/la-sci-sn-fish-anxiety-ocean-acidification-20131205-story.html>

⁹⁰State of California, Governor's Office of Planning and Research; California Natural Resources Agency; State of California Energy Commission. (2018). California's Fourth Climate Change Assessment – California's Coast and Ocean Summary Report. Retrieved from <https://www.energy.ca.gov/sites/default/files/2019-07/Statewide%20Reports-%20SUM-CCCA4-2018-011%20OceanCoastSummary.pdf>

There is limited information that directly examines the connection between changes in ocean temperature, acidity and pollution, and local aquatic ecosystems. However, NOAA's National Marine Fisheries Service is in the process of assessing the climate change risks for federally managed fish stocks on the West Coast, and California is considering implementing similar studies for state-managed fisheries.⁸⁹

TEMPERATURE CHANGE, EXTREME HEAT, AND AIR QUALITY

Temperature change, increasing extreme heat events, and declining air quality are three climate change factors that interact and exacerbate one another in our local environment.

In California, the average annual maximum daily temperature is projected to increase by 5.3 degrees Fahrenheit (assuming emission reductions) to 8.8 degrees Fahrenheit (assuming business-as-usual emission levels) by 2100. It is getting hotter, and extreme heat days and nights have become more frequent since 1950 and are projected to last longer.⁹²

Periods of extremely high temperatures have a number of serious impacts from increases in heat-related illnesses and deaths to increased water demand. Extreme heat also has the potential to lead to higher levels of air pollution generating greenhouse gases. There is evidence that periods of high heat, particularly increased daytime temperatures, lead to

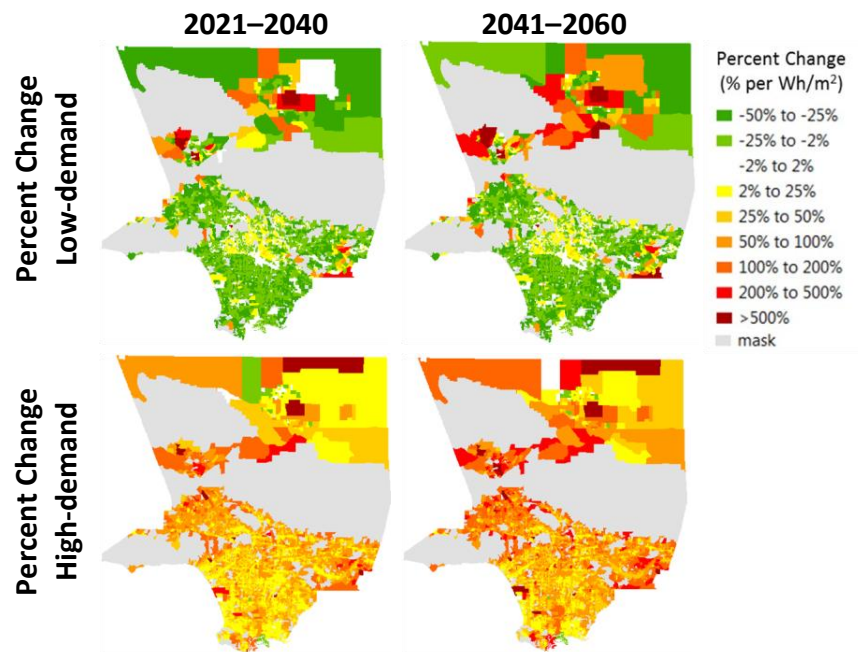


Figure 6-10: 2017 Sustainable LA Environmental Report Card for Los Angeles County: Energy & Air Quality

higher ozone levels.⁹³ In addition to natural processes, a recent study by researchers at the University of California, Los Angeles (UCLA) found that expected temperature increases and an upsurge in extreme heat events will result in increased energy demand in Los Angeles County, which is expected to grow from 37–50 percent between 2041 and 2060. As demand intensifies, increasing strain will be placed on the electrical grid and the likelihood of equipment failure and outages will rise.⁹⁴ Increased energy use also has the potential to negatively impact air quality. The good news is that the state's efforts to bring emissions under control have been succeeding, and California's greenhouse gas emissions have declined since 1990 despite increases in the state's population and economic output.⁹⁵ However, according to the 2017 Sustainable LA Environmental Report Card for Los Angeles County, UCLA

⁹¹State of California, Governor's Office of Planning and Research; California Natural Resources Agency; State of California Energy Commission. (2018). California's Fourth Climate Change Assessment – California's Coast and Ocean Summary Report.

⁹²Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (May 2018). Indicators of Climate Change in California. Retrieved from <https://oehha.ca.gov/media/downloads/climate-change/report/2018caindicatorsreportmay2018.pdf>

⁹³AECOM. (21 November 2018). Climate Change Vulnerability Assessment Results: Long Beach Climate Action and Adaptation Plan. Retrieved from <http://www.longbeach.gov/globalassets/city-manager/media-library/documents/>

memos-to-the-mayor-tabbed-file-list-folders/2019/january-4--2019---climate-action-and-adaptation-plan--caap--project-update-and-invitation

⁹⁴UCLA IoES. Electricity Demand Changes and Grid Infrastructure Vulnerabilities in LA County by 2060 Fact Sheet from "Climate Change in Los Angeles County: Grid Vulnerability to Extreme Heat," a report for California's Fourth Climate Change Assessment. (August 2018). Retrieved from <https://www.ioes.ucla.edu/project/climate-change-in-los-angeles-county-grid-vulnerability-to-extreme-heat/>

⁹⁵Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (May 2018). Indicators of Climate Change in California.

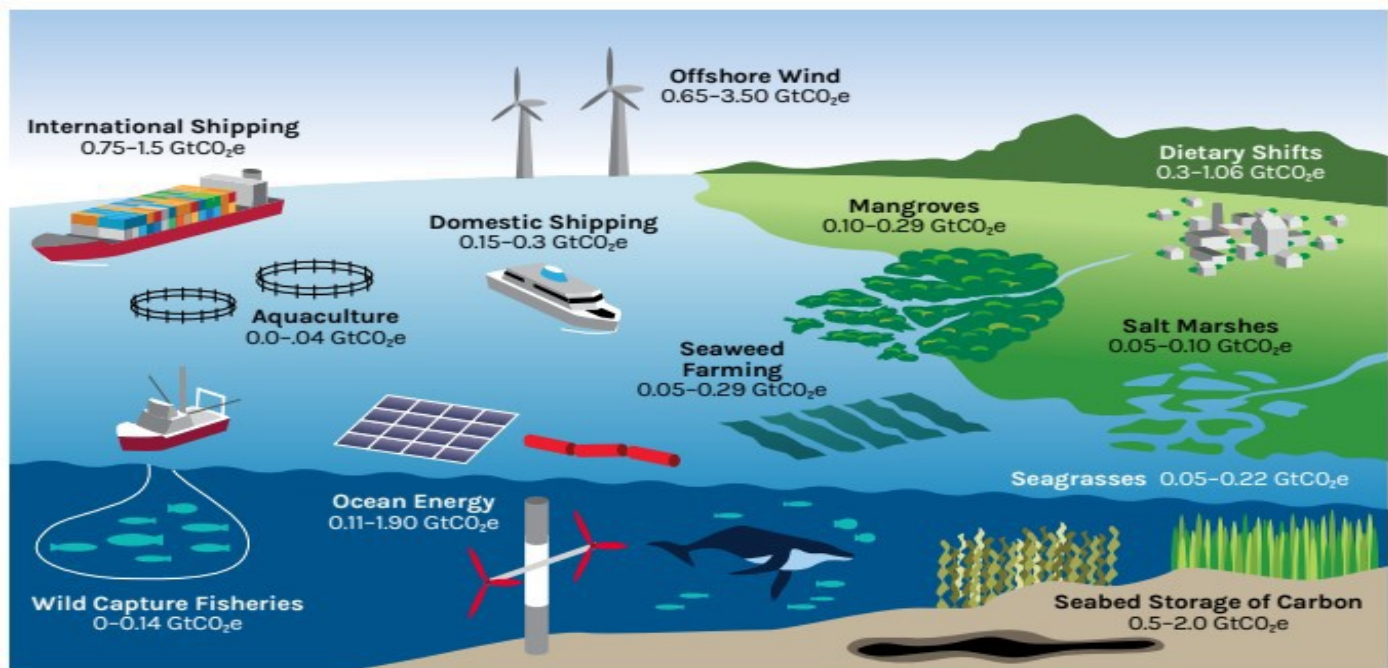


Figure 6-11: Contribution of Five Ocean-based Climate Action Areas to Mitigating Climate Change in 2050⁹⁶

researchers gave Los Angeles a C grade for energy and air quality after examining nearly a decade of related data.⁹⁷

As demonstrated, anticipated increases in air temperature and extreme heat events are likely to increase demand for energy which, if left unchecked, may boost production of greenhouse gases. From the standpoint of the ocean economy, the most critical potential impacts of these climate changes are pressures placed on ocean-related business including reduction in greenhouse gas emissions through increased efficiency and innovation, and generating more ocean-based, carbon-neutral sources of energy.

Temperature Change, Extreme Heat, and Air Quality: Impact on the Ship & Boat Building and Marine Transportation Sectors

The Ship & Boat Building sector accounts for less than 1 percent of Los Angeles County's GDP in the ocean economy. It includes construction and repair of ships as well as

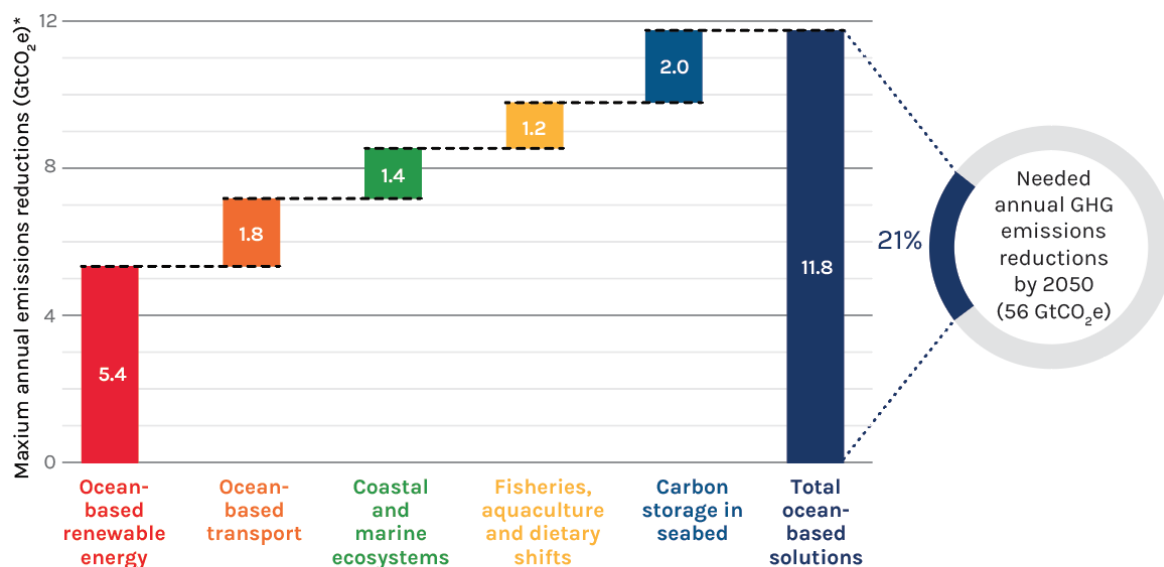
conversion and alteration. The Marine Transportation sector accounts for 68 percent of GDP. As demand rises for innovative solutions and increased operating efficiency to reduce greenhouse gas emissions, it is likely this sector will experience heavy pressure to find low- or no-carbon solutions for shipping and related transportation.

ECONOMIC OPPORTUNITIES FOR THE BLUE ECONOMY IN LOS ANGELES

While climate change will certainly have an impact on the blue economy, investing in the blue economy gives our region the opportunity to have measurable impacts on climate change and at the same time, create new revenue streams. This is perhaps one of the greatest opportunities that a blue economy presents to Los Angeles.

⁹⁶Hoegh-Guldberg, Ove et al. "Turning the Tide: Ocean-Based Solutions Could Close Emission Gap by 21%." World Resources Institute. (23 September 2019).
⁹⁷Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (May 2018). Indicators of Climate Change in California. Retrieved from <https://oehha.ca.gov/media/downloads/climate-change/report/2018caindicatorsreportmay2018.pdf>

⁹⁸Hoegh-Guldberg, Ove, et al. "The Ocean as a Solution to Climate Change: Five Opportunities for Action." Report. Washington, DC: World Resources Institute. (2019). Retrieved from https://khrono.no/files/2019/09/25/19_HLP_Report_Ocean_Solution_Climate_Change_final.pdf



Notes: * To stay under a 1.5°C change relative to pre-industrial levels

Figure 6-12: Ocean-based Mitigation Options and Potential by 2050

Economic Opportunities: Innovative solutions

Response from ocean-based businesses to the changing environment has the potential to not only be profitable, but also play a role in reducing the impacts from climate change. A 2019 report from the U.N. Secretary General's Climate Action Summit produced by the Expert Group Panel for a Sustainable Ocean Economy⁹⁸ highlighted five key solutions that would help limit effects of climate change and contribute to a sustainable ocean economy while protecting coastal communities from storms, providing jobs, and improving food security. These solutions include:

- ❖ Increasing the use of ocean-based renewable energy.
- ❖ Decarbonizing domestic and international shipping and transport.
- ❖ Increasing the protection and restoration of “blue carbon” ecosystems—mangroves, seagrasses, and salt marshes.
- ❖ Utilizing low-carbon sources of protein from the ocean, such as seafood and seaweeds, to help feed future populations in a healthy and sustainable way, while easing emissions from land-based food production.
- ❖ Carbon storage in the seabed.

Worldwide implementation of these ocean-based climate solutions could deliver one-fifth (up to 21%) of the annual greenhouse gas emissions cuts outlined in the Paris Agreement to help keep global temperature rise below the 1.5 degrees Celsius. Emission reductions of this magnitude are equivalent to eliminating the annual emissions from all coal-fired power plants worldwide or taking 2.5 billion cars off the road.

Ocean-Based Renewable Energy. Many technologies exist or are being developed to take advantage of the potential to generate renewable energy from the ocean. Some examples include fixed and floating offshore wind turbine installations, as well as energy extracted from ocean waves, tides, and currents. Energy can also be gathered from salinity and temperature differences. Another emerging approach is the use of floating photovoltaic solar energy. Each solution can provide answers to the growing demand for power while reducing impact on the environment. According to the International Energy Agency (IEA), offshore wind generation grew by 30 percent from 2010 to 2018 and is expected to increase fifteen-fold by 2040.⁹⁹ In 2018, electricity generation from all marine technologies only increased by 3 percent. According to the IEA, these technologies have

a much higher potential to meet a rapidly growing demand; the missing element is policy support to enable more research and development.¹⁰⁰

Ocean-Based Transport. Current estimates indicate that international and domestic shipping produces approximately 3 percent of all man-made global carbon dioxide emissions. Both domestic and international shipping sectors are expected to have high demand with estimated growth of 3 percent per year. In 2018, the United Nations International Maritime Organization adopted the objective to reduce shipping emissions by at least 50 percent globally by 2050. In order to achieve this goal, ships will need to develop more energy-efficient systems and begin to use low- and zero-carbon fuels, including biofuels.

Coastal and Marine Ecosystems.

Mangroves, salt marshes, seaweed, and seagrass have the potential to sequester carbon at very high rates. Mangroves, saltmarshes, and seagrass can prevent degradation of water ecosystems and rehabilitate associated organisms. In addition, seaweed has the potential to reduce emissions while also becoming a source of food via aquaculture. It can be used as food, feed, fertilizer, nutraceuticals, biofuels, and bioplastics.

Fisheries, Aquaculture and Shifting Diets.

There are possibilities to reduce waste and increase efficiency in the seafood supply chain, thus reducing carbon footprint. For example, reducing emissions from wild-capture fisheries through technological advances, engine efficiency, and improved hull design could cut current fishing emissions in half.¹⁰¹ Reductions can also be achieved by finding new and more efficient feeds for aquaculture systems. Even more important is the potential

CLIMATE CHANGE VULNERABILITY ASSESSMENT RESULTS: LONG BEACH CLIMATE ACTION AND ADAPTATION PLAN

November 2018

This report examined the threat posed by sea level rise and coastal flooding, riverine flooding, extreme heat, drought, and poor air quality. The goal was to understand how these climate factors may impact Long Beach assets, to aid the city in prioritizing the creation of adaptation strategies, and to provide information that would better inform decision-makers on future capital projects. Detailed findings were issued in a comprehensive vulnerability summary for several areas of expected impact. Areas of highest concern were:

- ❖ Buildings and Facilities
- ❖ Parks and Open Spaces
- ❖ Transportation Assets
- ❖ Energy Assets
- ❖ Stormwater Assets
- ❖ Wastewater Assets
- ❖ Potable Water Assets
- ❖ Public Health

of moving away from land-based animal protein consumption; ocean-based proteins have some of the lowest greenhouse gas emissions per unit of protein.

Carbon Storage in the Seabed. It may be possible to reduce our carbon impact on the planet through innovative ways of storing carbon dioxide in the ocean. Reduction methods include injection in the seafloor or

⁹⁹The International Energy Agency (IEA). Offshore Wind Outlook 2019. Retrieved October 2019 from <https://www.iea.org/offshorewind2019/>

¹⁰⁰The International Energy Agency (IEA). Ocean power: Tracking Clean Energy Progress. Retrieved October 2019 from <https://www.iea.org/tcep/power/renewables/oceanpower/>

¹⁰¹Hoegh-Guldberg, Ove, et al. "The Ocean as a Solution to Climate Change: Five Opportunities for Action." Report. Washington, DC: World Resources Institute. (2019). Retrieved from https://khrono.no/files/2019/09/25/19_HLP_Report_Ocean_Solution_Climate_Change_final.pdf

deep ocean, carbon dissolution, adding alkalinity, or ocean fertilization.¹⁰¹

The aforementioned categories outline both climate change solutions and potential pathways for economic opportunity. According to the Organization for Economic Cooperation and Development (OECD), the blue ocean economy is expected to double by 2030 if investments are made in the areas of sustainability and innovation.¹⁰² Los Angeles County is well positioned to take advantage of these pathways, as California policy already strongly leans towards sustainable planning and universities and businesses already offer education and training related to the ocean economy. The state's existing maritime workforce combined with blue economy solutions can create secure and stable jobs while ensuring the future of our oceans.

SUMMARY

Climate change is occurring at an alarming rate worldwide and efforts are currently being made to limit global temperature rise. California has already seen the effects of climate change through increased extreme heat days, larger wildfires, and sea level rise, to name a few. As a result, California has begun to combat climate change through state legislation and policies that aim to reduce environmental impacts. As with other locales, climate change threats including sea level rise, ocean warming and acidification, temperature change, extreme heat, and poor air quality extend to Los Angeles County and its ocean economy. Sea level rise threatens various sectors of Los Angeles County's ocean economy including Living Resources, Marine Construction, Marine Transportation, and Tourism and Recreation. Although the comprehensive consequence on the economy is difficult to narrow down, current models show devastating effects at various projections

of sea level rise that have significant implications for the Los Angeles ocean economy. Ocean warming and acidification directly affects wildlife, which, in turn, affects the Living Resources sector of Los Angeles County and the fisheries and businesses that depend on certain species for success. Furthermore, as temperatures rise, there will be a demand for reducing greenhouse gas emissions for the Ship and Boat Building and Marine Transportation Sectors.

In spite of these challenges, economic opportunities exist as Los Angeles County works to fight climate change and its threats. Traditional approaches to doing business in the ocean economy will need to evolve to address the realities of a changing climate, and there will be growing demand for innovative solutions.

Ocean based renewable energy can supply increasing demands while remaining environmentally sound and, in some cases, even serve to reduce climate change impact. Ocean based transport continues to grow, and as climate change impacts increase, there will be a greater need for efficient, low- and no-emission energy systems. Marine ecosystems can act as both a source of food for a growing population and a way to combat emissions through storage of carbon dioxide. Fisheries can reduce emissions through modernization of methods and equipment, and those concerned with environmental footprint can turn towards a sustainable diet based in aquaculture. With appropriate policy support, Los Angeles County is poised to be a leader in the emerging blue economy.

¹⁰²OECD (2016), The Ocean Economy in 2030, OECD Publishing, Paris.
<http://dx.doi.org/10.1787/9789264251724-en>

7. CREATING NEW POLICIES

An essential aspect to realizing the full potential of the blue economy is employing a more integrated approach to policy development. Creating policies that support rather than impede the development of sustainable ocean industries is easier to accomplish with a united front. Focus must be placed on collaboration and interweaving the encouraging partnership between the public and private sectors will help form a strong blue economic system.

Given the findings of this study, along with in depth analysis of similar regions and case studies, the IAE has developed the following policy recommendations intended to strengthen and grow the ocean economy in Los Angeles County.

LAEDC's leveraging of its long-standing relationships with relevant stakeholders in the region provided key insights in aiding IAE's recommendations. These stakeholders, along with the region's policymakers and citizens, are committed to the common objective of protecting our oceans and maximizing the ocean economy's impact on the County's regional economy.

Policy recommendations for the ocean economy fall into three different categories: environmental, workforce/industry cluster development, and governmental. Listed in no specific order, the recommendations help to preserve a renewable, clean, ocean economy while upholding California's image as a key trading partner and the nation's leader in environmental issues. While certain new regulations such as those on plastic straws are a start in the right direction, further developments in state regulation must be

taken in order to fully protect the ocean and its natural resources.¹⁰³

ENVIRONMENTAL POLICY RECOMMENDATIONS

Preserve the local waterfront, ocean, and their resources

While numerous non-profit organizations such as Heal the Bay and The Bay Foundation aid in protecting the local coastline, the responsibility ultimately falls upon the government to establish proper protocols. The impact of California beaches on the nation's economy totaled \$73 billion two decades ago.¹⁰⁴ As the impact grows, it is clear that Los Angeles must protect its shoreline from pollution and erosion. As stated by the California State Parks Division of Boating and Waterways, "California's coast, one of our most precious resources, is a naturally eroding shoreline."¹⁰⁵ Locally, the county should continue its nourishment of the coastline --as it has done in Santa Monica and Palos Verdes-- to expand and reinvigorate the beach in a natural manner.

Pollution of beaches, on the other hand, is harder to regulate. As popular public land, it is difficult to differentiate polluters from non-polluters. While it is nearly impossible to eliminate littering on beaches, incentives can be aligned through education and ease of access. Increasing the amount of trash cans and recycling bins on beaches can decrease littering as a byproduct of laziness, while posting signs, billboards, or advertisements can decrease littering as a byproduct of apathy. Los Angeles beaches already boast

¹⁰³Chapter XIX of The Los Angeles Municipal Code. 2019. Vol. 19601-19606. https://clkrep.lacity.org/online/docs/2018/18-0053_ord_draft_02-12-2019.pdf. City of Los Angeles.

¹⁰⁴King, Philip. 1999. "Evaluation of Shore Protection Projects In California". *California Department of Boating and Waterways*. <http://userwww.sfsu.edu/pgking/beaches.htm>.

¹⁰⁵"Coastal Beach Restoration and Erosion Control". 2019. *California State Parks Division of Boating And Waterways*. https://dbw.parks.ca.gov/?page_id=28766.

¹⁰⁶"Beach Report Card". 2019. <https://beachreportcard.org/>.



remarkable water and beach quality, but strides can always be made to improve the cleanliness of California's beaches.¹⁰⁶

Promote utilizing the ocean for renewable energy

With the key objective of protecting our oceans so that they can have a lasting role in the regional economy, sustainability and economic development can successfully join forces to drive regional growth. Primarily, California's goal of zero-emission energy sources by 2045 continues to be a major driving force of policy. To reach this goal, the region must pursue advancements in alternative energy sources.

At this point in time, Los Angeles and California have not actively taken advantage of renewable ocean energy technologies.

Typically called marine energy, renewable forms of ocean energy have yet to be utilized by Los Angeles Department of Water and Power. Renewable forms of marine energy include wave energy, tidal energy, and current energy. Technologies to harness these forms of energy are "at various stages of

development" according to the National Hydropower Association. Marine energy has the potential in the United States to generate around 90 Gigawatts,¹⁰⁷ the equivalent of 281.25 million solar panels.¹⁰⁸

While wind energy is not included in the ocean economy's current industry sectors, the development of offshore wind turbines has made this industry an emerging potential linchpin in the blue economy. Currently, wind energy is the country's fourth-largest source of electric capacity behind natural gas, coal, and nuclear energy, and is expected to increase as a percentage of generation. As mentioned, the International Energy Agency anticipates wind generation to increase fifteen-fold by 2040 and Los Angeles has substantial potential to add to this figure.

As a state, California has identified the benefits of fostering this industry. In October 2018, the Bureau of Ocean Energy Management received over a dozen nominations from companies interested in commercial wind energy leases in California. The three identified areas off the coast of central and

¹⁰⁷"Marine Energy". 2019. *National Hydropower Association*. <https://www.hydro.org/waterpower/marine-energy/>.

¹⁰⁸"How Much Power Is 1 Gigawatt?". 2019. *United States Department of Energy Office of Energy Efficiency and Renewable Energy*. <https://www.energy.gov/eere/articles/how-much-power-1-gigawatt>.

northern California total approximately 2,784 square kilometers (687,823 acres), which could support an offshore-wind-generating capacity of up to 8.4 GW.

Environmental monitoring is a key factor in developing offshore wind turbines, and the Energy Department is dedicated to upholding the stringent oversight requested by different protection groups and regulatory bodies. In order to minimize or eliminate negative impacts that wind turbines would have on natural habitats, multiple projects are being undertaken by the Energy Department in collaboration with academic leaders, international agencies and environmental experts to monitor and research ocean energy as well as to track species distribution and migration.

While offshore wind power is still more expensive than traditional wind turbines, the cost has drastically fallen in the past two years.¹⁰⁹ Countries such as the United Kingdom, the Netherlands, and Germany have already implemented offshore windfarms, powering millions of homes in their respective countries.¹¹⁰ Offshore wind power is a necessity in the increasingly ecologically-focused future of energy.

Continue to combat climate change and lead the nation in climate change policy

Global warming is at the forefront of political discourse across the world, and consistently ranks as one of the most important issues the United States faces, according to Gallup.¹¹¹ California has been a trailblazer by enacting environmental policy far beyond the standard of the remaining 49 states.¹¹² Although California remains at the forefront of global environmental protection, maintaining that



achievement requires further research into climate change and additional stringent policies on pollutants.

Continue to promote recycling of plastics and other long-life debris

The Environmental protection agency classifies marine debris as “any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment”.¹¹³ Plastics make up a large percentage of marine debris and pose both physical and chemical threats to the ocean. Due to their longevity, plastics in the ocean will not dissolve over time. While an ocean-wide cleanup would likely require national-level resources, Los Angeles can continue to mitigate the stream of plastics polluting the ocean by increasing the level of recycling and plastic waste capture from storm water in the region. Laws such as 2011 CA S 567 and 2014 SB 270 set a statewide baseline for how society intends to treat plastics moving

¹⁰⁹Musial, Walter, Philipp Beiter, Paul Spitsen, Jake Nunemaker, and Vahan Gevorgian. 2019. "2018 Offshore Wind Technologies Market Report". United States Department of Energy Office of Energy Efficiency and Renewable Energy. <https://www.energy.gov/sites/prod/files/2019/09/f66/2018%20Offshore%20Wind%20Technologies%20Market%20Report.pdf>.

¹¹⁰Vaughan, Adam. 2018. "World's Largest Offshore Windfarm Opens Off Cumbrian Coast". *The Guardian*. <https://www.theguardian.com/environment/2018/sep/06/worlds-largest-offshore-windfarm-opens-cumbrian-coast-walney-extension-brexit>.

¹¹¹Gallup, Inc. 2019. "Most Important Problem". *Gallup.Com*. <https://news.gallup.com/poll/1675/most-important-problem.aspx>.

¹¹²California Environmental Protection Agency. 2019. "Major Accomplishments 2011 – 2018". https://calepa.ca.gov/wp-content/uploads/sites/6/2019/03/CalEPA_Accomplishments_Report_2011-2018_a.pdf.

¹¹³"Toxicological Threats of Plastic". 2019. *US EPA*. <https://www.epa.gov/trash-free-waters/toxicological-threats-plastic>.



forward, while legislation such as AB-1080 attempts to phase out excessive packaging and priority single-use products by 2030.¹¹⁴ Additionally, AB-1080 ensures that all plastic packaging and single-use products manufactured and imported to California are recyclable or compostable. Though it has not yet passed, acts such as AB-1080 can serve as a model for Los Angeles and other cities looking to reduce their overall plastic consumption. California's numerous environmental organizations and initiatives, such as the California Ocean Litter Prevention Strategy, are working tirelessly to keep the state's coastline and waters pristine and safe for tourists, marine life and residents alike.

Promote the use of sustainable aquaculture to increase the food supply and restore ocean ecology

The National Aquaculture Act of 1980 deemed aquaculture as a national policy priority. However, both federal and state regulations and policies have impeded the growth of the industry in the United States and California.

While many natural fish stocks have reached and continue producing at their sustainable maximum yield, aquaculture production is growing at an average rate of 6.1% per year and playing an increasingly important role in supplying the world with food. According to NOAA Fishery Statistics No. 2017-2, the United States seafood trade deficit reached \$15.8 billion in 2017. A significant amount of the seafood products imported into the U.S. come from aquaculture farms abroad. Although it is clearly in the best interest of American consumers to support sustainable development of domestic aquaculture, the industry struggles with hurdles regarding both regulations and public perception.

There are several guiding policies on the federal, state, and local levels in existence for aquaculture production, some of which contradict each other. This has made it difficult to grow the sector in the United States. In an effort to streamline policy, the Department of Commerce and NOAA released aquaculture policies in 2011, as well as the National Ocean Policy, provide federal guidance for marine aquaculture activities. However, there is still much confusion and debate around the subject of aquaculture in offshore federal waters. The technology to sustainably grow aquatic plants and animals in ocean waters with minimal environmental impacts exists, yet there are few offshore farms that have received the necessary permits and leases to operate. This demonstrates an egregious mismanagement of economic and ecological opportunities for a country that has access to thousands of miles of coastline and ocean waters.

¹¹⁴AB-1080 Solid Waste: Packaging and Products. 2019. http://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=201920200AB1080: State of California Legislative Information.

Catalina Sea Ranch at AltaSea in the Port of Los Angeles was the first farm to receive a permit to grow bivalves and seaweed in federal waters 6 miles offshore. While L.A. County can take pride in celebrating this milestone, it is underscored by the fact that no finfish are currently in commercial production in federal waters.

Overfishing and climate change are having serious impacts on the wild stocks of fish that billions of people depend on for protein. Aquaculture is a promising way to help restore those stocks and at the same time feed our growing population. The capabilities of offshore cage culture of marine finfish have been proven through trials such as the Velella Project¹¹⁵. The Velella Project has gone through years of research and navigated the turbid waters of bureaucracy to get to its current status: the U.S. Environmental Protection Agency is now considering the approval of a permit to move the project into its commercial phase and to —for the first time— raise fish in a cage in federal waters.

With its ideal climate, long coastline, and ample ocean resources, California has a real opportunity to lead the way in sustainable aquaculture production in the U.S. However, federal, state, and local policies must shift to support more production. Only then will the multitude of industries within the aquaculture sector be given the opportunity to significantly impact the economies and coastal ecology of L.A. and California.

WORKFORCE/INDUSTRY CLUSTER POLICY RECOMMENDATIONS

Increase throughput of local ports by eliminating trade hurdles and promoting trade with trans-pacific partners

The ports of Los Angeles and Long Beach are the two largest ports in the United States.¹¹⁶ While national level trade disputes are stymieing local trade with China, Los Angeles should actively promote the message that it is still open for global trade, and is not represented by national discourse.¹¹⁷ While the local government cannot eliminate national tariffs, it can attract business by improving infrastructure and continuing to develop existing relationships. The Clean Air Action Plan being jointly pursued by both San Pedro Complex ports signals a robust beginning to the improvement of local oceanic trade infrastructure.

Invest in local training and development programs for maritime workers

As exhibited in Section 4, investment in programs such as construction engineering, mechanical engineering, and marine and environmental biology aid the training and development of maritime workers. Creating a productive and intelligent workforce capable of solving future problems is essential to the future development of the ocean economy. Certain key educational programs that feed into the ocean economy workforce are available in the greater Los Angeles area such as the Master's programs in Global Supply Chain Management at CSU Long Beach and the University of Southern California or a Bachelor's in Marine and Environmental Biology at University of Southern California, UCLA, CSU Long Beach or CSU Northridge. Despite this extensive selection of programs which aid the education of maritime workers, programs such as Energy Management or

¹¹⁵<http://ocean-era.com/projects>

¹¹⁶"Top 50 World Container Ports". 2019. *World Shipping Council*. <http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports/>.

¹¹⁷City News Service. 2019. "LA Port Director Discusses Local Effects Of US-China Trade War". *NBC Southern California*. <https://www.nbclausangeles.com/news/local/LA-Port-US-China-Trade-War-Local-Effects-559317711.html>.

Resource Management offered at CSU University Channel Islands or Marine Transportation and Transportation Management offered the CSU Maritime Academy do not exist in Los Angeles. These specialized programs offer an in-depth education on pressing issues in trade, transportation, and the environment, and their impact on the ocean and its economy. Developing these programs at local California State Universities or local community colleges can demonstrate to local students' new career paths with the future in mind.

Creating new educational opportunities can and will expand the blue economy opportunities and workforce, especially in highly technical jobs.

Expand Investment in Regional Research and Development

Beyond educating our Ocean Economy workforce, the region's world class research universities are advancing the field of marine research and seeding the innovation that will spawn new businesses and help make Los Angeles a global center for the blue economy.

Twenty three local universities have aligned in creating the Southern California Marine Institute (SCMI), a research institute located at the Port of Los Angeles dedicated to researching the urban impacts of the greater Los Angeles region on the ocean. Efforts to attract public and private funding for universities and their marine research facilities could yield important scientific advances and environmental benefits. A greater understanding of the coast's ecology and climate will allow researchers to guide SoCal's businesses and policymakers in creating economic opportunities that are equally as

beneficial to the region's workers as they are to our oceans. Facilitating university R&D and commercialization would accelerate L.A.'s pipeline of entrepreneurs, job opportunities, and regional competitive advantage.

Grow ecotourism in Los Angeles

Ecotourism is defined as the responsible travel to protected natural areas. In Los Angeles, activists and residents have worked to classify much of the coast as marine protected areas (MPAs). To date, Point Dume and Point Vicente-Abalone Cove in Los Angeles have been classified as MPAs.¹¹⁸ Statewide, 16 percent of coastal waters are protected through over 120 MPAs.¹¹⁹

The protected areas of Los Angeles and throughout California play a major role in the Los Angeles ocean economy. Millions flock every year to the warm beaches and desirable climate.¹²⁰ Promoting tourism in an ecologically conscious way is important to perpetuate a healthy environment for global ecotourism. Proper ecotourism measures call for conservation of both the biological and cultural diversity of a region. In California and Los Angeles, this means that in addition to protecting the marine life and waters on the coast, the culture of residents and economic wellbeing of local businesses must also be protected. Increased environmental awareness and sustainable use of ecological resources are also key factors to ecotourism that can guide the County in its role of addressing tourism's impact on L.A.'s beaches and communities.

¹¹⁸Los Angeles Water Keeper, *Marine Protected Areas*

¹¹⁹California Fish and Wildlife Department, Regional MPA Statistics

¹²⁰U.S. Department of Commerce, Office of Travel and Tourism Industries; TNS Global Travels America Survey; CIC Research

¹²¹Baertlein, Lisa. 2019. "Port of Los Angeles Import and Export Volumes Drop In October". *Reuters*. <https://www.reuters.com/article/us-usa-trade-imports/port-of-los-angeles-import-and-export-volumes-drop-in-october-idUSKBN1XH2ZZ>.

GOVERNMENTAL POLICY RECOMMENDATIONS

Communicate potential legislation to small and large firms and trading partners involved in the ocean economy in order to prepare them for upcoming legal changes

Communicating and providing resources to firms operating in the blue economy increases the attractiveness of Los Angeles as a blue economy hub. As stated prior, national tariffs cannot be controlled or massively influenced at a local level. Nevertheless, making trade with Los Angeles easier through an influx of trade resources such as infrastructure can increase ship calls, which were down 25 percent.¹²¹

Coupled with each of these policy recommendations, local governments should be communicating their goals with residents and tracking all measurable progress. Utilizing benchmarks and goals is one of the best ways to demonstrate the county's priorities to residents. Posting these goals online and in publications can notify the public of their local successes and shed light on areas where the county needs to improve. Demonstrating accomplishment over time is immensely useful for building community and creating change.

Advocate for policy changes that benefit emerging industries

In addition to supporting existing industries, there is a marked need to facilitate sustainable policy making for emerging industries. As previously discussed, creating better policies and more streamlined regulations for industries such as marine aquaculture, offshore renewable energy, and efficient transportation are key elements to realizing the full potential of the blue economy and getting the best returns on investments.

It is in the best interest of our society and environment for the government to create an effective framework that helps strengthen the integrated management of ocean activities and

favors the sustainable development of the emerging blue economy.

The recommendations presented in this section act to preserve a renewable, clean, blue economy while upholding California's image as a key trading partner and the nation's leader in environmental issues.



CONCLUSION

Californians have developed a deep appreciation for their beaches and the ocean, in awe of both its beauty and economic significance. Long established businesses in the tourism and recreation sector have dominated the ocean economy throughout the state and entice new visitors each year. Other sectors, such as marine construction and transportation, represent untapped opportunities to combat risks presented by climate change as well as spark further economic growth and innovation.

California's economy is the largest in the country and fifth largest globally; it has grown so strong largely because of its geography. Our oceans link us to the rest of the world, and akin to history's greatest explorers, our curiosity does not cease where water meets the shoreline. Instead, Californians continue to look beyond and find inspiration on the horizon. To understand the complete effect of California's oceans is to dig deeper into the profound emotional and cultural ties that Californians have with their rich natural landscape.

The total impact of California's shoreline transcends the economic and ecological impacts defined by this study. In addition to over one million workers in the state for whom the shoreline and coastal waters are a source of economic opportunity, California's 26 million coastal residents also depend on the shoreline in some form or fashion. In the face of growing threats such as climate change, our state must capitalize on its unique position to create and employ innovative ways to protect its most prized resource: the ocean.

APPENDIX

Relevant NAICS codes (NOAA 2016)

Sector	NAICS Code & Description	NAICS
Living Resources	Animal Aquaculture	112511
		112512
		112519
	Commercial Fisheries	114111
	Shellfish Fishing	114112
	Other Marine Fishing	114119
	Seafood Production Prep & Packaging	311710
	Fish & Seafood Market	445220
	Fish & Seafood Merchant Wholesalers	424460
Marine Construction	Marine Construction: Heavy and Civil Engineering Construction	237990
Marine Transportation	Deep Sea Freight Transportation	483111
	Deep Sea Passenger Transportation	483112
	Coastal and Great Lakes Freight Transportation	483113
	Coastal and Great Lakes Passenger Transportation	483114
	Port & Harbor Operations	488310
	Marine Cargo Handling	488320
	Navigational Services to Shipping	488330
	Other Support Activities for Water Transport	488390
	Search, Detection, Navigation etc. Instrument Manufacturing	334511
	Warehousing	493110
		493120
		493130
Offshore Mineral Resources	Construction Sand & Gravel Mining	212321
	Industrial Sand Mining	212322
	Drilling Oil & Gas	213111
	Support Activities for Oil & Gas	213112
	Crude Petroleum Extraction	211120
	Natural Gas Extraction	211130
	Geophysical Exploration and Mapping	541360
Ship & Boat Building	Ship Building Repair	336611
	Boat Building Repair	336612
Tourism & Recreation	Boat Dealers	441222
	Hotel & Lodging	721110
		721191
	Rec Vehicle Park/Camp	721211
	Eating & Drinking	722511
		722513
		722514
		722515
	Scenic & Sightseeing Transport, Water	487210
	Scenic and Sightseeing Transportation, Other	487990
	Sporting and Athletic Goods Manufacturing	339920
	Sports and Recreation Instruction	611620
	Arts, Entertainment & Recreation	712130
	Nature Parks & Other Similar Institutions	712190
	Marinas	713930
	Amusement & Recreation Services	713990
	Recreation Goods Rental	532284

OCEAN ECONOMY SECTOR DESCRIPTIONS

1. *Living Resources*

Living Resources, which includes: Fish Hatcheries and Aquaculture; Fishing; Seafood Processing; and Seafood Markets.

Aquaculture refers to the rearing of aquatic animals or cultivation of aquatic plants. While this is primarily associated with human consumption, such as providing shellfish and finfish for fishmongers and supermarkets, aquaculture also plays a role in rebuilding wild populations by producing fish and shellfish that are later released into the wild.

2. *Marine Transportation*

The marine transportation sector encompasses warehousing, passenger transportation, deep sea freight, search and navigation equipment, and marine transportation services.

3. *Marine Construction*

Marine construction refers to heavy and civil engineering related to the ocean. Coastal Community developments use “hard” infrastructure elements, such as sea walls, breakwaters and various wave-deflecting structures, to withstand a harsh marine environment,

Dredging is an essential factor in construction along California’s coast, as it removes sediments and debris in the waterbed to clear the area before construction commences. Beach nourishment, or adding large quantities of sand or sediment to the beach, is also a common activity for this sector, allowing the coast to combat issues with erosion, thereby stabilizing shorelines.

4. *Offshore Mineral Resources*

Activities such as oil and gas extraction are included in the offshore mineral resources

sector, with supporting roles inclusive of drilling, geophysical exploration and mapping, and sand mining.

5. *Ship and Boat Building*

Ship and boat building encompasses activities primarily occurring in shipyards, boatyards, and manufacturing facilities. Ships are defined as watercraft for non-recreational use, while boats are defined as watercraft intended for personal use.

6. *Tourism and Recreation*

California’s beaches and the recreational activities they support are key factors in California’s global position as a top tourist destination. Activities in this sector include surfing and snorkeling, camping, sightseeing operations, ocean-related botanic gardens and zoos, aquariums, recreational boat dealers and many food and accommodation services located along the coast.

LOCAL TALENT DEVELOPMENT

A wide range of college degree options are available for those interested in joining the ocean economy's workforce. Universities and community colleges in Los Angeles County provide degree pathways into all the key sectors of the ocean economy, and offer certificate programs for those who are unable to complete a full degree program.

Marine Construction

A critical component of the ocean economy is marine construction, which accounts for activities such as dock building, construction of offshore platforms, dredging navigation channels, and other heavy operations. There are a variety of local programs which can feed into this industry. Degrees in Construction Management or Construction Engineering are offered at California State University campuses like Northridge, Long Beach, and Pomona. These degrees structure coursework around fundamental construction engineering management principles and current technologies, communication skills, and practical construction experience.

At a more generalized level, Mechanical Engineering is another degree that provides expertise applicable to marine construction. Mechanical Engineering programs are available at nearly every university in the county.

More options exist at the community college level, such as the Associate Degree in Sustainable Construction Management from LA Valley College, which gives students a background in architectural planning, construction management, and environmental geology. LA Valley College, LA Mission College and West LA College also offer engineering degrees that prepare students for construction and engineering work in the ocean economy. Marine Science programs are included in this sector as well, as they focus on

ocean engineering and marine geophysics; unfortunately, options are scarce in Los Angeles County, but several programs are offered at California State University campuses in other counties such as East Bay, Monterey Bay, and San Luis Obispo.

Offshore Mineral Extraction

Another key sector of the ocean economy is offshore mineral extraction. This division focuses on the exploration and production of oil and gas, as well as limestone, sand, and gravel mining in coastal and marine environments. Though it employs less than five percent of American ocean economy workers, wages in this sector are higher than average across all skill levels.

Students that graduate from Mechanical and Chemical Engineering programs, offered at most universities in the county, are likely to find employment in this industry. The oil and gas industry requires mechanical engineers for large product design and implementation including the construction of pipelines and refineries, and chemical engineers for analyzing the chemical processes of oil refining. Students may also consider a degree in Energy Management or Resource Management, which often involves coursework on petroleum engineering; while there are no programs in Los Angeles County, the nearby California State University Channel Islands does provide an Environmental Science and Resource Management degree. There are few degree programs specific enough to flow directly into the industry. However, the University of Southern California does offer a Master's of Science in Petroleum Engineering, which involves the technology of economically developing and producing reservoirs of oil, gas, steam, and hot water, and designing underground waste disposal facilities. Workers or students that have prior industry experience may consider such a degree if they are looking

to explore employment in offshore mineral extraction.

Maritime and coastal tourism and recreation is by far the largest sector of the ocean economy, as it has more business establishments and employs more workers than all other sectors combined. It also contributes 41 percent of the entire United States ocean economy's gross domestic product. This includes businesses that attract or support maritime tourism and recreation, such as hotels and other accommodations, tour operators, aquariums and parks, eating and drinking places, and much more. There are several college programs associated with positions in this sector. Hospitality Management, which prepares students with the necessary background and expertise to excel as managers in the restaurant, food service, hotel, and lodging industries, is offered at universities like CSU Long Beach, California State Polytechnic University Pomona, and CSU Dominguez Hills. A similar program for Tourism Hospitality and Recreation Management is provided at CSU Northridge, which places an increased focus on the tourism-based aspects of hospitality. At the community college level, Hospitality Management programs are available at Mt San Antonio College, Pasadena City College, West LA College, and others. Smaller certificate options are offered as well, such as the Food Industry Management Certificate Program at the University of Southern California.

The marine transportation and port activities sector of the ocean economy is also extremely important, as it includes businesses engaged in the traffic of deep-sea freight, marine passenger and transportation services, warehousing, and the manufacture of marine navigation equipment. This sector is particularly important in California, as the state supports around a quarter of the entire American marine transportation industry's employment and gross domestic product.

Within the sector, warehousing and port activities account for nearly half of overall employment. The closest related college program that feeds into warehousing activities is Supply Chain Management, which develops an understanding of the design, control, and operation of complex supply chains. This is offered at the undergraduate level at Cal State Northridge. There are additional Master's programs in Global Supply Chain Management at CSU Long Beach and the University of Southern California, while the Master's Degree in Management at schools like Loyola Marymount also includes elements of supply chain logistics. Community college options are available as well, such as the Hospitality Program at West LA College and Lodging Management degree at LA Mission College. With regards to marine transportation, graduate programs in Transportation Science are offered a county over at UC Irvine, while the CSU Maritime Academy in the Bay Area provides dedicated degrees in Marine Transportation and Transportation Management.

For overall degree programs that can inform careers in the ocean economy, students can always consider degrees in Marine and Environmental Biology, which introduces a wide range of topics such as marine environmental biology and chemistry, geobiology, oceanography, population dynamics, and more. These degrees are offered at many schools including the University of Southern California, UCLA, CSU Long Beach, CSU Northridge, and others. Though many critical maritime professions do not require a dedicated college degree, many degree programs have elements or general coursework that can inform or provide valuable experience for a career in the ocean economy.

METHODOLOGY

Economic Impact Analysis

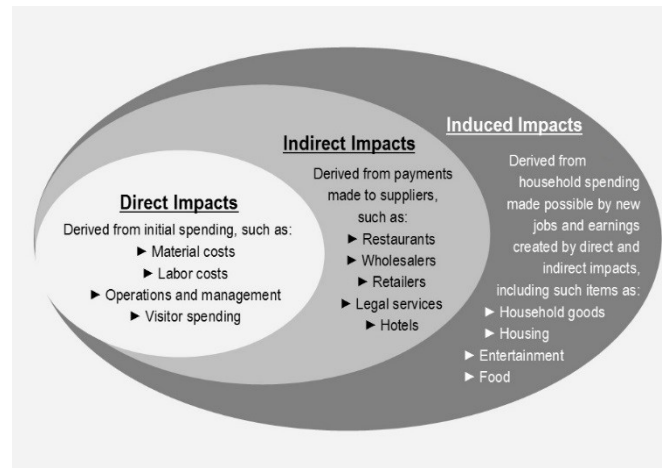
Economic impact analysis is used to estimate the overall economic activity, including spill-over and multiplier impacts (often referred to as indirect and induced activity), which occur as a result of the direct activity.

The initial economic activity related to the operations of the ocean economy is the purchase of goods and services from local vendors and the wages and benefits paid to local workers. This injection of funds into the region circulates from expenditures incurred by ocean-related establishments as well as employees that help supply the goods and services to ocean economy-related industries. These suppliers in turn hire workers and buy goods and services to facilitate their business.

The extent to which the initial expenditures multiply is estimated with economic models that depict the relationships between industries (such as construction and its suppliers) and among different economic agents (such as industries and their employees). These models are built upon actual data of expenditure patterns that are reported to the U.S. Bureau of Labor Statistics, the U.S. Census Bureau and the Bureau of Economic Analysis of the U.S. Department of Commerce. Data is regionalized so that it reflects and incorporates local conditions such as prevailing wages, rates, idiosyncratic expenditure patterns and resource availability and costs.

The magnitude of the multiplying effect differs from one region to another depending on the extent to which the local region can fill the demand for all rounds of supplying needs. For example, the automobile manufacturing industry has high multipliers in Detroit and Indiana since these regions have deep and wide supplier networks, while the same industry multiplier in Phoenix is quite small. In another example, the jobs multiplier for the

construction industry is higher in Arkansas than in California because the same amount of spending will purchase fewer workers in Los Angeles than in Little Rock.



Multipliers can also differ from year to year as relative material and labor costs change while the production “recipe” of industries changes as well. For example, the IT revolution significantly reduced the job multiplier of many industries (such as manufacturing, accounting, architecture and publishing) as computers replaced administrative and production workers.

A visual depiction of the different impacts is shown above.

Approach and Methodology

Economic impact analysis typically begins with an increase in the final demand for an industry’s output, such as a purchase of construction services, or an in-flow of out-of-town visitors who spend money at local accommodations and retail outlets.

We begin by estimating the impact of the operations within the five-county region of Southern California based on data provided by the client. Once the initial direct activity was determined, we estimated the indirect and induced impacts using models developed with

data and software from MIG, Inc. which offers a robust, widely-used set of modeling tools that provide economic resolution from the national level down to the ZIP code level.

The metrics used to determine the value of the economic impact include employment, labor income and the value of output. *Employment* numbers include full-time, part-time, permanent and seasonal employees, and the self-employed, and are measured on a job-count basis regardless of the number of hours worked. *Labor income* is a measure of all income received by both payroll employees and the self-employed, including wages and benefits such as health insurance and pension plan contributions. *Output* is the value of the goods and services produced. For most industries, this is simply the revenue generated through sales; for others, in particular retail industries, output is the value of the services supplied.

Direct employment is the personnel working within the defined sectors that make up the ocean economy. These would include jobs in fishing, boating, and eco-tourism.

Direct output is the value of the services provided by each business firm or entity. *Indirect* effects are those that stem from the employment and output motivated by the purchases made by each direct company. For example, indirect jobs are sustained by the suppliers of the office supplies and insurance coverage purchased by participating institutions. *Induced* effects are those generated by the household spending of employees whose wages are sustained by both direct and indirect spending.

In order to dynamically assess the economic contribution of the ocean economy over the forecast period used in this report, 2019 to 2023, the LAEDC uses the Regional Economic Models Inc. (REMI) PI+ model. REMI PI+ is calibrated to many sub-national regions, Los Angeles County in this case, for policy analysis

and forecasting. These impacts were estimated using the employment forecasts produced by the LAEDC and the consequent wage estimates. Using REMI, the LAEDC forecasted the contribution of the ocean economy's employment and the wages paid to those employees. The model produces estimates for regional output, GDP, labor income and indirect employment impacts by industry. For REMI, no distinction is made between *indirect* and *induced* effects.

Unless otherwise noted, labor income, expenditures and output are expressed in current 2019 dollars. Employment estimates are reported on an annual basis, i.e., the number of full and part-time jobs supported in one year.