OECD Science, Technology and Industry Working Papers
2021/04

Blueprint for improved measurement of the international ocean economy: An exploration of satellite accounting for ocean economic activity

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https://dx.doi.org/10.1787/aff5375b-en

OECD

Note to Delegations:
This document is also available on O.N.E under the reference code:
DSTI/STP(2021)6/FINAL

Foreword

Good planning, management and protection of our ocean and seas requires reliable data on which to base decision making. In recent years, growing realisation of this need has led to much greater demand for improved ocean economy statistics. That demand is emerging at local and regional levels but also, and especially, at international level where the importance of interlinkages between ocean economic activities, ever increasing uses of marine space and resources, marine environmental dynamics, biodiversity loss and global climate change have become increasingly clear.

For the past six years, the Ocean Economy Group of the OECD's Directorate for Science, Technology and Innovation (OECD STI Ocean Economy Group) has contributed to meeting the growing demand for improved ocean economy statistics to support decision-making.

The flagship publication *The Ocean Economy to 2030* (OECD, 2016[1]) focussed on the economic contribution of ocean related industries worldwide and estimated that, in 2010, they produced value-added equivalent to 3% of global GDP and full-time employment for around 30 million people. Such a snapshot proved essential for raising awareness and encouraging strategic thinking about the ocean economy around the globe. And chapter four of the book *Rethinking Innovation for a Sustainable Ocean Economy* (OECD, 2019[2]) emphasised recent progress towards measuring the ocean economy through national statistical systems. It underlined the advances that need to be made in national accounting approaches that incorporate both pillars of the ocean economy – the contribution of ocean economic activities and the assets and ecosystem services provided by the marine environment.

The objective of the STI Ocean Economy Group's current phase of work on measurement issues is to improve the empirical knowledge base for worldwide ocean economic activity. This working paper aims to inform current international discussions on measurement of the ocean economy and outline ways in which statistics on which to base decisions can be improved through satellite accounting approaches. Using a pragmatic step by step approach, the work contributes to the larger ambition of future comprehensive ocean accounts that will include marine environment-economy linkages and ecosystem services. This represents a long-haul project requiring sustained cooperation with many actors, but much progress is being made and is summarised in this working paper alongside:

- an assessment of the challenges ocean economy analyses face and the level of detail provided by official data;
- a presentation of the contribution of several established ocean economic activities to global gross domestic product and employment; and,
- a discussion on the way forward for international ocean economy statistics in the form of an experimental OECD ocean economy satellite account, which will provide a serviceable framework for the regular publication of reliable international statistics going forward.

Acknowledgements

This working paper was researched and drafted by James Jolliffe, Economist, and Claire Jolly, Head of Unit, both of the Ocean Economy Group of the OECD's Directorate for Science, Technology and Innovation (OECD STI Ocean Economy Group), and Barrie Stevens, consultant and senior advisor to the Secretariat. The work of the OECD STI Ocean Economy Group is kindly supported by the following organisations: Department of Economy, Science and Innovation of Flanders (DESI), Belgium; Danish Maritime Authority (DMA), Denmark; Marine Institute, Ireland; Stazione Zoologica Anton Dohrn (SZAD), Italy; Korea Maritime Institute (KMI), Korea; Research Council of Norway (RCN), Norway; the Directorate-General for Maritime Policy (DGPM) and Foundation for Science and Technology (FCT), Portugal; and, National Oceanic and Atmospheric Administration (NOAA), United States.

The programme of work on ocean economy measurement would not exist without the continued support, generous expertise and invaluable advice provided by the Steering Board of the OECD STI Ocean Economy Group *Innovation and the Ocean Economy* project. The current and past Steering Board members contributing to this work stream are: Gert Verreet (DESI, Flanders, Belgium); Rasmus With (DMA, Denmark); Niall McDonough and Jenny O'Leary (Marine Institute, Ireland); Marco Borra (SZAD, Italy); Jeong-In Chang (KMI, Korea); Christina Abildgaard (RCN, Norway); Conceição Santos (DGPM, Portugal); Sofia Cordiero (FCT, Portugal); and, Monica Grasso (NOAA, United States).

Special thanks are due to Paul Sletten and Tor K. Ånestad from Statistics Norway for their nuanced and informed comments on the definition of the ocean economy for statistical purposes. Many other national experts kindly commented on drafts and provided key inputs during bilateral webinars and proceeding correspondence. They include in particular those listed in the table below.

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Within the OECD, warm thanks are due to Peter van de Ven, Head of the National Accounts Division of the OECD's Statistics and Data Directorate (SDD), for his support throughout the project and patient clarifications of certain technical aspects of the System of National Accounts. Useful comments from his colleagues in SDD are also recognised: Daniel Clarke, Researcher (SEAA) and Catherine La Rosa-Elkaim, Analyst/Statistician. Early research for this working paper also benefitted from the kind support of, and comments from, multiple OECD experts, including: Norihiko Yamato and Colin Webb from the Productivity, Innovation and Entrepreneurship Division of the Directorate for Science, Technology and Innovation (DSTI); Roger Martini, Claire Delpeuch, James Innes, Fabiena Cerasa and Will Symes from the OECD Committee of Fisheries in the Trade and Agriculture Directorate (TAD); Laurent Daniel and Karin Gourdon from the OECD Secretariat of the Council Working Party on Shipbuilding (WP6); and Olaf Merk from the OECD International Transport Forum (ITF).

Executive summary

The ocean is crucial to human wellbeing. It enables many important economic activities and provides a vast and extraordinary array of natural assets and environmental services. The ocean economy should be thought of as a complex system of interactions between ocean economic activities and the marine environmen, in which all elements are interlinked and interdependent. Changes in one generate effects in the other, impacting economic, social and environmental outcomes in fundamental and dynamic ways. Yet the ocean economy remains poorly understood and information concerning changes in its state tends to be less visible than in other areas crucial to global opportunity, prosperity and stability.

OECD estimates suggest that uses of the ocean have increased in recent decades, with some ocean economic activities having increased dramatically so. The ocean is becoming ever more important as a source of food for growing human populations, as a source of fossil fuels, renewable energies, and minerals, as a means of transport crucial for maintaining the global trading system, and as a popular place for holidays and leisure pursuits. It is also becoming clear to ocean scientists and those that use the ocean regularly that the health of the marine environment, the activities that depend on it, and the services that it provides are under threat from a multitude of anthropogenic influences. The overwhelmingly negative effects of climate change and biodiversity loss are being felt on marine ecosystems globally.

Combining reliable and comparable ocean economic data with marine environmental data holds great promise for improving the sustainability of the ocean economy. The objective of all ocean economy measurement strategies should be the production of a statistical information system that measures the multitude of ways the ocean contributes to wellbeing and the impacts that economic activities have on the marine environment. The measurement of ocean economic activity and, in particular, the methods by which statistics on ocean economic activity can be improved internationally are the subject of this paper. Without better ocean economic data, decision takers will not have access to the information required to design and pursue policies that drive a more sustainable ocean economy. A key condition for better measurement of ocean economic activity must be that the framework adopted to produce statistics enables economic data to be compared with environmental data going forward.

Current measurements of ocean economic activity are limited by the challenge of isolating ocean economic activities within broad, aggregated, categories of economic statistics. As a result, statistics on ocean economic activities tend to be incomplete and incomparable with data on the rest of the economy. The methods pursued in national studies of ocean economic activity tend to fall into three groups: identification of direct economic contributions in the results of surveys conducted by national statistical offices and/or ad-hoc specialised surveys; economic modelling of direct, indirect and induced impacts through input-output models; and development of ocean economy satellite accounts in line with the core national accounting system. At international level, consistent and comparable data are available for only a handful of ocean economic activities.

In order to improve international ocean economy statistics, this paper establishes a precise definition of ocean economic activities for comparative statistical purposes. Definitions of economic sectors are important in as much as they set the boundaries for the activities and products that are to be

considered in the collection and calculation of detailed economic statistics. This paper also establishes detailed lists of activities and products, to be used in future international ocean economy statistics and in accordance with the appropriate international classification standards. The lists of classifications provides a starting point, but any activity that falls within the following definition should be counted as part of the ocean economy. Building on a large consultation effort, the OECD definition ascertains that the ocean economy includes economic activities that:

- take place on or in the ocean;
- produce goods and services primarily for use on or in the ocean;
- extract non-living resources from the marine environment;
- harvest living resources from the marine environment;
- use living resources harvested from the marine environment as intermediate inputs;
- would likely not take place were they not located in proximity to the ocean; or,
- gain a particular advantage by being located in proximity to the ocean.

Satellite accounting frameworks that collect and compile comparable data on ocean economic activity in a supply and use framework offer an opportunity for improved understanding of ocean economies and enhanced evidence-based policymaking. The benefits of the satellite accounting approach to ocean economy measurement are profound. The production of statistics that are comparable with those published in the national accounts, reducing the risk of double-counting and over-estimating values, is crucial for providing reliable and trusted analyses of the performance of the ocean economy in comparison with other sectors. Insight on interlinkages between activities within and beyond the ocean economy, better understanding of the uses of ocean goods and services, and reliable economic data stewardship are further key benefits. Given these advantages, a growing number of countries, including Portugal and the United States, have produced or are in the process of producing ocean economy satellite accounts.

Experimentation with an OECD international satellite account for ocean economic activities may prove transformative for statistics that are comparable across countries, enabling a range of economic analyses that are at present difficult to achieve. It will also contribute to supporting and enhancing ocean economy measurement efforts at national levels. Compiling international accounts would enable a large number of internationally comparable experimental aggregates to be calculated including the gross value added of ocean economic activities and their contribution to GDP. The data would be comparable with the OECD's national accounts data. And would in turn enable experimentation with the production of ocean economy data that are comparable with the statistics produced by the OECD on the structure of its member countries' economies through the Structural Analysis (STAN) family of databases. These databases allow for the calculation of a range of statistics – such as productivity growth, structural change and trade in value added – and are used by analysts globally.

Initial OECD accounts for ocean economic activity should be seen as a step towards more complete ocean accounts, including marine environmental-economic linkages and accounts for marine ecosystem services. Eventually, the ability to account for marine natural assets and many important marine ecosystem services will become a practical reality, at least in physical terms. Satellite accounts that provide regular, reliable and comparable statistics on both ocean economic activity and marine economy-environment linkages would provide a robust tool for measuring the sustainability dimensions of the ocean economic activities.

Table of contents

Tables

Figures

Boxes

1 An overview of selected ocean economy sectors and the importance of measuring them

Humankind has exploited the ocean and its resources for millennia. However, trends in global ocean economic activity suggest that a number of established and emerging industries – from the ports facilitating the global trading system to the generation of renewable energy – have increased dramatically in recent decades. This section provides data on the increasing importance of selected ocean economic activity to human wellbeing and demonstrates how the ocean economy is an interdependent and interlinked system in need of better measurement.

Introduction

Multiple and varied economic activities are part of the ocean economy, from long established industries such as marine fishing and passenger transport, to new, burgeoning activities like offshore wind electricity generation and marine biotechnology. In recent years, growth in ocean economic activity has provided ever more food, energy and minerals, as well as the impetus for many innovations (OECD, 2019[3]). The ocean has transported ever more goods and passengers, and is an ever more popular setting for holidays and a place to relax. Unsurprisingly, the potential for the ocean economy to provide for humanity into the future has become a topic of great interest (OECD, 2016[1]; OECD, 2019[3]; OECD, 2020[4]; OECD, 2020[5]). In the past, each economic activity was small enough and isolated enough that activities could operate relatively unburdened from their effect on each other. Increasingly, however, marine space is at a premium, with conflict between ocean economic activities a major concern for those who manage it (OECD, 2016[1]).

The ocean also provides many natural resources and ecosystem services that are crucial for human wellbeing. Yet anthropogenic threats to the health of the ocean are increasing in seriousness (IPCC, 2019[6]; IPBES, 2019[7]). These include the effects of climate change on the temperature and acidity of the ocean, increasing levels of marine pollution as a result of both ocean- and land-based activity, the role of illegal and unreported fishing in reducing the reproductive capacity of wild fish stocks, and the presence of invasive species in marine ecosystems carried across the planet by maritime shipping (OECD, 2020[4]). If

managed incorrectly, the effects of human activity are likely to reduce the oceans ability to sustain the multiple resources and services that it currently provides (OECD, 2017[8]).

Without reliable and accurate data, neither ocean economic activity nor the marine environment can be managed effectively. Understanding how each individual activity contributes to society is crucial to targeting policies that seek to maximise their potential. Likewise, measuring and monitoring the adverse environmental effects of the ocean economy is crucial for ensuring that the marine environment is conserved and used sustainably. While both economic activity and environmental aspects are fundamental components to an effective ocean statistical information system, this paper explores ways in which policymakers can improve the data available to them on the performance of ocean economic activities in particular.

Multiple data points indicate the increasing importance of ocean economic activity to human wellbeing

In 2016, the contribution of a number of ocean economic activities to global gross domestic product (GDP) was projected by the OECD to double in size from USD 1.5 trillion in 2010 to USD 3 trillion by 2030 (OECD, 2016[1]). The upward trends highlighted in the OECD's 2016 analysis have been compared to the industrial revolution on land and more recent analysis has described an exponential increase in certain activities (Posner et al., 2020[9]). Data suggest that uses of the ocean have increased in recent decades, some dramatically so. The ocean is becoming ever more important as a source of food for growing human populations, as a source of fossil fuel and renewable energies, and minerals for final consumption and/or intermediate inputs for the production of other goods, as a means of passenger transport and freight transport crucial for maintaining the global trading system, and as a popular place for holidays and pursuing leisure.

The ocean as a source of food

Marine capture fisheries, marine aquaculture harvesting and the processing and preserving of marine fish, crustaceans and molluscs

Fish consumption is a major source of protein in diets throughout the world, accounting for around 17% of animal protein consumed globally in 2018 (FAO, 2020[10]). While fishing and aquaculture activities can take place in both inland and marine waters, the largest source of fish produced globally are marine capture fisheries and aquaculture harvesting. In 2018, production from marine sources reached just over 115 million tonnes (FAO, 2020[10]), the vast majority of which were caught in marine capture fisheries (Figure 1.1). However, marine catches peaked in 1996 at 86.4 million tonnes and are unlikely to return to that level soon given that 34.2% of fish stocks globally are overfished (FAO, 2020[10]).

Better management and government support that helps fishers run their businesses better should increase the sustainability and profitability of marine capture fisheries in the long-term (OECD, 2020[11]). But while production fluctuates annually, much of the increase in marine production in the past 15 years have been a result of increases in fish harvested in marine aquaculture farms. Marine aquaculture production has grown at a faster rate than marine capture fisheries since the early 1980s (Figure 1.1).

The vast majority of the produce of marine capture fisheries and aquaculture farms is consumed directly by humans, but there are multiple other uses (FAO, 2020[10]). A small amount is kept alive for aquariums, for example. Or the offal of gutted fish may be ground into meal and sold to other agricultural industries as a protein source. A growing part of the activity associated with marine fishing and aquaculture is therefore the processing and preserving of marine fish, crustaceans and molluscs (Figure 1.2). These activities are part of a complex value chain derived from capture fisheries and aquaculture harvesting and ending with

the wholesale and retail marketing of seafood products. There are almost as many seafood value chains as species, with localised networks surrounding small-scale fisheries and extensive global trade networks that connect fisheries' production and multinational corporations.

Box 1.1. Ocean economic activity and COVID-19

Introduction to the potential effects of the pandemic on the ocean economy in 2020

None of the indicators presented here reflect recent changes caused by the COVID-19 pandemic. However, global output contracted substantially as a result of the measures put in place to control it and the OECD projects that global GDP could have declined by 4.1% in 2020 (OECD, 2020[12]).

The response to the pandemic has disrupted consumer-facing industries strongly and it is inevitable that some ocean economic activities will be affected more than others. Overall international tourism arrivals, for example, decreased by 74% in 2020 according to estimates (UNWTO, 2021[13]). And although domestic tourism picked up quickly in mid-2020, it is likely to have decreased substantially in countries that have implemented a second round of social distancing policies and lockdown control measures. Maritime cruises stopped almost entirely in spring and summer 2020, and it is not clear how soon demand among passengers will return to pre-pandemic levels. Hotels, bars and restaurants in coastal regions have also been severely affected. Activity in marine and coastal tourism is most likely to have decreased on aggregate in all countries as a result, with perhaps the greatest impacts felt in countries particularly reliant on it such as Small Island Developing States (OECD, 2021[14]).

Since the onset of the pandemic, the marine fishing and aquaculture industries have faced a period of severe uncertainty. Fish markets have been closed periodically to contain transmission of the virus. And the closure of the hotels, restaurants and catering sector in many countries for much of 2020 has reduced the demand for fish and fish products. The effects of the pandemic control measures are reflected throughout the fish supply chain and have resulted in high price volatility, putting jobs, income and, in some places, food security at risk (OECD, 2020[15]; FAO, 2020[16]).

In other areas, however, the effects of the pandemic are more nuanced. The maritime freight transport industry experienced a dramatic drop in demand in early 2020 and service cancellation rates increased as a result. The fortunes of shipping companies changed somewhat in the second half of 2020 as lower oil prices and increasing confidence among shippers have resulted in far healthier balance sheets, particularly for container shipping. The United Nations Conference on Trade and Development (UNCTAD) estimates the volume of international maritime trade will have decreased by 4.1% in 2020 (UNCTAD, 2020[17]).

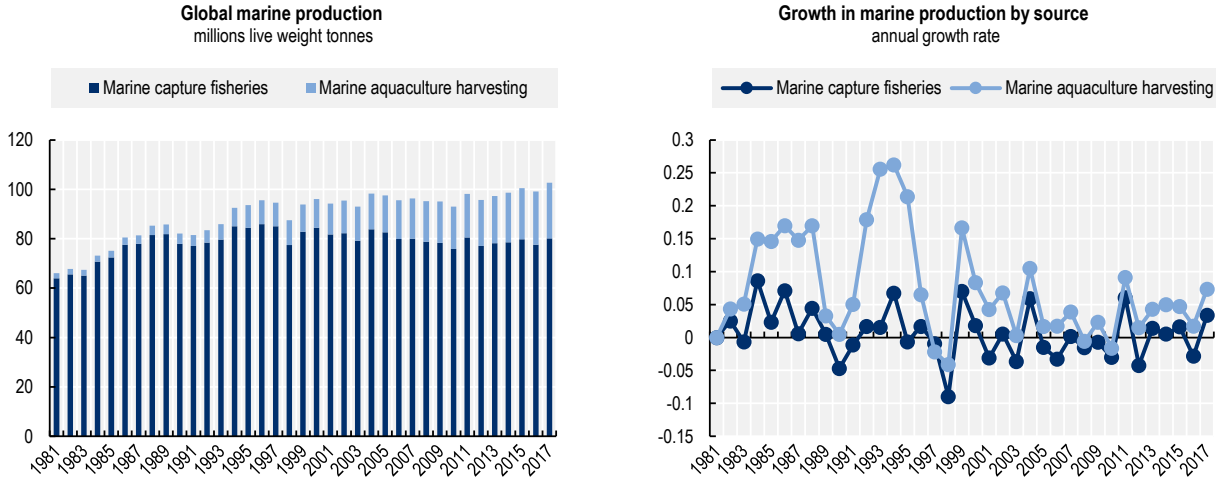
At present, the overall impact of the pandemic on ocean economic activity is uncertain and it is too soon for the effects on the ocean economy to be visible in the official economic data provided to the OECD by member countries. The above summaries of ocean economic activity should therefore be read as they are – an exploration of the trends in particular pre-pandemic activities. Whether these upward trends continue in the coming years as economic output recovers from the crisis is partly a question of the efficacy of policies pursued in response to the disruption caused by the pandemic control measures.

The preparation, preservation and packaging of fish and other seafood's diversifies fishing and aquaculture products for market and helps ensure they last longer and are more nutritious. Freezing fish is a common preservation method but the infrastructure required is substantial. Potable water for sanitation and electricity to operate refrigerators – infrastructure that are not commonly available in lower income countries – are required if cold storage is to be pursued. Despite this, wastage rates are over 35% in the relatively well-resourced areas of North America and Oceania (mostly as a result of food waste) and under

30% in Africa and Latin America (due to lack of access to preservation infrastructure) (FAO, 2020[10]). Going forward, the processing industry will play an important role in reducing this loss and waste.

Figure 1.1. Growth in marine aquaculture pushed production from marine capture fisheries and aquaculture harvesting over the 100 million tonnes mark for the first time in 2015

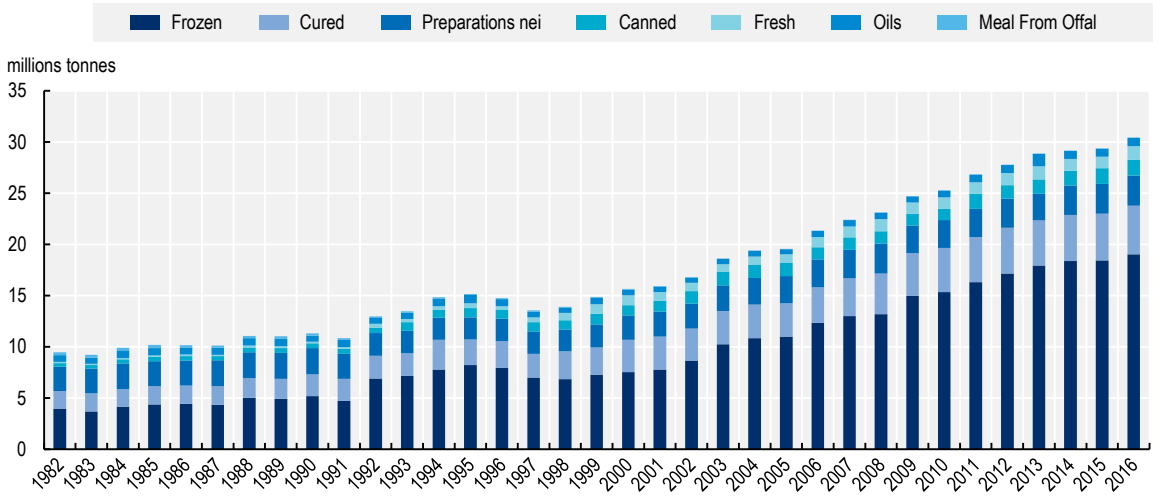
Global production of fish, crustaceans, molluscs etc. from marine sources in millions of live weight tonnes



Note: Does not include aquatic plants; whales, seals and other aquatic mammals; miscellaneous aquatic animals; and, miscellaneous aquatic animal products.
Source: OECD calculations using data from FAO (2019) *Fishery and Aquaculture Statistics: Global production by production source 1950-2017 (FishstatJ)*

Figure 1.2. Marine fish processing has doubled its output since 2000, outstripping production growth in marine capture fisheries and aquaculture harvesting

Global marine fish processing by type of preparation in millions of tonnes



Note: Frozen represents an aggregation of the categories Frozen, Whole and Frozen Fillets. Fresh represents an aggregation of Fresh Fillets and Fresh. Oils represents an aggregation of Liver Oils and Body Oils.
Source: OECD calculations using data from FAO (2018*) Fishery and Aquaculture Statistics: Global Fisheries commodities production and trade 1976-2016 (FishstatJ)*

The ocean as a source of energy and minerals

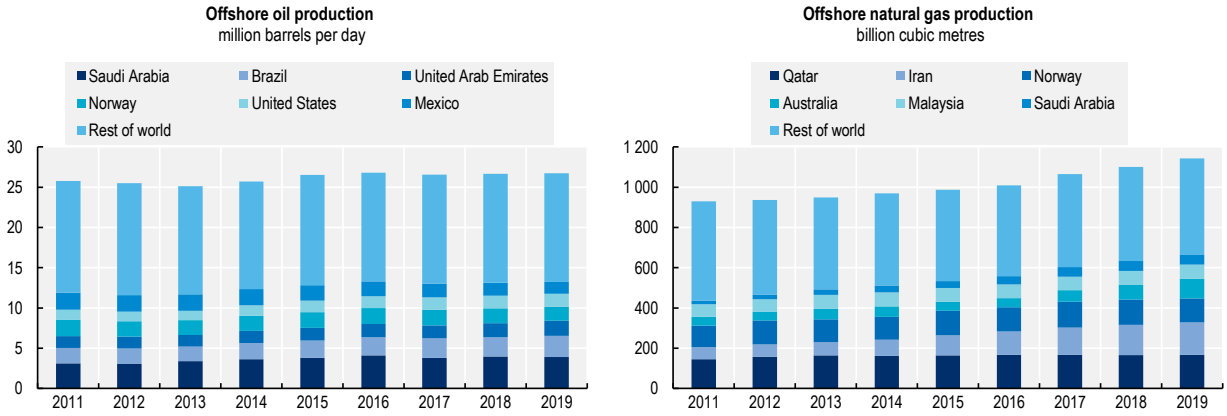
Extraction of offshore crude petroleum and natural gas, offshore wind and marine renewable energy generation, marine and seabed mining, and offshore industry support services

The exploitation of oil and natural gas from underneath the seabed has occurred at least since the first offshore oil well was drilled in the Gulf of Mexico in 1947 (IEA, 2018[18]). Since then, oil and natural gas deposits have been developed in the exclusive economic zones of many countries. In 2019, around 26 million barrels of oil were produced from offshore sources per day and just under 1 200 billion cubic metres of natural gas were extracted in the same year (Figure 1.3). Offshore extraction accounted for around 28% of both total oil and total natural gas production globally in 2019 (IEA, 2020[19]). In 2016, the OECD estimated offshore fossil fuel extraction to be the largest ocean based industry providing over a third of global ocean economy value added in 2010 (OECD, 2016[1]). The analysis also documented a potential decline in the importance of the contribution of the offshore oil and gas industry to the overall ocean economy by 2030, at which point it was projected to be worth 21% of total value added and sit behind faster growing activities such as marine and coastal tourism (OECD, 2016[1]). Indeed, since 2010 offshore oil production has remained at similar levels and all the growth in offshore extraction has occurred in natural gas (Figure 1.3).

The offshore extraction of fossil fuels has occurred for over 70 years, but the ocean is increasingly the source of clean energy too. Offshore wind electricity generation has expanded at an extraordinary rate, from practically non-existent at the turn of the millennium to almost 30GW net capacity in 2019 and increasing too as a share of total electricity generation (Figure 1.4). According to the International Energy Agency (IEA), offshore wind has the technical potential to generate current global electricity demand 18 times over and is therefore considered key to lowering emissions from electricity generation (IEA, 2019[20]). Depending on the quality of the wind resources available and the costs of completing projects, there is likely to be substantial variation in offshore wind's contribution to the electricity generated in different parts of the world. In the European Union, for example, where wind is plentiful and generation costs are relatively low, offshore wind may be the dominant electricity source by 2050 if net-zero emissions targets are to be met (IEA, 2020[19]).

Figure 1.3. Growth in offshore oil and natural gas production since 2011 has come mainly from natural gas, while oil output has remained steady around 26 million barrels per day

Global offshore oil and natural gas production in million barrels per day and billion cubic metres respectively



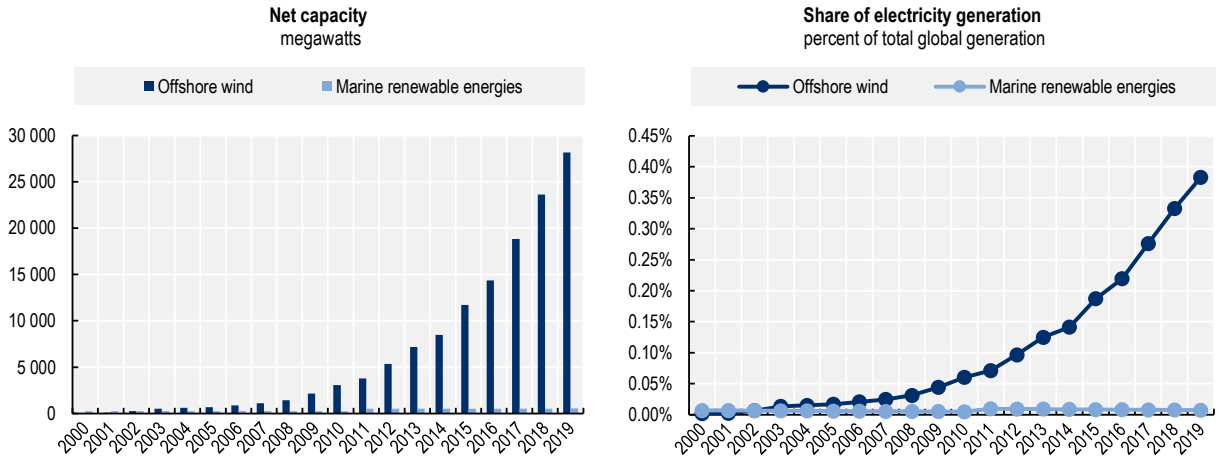
Source: IEA (2020) *World Energy Outlook 2020*

Other forms of ocean renewable resources are harvested through conversions of tidal currents, tidal ranges, ocean waves, ocean currents, ocean thermal energy and salinity gradient power into power (OES, 2017[21]). A focus of research and development in recent years (Figure 1.5), marine renewable energy (MRE) technologies are for the most part at the demonstration stage with only a few prototypes moving towards commercialisation. In 2019, installed MRE capacity generated around 530 MW (Figure 1.4). Although this represents more than double the amount generated in 2000, at present MREs contribute very little to the global energy mix. The most transformative potential for MREs is perhaps on islands or in remote coastal areas, where ocean energy resources are favourable and there is limited space for other forms of renewable energy (OES, 2020[22]). The combination of MRE conversion technologies with ocean economic activities such as marine aquaculture or marine and seabed mining holds promise for generating localised clean energy (OES, 2020[23]). In general, however, MREs are considered an important potential source of low carbon electricity and have been earmarked for diversifying the renewable energy mixes of countries targeting net-zero emissions (IEA, 2020[19]).

In addition to the offshore oil and natural gas industry, offshore extractive activities include marine and seabed mining. Numerous marine mining projects are currently in operation in various parts of the world, almost exclusively on continental shelves. They are for the most part targeted towards extracting diamonds and phosphate deposits. From the limited data available, one can derive that this is, for the time being, a relatively small activity on a global scale and much marine mining currently takes place in shallow water depths. But the deep sea also contains valuable metal resources including nickel, cobalt, gold and silver found surrounding hot springs and in manganese nodules. Deep-sea mining (DSM) is marine mining conducted at depths of 1 400 metres or more. Mining of the deep sea has been commercially unviable for much of the time since the discovery of the metal resources. Deep-sea mining activity beyond areas of national jurisdiction has been governed by the International Seabed Authority (ISA) since 1994, with much of the activity permitted by the organisation up to now concerned with seabed exploration and the development of technologies for extraction.

Figure 1.4. Ocean renewable electricity generation is dominated by offshore wind, the capacity of which has increased nine fold since 2010 and six fold in its contribution to total electricity generation

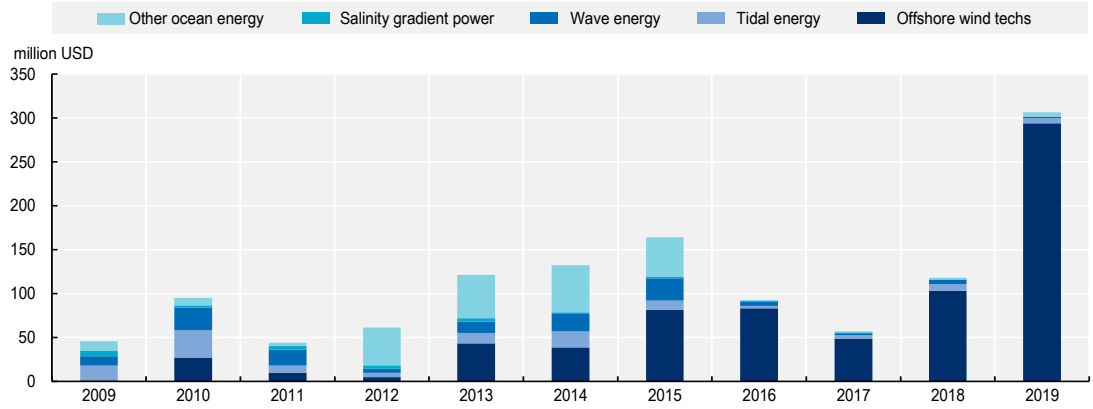
Global offshore wind and marine renewable energy electricity generation capacity in megawatts and as a percentage of total generation capacity from all resource types



Note: Marine renewable energy is labelled "marine energy" in IRENA's taxonomy. Total generation capacity is calculated by summing the capacity of all technology types, including fossil fuels, in each year.
Source: OECD calculations using data from IRENA (2020) *IRENA Renewable Energy Statistics 2020*

Figure 1.5. Spending on research, development and demonstration for offshore renewable energies reached record highs in 2019, after a decade of fluctuating expenditure

Total research, development and demonstration (RD&D) expenditure by renewable technology in millions constant 2019 USD



Note: Offshore wind technologies expenditure excludes low wind speed and spending on wind energy systems
Source: IEA (2020) *Energy technology RD&D budgets database*

The ocean as a means of transport

Maritime passenger and freight transport, maritime ports and support activities for maritime transport, maritime shipbuilding and maritime manufacturing, repair and installation

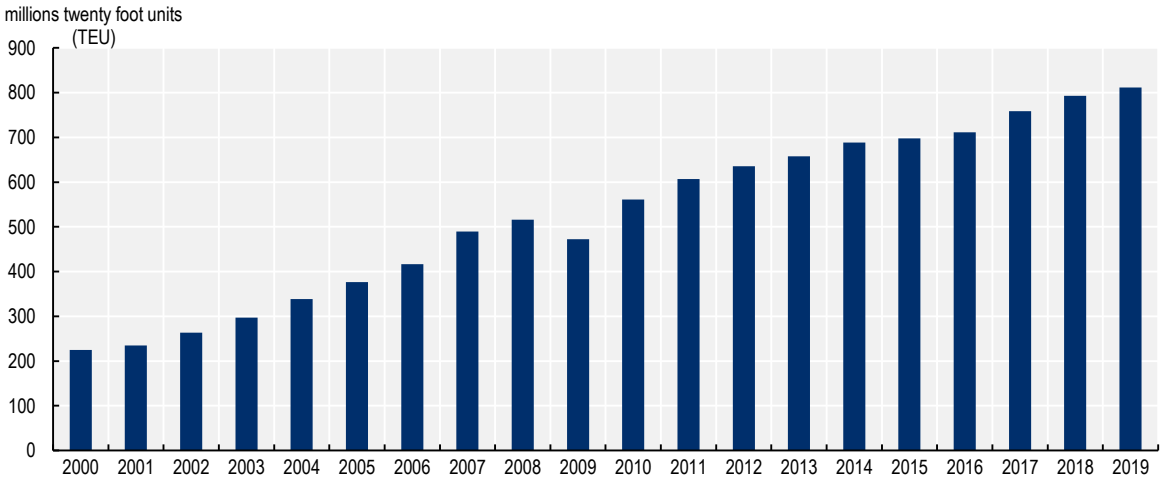
Almost every year of the last few decades witnessed growth in international maritime trade with record levels reached in 2018 at 11 billion tons loaded (UNCTAD, 2020[17]). Tanker shipments of oil, gas and chemicals, and main dry bulk cargo (iron ore, grain and coal) account for almost 30% of total maritime trade volume each. The remaining 40% is made up of other segments including containerised trade. Developing countries continue to account for most global maritime trade flows, accounting for close to 60% of exports and two-thirds of imports shipped by sea. High income countries, on the other hand, have seen their share of both types of traffic decline over time.

Importantly, however, the maritime transport landscape is changing markedly. Trade growth is slowing, supply chains and trade patterns are becoming increasingly regionalised, technology and services are expanding their role in logistics and services, and sustainability issues are looming larger on the industry's agenda (ITF, 2019[24]). On the supply side, carrier's interest in ever bigger vessels seems to be waning, and consolidation is continuing. This is especially the case in the container shipping segment, where the combined market share of the top 10 container shipping lines increased from 68 per cent in 2014 to 90 per cent in 2019 (UNCTAD, 2020[17]). The ongoing consolidation process is reflected at country level: the top five ship-owning countries in the world - Greece, Japan, United States, the People's Republic of China (hereafter 'China'), Norway – today own some 45% (in value terms) of all vessels (UNCTAD, 2020[17]).

Maritime ports play a key role in the global ocean economy, handling over 800 million containers in 2019 (Figure 1.6) and many more tonnes of cargo. There are a range of tangent support activities related to maritime transport linked to ports. Marine dredging, for example, is a well-established industry with global annual turnover estimated at around EUR 5 billion in 2018, with Europe and Asia accounting for the bulk of the business (excluding closed markets such as China and the United States (IADC, 2019[25])).

Figure 1.6. Maritime ports handled 811 million containers globally in 2019, around four times more than they handled in 2000

Total annual container port throughput in millions of twenty foot units (TEUs)



Note: Port container traffic measures the flow of containers from land to sea transport modes and vice versa in a standard-size container.
Source: UNCTADstat (2020) *Maritime Transport Indicators*

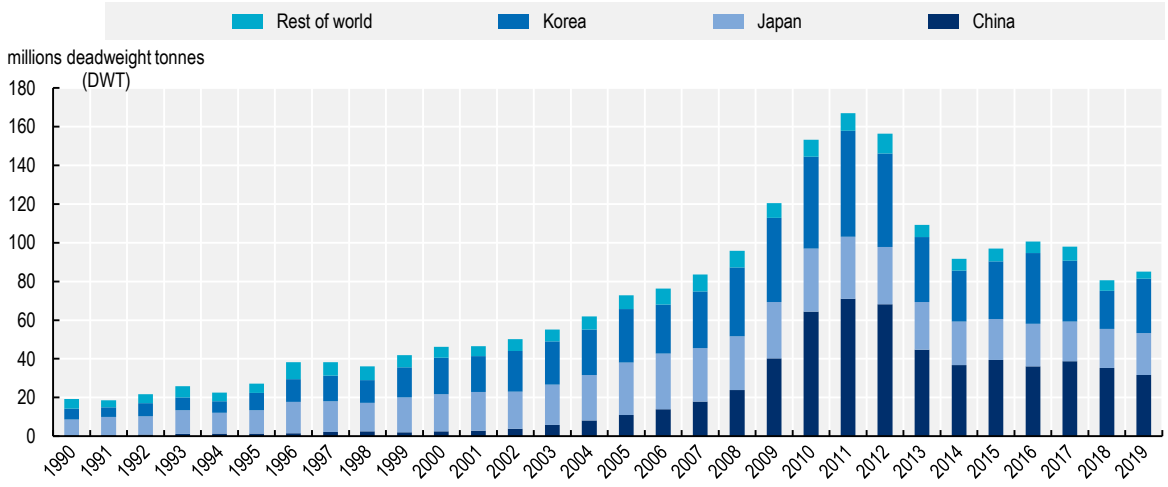
While increases in container traffic play a part role in the demand for new maritime ships, developments in shipbuilding are influenced by a multitude of factors. They range from global trade, energy consumption and prices, and changes in cargo types and trade patterns to vessel age profiles, scrapping rates and replacement levels. They also depend heavily on existing capacity. Recent years saw a considerable build-up of overcapacity, as growth of the global shipping fleet (measured in deadweight tonnage or DWT) outstripped that of world seaborne trade by a considerable margin.

By 2013 cumulative overcapacity had reached some 83 million gross tonnes in tankers, 113 million gross tonnes in bulk carriers, and in container vessels it stood at over one-quarter of the entire container fleet worldwide (OECD, 2016[1]). Since then, developments in the world fleet have been unfolding against a background of continued oversupply in ship-carrying capacity (Gourdon, 2019[26]). Oversupply has remained a structural feature in most shipping segments, causing downward pressure on freight rates particularly in the container ship segment (UNCTAD, 2020[17]). Overcapacity has been taking its toll on order books for new vessels worldwide for some time now, orders have declined year on year since 2014 and are likely to have reached their lowest point in 17 years in 2020 (BIMCO, 2020[27]).

The dominance of Asian shipbuilding countries in the world market continues, with China, Japan and Korea together accounting for some 93% of global new-build deliveries which stood at about 66 million gross tons in 2019 (UNCTAD, 2020[17]). Bulk carriers (35%), oil tankers (30%), and container ships (17%) represent the vast majority of the new build tonnage. While the Asian shipbuilding economies dominate the market in terms of tonnage, European yards account for a substantial share of the contract value of ships ordered worldwide due largely to the high added value and complexity involved in the construction of cruise ships (OECD, 2018[28]). Indeed, for builders in European countries, cruise ships form the bulk of the order book in terms of gross tonnage. In 2019, European cruise ships accounted for 9.7% of the global market in comparison to 0.4% in China, 0% in Japan and 0% in Korea (Barry Rogliano Salles Group, 2020[29]).

Figure 1.7. Ship deliveries grew consistently for 20 years until 2011 when 167 million tonnes were produced, but has since dropped off to around 80 million tonnes in 2019

Global shipbuilding deliveries in deadweight tonnes



Source: Clarkson Research (2019) *Shipping Intelligence Network Timeseries*

The ocean as a place of leisure and destination for tourism

Marine and coastal tourism

Having grown consistently for the past six decades, tourism overall is considered an important economic sector for generating income and foreign exchange globally. In OECD countries, tourism represents around 4.4% of GDP, 6.9% of employment and 21.5% of service exports (OECD, 2020[30]). Marine and coastal tourism, which covers activities ranging from the hire of pleasure boats, hotels, restaurants and bars in coastal resorts, whale sightseeing trips, cruise holidays, and many more aspects represents a potentially significant portion of these totals. Based on an ad-hoc exercise to measure the ocean economy as a whole, OECD estimates suggest that, in 2010, marine and coastal tourism was the second largest ocean related industry after the oil and gas industry in terms of global value added and the second largest after capture fisheries in terms of employment (OECD, 2016[1]). More recent analysis finds that international tourist expenditure as a percentage of GDP is particularly high in Small Island Developing States (SIDS), with two thirds of them regularly recording levels of 20% of more (OECD, 2018[31]; OECD, 2020[4]).

One reason for the existence of tourism in marine and coastal environments may be their contribution to human wellbeing and mental health. A recent report commissioned by the UK Government's Department for Environment, Food and Rural Affairs (Defra) reviewed the existing literature on the benefits of exposure to marine and coastal environments in the UK (DEFRA, 2020[32]). Estimates based mainly on cross-sectional surveys suggest spending time in marine and coastal margins increases happiness in comparison to time spent in urban and green spaces. And there is some evidence to suggest that marine and coastal recreation reduces the need for health-care interventions due to the physical or mental health benefits of taking part in it. Conserving marine and coastal environments so that they may continue to provide the many benefits associated with spending leisure time in them are key recommendations flowing from the evidence presented.

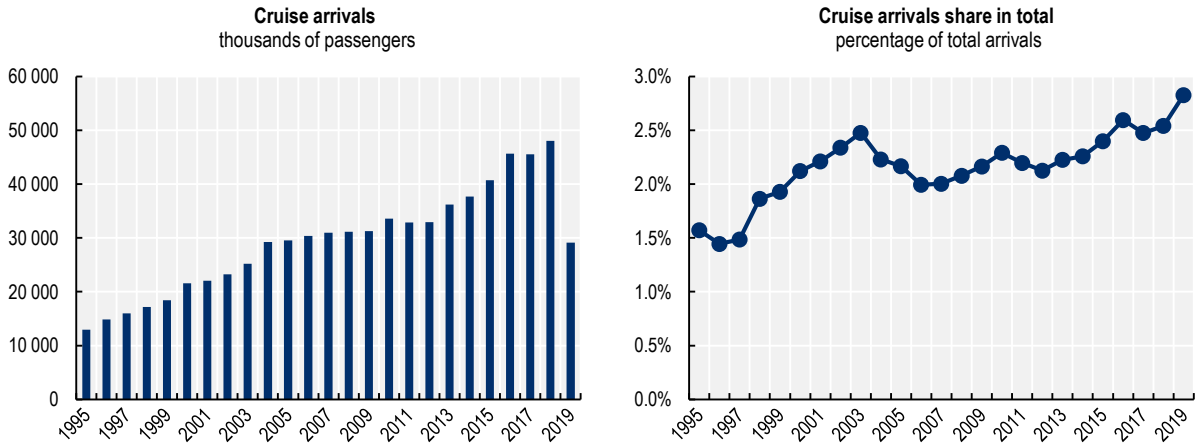
Furthermore, various factors appear to drive the popularity of tourist destinations and tourism tends to be highly unevenly distributed between and within countries. One factor that appears to be an important determinant of destination popularity, and the prices that hotels and other tourist accommodation

establishments are able to charge, is access to the coastline and beaches in particular (Alegre, Cladera and Sard, 2013[33]; Soler, Gemar and Guzman-Parra, 2019[34]). Furthermore, the level of accessibility – the existence of boat ramps, campsites, and toilets, for example – proves to be a particularly significant determinant of use of the coastline (Matthews, Scarpa and Marsh, 2018[35]). Combining official data with big data from online booking services suggests that coastal areas and islands are two of the most intensely visited spatial areas in Europe, alongside cities and the Alps (Batista e Silva et al., 2018[36]). This is true of all seasons, but coastal areas and islands are particularly popular in the summer months.

One area of economic and increasingly pressing environmental importance in marine and coastal tourism is the maritime cruise industry. The number of passengers choosing to travel on cruise ships grew by more than four times between 1995 and 2018 (Figure 1.8). Even though preliminary data from the United Nations World Tourism Office (UNWTO) suggest a drop off in cruise passenger arrivals between 2018 and 2019, their share in total tourist arrivals globally increased to 2.8% in 2019, the highest level recorded. According to industry data, the most popular destination for cruise ships in 2019 was the Caribbean with 34% of total deployments, followed by the Mediterranean with 17% of the total (CLIA, 2020[37]). (Cruise passenger numbers collapsed again in 2020 due to the COVID-19 pandemic. See Box 1.1).

Figure 1.8. As a share of overall tourist arrivals, cruise passengers reached their highest point in 2019 at 2.8%

Tourist arrivals on cruise ships in thousands of passengers and as a percentage of total arrivals



Note: Statistics for 2019 remain provisional as of November 2020. Cruise arrivals are measured as same-day excursionists of which are cruise passengers.
Source: OECD calculations using data from UNWTO (2020) *Inbound Tourism: Arrivals*

But the ocean economy is an interdependent and interlinked system in need of better measurement

It is evident that these descriptions of the level of and growth in ocean economic activities use data from different sources and rely on very different metrics of output. Data generally available on the performance of the ocean economy measure different things in different ways. But if we are to grasp the full extent and complexity of the ocean economy, monitor and manage it properly, and design policies to foster sustainable growth, then we have to make a much better job of measuring it in a consistent and comparable manner.

However, as the following sections in this paper show, there are considerable obstacles to be overcome before reliable and extensive ocean economic data are available.

This paper is concerned with the measurement of the economic activities reliant on or attributable in specific ways to the ocean. At national and regional levels, countries continue to develop measurements of ocean economic activity. The best studies express economic statistics on the ocean economy in a way that is comparable with the measurement of activities in the economy at national and/or regional levels. However, measurement of the ocean economy remains a novel exercise in most countries and is beset by technical challenges. Not least because ocean economic activities can be difficult to distinguish from their land-based alternatives through established industrial classification systems. As a result, data for many ocean economic activities are unavailable at the level of comparability guaranteed by national accounting systems – the standard bearer for the measurement of economic activity. OECD (2019[2]) therefore outlines the case for work to begin within countries on ocean economy satellite accounts, such as those already achieved in Portugal (INE and DGPM, 2016[38]; INE, 2020[39]) and the United States (BEA and NOAA, 2020[40]).

Regular and reliable economic data on ocean activity are also scarce at the international level, where the criteria for comparability between countries must be met in addition to those across activities within countries. In general, the burden of ensuring international comparability precludes countries from providing detail beyond a limited number of aggregated industry groupings. Much like national-level systems, recognised repositories of detailed internationally comparable industry data – such as the OECD's Structural Analysis (STAN) or the United Nations Industrial Development Organisation's INDSTAT databases – are not detailed enough for understanding the full breadth of ocean economic activity. For most ocean related activities, time series of disaggregated economic data that are comparable between countries are not readily available.

In part, this paper documents the OECD's endeavours to produce time series of gross value added and employment for ocean economic activities that are replicable, comparable and suitable for international analyses. To help ensure international comparability in the first instance, data are collected from a range of existing international data repositories. In order to approximate the contribution of ocean activities in isolation, a set of country-level manipulations are carried out which are detailed in the methodological notes in Annex B. The resulting datasets contain annual statistics for a number of established ocean economic activities at country-level. Some analysis of the data produced is available in (OECD, 2020[4]) and the results are summarised in Section 2 below. There are, however, eight or so groupings of ocean economic activity that are not at present measurable using official source data. Data on important ocean industries such as offshore oil and gas extraction and marine and coastal tourism are not available at the required level of coverage and quality. But the OECD has provided estimations of the value of these industries on an ad-hoc basis before, and non-official data suggest they generate substantial contributions to the economy (OECD, 2016[1]).

Official data are therefore unable to highlight what are in some instances the largest and in others the fastest growing elements of the ocean economy (Virdin et al., 2021[41]). To fill this gap, international research efforts have been directed towards improving the visibility of ocean economic activities in national accounts (Park and Kildow, 2015[42]; Colgan, 2016[43]). In 2019, the OECD called for better use of national statistical systems in the measurement of ocean economic activity and its impacts on the marine environment (OECD, 2019[3]). And, most recently, the High Level Panel for a Sustainable Ocean Economy has advocated better use of the national statistical system in providing data suitable for ocean economy policy analysis (Fenichel, Milligan and Porras, 2020[44]).

Furthermore, the wellbeing generated through ocean economic activity is outweighed considerably by the range of important and invaluable ecosystem services – from the regeneration of food stocks, to natural hazard protection, to regulation of the climate – provided by the marine environment (OECD, 2017[8]). However, human actions are placing unprecedented pressures on marine biodiversity and the effects of

climate change on the ocean are already considerable (IPBES, 2019[7]; IPCC, 2019[6]). Conserving and sustainably using the marine environment is therefore of primary importance to safeguarding not just the future of the ocean economy and the human wellbeing that relies upon it, but on humanity writ large.

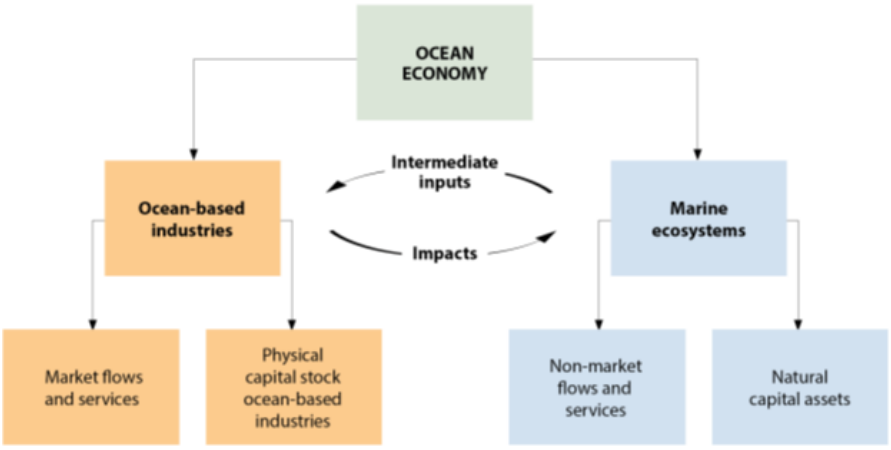
The OECD has recognised the ocean economy as a system of interactions and interdependencies between ocean economic activities and the marine environment since 2016 (Figure 1.9). But assessments of the sustainability of the ocean economy are in part complicated by the realisation that diverse ocean economic activities depend on the marine environment in different ways (OECD, 2020[5]). Some activities such as marine capture fisheries exploit natural capital – in this case fish stocks – as their primary product. Others such as maritime transport are not dependent on marine natural capital per se, but are physically located on the ocean and have a different set of environmental effects altogether. The impacts of each of these examples on the marine environment are distinct, requiring different measures and detailed data in order to orientate policies towards greater sustainability (OECD, 2020[5]).

Although OECD (2019[3]) outlines arguments in favour of measuring the value of all assets and flows related to the marine environment in a manner that is comparable with national economic statistics, work continues at international level to develop the methods required to achieve comparable marine environmental-economic accounts. The OECD is contributing to the preparatory work for future revisions of the System of Environmental-Economic Accounting (SEEA), including the extensions on accounting for ecosystems. However, many technical issues specific to the measurement of the marine environment remain.

It is, therefore, the combination of ocean economic data with marine environmental data that holds the greatest promise for improving the sustainability of the ocean economy. The ultimate objective of all ocean economy measurement strategies should be the production of a statistical information system that measures the multitude of ways the ocean contributes to wellbeing and the impacts that economic activities have on the marine environment. At present, however, statistics on ocean economic activities are incomplete and incomparable with data on the rest of the economy.

The measurement of ocean economic activity is the subject of the present paper and, in particular, methods by which statistics on ocean economic activity can be improved internationally. After all, without better ocean economic data, decision takers will not have access to the information required to pursue policies that drive a more sustainable ocean economy.

Figure 1.9. Illustration of the productive elements of the ocean economy



Source: OECD (2016[1]) *The Ocean Economy in 2030*

2 Recent progress in measuring the contribution of ocean economic activity to the economy

Building on recent statistical efforts at national levels and broad consultations with relevant stakeholders, this section provides an exhaustive definition of the ocean economy for the purposes of compiling internationally comparable ocean economy statistics. It names key activities based on the reference classification systems used by countries to compile statistics. It also outlines selected national efforts to measure the contribution of their ocean economies to gross domestic product and the challenges faced when doing so. Finally, OECD analysis of the value added and employment generated by six established ocean economic activities is presented. One key takeaway from this work is that many of the fastest growing parts of the ocean economy are not immediately visible in national accounts and other official data, either at country-level or internationally.

Introduction

The ocean economic activities addressed in this paper share a number of measurement challenges. Regular and reliable economic data tend to be scarce, the ocean-relevant data are often difficult to separate out from broader categories, and ocean economy studies differ in terminology, sectoral coverage and groupings. This section aims to ameliorate some of these issues by providing a definition of the ocean economy and a standardised classification of ocean economic activity for international statistics. The different strategies pursued by countries to measure their ocean economies are also summarised.

In addition, the OECD has developed a methodology for calculating the value added and employment emanating globally from six established activities. The statistics presented are based primarily on official OECD datasets and the data published by various other international organisations. The source data are in most cases incomplete in terms of time and country coverage, requiring a number of data manipulations and standardisations to allow comparability between countries and across activities. They form the first

building blocks of an OECD project to improve international ocean economy statistics through satellite accounting. The improvement of international ocean economy statistics is the subject of Section 3 below.

Defining ocean economic activity for statistical purposes

Definitions of economic sectors are important in as much as they set the boundaries for activities and products that are to be considered in the collection and calculation of detailed economic statistics. Ocean economic activity can be difficult to define for a number of reasons. The structure of statistical classification systems typically used to distinguish between different types of economic activity are such that ocean economic activities and ocean characteristic products are not separated from broader, non-ocean based categories. At present, no widely applied guidelines for ocean economy measurement exist in order to ensure the separation of ocean based activities from broader categories is conducted in a comparable manner.

Since the publication of *The Ocean Economy in 2030* (OECD, 2016[1]), considerable attention has been awarded to the ocean economy and countries are pursuing increasingly robust methodologies to collect, compile and disseminate accurate ocean economy statistics. The recent country studies summarised in the following section contain a range of ocean economy definitions. The more detailed definitions incorporate the role of the ocean in providing inputs to production and/or generating demand for the outputs of productive activity in the economy writ large. Ocean inputs may be subject to transactions throughout industrial supply chains and marine natural resources and ecosystem services may be consumed and relied upon as inputs, either directly or indirectly, in the process. Linkages between ocean economic activities and the environment are being considered in greater detail in ongoing revisions to the UN System for Environmental-Economic Accounting (SEEA). Park and Kildow (2015[42]) describe the collection of these ocean uses as economic activity that flows “to the ocean”, takes place “in the ocean”, and receives inputs “from the ocean”.

Despite the absence of ocean relevant classifications and guidelines, analysis of the latest ocean studies suggests that many countries are beginning to converge around a similar concept of the ocean economy. In order to work towards lists of activities and products that may be used for internationally comparable statistics, the OECD has adopted the definition of ocean economic activities provided in Box 2.1. The seven parts of the definition describe different relationships and dependencies between economic activity and the ocean and help to clarify what activities should be considered part of the ocean economy. The different elements are detailed below:

Ocean economic activities are those that take place on or in the ocean: A key consideration with regards to any definition of the ocean economy is what counts as “the ocean”. Internationally agreed terms relating to the rights of nations over the ocean are defined in the 1982 United Nations Convention of the Law of the Sea (UNCLOS). One relevant concept outlined in UNCLOS is the exclusive economic zone (EEZ) – the area extending 200 nautical miles out to sea from a baseline usually defined as the low water mark of a coastal state. Many ocean economic activities do not fit neatly into such geographical definitions. Fishing fleets, for example, may fish waters beyond EEZs. Maritime passenger and freight transport services often depart from one national jurisdiction and arrive in another, crossing the high seas and passing through other EEZs along the way. A significant amount of deep sea mineral deposits are located in areas beyond national jurisdiction. Ocean economic activity is not restricted to the EEZ of a country. Therefore, any activity that takes place on or below waters beyond the low water mark of a coastal state, or any other metric used as the baseline to establish a particular country’s EEZ, may be considered part of the ocean economy. (Some countries opt to include major internal waters in their definitions. The United States, for example, counts activity associated with the Great Lakes as part of its ocean economy).

Box 2.1. Definition of ocean economic activities for international statistical purposes

Ocean economic activities are those that:

- take place on or in the ocean;
- produce goods and services primarily for use on or in the ocean;
- extract non-living resources from the marine environment;
- harvest living resources from the marine environment;
- use living resources harvested from the marine environment as intermediate inputs;
- would likely not take place were they not located in proximity to the ocean; or
- gain a particular advantage by being located in proximity to the ocean.

Ocean economic activities are those that produce goods and services primarily for use on or in the ocean: Multiple economic activities exist primarily in order to supply goods and services to activities that take place on or in the ocean. These activities would not take place or would be altered greatly if the ocean did not exist. Marine civil engineering, naval architecture, marine hydrographic surveying, and maritime shipbuilding and repair are all examples of industries that produce goods and services primarily for use in activities that take place on or in the ocean, and are important aspects of the ocean economy. The maritime equipment industry, for example, designs, manufactures, and installs technical machinery for the maritime ship and boat building industries. It has been estimated to contribute between 6% and 11% of the total output value of the shipbuilding industry in major shipbuilding countries (Gourdon and Steidl, 2019[45]).

Ocean economic activities are those that extract non-living resources from the marine environment and/or harvest living resources from the marine environment: Many activities that take place on or in the ocean extract or harvest ocean resources. The marine fishing industry harvests fish stocks. Offshore hydrocarbons are extracted from under the seafloor by the offshore petroleum and natural gas industry. Sands and gravels are dredged and used in the construction industry. Precious diamonds and minerals are extracted from deposits on the seabed. Marine algae is harvested for use in a wide range of products including cosmetics, fertilisers and fuels. All economic activities that extract resources, living and non-living, from the marine environment are considered part of the ocean economy.

Ocean economic activities are those that use living resources harvested from the marine environment as intermediate inputs: In terms of activities that use marine resources as intermediate inputs, only those that rely upon living resources are included in the definition in Box 2.1. This means, for example, that the processing of marine fish is included but the refining of oil extracted from offshore sources is not. The dredging of the seabed for aggregates is included but the production of materials for the construction industry from those aggregates is not. The extraction of sea salt and other minerals from the ocean is included but activity that processes them into other final products is not. Why are activities that use marine living resources as intermediate inputs counted as part of the ocean economy while activities that use non-living resources are excluded?

One justification is that many activities that use marine living resources as intermediate inputs produce goods and services that remain characteristically of the ocean. Frozen marine fish fillets, a product of the marine fish processing industry rather than the marine fishing and aquaculture industries, are sold explicitly as an ocean characteristic product. Cosmetics made from seaweed are often marketed due to their properties relating to the ocean. This is not necessarily true of the products emanating from the processing of non-living resources. Refined petroleum products such as gas and diesel oil, naphtha, liquefied petroleum gas and kerosene type jet fuel tend not to be sold on the basis of their origin beneath the ocean

or on land. Products that rely on salt as an input tend not to advertise their link to the ocean. There may be examples of marine non-living resources that are processed into ocean characteristic products. And the use of intermediate living and non-living resources to distinguish between ocean and non-ocean characteristic products may become fuzzy at the margin. This area of the definition of the ocean economy may therefore evolve as understanding of the uses of marine resources in economic activity improves. At least at present, the exclusion of activities that rely on marine non-living resources as intermediate inputs places the boundary of the ocean economy where it is commonly understood to be.

Ocean economic activities are those that would likely not take place were they not located in proximity to the ocean: A further area of the definition likely to evolve as our understanding of the ocean economy improves concerns the multiple and varied economic activities that are located in proximity to the ocean. The boundary of proximity in this case is of key concern for statisticians working on ocean economy statistics. Countries have particular ways of measuring coastal zones and country studies typically rely upon these to guide which productive units count as being within the coastal zone and which do not. The OECD, for example, has developed indicators of the extent and change of the built-up environment in coastal areas based on different measures of the coastal zone (OECD, 2021[46]). Despite a relatively good understanding of the boundaries of the coastal zone in coastal OECD countries, this part of the definition describes economic activities that create challenges for the practical application of refining ocean economy statistics.

Desalination plants and some of the activities associated with marine and coastal tourism are good examples of activities that simply would not exist were they not located in proximity to the sea. The conversion of saltwater to freshwater could not happen without access to the ocean. Maritime pleasure boat hire, leasers of marine sports equipment such as scuba gear, and beachside surf schools could not operate without an ocean to sail on and dive in, and marine waves to surf on. Identification of the productive units that partake in such activities is mostly a case of locating them within the designated coastal zone and their justification for inclusion in the ocean economy is likely to be clear.

Ocean economic activities are those that gain a particular advantage by being located in proximity to the ocean: The final group of activities located in proximity to the ocean relates to those that may or may not warrant inclusion in ocean economy statistics based on more nuanced local circumstances. There are roughly two sets of activities that should be included in this grouping:

- The first set are exemplified by concentrations of hotels, restaurants, amusement arcades, and gift shops that are common in coastal locations but also exist in many other locations. When demand for the goods and services produced from such activities is derived from their location next to the sea, they are generally considered to be part of the ocean economy.
- But there is also a more complex set of activities for which decisions surrounding their inclusion in ocean economy statistics is less straight forward. For example, many of the world's largest oil refineries are located by the coast or along estuaries and many nuclear power stations are also located near the ocean. Demand for oil products flowing from coastal refineries and for electricity generated in coastal nuclear power stations is not, however, derived solely from their location next to the sea.

What then of activities that have been placed by the coast due to the particular advantages gained from being located near the ocean but that could be located elsewhere? When an establishment is advantaged by its location in proximity to the ocean, then the value it gains over similar establishments not in proximity to the ocean may also be recognised as being attributable to the ocean economy. Identifying the establishments that qualify for this particular group of ocean economic activities will depend largely on national and sub-national circumstances and estimating the additional value generated from their coastal location is a complex endeavour. For this reason, several activities associated with the ocean due only to the advantages gained by being in proximity to it are not included in the list of ocean economic activities for international statistics outlined below. They will however be the subject of future research on the topic.

Standardised classifications of ocean economic activities

The basis of the collection and compilation of all comparable economic statistics are classification systems that provide standardised descriptions of economic phenomena. There are several main families of classifications, each ensuring that the categories contained within them are mutually exclusive and conceptually sound. Two specific classifications are of relevance to defining ocean economic activities. The first are classifications of activities that categorise productive units (such as enterprises) for statistics on output, labour, material inputs etc. The others are product classifications that categorise goods and services for statistics on consumption, trade, transportation, etc.

The most recent versions of activity and product classifications approved by the United Nations Statistical Commission (UNSC) are the International Standard Industrial Classification (ISIC) Rev.4 and the Central Product Classification (CPC) Version 2.1. These internationally agreed systems are known as *reference classifications* and are intended to serve as the basis for the development of more detailed classifications suitable for regional, national and provincial levels.

Classifications built upon the reference classifications in order to include further detail relevant to local conditions and requirements are known as *derived classifications*. The EU's Statistical Classification of Economic Activities in the European Community (NACE) is an example of an activities classification that is derived from ISIC. NACE corresponds with ISIC up until the most detailed level, where additional categories relevant to the EU are defined. NACE, in turn, acts as a reference classification for national level systems within the EU. The French Classification of Activities (NAF), for example, is concordant with NACE (and therefore ISIC) until the most detailed level where it describes additional categories of importance to the French economy.

Regional and national classifications that only partially refer to the reference classifications are known as *related classifications*. The North American Industry Classification System, used by United States, Canada and Mexico, is structured differently to ISIC and only partially relates to it. However, both NAICS and ISIC have been designed to enable internationally comparable data at least at the ISIC division level which is the level of detail provided by the national accounts of most countries. In reality, the definitions of many of the categories contained in ISIC and NAICS are purposefully harmonised in order to allow comparability at greater levels of detail. The Australian and New Zealand Standard Industrial Classification (ANZSIC) is another related classification for which it is possible to compare data with ISIC categories at more detail than the division level.

OECD list of ocean economic activities and ocean characteristic products

The compilation of lists of activities and products specific to the ocean economy is key to facilitating comparability.

The OECD has developed a list of ocean economic activities using the reference classification for industrial activity. The list was established in the following manner. Firstly, codes that meet the definition of the ocean economy in Box 2.1, either completely or partially, were searched for in the internationally agreed statistical classification systems. In a second step, activity descriptions and their assigned codes were extracted from recent country studies and cross checked with national experts; see Table 2.1. A table of correspondence between ISIC Rev.4 and the different derived and related classification systems used in each study was then created, allowing comparisons to be made between activities appearing in each example publication. Finally, a description of the ocean specific activity in question has been suggested based on the broader descriptions found in both the national studies and the classification systems.

The resulting OECD list of ocean economic activity descriptions is given in

Table 2.2. Annex A provides the corresponding ISIC Rev.4 activity codes. The codes listed are likely to capture the vast majority of value added associated with the ocean economy. However, the proposed list is not exhaustive and excludes for now a number of emerging activities. Marine biotechnology for instance has been classified and is identifiable in international research and development (R&D) statistics (OECD, 2017[47]), but has not yet become visible as an established economic activity in national economic accounts.

Table 2.1. Selected ocean economy studies developed at national/regional level

Country/Region	Reference
Australia	AIMS (2018), The AIMS Index of Marine Industry, Australian Institute of Marine Science, Australian Government
Canada	DFO (2020), Marine sectors in Canada methodology, Department of Fisheries and Oceans, Government of Canada
France	INSEE (2019), Économie maritime - Des activités à forte valeur ajoutée et des emplois qualifiés, INSEE Flash Provence-Alpes-Cote d'Azur
Ireland	SEMRU (2019), Ireland's Ocean Economy, NUI Galway Whitaker Institute Socio-Economic Marine Research Unit (SEMRU), June 2019
Korea	KMI (2020), Korea's Ocean Economy 2020, Korea Maritime Institute, Busan, Korea
Portugal	INE (2020), Satellite Account for the Sea 2016-2018, Government of Portugal
Scotland	Marine Scotland (2019), Scotland's Marine Economic Statistics, Marine Scotland, Scottish Government
United States of America	BEA and NOAA (2020[40]) *Defining and Measuring the U.S. Ocean Economy*, Bureau of Economic Analysis, United States Government
European Union	DGMAF (2019), The EU Blue Economy Report 2019, Directorate-General for Maritime Affairs and Fisheries (European Commission)

The majority of the four digit ISIC codes in Annex A include activity that does not meet the definition of ocean economic activities in Box 2.1. Data compiled under these categories will represent the broader activities visible in national statistical systems and count value added that should not be attributed to the ocean economy. Accounting for ocean economic activities in isolation is a challenging endeavour. A summary of how countries overcome this challenge is provided below.

The ocean economy can also be classified in terms of ocean characteristic products. The purpose of product classifications is to define and categorise goods and services resulting from production in an economy. The international reference classification, the Central Product Classification (CPC), is related to ISIC in that each good and service categorised within it is defined as being produced by an activity categorised in ISIC. The EU's Statistical Classification of Products by Activity (CPA) is derived from the CPC in much the same way that the EU's NACE is derived from ISIC. As far as possible, each of the product categories in the CPA 2008 is concordant with an activity category in NACE Version 2.1. Similarly, the North American Product Classification System (NAPCS) 2017 can be linked to the activities outlined in NAICS 2017.

The OECD's previous analyses of ocean-based industries are based on data aggregated under activities only, and most of the ocean economy studies analysed for this paper pursue a similar strategy. But some countries have considered ocean characteristic products in their analyses. The Portuguese Satellite Account for the Sea breaks down activities into products and provides details of the process undertaken to arrive at a representative list (INE and DGPM, 2016[38]; INE, 2020[39]). The US Ocean Economy Satellite Account also considers ocean characteristic products in order to measure the contribution of economic activity that can be attributed to the ocean economy (BEA and NOAA, 2020[40]).

Table 2.2. OECD list of ocean economic activities for internationally comparable statistics

	Ocean specific description
1	Marine fishing
2	Marine aquaculture
3	Maritime passenger transport
4	Maritime freight transport
5	Offshore extraction of crude petroleum & natural gas
6	Marine and seabed mining
7	Offshore industry support activities
8	Processing and preserving of marine fish, crustaceans and molluscs
9	Maritime ship, boat and floating structure building
10	Maritime manufacturing, repair & installation
11	Offshore wind & marine renewable energy
12	Maritime ports & support activities for maritime transport
13	Ocean scientific research & development
14	Marine & coastal tourism

Measuring ocean economic activity

The number of countries interested and engaged in measuring their ocean economy as a collection of activities, rather than a few standalone industries, has grown in recent years in both OECD countries and partner economies. Early explorations of countries' attempts to measure their ocean economies are available in Park and Kildow (2015[42]) and, more recently, OECD (2020[4]). They indicate the importance of improved measurement in the sustainable development plans of lower income countries. Among OECD countries, recent ocean economy studies are available for multiple countries – OECD (2019[3]) contains summaries of the reports available at the time for reference purposes.

The OECD has examined the issues faced in the production of the recent ocean economy studies referenced in Table 2.1. As is typical for the relevant literature, the publications begin by defining the ocean economy. Each definition acts as a normative statement of intent that sets the parameters of the study and the geographical areas to be measured, and assists with understanding the types of activities and products to be focussed on. A detailed list of activities is then outlined and their compatibility with industrial classification systems noted. The classifications play an important role in reducing the risk of double-counting and ensuring economic data is comparable across the different sectors operating within an economy.

Once a compatible set of classification codes have been identified, economic data tends to be sourced from datasets published by national statistical offices or, in the case of the European Union (EU) example, the EU statistical organisation Eurostat. The surveys relied upon to populate these datasets are typically business, household and labour force surveys. Such surveys provide the source data for the national accounts and other official statistics produced through national statistical systems.

All estimations of economic activity published in the country studies are based on national economic statistics, but a range of divergent methods are used in order to isolate the ocean economic activities in question and group together relevant official data. This makes comparisons between the published estimates of ocean value added and broader economic statistics difficult to achieve, both within and between countries.

Recent studies highlight the challenge of isolating ocean activities from all others

A key constraint to using structural surveys is that only a small number of ocean economic activities are recognised explicitly through industrial classification systems.

Many activities associated with the ocean economy cannot be isolated from their broader, aggregated categories. Offshore wind electricity generation, for example, represents one part of the industry described by ISIC Rev.4 code 3510 as 'electric power generation, transmission and distribution'. The code assigned to it includes not only all forms of renewable and non-renewable, land- and ocean-based generation, but also the transmission and distribution of the electricity generated. This implies that a firm involved in offshore wind will correctly answer a structural survey by marking their activities as belonging to the broader activity code (3510) categorised in the industrial classification. The detail of the source of the electricity is not communicated in the survey response and information concerning an increasingly important part of the ocean economy is lost.

Where structural surveys do not provide the necessary level of detail, country studies often rely on more refined, specialised surveys carried out by national statistical offices or conduct their own ad-hoc surveys, and in some cases rely on reports by industry itself. The example from Ireland relies upon a special survey for collecting data regarding offshore oil and gas activity, marine renewable energies, marine engineering, high-tech marine services, marine commerce, marine retail services and marine biotechnology – none of which have a fully corresponding industrial classification code (SEMRU, 2019[48]). If resources are not available for ad-hoc surveys, simplifying assumptions are used that designate some proportion of a broader aggregate activity to the ocean economy. The EU publication, for example, measures the ocean-based contribution of cargo handling and warehousing and storage to maritime port activities by assuming ocean economic activities account for 50% of the total in each EU Member State for which no better information is available (DG MARE, 2019[49]).

Using the results of structural surveys as a baseline from which to estimate the contribution of the ocean economy in official economic statistics provides an indication of the direct contribution of ocean economic activity to the overall economy. The aggregation of the direct contribution of all ocean economic activities is considered the national total.

Ocean economic analysts are often interested not only in direct contributions but in the impacts that ocean economic activities have more broadly. Indirect impacts occur when ocean industries demand products from other areas of the economy. Further 'induced' impacts are generated when the income from ocean economic activity is spent in the economy as a whole (through the wages earned from labour provided to the ocean economy, for example). The aggregation of direct, indirect and induced impacts provides an indication of the *total economic value added* of an industry or sector to an economy. The Irish and Australian examples both measure the indirect impacts of the ocean economic activities they consider.

Where possible, indirect impacts are estimated using Input-Output (IO) tables. IO tables are sometimes produced through national statistical systems and published along with the national economic accounts. The IO tables constructed in this scenario are sourced from the business, household and labour force surveys mentioned above. This leads to similar issues concerning the isolation of ocean economic activities as experienced when conducting direct measurements using structural economic surveys. Often then, analysts estimate their own IO tables using both official and unofficial source data.

While the above methods result in values that are difficult or impossible to compare with the statistics outlined in the national economic accounts, two countries have developed and applied methodologies that ensure ocean economy measurements are aligned with the core national accounts. In general, estimates of economic activity that apply the accounting frameworks of the system of national accounts are known as satellite accounts. More information on satellite accounts and their role in providing comparable and consistent ocean economy statistics is provided in Section 3 below.

Portugal became the first country to produce an experimental ocean economy satellite account in 2016 and now published a second, more detailed version including first time estimates for the Autonomous Regions (Azores and Madeira) (INE and DGPM, 2016[38]; INE, 2020[39]). The Portuguese Satellite Account for the Sea (SAS) constructs a series of alternative aggregations of national accounts data that highlight the contribution of ocean economic activity between 2010 and 2013. Ocean economy gross value added, imports, exports, employment and investment are calculated in a manner that ensures each metric is comparable with broader statistics on the Portuguese economy. Both the domestic and imported supply of ocean characteristic products are considered and their uses among different sectors and, through exports, the rest of the world outlined.

The United States has also constructed an ocean economy satellite account (BEA and NOAA, 2020[40]). The account provides estimates of output, value added, employment and compensation of employees for ten marine activity groupings between 2014 and 2018. The results are calculated using the same procedures applied to other satellite accounts constructed by the Bureau of Economic Analysis – one of the national statistical offices charged with producing national economic statistics in the United States. The US ocean economy satellite account enables comparisons between the ocean economy and other sectors in the US economy.

In summary, the methodologies used in recent ocean economy country studies can be split into three related but distinct types. All three methods, each of them limited by the challenge of isolating ocean economic activities in aggregations inherent to broadly categorised economic statistics, are as follows:

- identification of direct economic contributions associated with ocean economic activity in the results of surveys conducted by national statistical offices and/or ad-hoc specialised surveys;
- economic modelling of direct, indirect and, perhaps, induced impacts through input-output models or analytical techniques related to or based on input-output tables; and
- development of ocean economy satellite accounts in line with the core national accounting system (see Section 3 below for a more in-depth description of satellite accounting).

Calculating the contribution of ocean economic activities to the global economy

Despite the difficulties associated with using official data to measure ocean economic activities, several projects have attempted to provide internationally comparable ocean economy statistics. The EU's Directorate-General for Maritime Affairs and Fisheries (DG MARE, 2018[50]; DG MARE, 2019[49]), for example, conducts an annual exercise for EU Member States using official data available through Eurostat, the region's statistical office, and other estimates. The Caribbean Development Bank has explored the potential for satellite accounts for the ocean economy and provided a case study using national accounts data from Jamaica (Ram, Ramrattan and Frederick, 2019[51]).

The OECD has played a key role in measuring and emphasising the importance of the conservation and sustainable use of the marine environment. OECD (2016[1]) contains global estimates of the value added and employment associated with ten ocean-based industries and projects these values to 2030 in order to consider the future of the ocean economy. Due to data limitations, the methodology uses official data for a fraction of the industries and relies upon industry-led reports or other documented estimates for the rest. Following the 2016 publication, the OECD explored new ways in which the ocean economy could be measured in order to ensure consistent and comparable data are available for analysis (OECD, 2019[3]). A key recommendation of this work is that countries begin to explore the use of ocean economy satellite accounts for both ocean economic activity and environmental-economic linkages.

Since OECD (2019[2]), the OECD has returned to developing its statistical base in ocean economic activity using data from official sources only. The objective of this exercise was threefold. The estimations of economic activity produced in OECD (2016[1]) were carried out in order to gain an initial understanding of

the size of the global ocean economic activity – an assessment that had not been conducted before. In order to include data on as many industries as possible, the analysis relied upon a broad range of sources. Substantial resources were devoted to ensuring data remained consistent and comparable across the range of activities measured. The first objective of the present analysis was therefore to survey the official data available to the OECD for changes in detail in order to ascertain whether a larger set of industries could be measured from reliable sources. A secondary objective was to apply the same statistical standards to data from outside the OECD in order to build a large dataset of ocean economic performance using official data from both OECD countries and partner economies. Finally, approximations of the activities measured using official data were produced for all countries for which no data exists in order to provide an understanding of differences in the contributions of ocean economic activities to economies in countries of different income levels.

OECD approximations of global value added and employment in six established ocean economic activities

The OECD has approximated value added and employment in six established ocean economic activities – marine fishing, marine aquaculture, marine fish processing, maritime freight transport, maritime passenger transport and shipbuilding – between 2005 and 2015. In order to ensure comparability between countries, data compiled by international organisations according to agreed statistical guidelines and standards are relied upon as far as possible. Where the relevant series available in such datasets are missing values, a simple methodology has been developed in order to fill the gaps or provide approximations for countries where no data are available (Annex B).

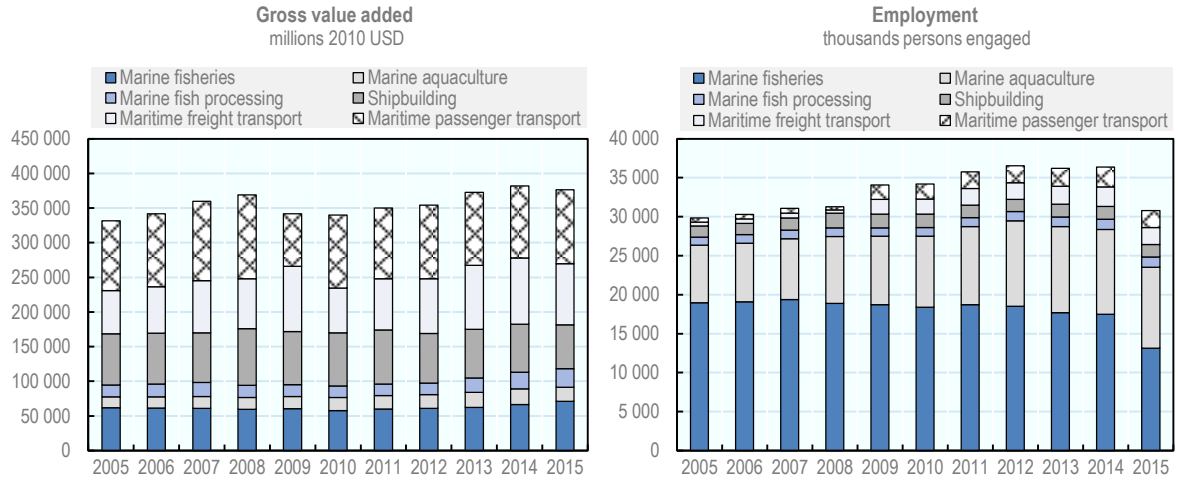
Value added refers to gross value added and is equivalent to the value of output minus intermediate consumption in each activity. Employment is measured in terms of the number of people engaged and includes both full-time and part-time workers. Other important economic terms used throughout this paper are defined in Box 2.2. The data have been collated in annual country-level time series and then aggregated to arrive at global estimates.

The results suggest that the six established ocean economic activities contributed just over USD 375 billion (constant 2010 USD) in gross value added and employment for over 30 million people in 2015 (Figure 2.1). In 2005, global value added in the six activities was approximately USD 330 billion (constant 2010 USD) suggesting combined performance increased by around 14% over the decade. The largest of the six industries in terms of value added is maritime passenger transport in every year but 2009 when maritime freight transport briefly takes over. The largest employer globally is consistently marine fishing. However, employment in marine aquaculture becomes increasingly important over the period rising from just over 7.3 million persons engaged in 2005 to 10.4 million in 2015.

The share of ocean economic activities in the overall economy tends to be higher in lower income countries than in OECD countries. The six activities measured contributed less than 2% of the GDP of high and upper middle income countries throughout most of the period measured. The largest shares of GDP occur in lower middle income countries, where the six activities represented just under 12% of total GDP in 2015. In high and upper middle income countries, substantial shares of total value added are generated by all activities. In lower income countries, most ocean economic activity is associated with exploiting natural resources. Marine fishing and aquaculture are the major industries present in lower middle income countries. In low income countries, where marine fishing alone dominates, the six activities accounted for around 6% of GDP throughout the period. OECD (2020[4]) contains more detailed analysis of the trends highlighted by this data and their implication for sustainable ocean economic development globally.

Figure 2.1. Calculations based on official data suggest six established ocean economic activities contributed roughly USD 375 billion to global GDP and employed around 30 million people in 2015

Global gross value added and employment in six ocean economic activities in millions of constant 2010 USD and thousands of persons employed



Note: The values presented here are part of ongoing experimental work in constructing an OECD ocean economy satellite account. Future estimates may vary for definitional and other reasons as the source data used to generate the estimates becomes more refined. The drop in employment in 2015 can be linked to delays in the inclusion of up-to-date production statistics in marine fisheries that are part of the model.

Consistent and comparable international economic data are available for only a minority of established ocean economic activities

The data presented above provide an overview of several well-established ocean economic activities. However, they represent less than half of the activities represented in the OECD's list and feature no emerging activities. Ideally, the methodology used to approximate global activities outlined in Annex B would be applied to all the ocean economic activities in the OECD's list. But the data requirements for internationally comparable measurements of the annual contribution of ocean economic activities in all ocean economies are substantial and, in reality, the data available for many ocean economic activities are so limited that the simplifying assumptions do not hold to an appropriate degree of reliability. Data are simply not available at the detail required for accurate measurements of all but the subset ocean economic activities presented above.

Data on value added and employment in the extraction of crude petroleum and natural gas, for example, are difficult to elicit at country level and even more so internationally. Often recourse has to be made to a variety of sources ranging from relevant national agencies, industry associations and private research consultancies. Access to official data in the national accounts data collected by international organisations is limited, not least because the publication of detailed national accounts is less well developed in many important oil and natural gas producing OECD partner economies. Statistics on value added and employment are available in a few OECD countries, drawn principally from research conducted by international organisations and private institutions. But only eight of the 32 largest oil and gas producing countries are members of the OECD (IEA, 2018[18]).

Internationally comparable economic data are scarce also for offshore wind and marine renewable energies necessitating the need for sophisticated methodologies to fill the gap in previous analyses. With respect to employment figures, initiatives have been launched recently to map employment structures in offshore wind and marine renewable energy through the International Energy Agency's (IEA) Ocean

Energy Systems Technology Collaboration Programme (OES, 2019[52]). The research should provide helpful insight as to how methodologies can be designed to estimate the employment effects of emerging ocean technologies in the ocean economy.

Offshore energy industries are supported by substantial activity in surveying, engineering and transportation services normally carried out on a contractual basis. In light of the size of the offshore crude petroleum and natural gas industry and the rapid growth of offshore wind, it is reasonable to assume that the contribution of support services to the ocean economy is significant. Offshore industry support activities encompass a wide range of specialised activities, making it difficult to assemble the component parts for aggregation purposes.

Similar data compilation issues afflict the measurement of the maritime manufacturing, repair and installation industry, which straddles numerous activities providing goods and services that are used as inputs to production in the maritime shipbuilding industry. Depending on where the boundaries of the industry are drawn, maritime manufacturing, repair and installation ranges across ten or more ISIC Rev.4 classes and many more CPC Version 2.1 product subclasses, each of which contributes only partially to the ocean economy. Identifying the ocean relevant goods and services produced by each of these activities, isolating the value attributable to the ocean economy, and aggregating the results reliably without errors such as double-counting requires highly granular data and meticulous accounting work.

Further attribution problems arise when considering the contribution of maritime ports and support activities for maritime transport. A large part of the economic activity in and around ports is not directly connected to the ocean economy. In many parts of the world, urban development, infrastructure, social activity and general business agglomerate around maritime ports. Often these make up the bulk of the activity associated with maritime ports and outweigh those that are core to the ocean economy. Accounting for the direct value added generated from a maritime port and isolating the direct ocean economic activity is a difficult exercise requiring detailed localised economic data. Even the data currently available through regional statistical information systems are for the most part not provided at the detailed level required to do so reliably.

One area where international guidance exists for robustly splitting value between multiple related activities spanning diverse industries is tourism, which has benefited from decades-long international efforts to develop an appropriate statistical system (OECD, 2010[53]; UN, 2008[54]). The UN World Tourism Organisation collects tourism statistics annually including value added and employment data. However, the data are compiled under activity categories which have only partial relevance for the ocean economy. While they provide robust measurements of the overall tourism economy, the contribution of marine and coastal tourism to the total remains unaccounted for and important measurement issues remain to be resolved. Strong assumptions are necessary to separate the economic activity derived from tourists that is directly attributable to the ocean and, in particular, to determine the extent and limits of what constitutes a marine and coastal tourism area.

Finally, ocean scientific research and development is a particularly under-developed area of ocean economy statistics, with very few countries publishing national data and with significant hurdles to be overcome in engendering internationally comparable statistics. As the Intergovernmental Oceanographic Commission's Global Ocean Science Reports indicate, ocean science activity has been growing strongly in recent years (UNESCO-IOC, 2017[55]; UNESCO-IOC, 2020[56]). However, ocean scientific assets like science infrastructure, scientific capacity and the number of marine scientists are difficult to map and track at international level. Ongoing work on these aspects is proceeding in view of the future editions of the Global Ocean Science Report. Still, economic data are certain to prove scarce, not least because of definitional and conceptual issues involved in establishing the value added of scientific contributions to the ocean economy.

Given the challenges associated with understanding the contribution of the ocean economy globally outlined above, the OECD has considered how best to improve international ocean economy statistics.

Section 3 below expands upon how ocean economy satellite accounts provide a way forward and summarises plans to construct the first experimental OECD ocean economy account.

Box 2.2. Definitions of key economic terms found in this paper

Industry: An industry consists of a group of establishments engaged in the same, or similar, kinds of economic activity. The classification of economic activities into industries used in the System of National Accounts is the International Standard Industrial Classification. In common language, the term "sector" is often used as an equivalent to "industry".

Value added: Gross value added is the value of output less the value of intermediate consumption. It is a measure of the contribution to gross domestic product (GDP) made by an individual producer, industry or sector; gross value added also represents the (primary) income generated through the production of goods and services, and consists of compensation of employees, other taxes less subsidies on production and gross operating surplus (or, in the case of unincorporated enterprises, mixed income, a mixture of operating surplus and remuneration for labour input of the owner and/or family members). Net value added equals gross value added minus consumption of fixed capital.

Gross domestic product (GDP): GDP is an aggregate measure of production, and equals the sum of the gross values added of all resident units engaged in production (plus any taxes less subsidies on products not included in the value of their outputs). It also represents the sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices, less the value of imports of goods and services.

Value added deflator: A price index – described as a "deflator" – used to revalue gross value added to the general price level of a reference period.

Employment: Two main measures are used for employment: the number of employees and the number of employed, the latter including self-employed persons. More complex measures are sometimes produced by measuring the number of hours worked or by conversion into full-time equivalent units.

Source: OECD Glossary of Statistical Terms (https://stats.oecd.org/glossary/) and Peter van de Ven (Director, OECD National Accounts Division)

3 The need for satellite accounts in improving international ocean economy statistics

The ocean economy comprises increasingly important economic activities and a marine environment that is under threat. Despite this, detailed statistics that would provide the evidence base for effective ocean economic policymaking are lacking. One solution for the better measurement of ocean economic activities is the collection and compilation of comparable data in a supply and use framework. This chapter outlines an approach to improved international statistics aligned with the efforts of countries pursuing or considering the development of ocean economy satellite accounts in line with the core national accounting systems.

Introduction

Principles of accurate and reliable data are embodied in statistics produced by means conforming to the *System of National Accounts 2008* (2008 SNA), an internationally agreed set of accounting guidelines for national economic statistics (OECD et al., 2009[57]). All OECD countries and most non-members produce their national accounts in concordance with the 2008 SNA (or earlier versions). The SNA therefore provides a powerful tool for measuring the ocean economy in a manner consistent with and comparable to broader economic statistics both nationally and internationally.

National economic statistics constructed using the SNA are however collected and published at a level above and beyond that at which the ocean economy can be readily identified. In order to arrive at estimates of the contribution of specific ocean economic activities in the national accounts, more granularity of currently available data and, in some cases, deviations from the standards outlined in the SNA are required. When more granularity and deviations are necessary, the 2008 SNA recommends the construction of satellite accounts to the core accounting system. An experimental OECD ocean economy satellite account is the focus of this chapter.

No international guidelines for ocean economy measurement currently exist. But multiple documents are available that could guide the construction of an experimental OECD ocean economy satellite account. Foremost is Chapter 29 of the 2008 SNA, which outlines the basic principles of adapting national accounts to meet specific objectives while maintaining coherence with the core structure. Two types of satellite account are mentioned. In the first, the premise of the core accounts is maintained but added detail is provided for a particular sector or phenomenon. The second type gives greater flexibility by allowing traditionally non-accounted for aspects – time spent on unpaid household activities or the value of human capital, for example – to be included. The second type of satellite account enables "extending the SNA production boundary" by measuring non-market goods and services within a national accounting framework. The ocean economy satellite account under discussion is related to the first type. The production boundary of the 2008 SNA is maintained for the compilation of a thematic satellite account for the ocean economic activity.

General background to satellite accounting

Satellite accounts are not a novel concept given their prominence in the 2008 SNA. Recently national statistical offices have reported a proliferation of requests for their development. In response to such demand, the Bureau of the Conference of European Statisticians (CES) conducted research into national practices in satellite accounting (Statistics Canada, 2019[58]). The research refers to thematic (the first type in the 2008 SNA) and extended (the second type in the 2008 SNA) accounts, and this typology will be maintained throughout the rest of this document.

Among a range of insights, Statistics Canada (2019[58]) consider the funding, frequency, motivation, guidance and demand for satellite accounts internationally through a survey of national statistical offices. A preliminary inventory records that over 200 satellite accounts are active in around 80 countries, the majority of them thematic accounts that "do not deviate from the core concepts of the SNA". Furthermore, the construction of the majority of the satellite accounts in the survey benefited from international guidance. This is reflected in the subject areas of the accounts counted in the inventory, which concentrate mainly around the areas for which guidelines exist.

Examples of internationally agreed documents detailing guidance for producing specific thematic satellite accounts include the *Tourism Satellite Account: Recommended Methodological Framework 2008* (OECD, 2010[53]) and for extended satellite accounts the *Satellite Account for Non-profit and Related Institutions and Volunteer Work* (UN, 2018[59]). The Tourism Satellite Account (TSA) guidelines are built upon concepts and statistical conventions detailed in the *International Recommendations for Tourism Statistics* (UN, 2008[54]). The combination of the two tourism publications provides a well-established, internationally agreed statistical system for measuring the contribution of tourism to overall economies.

Given the exemplar nature of the statistical guidance available and the importance of marine and coastal tourism in the ocean economy, the TSA could provide a reference for a proposed set of international ocean economy guidelines. However, important differences in the objectives of the TSA and an ocean economy account exist that reduce the applicability of its statistical framework. The TSA is concerned with separating the value of goods and services demanded by tourists from the value of those demanded by residents, plus the employment and investment generated by enterprises supplying tourist demand. The aim of the ocean economy satellite account is to better understand the value of overall economic activity that meets the definition outlined in Box 2.1, plus the employment and investment required to generate that value. Not all of the tables and methods suggested by the TSA are therefore relevant.

Satellite accounts and the supply and use framework

At the core of almost all thematic satellite accounts are Supply and Use Tables (SUTs) that detail the flows of goods and services between producers and consumers in an economy (van de Ven, 2019[60]). SUTs are the accounting mechanism used by national accountants to estimate key indicators of economic performance including gross domestic product (GDP) in a balanced manner (Lequiller and Blades, 2014[61]). As such, the OECD Statistics and Data Directorate provides online access to an international database of SUTs allowing country comparisons across 89 ISIC Rev.4 activities and 89 concordant CPA 2008 products categories (OECD, 2020[62]). A simplified illustration of the data compiled within SUTs is provided here. In general, SUTs are structured so that activities appear column-wise and products appear row-wise.

The Supply Table contains a number of components. The domestic output of each economic activity according to the goods and services produced is detailed in the form of an activity by product matrix. The output values are measured in basic prices – the amount received by the producer for its output minus taxes paid plus subsidies received on products. The Supply Table also records the imports of each product. The combination of domestic output and imports is equivalent to the domestic supply of each product.

The production matrix and the value of total domestic supply at basic prices are shown in the grey and blue areas of the stylised Supply Table in Figure 3.1. In the simple economy depicted, there are only three activities (agriculture and hunting, forestry and logging, and fishing and aquaculture) and three groups of goods produced (crops and meat, wood, and fish). In this case, the value of domestic output of crops and meat is 80 000 and the value of imports of crops and meat is 2 000. Total domestic supply of crops and meat at *basic prices* is therefore equal to 82 000. By the same logic, the total domestic supply of wood and fish are valued at 3 000 (3 000 + 0) and at 5 000 (4 000 + 1 000) respectively.

Figure 3.1. Worked example of a basic Supply Table for a simple economy

The Supply Table represents the supply of products at basic prices and its transformation into purchasers' prices

							Valuation layers				
		Output by domestic industry			Total domestic supply at basic prices		Trade and transport margins		Taxes less subsidies		Total domestic supply at purchasers' prices
		Agriculture and hunting	Forestry and logging	Fishing and aquaculture	Total output at basic prices	Imports	Trade margins	Transport margins	Taxes on products	Subsidies on products	
Supply of products	Crops and meat	80 000	0	0	80 000	2 000	2 000	2 000	710	- 210	86 500
	Wood	0	3 000	0	3 000	0	0	990	20	- 10	4 000
	Fish	0	0	4 000	4 000	1 000	800	210	30	- 40	6 000
	Trade services	2 650	100	50	2 800	0	-2 800	0	0	0	0
	Transport services	1 800	500	900	3 200	0	0	-3 200	0	0	0
	Total	84 450	3 600	4 950	93 000	3 000	0	0	760	- 260	96 500

The parts beyond the grey production matrix of the example Supply Table provide detail that enables output values in *basic prices* to be transformed into *purchasers' prices*. As most goods and services in an economy are not sold directly by the producer but by wholesalers and retailers, the price paid by the purchaser of a product usually also includes the costs of transporting it to where it is sold and an additional mark-up for the trader – so called trade and transport margins. There are also taxes and subsidies levied

on goods and services, value added tax (VAT) being but one example. In order to value domestic supply at *purchaser's prices*, it is therefore necessary to consider the effect that taxes and subsidies on products and trade and transport margins have on the prices of goods and services paid for.

In the Supply and Use framework, the work of wholesalers and retailers and the transportation of goods and services to the user are considered services that are produced or imported much like other products that make up domestic supply. The value of this output is represented in the rows for trade and transport services in Figure 3.1. In reality, there are entire retail, wholesale, and transport industries that provide such services. However, for the purposes of the simplified example, assume that the three domestic industries take care of trade and transport services and that they charge purchasers for them separately but alongside the goods they produce. The trade and transport margins in the example are represented by the yellow area in Figure 3.1. (Assuming that purchasers pay for trade and transport services alongside their goods, trade and transport margins on traded and transported products must be deducted from the output value of trade and transport services. Hence the negative values in the yellow parts of the rows for trade and transport services in Figure 3.1.)

Taxes and subsidies are not produced like trade and transport services but are levied by authorities and bound up in the prices paid for products by purchasers. As a result, their inclusion is crucial to the valuation of output at *purchasers' prices*. The value of taxes and subsidies on products are included in the orange area in Figure 3.1. The example given now contains all of the pieces necessary to transform domestic supply at *basic prices* to domestic supply at *purchasers' prices*. The relevant trade and transport margins are reallocated from trade and transport services to the rows for fish products (800 + 210 = 1 010) and taxes less subsidies on fish products are accounted for (30 – 40 = -10). The total domestic supply of fish at *purchasers' prices* is therefore 6 000. By the same process, the value of the total domestic supply of crops and meat at *purchasers' prices* is 86 500 and for wood it is 4 000.

The different concepts of valuation outlined in the SUTs result from the surveys used to collect the source data. In general, producers answer structural surveys using prices that they receive for the product (basic prices), while consumers answer surveys with the price they paid for it (purchasers' prices). The computation of total domestic supply at *purchasers' prices* is therefore important because it enables domestic supply to be expressed in the same valuation concept used in the Use Table – where consumption, both intermediate and final, are recorded, in addition to gross capital formation (i.e. investments) and exports.

Like the Supply Table, the Use Table contains a number of component parts. An initial matrix outlines the value of products used as inputs in the production of other products. This is known as intermediate consumption and is depicted in the grey area in Figure 3.2. The value of final consumption of products is also recorded and is usually split between households, non-profit institutions serving households, and government columns (yellow area in Figure 3.2). The remaining sections of the Use Table account for the use of each product in gross capital formation and the value of the exports of each product. The total final use of each product is therefore the sum of the consumption of each product, both intermediate and final, gross capital formation and exports.

The elements of the Use Table are valued at *purchasers' prices*. They therefore include trade and transport margins and taxes less subsidies on products. In reality, there will be trade and transport services produced in addition to those supplied alongside goods and these products would be used in intermediate and final consumption, investment and exports. For the purposes of this simple example however, trade and transport margins are charged by industries alongside the goods produced. As explained above, in the Supply Table, the values of the output of trade and transport services are reallocated from the relevant row to the valuation column for trade and transport margins, thus resulting in a total of zero. Accordingly the total value of the use of trade and transport services in the Use Table are zero as well.

Figure 3.1 reveals total domestic supply of the products produced in the simple economy and Figure 3.2 reveals total use of the products. Crucially, both total supply and total use are valued in the same metric –

purchasers' prices – and the green areas in the Supply Table in Figure 3.1 and the Use Table in Figure 3.2 are equal. Total domestic supply at *purchasers' prices* and total use at *purchasers' prices* are therefore balanced. In this way, the SUTs provide the framework by which supply and demand are reconciled in the national accounts and the risk of accounting inconsistencies such as double-counting or missing data is reduced in the calculation of gross value added per activity and eventually GDP.

Given total supply and total use in the simple economy are balanced, gross value added (GVA) can be calculated with confidence. The GVA of an industry is defined as its gross domestic output (at basic prices) minus the value of the industry's intermediate consumption (at purchasers' prices). Gross domestic output of each industry at *basic prices* is equal to the sum of the domestic industry columns in the Supply Table in Figure 3.1 and is repeated in the row named *total output* in the Use Table in Figure 3.2. Intermediate consumption at *purchasers' prices* is equal to the sum of the domestic industry columns in the Use Table in Figure 3.2. GVA is therefore calculated as the difference between the two.

In the example given, gross domestic output of agriculture and hunting is equal to 84 450 (80 000 + 0 + 0 + 2 650 + 1 800) and intermediate consumption is equal to 20 120 (20 000 + 100 + 20 + 0 + 0). GVA from agriculture and forestry in the simple economy is therefore 64 330 (84 450 – 20 120). The same process reveals the GVA of forestry and logging, and fishing and aquaculture, to be 3 100 and 4 250 respectively. The GDP of this simple economy is 71 680, which is the sum total of the GVA of each industry operating within it. Agriculture and hunting is the largest industry, contributing 90% of GDP, while fishing and aquaculture contribute around 6% of GDP and forestry and logging contribute the remainder.

Figure 3.2. Worked example of a basic Use Table for a simple economy

The Use Table represents the use of the products at purchasers' prices

		Intermediate uses				Final uses					
		Intermediate consumption by domestic industry			Intermediate consumption at purchasers' prices	Final consumption		Gross capital formation		Exports	Total use at purchasers' prices
		Agriculture and hunting	Forestry and logging	Fishing and aquaculture		Final consumption by households	Final consumption by government	Gross fixed capital formation	Change in inventories		
Use of products	Crops and meat	20 000	200	400	20 600	43 600	7 500	0	- 200	15 000	86 500
	Wood	100	300	0	400	2 000	300	800	20	480	4 000
	Fish	20	0	300	320	4 100	780	0	0	800	6 000
	Trade services	0	0	0	0	0	0	0	0	0	0
	Transport services	0	0	0	0	0	0	0	0	0	0
	Total	20 120	500	700	21 320	49 700	8 580	800	- 180	16 280	96 500
	Total output	*84 450*	*3 600*	*4 950*	*93 000*						
	Gross value added	64 330	3 100	4 250	71 680						

In addition to producing reliable economic statistics such as GVA and GDP, SUTs such as those described here are used as the basis for the construction of input-output tables (IO). IO tables transform the activity by product structure of the SUTs into square activity by activity or product by product matrices. A number of transformation methods are adopted for doing so, each relying upon different simplifying assumptions concerning the way production occurs in different industries and the ways products are sold by different industries. IO models are commonly used to estimate the interdependencies between different activities

and products in an economy and to understand the potential direct and indirect impacts of various policies. The transformation of SUTs into input-output tables is however beyond the scope of this paper.

Box 3.1. OECD Supply and Use Table Database and the STAN Family of Databases

The OECD Statistics and Data Directorate collects Supply and Use Tables in an internationally agreed format. It provides information by industry (at the two digit ISIC Rev.4 level for 89 industries) with corresponding breakdowns by product using the comparable Statistical Central Product by Activity (CPA) classification. The database presents multiple components, all of which are prepared from statistics reported to the OECD by countries in their answers to a Supply and Use Table questionnaire. The following tables are available and internationally comparable for most OECD member countries and multiple partner economies:

- the Supply Table at basic prices and its transformation into purchaser's prices;
- valuations matrices for trade and transport margins and taxes less subsidies on products;
- the breakdown of output at basic prices between market output, output for own final use and non-market output;
- the Use Table at purchaser's prices and at basic prices;
- output, intermediate consumption, value added and its components (compensation of employees, gross operating surplus etc.), gross fixed capital formation and gross fixed assets;
- employment by activity; and
- a range of indicators calculated from the Supply and Use statistics.

The OECD Directorate for Science, Technology and Innovation produces publicly available data on the structure of its member countries' economies through the Structural Analysis (STAN) family of databases. STAN databases are unified by a common list of industries and include the OECD Structural Analysis datasets, the OECD Harmonised National Input-Output tables and the OECD Inter-Country Input-Output tables. These databases allow for the calculation of a range of statistics – such as productivity growth, structural change and trade in value added – and are used by analysts globally. At present, the ocean economy is not readily identifiable in these databases. The production of an experimental OECD ocean economy satellite account would begin the process of enabling it to be so.

Both the OECD Supply and Use Table Database and the OECD STAN Family of Databases are made publicly available on the OECD's data portal OECD.Stat (https://stats.oecd.org/).

Benefits of a satellite accounting approach to ocean economy measurement

The benefits of improved economic statistics such as balanced estimations of output and gross value added result from the use of the data for the betterment of decision making. The section above describes how SUTs, the core accounting mechanism used in satellite accounts, generate important technical benefits to measuring ocean economies as opposed to alternative options. Many of the benefits of the satellite accounting approach to ocean economy measurement are summarised in OECD (2019[2]) but three reasons to adopt satellite accounts more generally are worth reemphasising here.

Comparable data on ocean economic phenomena

Satellite accounts highlight certain fields or aspects of economic and social life in a framework that is linked to national accounting systems. At the core of the national accounts are tables detailing the transactions of all goods and services in an economy in a manner that balances supply with demand (as outline in the Use Table). Satellite accounts make visible parts of the economy that are at present included but not distinctively visible in the statistics normally produced. A key benefit of satellite accounts is therefore comparability with statistics summarising the broader economy published in the national accounts. As a result, the risk of double-counting or over-estimating the contribution of ocean economic activities is reduced. This is crucial for providing reliable and trusted analyses of the performance of the ocean economy in comparison with other sectors. The development of an experimental international satellite account by the OECD, complementing existing datasets, would enable ocean economy statistics to be comparable not just within countries but across them too.

Insight on interlinkages between activities within and beyond the ocean economy

In addition to measuring its contribution to the overall economy in a comparable manner, satellite accounting provides an approach to understanding how the ocean economy functions. Data compiled through a satellite accounting framework enable detailed analysis of the production of goods and services, including the inputs used to produce these products (intermediate consumption, compensation of employees, etc.), and the ways in which they are consumed. The depiction of the economy allows for various structural analyses to be conducted. The mix of domestically produced ocean economy products and imports in domestic supply, for example. Or how the products of ocean economic activities are used as intermediate inputs in other industries. Transformations of SUTs into input-output tables provides further insight into the structure of an economy and the interdependencies inherent in production.

Better understanding of the uses of ocean economy goods and services beyond intermediate consumption

The example given in the introduction to this section outlines the role of SUTs in providing reliable estimates of gross value added. While most country ocean economy studies focus on production, some also emphasise the role of public expenditure in generating ocean economic activity. Government can be a major source of activity due its role in providing environmental protection along coastlines, for example, or dredging waterways in order to ensure they're navigable. Public expenditure is also a major input to ocean research in research institutes and ocean education in universities. Ocean goods and services will also be invested in through the formation of capital. The Use Table in particular details expenditure on goods and services in the economy. Uses of products in intermediate consumption, final consumption by households and government, in gross capital formation, and as exports are detailed. A comprehensive satellite account would include detailed elaborations of each, classified according the appropriate internationally agreed classification system.

Reliable economic data stewardship

The surveys currently used by national statistical offices to construct national economic statistics do not enable accurate measurement of many ocean economic activities. For this reason and several others outlined in Section 2, measuring the ocean economy will inevitably require data sourced from outside of the national statistical system. In order to ensure source data meet the necessary quality standards, data authorities should be involved in the compilation of ocean economy statistics. National statistical offices have considerable experience and expertise in economic data stewardship and perform this role on behalf of governments. They pursue strict policies for accuracy and conduct assurance checks as a matter of course. Adopting a satellite accounting approach to ocean economy measurement makes use of the

expertise of national statistical offices, ensuring that source data are managed correctly and are of the appropriate quality. Furthermore, ocean, marine and maritime statisticians, who are knowledgeable about the intricacies of certain ocean activities and have access to the granular data required for reliable estimations of ocean economic activity, will be required to construct source datasets. The involvement of trusted data authorities and cooperation between national accountants and ocean data specialists should ensure accuracy in the values estimated and, ultimately, in the results of analysis using the statistics.

Blueprint for an experimental OECD ocean economy satellite account

The experimental OECD ocean economy satellite account should result from a research programme directed at the construction of ocean economy Supply and Use Tables (SUTs) across a number of OECD pilot countries. Compiling experimental ocean economy SUTs would enable a large number of internationally comparable aggregates to be calculated including the gross value added of ocean economic activities and their contribution to GDP. The statistics would in turn allow for experimental descriptions of the ocean economy that are comparable with data in the system of national accounts and related databases. The process by which the OECD will begin to develop SUTs for the ocean economy is outlined below.

The Supply and Use Tables Database, as collected by the OECD, will be used as the foundational data source to separate out ocean economic activities and their corresponding values. These SUTs have undergone the steps necessary to ensure international comparability. OECD countries use, for example, a number of different derived and related classification systems to organise the data in their SUTs (see Section 2 above for a brief summary of statistical classifications). For activities, European countries use NACE; Canada, United States, and Mexico use NAICS; Japan uses JSIC; Korea uses KSIC and, Australia and New Zealand use ANSZIC. Other OECD countries use ISIC Rev.4 or further related classifications.

Each of these statistical classification systems are concordant with each other at relatively high levels of aggregation. This means member countries are asked to provide SUT data corresponding to categories at a more aggregated level than would be compiled by national statistical offices for the production of their national accounts. Whereas the SUTs compiled in some countries have up to 250 activity categories and thousands of products, the internationally agreed SUTs collected by the OECD contain 89 ISIC Rev.4 activities and 89 concordant CPA 2008 products categories. The activities and products outlined in the internationally agreed SUTs are therefore far too aggregated for the ocean economy to be identified immediately.

The production of ocean economy SUTs will thus require experimentation with introducing further detail to the tables published in the OECD's SUT Database. As is the case in the country studies outlined in Section 2, the value associated with the ocean will have to be disaggregated if reliable estimations of the flows outlined in the SUTs are to be realised for the ocean economy. A detailed breakdown of the current categories into production and consumption that is and is not associated with ocean economic activities will be necessary.

Although not perfectly analogous, tourism statistics face a similar methodological issue – there is no way to differentiate economic value between tourist and non-tourist expenditure in the core national accounts. In response, the Tourism Satellite Account (TSA) guidelines provide a transparent procedure for splitting tourism demand from the rest (OECD, 2010[53]). A series of data tables and calculations based on them enable the measurement of internal (i.e. both domestic and inbound) tourism expenditure and eventually internal tourism consumption (a broader metric than expenditure that includes the value of non-monetary aspects such as accommodation belonging to a tourist as a holiday home). Using this construct, it is then possible to estimate the share of the output value of each tourism-related product found in the SUTs of the core national accounts. This estimate is labelled the "tourism share (in value)" in the TSA. Aggregated by product the tourism share in value is equal to the value of internal tourism consumption of each product.

The premise of this methodology will be adapted for the experimental OECD ocean economy satellite account. The initial values will be equal to that available in the SUTs in the OECD's database and will include non-ocean activity. It will then be necessary to breakdown the share that meets the definition of ocean economic activity in Box 2.1 in order to arrive at ocean economy estimates. Given this, ocean related value may be defined as the share of activities in the SUT framework that is attributable to the ocean according to the definition of ocean economic activity in Box 2.1. The programme through which the breakdowns to recognise ocean related value will be collected is described in the sections below.

International cooperation for improved international ocean economy statistics

None of the ocean economic activities outlined in Annex A are directly visible in the OECD's SUT Database. The steps taken to reveal ocean related value will involve estimating the contribution of the ocean to broader categories. There are broadly two approaches that could be adopted for designating the ocean based component of each activity: 1) surveys of a sample of productive units operating in the ocean economy, and 2) reverting to qualified expert opinion using existing data sources. Given the resources required to conduct additional surveys, qualified expert opinion will be pursued in the pilot stages of the OECD project.

In order to develop an experimental OECD ocean economy satellite account and break down the activities at country-level, the OECD will work with its partners and collaborate with country experts. Several OECD countries are considering or are in the process of measuring their ocean economies through satellite accounting frameworks and have already begun the process of understanding ocean related value. The breakdowns of activities required will be conducted in conjunction with this country-level work, supporting the efforts of national stakeholders in the process.

The OECD will therefore pursue a data collection programme among a core set of OECD countries with particular interest in measuring their ocean economies through satellite accounts, as a start. The exercise aims to benefit participating countries by providing both a platform for internationally comparable ocean economy statistics and a forum for sharing lessons learned as countries develop their ocean economy measurement strategies. In addition, this effort is being, and will continue to be further, coordinated with other international initiatives led by different bodies and also with OECD partner economies in order to benefit the global ocean statistics community (e.g. UNSC's revision process for the System of Environmental-Economic Accounting (SEEA); UN Economic and Social Commission for Asia and the Pacific (UNESCAP); the Norwegian led High Level Panel on the Sustainable Ocean Economy).

The project represents the first attempt by the OECD to collect internationally comparable data for selected countries on both the supply and the use side of the ocean economy. The ultimate objective is to experiment with the production of internationally comparable ocean economy SUTs and the publication of experimental international ocean economy statistics on OECD.Stat, an online platform where users can search and access the OECD's statistical databases.

Collecting ocean related value coefficients

The experimental OECD ocean economy satellite account data collection programme will involve the collection of ocean related value coefficients in a standardised framework for each participating country. Ocean related value coefficients provide the detail required to make the adjustments that need to be made to the SUTs outlined above in order to isolate the share of production and use attributable to ocean economic activity.

Ocean related value coefficients could be arrived at in multiple ways for each ocean economic activity and the level of detail possible will depend on the respective countries' specialisation in a given area. In the first instance, the methods adopted at country level to isolate ocean related value in the SUTs used in country ocean economy studies will be analysed in detail and similarities between approaches outlined. In

order to increase the data available for calculating ocean related value coefficients, national accountants will usually need to link with country ocean experts and vice versa. While national accountants have expertise in the supply and use framework and hold a detailed knowledge of why source data tend to differ from that compiled in SUTs, ocean experts are more likely to have access to the detailed data required to break down existing categories (van de Ven, 2019[60]).

Collaboration between ocean experts and national accountants is already happening in some countries and breakdowns and coefficients have already been estimated for selected ocean economic activities. The Portuguese Satellite Account for the Sea, for example, contains many products "partially related to the sea" (INE and DGPM, 2016[38]; INE, 2020[39]). Robust estimates of ocean related value were therefore arrived at through additional research work. The United States has conducted a similar exercise for estimating the "ocean portion" of aggregated data in its preparatory work for its Ocean Economy Satellite Account (NOAA, 2019[63]). The French National Institute of Statistics and Economic Studies (INSEE) has developed a method for separating ocean related value for all activities it considers part of the ocean economy that are not "100% maritime" (INSEE, 2019[64]).

These efforts are expected to provide the basis for the ocean related value coefficients collected. By way of example, consider the table in Figure 3.3 related to the maritime shipbuilding industry. Shipbuilding activities are defined by ISIC Rev.4 code 301 as building of ships and boats and are displayed in columns alongside the other activities classified under the same industry division. The level of detail in the OECD SUT Database is the more aggregated division 30 manufacture of other transport equipment, which includes all of the value associated with non-maritime shipbuilding manufacturing activities under the same category.

In addition to the codes classifying shipbuilding activities, there are 13 product categories defined in CPC Version 2.2 of immediate relevance to shipbuilding industry outputs. The product definitions include, for example, code 49312 for tankers (ships), 49316 for tugs and pusher craft, and 49410 for sailboats (except inflatable) with or without auxiliary motor. None of these categories distinguish between maritime shipbuilding and that designed for use on inland waters. A grouping of the goods and services that may be associated with shipbuilding is given in the rows of Figure 3.3 mirroring the production matrix of the Supply Table and the intermediate consumption matrix of the Use Table.

The ocean related value associated with shipbuilding will therefore have to be isolated from all other parts of the manufacture of other transport equipment using an ocean related value coefficient. In this case, the ocean related value coefficient could be estimated by first attributing a portion of the value of the building of ships and floating structures and the building of pleasure and sporting boats to the ocean economy. This will require access to detailed SUTs compiled by national statistical offices and in most cases more granular data on the output of the shipbuilding industry usually available through maritime agencies or industry consultancies. Dividing the total value of maritime shipbuilding by the total for manufacture of other transport equipment would provide a coefficient – the ocean related value coefficient for maritime shipbuilding – applicable in the experimental OECD ocean economy satellite account.

Given the level of aggregation in the SUTs available at the OECD, ocean related value coefficients will be required for all ocean economic activities. Data on fishing and aquaculture activities in the OECD's database, for example, are an aggregation of marine fishing, marine aquaculture, freshwater fishing, and freshwater aquaculture. The aggregated data will need to be split between fishing and aquaculture, and between marine and freshwater sources in order to isolate ocean related value. Similarly, data for the extraction of crude petroleum and natural gas includes both onshore and offshore extraction. Ocean related value coefficients would therefore enable the data to be split between onshore and offshore sources.

Figure 3.3. Illustration of ocean related value coefficients for maritime shipbuilding

Isolating the building of maritime ships and boats from the broader category manufacture of other transport equipment can be achieved through ocean related value coefficients

	30 Manufacture of other transport equipment										
	301 Building of ships and boats				302 Manufacture of railway locomotives and rolling stock	303 Manufacture of air and spacecraft and related machinery	304 Manufacture of military fighting vehicles	309 Manufacture of transport equipment n.e.c.			Of which building of maritime ships, floating structures, and boats
	3011 Building of ships and floating structures	*Of which maritime*	3012 Building of pleasure and sporting boats	*Of which maritime*	3020 Manufacture of railway locomotives and rolling stock	3030 Manufacture of air and spacecraft and related machinery	3040 Manufacture of military fighting vehicles	3091 Manufacture of motorcycles	3092 Manufacture of bicycles and invalid carriages	3099 Manufacture of other transport equipment n.e.c.	
Products of the manufacture of other transport equipment											
All other products											

Ensuring ocean related value coefficients are internationally comparable

The level of detail achieved in the SUTs will depend on each contributing country's situation and the data available to them. Given the challenge of isolating ocean economic activity outlined in Section 2, it is unlikely that countries will at present be able to breakdown the full range of ocean economic activities across the full range of data required for complete SUTs. However, experimenting with deriving ocean related value coefficients and using them to compile ocean economy SUTs is an important part of the research process.

A central motivation for the research phase of the experimental accounts is to provide insight that will guide the future of ocean economy satellite accounting, so that international comparability of the estimates produced can be achieved sooner rather than later. It will be an opportunity to harmonise definitions of ocean economic activity across countries with differing classification systems and approaches to building SUTs. A key element of this research will be deciding how best to assign particular ocean related value among different ocean economic activities according to the goods and services that are produced. In some parts of the ocean economy the reference classification systems simplify this attribution process.

For example, the ISIC Rev.4 category for water transport is division 50. The hierarchical structure of the classification provides more detail by splitting water transport into two groups; 501 sea and coastal water transport and 502 inland water transport. These categories are in turn split by the class 5011 sea and coastal passenger water transport, 5012 sea and coastal freight water transport, 5021 inland passenger water transport and 5022 inland freight water transport. These ISIC activities are depicted horizontally in Figure 3.4.

Data aggregated under the most detailed ISIC Rev.4 water transport categories are easily split between ocean and non-ocean economic activity. Any value counted under sea and coastal water transport is by definition part of the ocean economy and the value of inland water transport is by definition not part of the ocean economy. However, the activity classifications mask that sea and coastal water transport involves the provision of a range of services. Some of the goods and services relevant to water transport and classified in CPC Version 2.2 are given vertically in Figure 3.4. While most services related to sea and coastal passenger water transport could be accounted for under the category described as maritime passenger transport in the OECD's list of ocean economy activities, some of these services are more appropriately attributed to different parts of the ocean economy. In this case, the value associated with sightseeing services and cruises would be better accounted for under marine and coastal tourism.

This example highlights an important nuance to the derivation of ocean related value coefficients. Different countries will be able to provide data for the experimental OECD ocean economy satellite accounts at different levels of detail. Countries that are unable to split sea and coastal water transport among its constituent services, for example, would not be able to attribute the parts of the value of sea and coastal water transport that would be better assigned to marine and coastal tourism. In terms of Figure 3.4, the orange sections would be counted under maritime passenger transport and would not be counted under marine and coastal tourism as defined in the list of ocean economic activities in Annex A. In comparison to a country with access to the level of detail required to split the services associated with sea and coastal water transport, the result would be an overestimation of the value of maritime passenger transport and an underestimation of the value of marine and coastal tourism.

Laying the foundations for much improved understanding of ocean economies

Part 3 of this paper outlines why international ocean economy statistics would be improved through experimentation with ocean economy satellite accounts and introduces a long-haul project to produce internationally comparable data across a range of ocean economic activities. The research programme required to fulfil this objective will provide information that should benefit countries interested in more robust ocean economy measurements and analysts that require accurate and reliable economic data.

There are, however, many pressing questions to be answered. Initially, clarifying the data available for an international satellite account will enable gaps to be highlighted so that the limits of what is presently possible can be ascertained. Important questions in this regard concern the development of clearer definitions of ocean goods and services and descriptions of their uses in ocean economic activities at country level, the relevant geospatial boundaries for ocean economic activity at country level, and development of the appropriate metadata standards and other data governance issues internationally.

It will also be necessary to explore the limits of the satellite accounting approach for ocean economy statistics. At present, a major focus of ocean policymakers is the potential for new, enabling technologies, developed in part by small and medium sized enterprises, in generating more sustainable ocean economic activity. The rapid pace of innovation in fields such as autonomous underwater vehicles and digital twins are unlikely to be captured by satellite account style statistics, which rely upon estimates from annual surveys and are benchmarked only every five years or so on more detailed data. Estimates of newer ocean economy contributors will be poorer as a result, at least until such activities become more established. Furthermore, the ocean economy satellite account envisaged in this paper will, once realised, provide internationally comparable data on an annual basis with a likely lag of two or more years. This marks a major step forward in ocean economy statistics and is aligned with the general time frame for internationally comparable statistics in all other areas. But internationally comparable satellite accounts cannot provide data on ocean economic phenomena in the here and now. In order to provide real time estimates of economic activity, economists use data on financial markets and other high-frequency measures in a range of methods known as "nowcasting". Such techniques are, however, reliant on the solid statistical foundation

provided by the accurate and reliable estimates of activity such as those that would be made available by an ocean economy satellite account.

Finally, an ocean economy satellite account is only half complete if it does not also include comparable accounts that detail marine environment-economy linkages and ecosystem services. Eventually, the ability to account for marine natural assets and many important marine ecosystem services – at present a largely theoretical concept although more studies are being realised – will become a practical reality, at least in physical terms. Laying the foundations for understanding economy-environment linkages is not the only way to make assessments of the true sustainability of the ocean economy, but, if implemented, satellite accounts that include both ocean economic activity and marine environmental aspects would provide a robust tool for measuring the impacts of ocean economic activities.

The initial experimental OECD ocean economy satellite accounts should therefore be seen as a step towards encouraging the development of more complete accounts, including marine environmental-economic linkages and accounts for marine ecosystem services. This work complements well the results of the United Nations Statistical Commission's review of the System of Environmental-Economic Accounting (SEEA) Experimental Ecosystem Accounting guidelines. During the 52nd session of the United Nations Statistical Commission in February 2021, the delegates established a working group to draft a methodological document for ocean accounting, SEEA Ocean, in support of the SEEA Central Framework and SEEA Ecosystem Accounting (UNESCAP and GOAP, 2021[65]).

In this regard, a relevant set of established international guidelines is the SEEA for Water (UN, 2012[66]). SEEA-Water describes the compilation of statistics that provide comparable information on both the physical and economic elements of the water system. The SEEA-Water tables enable an understanding of how water – natural and sewerage – contributes to the economy and the impact of economic activity on water resources (see Figure 3.4). The SEEA-Water guidance of most interest to ocean economy satellite accounts is the description of economic accounts for activities and products related to water. The water system can be depicted more simply than the large number of activities and products and broad range of natural resources and ecosystem services of the ocean economy. Nonetheless, SEEA-Water provides an aspirational example for measuring the relationship between ocean economic activity and the marine environment.

Building up the experimental OECD satellite accounts on ocean economic activities, with a pragmatic step by step approach, will contribute to this ambition of future comprehensive ocean accounts, including marine environment-economy linkages and ecosystem services.

Figure 3.4. Water transport classifications and the ocean economy

Attributing the output of all services classified under sea and coastal passenger water transport would include some aspects of marine and coastal tourism and overestimate its contribution to the ocean economy

				50 Water transport			
				501 Sea and coastal water transport		502 Inland water transport	
				Sea and coastal passenger water transport	Sea and coastal freight water transport	Inland passenger water transport	Inland freight water transport
64 Passenger transport services	641 Local transport and sightseeing transportation services of passengers	6411 Urban and suburban land transport services of passengers					
		6412 Local water transport services of passengers	64121 Inland water transport services of passengers by ferries				
			64122 Inland water transport services of passengers on cruises				
			64129 Other inland water transport services of passengers				
		6413 Sightseeing transportation services	64131 Sightseeing services by rail				
			64132 Sightseeing services by land, except rail				
			64133 Sightseeing services by water				
			64134 Sightseeing services by air				
	642 Long-distance transport services of passengers	6421 Interurban railway transport services of passengers					
		6422 Interurban road transport services of passengers					
		6423 Long-distance water transport services of passengers	64231 Coastal and transoceanic water transport services				
			64232 Coastal and transoceanic water transport services of passengers on cruise ships				
			64239 Other coastal and transoceanic water transport services of passengers				
		6424 Air transport services of passengers					
		6425 Space transport services of passengers					
65 Freight transport services	651 Land transport services of freight	6511 Road transport services of freight					
		6512 Railway transport services of freight					
		6512 Railway transport services of freight					
	652 Water transport services of freight	6521 Coastal and transoceanic water transport services of freight	65211 Coastal and transoceanic water transport services				
			65212 Coastal and transoceanic water transport services of freight by tankers				
			65213 Coastal and transoceanic water transport services of intermodal containers by container				
			65219 Other coastal and transoceanic water transport services of other freight				
		6522 Inland water transport services of freight	65221 Inland water transport services of freight by refrigerator vessels				
			65222 Inland water transport services of freight by tankers				
			65229 Other inland water transport services of freight				

Note: The diagram displays the ISIC Rev.4 hierarchy for water transport horizontally and the most relevant parts of the CPC 2.2 for passenger and freight transport services vertically. Parts of the diagram shaded green indicate value that should be attributed to maritime transport in the OECD's list of ocean economic activities. Orange sections represent value that should be attributed to marine and coastal tourism. Red indicates value attributable to inland water transport that would not be counted under the OECD's definition of ocean economic activity.

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Annex A. List of ocean economic activities and related goods and services

To facilitate international comparability, it is important to ensure that the ocean economy is classified according to existing standards. Table A.1 contains a list of ocean related economic activities and corresponding goods and services from the international reference classifications International Standard Industrial Classification (ISIC) Rev.4 for activities and Central Product Classification (CPC) Version 2.1 for products.

Table A.1. List of ocean economic activities and products for internationally comparable statistics

	Ocean specific description	ISIC 4	ISIC 4 description	CPC 2.1	CPC 2.1 description
1	Marine fishing				
		0311	Marine fishing		
				04111	Wild ornamental fish
				04191	Other wild live fish, not for human consumption, including seeds and feeds for aquaculture
				04221	Wild salmonidae, live, fresh or chilled
				04231	Wild flatfish, live, fresh or chilled
				04241	Wild fish of Gadiformes, live, fresh or chilled
				04251	Wild tunas, skipjack or stripe-bellied bonito, live, fresh or chilled
				04261	Other wild pelagic fish, live, fresh or chilled
				04291	Other wild fish, live, fresh or chilled
				04311	Wild crabs, live, fresh or chilled
				04321	Wild rock lobster and other sea crawfish, live, fresh or chilled
				04331	Wild lobsters (Homarus spp.), live, fresh or chilled
				04341	Wild Norway lobsters, live, fresh or chilled
				04351	Wild cold-water shrimps and prawns (Pandalus spp., Crangon crangon), live, fresh or chilled
				04361	Other wild shrimps and prawns, live, fresh or chilled
				04391	Other wild crustaceans, live, fresh or chilled
				04411	Wild abalone, live, fresh or chilled
				04421	Wild oysters, live, fresh or chilled
				04431	Wild mussels, live, fresh or chilled
				04441	Wild scallops, live, fresh or chilled
				04451	Wild clams, cockles and ark shells, live, fresh or chilled

				04471	Wild octopus, live, fresh or chilled
				04491	Other wild molluscs, live, fresh or chilled
				04511	Wild sea cucumbers, live, fresh or chilled
				04521	Wild sea urchins, live, fresh or chilled
				04530	Jellyfish, live, fresh or chilled
				04590	Other aquatic invertebrates, live, fresh or chilled, n.e.c.
				04911	Coral and similar products, shells of molluscs, crustaceans or echinoderms and cuttle-bone
				04912	Wild live aquatic plants and animals for ornamental purpose
				04920	Natural sponges of aquatic animal origin
				04931	Wild seaweeds and other algae, fresh, frozen or dried, whether or not ground, fit for human consumption
				04933	Wild seaweeds and other algae, fresh, frozen or dried, whether or not ground, unfit for human consumption
				38210	Pearls, natural or cultured and unworked
				86151	Fishing services on resources owned by others
				86153	Support services to fishing
2	Marine aquaculture				
		0321	Marine aquaculture		
				04112	Farmed ornamental fish
				04192	Other farmed live fish, not for human consumption, including seeds and feeds for aquaculture
				04222	Farmed salmonidae, live, fresh or chilled
				04232	Farmed flatfish, live, fresh or chilled
				04242	Farmed fish of Gadiformes, live, fresh or chilled
				04252	Farmed tunas, skipjack or stripe-bellied bonito, live, fresh or chilled
				04262	Other farmed pelagic fish, live, fresh or chilled
				04292	Other farmed fish, live, fresh or chilled
				04312	Farmed crabs, live, fresh or chilled
				04322	Farmed rock lobster and other sea crawfish, live, fresh or chilled
				04332	Farmed lobsters (Homarus spp.), live, fresh or chilled
				04342	Farmed Norway lobsters, live, fresh or chilled
				04352	Farmed cold-water shrimps and prawns (Pandalus spp., Crangon crangon), live, fresh or chilled
				04362	Other farmed shrimps and prawns, live, fresh or chilled
				04392	Other farmed crustaceans, live, fresh or chilled
				04412	Farmed abalone, live, fresh or chilled
				04422	Farmed oysters, live, fresh or chilled
				04432	Farmed mussels, live, fresh or chilled
				04442	Farmed scallops, live, fresh or chilled
				04461	Wild cuttle fish and squid, live, fresh or chilled
				04472	Farmed octopus, live, fresh or chilled
				04492	Other farmed molluscs, live, fresh or chilled
				04512	Farmed sea cucumbers, live, fresh or chilled
				04522	Farmed sea urchins, live, fresh or chilled
				04590	Other aquatic invertebrates, live, fresh or chilled, n.e.c.
				04911	Coral and similar products, shells of molluscs, crustaceans or echinoderms and cuttle-bone
				04913	Farmed live aquatic plants and animals for ornamental purpose
				04932	Farmed seaweeds and other algae, fresh, frozen or dried, whether or not ground, fit for human consumption
				04934	Farmed seaweeds and other algae, fresh, frozen or dried, whether or not ground, unfit for human consumption
				38210	Pearls, natural or cultured and unworked
				86152	Aquaculture services on inputs owned by others

				86154	Support services to aquaculture
3	Maritime passenger transport				
		5011	Sea and coastal passenger water transport		
				64231	Coastal and transoceanic water transport services of passengers by ferries
				64239	Other coastal and transoceanic water transport services of passengers
4	Maritime freight transport				
		5012	Sea and coastal freight water transport		
				65211	Coastal and transoceanic water transport services of freight by refrigerator vessels
				65212	Coastal and transoceanic water transport services of freight by tankers
				65213	Coastal and transoceanic water transport services of intermodal containers by container ships
				65219	Other coastal and transoceanic water transport services of other freight
				66022	Rental services of freight vessels for coastal and transoceanic water transport with operator
5	Offshore extraction of crude petroleum & natural gas				
		0610	Extraction of crude petroleum		
				12010	Petroleum oils and oils obtained from bituminous minerals, crude
				12030	Bituminous or oil shale and tar sands
				86221	Oil and gas extraction services on resources owned by others
		0620	Extraction of natural gas		
				12020	Natural gas, liquefied or in the gaseous state
6	Marine and seabed mining				
		0729	Mining of other non-ferrous metal ores		
				14210	Copper, ores and concentrates
				14220	Nickel ores and concentrates
				14230	Aluminium ores and concentrates
				14240	Precious metal ores and concentrates
				14290	Other non-ferrous metal ores and concentrates (other than uranium or thorium ores and concentrates)
				86229	Other mining services on resources owned by others
		0810	Quarrying of stone, sand and clay		
				15310	Natural sands
				15320	Pebbles, gravel, broken or crushed stone, macadam; granules, chippings and powder of stone
				15400	Clays
				16330	Chalk and dolomite
		0891	Mining of chemical and fertilizer minerals		
				16110	Natural calcium phosphates, natural aluminium calcium phosphates and phosphatic chalk
				16190	Other chemical minerals
				34639	Carnallite, sylvite and other potassic fertilizers, n.e.c.

				34654	Excreta of animals useful for manure/fertilizer and fuel preparation
		0893	Extraction of salt		
				16200	Salt and pure sodium chloride; sea water
7	Offshore industry support activities				
		0910	Support activities for petroleum and natural gas extraction		
				86211	Support services to oil and gas extraction
		0990	Support activities for other mining and quarrying		
				86219	Support services to other mining
		4290	Construction of other civil engineering projects		
				53261	Mining constructions
				54261	General construction services of mines
8	Processing and preserving of marine fish, crustaceans and molluscs				
		1020	Processing and preserving of fish, crustaceans and molluscs		
				21211	Freshwater fish, frozen
				21212	Salmonidae, frozen
				21213	Flatfish, frozen
				21214	Fish of Gadiformes, frozen
				21215	Tunas, skipjack or stripe-bellied bonito, frozen
				21216	Other pelagic fish, frozen
				21219	Other fish, frozen
				21221	Fish fillets and fish meat (whether or not minced), fresh or chilled
				21222	Fish fillets, frozen
				21223	Fish meat, whether or not minced, frozen
				21224	Fish fillets, dried, salted or in brine, but not smoked
				21225	Fish livers and roes, fresh or chilled
				21226	Fish livers and roes, frozen
				21227	Fish livers and roes dried, smoked, salted or in brine
				21231	Fish, dried, but not smoked; salted, but not dried or smoked; or in brine
				21232	Fish including fillets, smoked
				21233	Edible fish meal
				21234	Edible fish offal ; fish fins, heads, tails, maws and other edible fish offal
				21242	Fish, otherwise prepared or preserved
				21243	Caviar and caviar substitutes
				21251	Crabs, frozen, dried, salted or in brine
				21252	Rock lobster and other sea crawfish, frozen, dried, salted or in brine
				21253	Lobsters, frozen, dried, salted or in brine
				21254	Norway lobsters, frozen, dried, salted or in brine
				21255	Cold-water shrimps and prawns, frozen, dried, salted or in brine
				21256	Other shrimps and prawns, frozen, dried, salted or in brine
				21259	Other crustaceans, frozen, dried, salted or in brine
				21261	Abalone, frozen, smoked, dried, salted or in brine

				21262	Oysters, frozen, smoked, dried, salted or in brine
				21263	Mussels, frozen, smoked, dried, salted or in brine
				21264	Scallops, frozen, smoked, dried, salted or in brine
				21265	Clams, cockles and ark shells, frozen, smoked, dried, salted or in brine
				21266	Cuttle fish and squid, frozen, smoked, dried, salted or in brine
				21267	Octopus, frozen, smoked, dried, salted or in brine
				21268	Other molluscs, frozen, smoked, dried, salted or in brine
				21269	Other aquatic invertebrates, frozen, smoked, dried, salted or in brine
				21270	Crustaceans, otherwise prepared or preserved
				21280	Molluscs and other aquatic invertebrates, otherwise prepared or preserved
				21291	Flours, meals and pellets, inedible, of fish, crustaceans, molluscs or other aquatic invertebrates
				21299	Products n.e.c. of fish, crustaceans, molluscs or other aquatic invertebrates; dead fish, crustaceans, molluscs or other aquatic invertebrates unfit for human consumption
				88120	Fish processing services
9	Maritime ship, boat and floating structure building				
		3011	Building of ships and floating structures		
				49311	Cruise ships, excursion boats and similar vessels, principally designed for the transport of persons; ferry boats of all kinds
				49312	Tankers (ships)
				49313	Refrigerator vessels (ships), except tankers
				49314	Other vessels for the transport of goods and other vessels for the transport of both persons and goods
				49315	Fishing vessels; factory ships and other vessels for processing or preserving fishery products
				49316	Tugs and pusher craft
				49319	Other vessels (including light-vessels, fire-floats, dredgers, floating cranes, floating docks, warships and lifeboats other than rowing boats), except floating or submersible drilling or production platforms
				49320	Floating or submersible drilling or production platforms
				49390	Other floating structures
				88821	Ship building services
		3012	Building of pleasure and sporting boats		
				49410	Sailboats (except inflatable), with or without auxiliary motor
				49490	Other vessels for pleasure or sports; rowing boats and canoes
				88822	Pleasure and sporting boat manufacturing services
10	Maritime manufacturing, repair & installation				
		2022	Manufacture of paints, varnishes and similar coatings, printing ink and mastics		
				35110	Paints and varnishes and related products
				88425	Paint manufacturing services
		2651	Manufacture of measuring, testing, navigating and control equipment		

				48211	Direction finding compasses; other navigational instruments and appliances
				48212	Rangefinders, theodolites and tachymeters (tacheometers) and levels
				48219	Other surveying, hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances
				48220	Radar apparatus, radio navigational aid apparatus and radio remote control apparatus
				48242	Cathode-ray oscilloscopes and cathode-ray oscillographs
				48243	Instruments and apparatus (except cathode-ray oscilloscopes and oscillographs) for measuring or checking voltage, current, resistance or power, without a recording device (except electricity production or supply meters)
				48244	Instruments and apparatus (except cathode-ray oscilloscopes and oscillographs) for telecommunications
				48249	Instruments and apparatus for measuring or checking electrical quantities n.e.c.
				48251	Hydrometers and similar floating instruments, thermometers, pyrometers, barometers, hygrometers and psychrometers
				48252	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases, except navigational, hydrological or meteorological instruments and appliances, gas or liquid supply meters and automatic regulating or controlling instruments and apparatus
				48253	Instruments and apparatus for physical or chemical analysis, for measuring or checking viscosity, porosity, expansion, surface tension or the like, or for measuring or checking quantities of heat, sound or light
				48263	Gas, liquid or electricity supply or production meters
				48264	Revolution counters, production counters, taimeters, mileometers, pedometers and the like; speed indicators and tachometers, except hydrographic and meteorological instruments; stroboscopes
				48266	Automatic regulating or controlling instruments and apparatus, hydraulic or pneumatic
				48269	Measuring, checking, regulating or controlling instruments, appliances and machines n.e.c.
				88745	Measuring, testing, navigating and control equipment manufacturing services
		2731	Manufacture of fibre optic cables		
				46360	Optical fibre cables made up of individually sheathed fibres
				48311	Optical fibres and optical fibre bundles; optical fibre cables (except those made up of individually sheathed fibres); sheets and plates of polarizing material; lenses, prisms, mirrors and other optical elements (except of glass not optically worked), whether or not mounted, other than for cameras, projectors or photographic enlargers or reducers
				88753	Fibre optic cable manufacturing services
		3311	Repair of fabricated metal products		
				87110	Maintenance and repair services of fabricated metal products, except machinery and equipment
		3312	Repair of machinery		
				87120	Maintenance and repair services of office and accounting machinery
				87156	Maintenance and repair services of commercial and industrial machinery
		3313	Repair of electronic and optical equipment		
				87154	Maintenance and repair services of medical, precision and optical

					instruments
				87290	Maintenance and repair services of other goods n.e.c.
		3314	Repair of electrical equipment		
				87152	Maintenance and repair services of electrical machinery and apparatus n.e.c.
		3315	Repair of transport equipment, except motor vehicles		
				87149	Maintenance and repair services of other transport equipment
		3319	Repair of other equipment		
				87159	Maintenance and repair services of other equipment
		3320	Installation of industrial machinery and equipment		
				54619	Other electrical installation services
				87310	Installation services of fabricated metal products, except machinery and equipment
				87320	Installation services of industrial, manufacturing and service industry machinery and equipment
				87331	Installation services of mainframe computers
				87340	Installation services of radio, television and communications equipment and apparatus
				87360	Installation services of electrical machinery and apparatus n.e.c.
				87390	Installation services of other goods n.e.c.
		3510	Electric power generation, transmission and distribution		
				17100	Electrical energy
				69111	Transmission of electricity (on own account)
				69112	Distribution of electricity (on own account)
				86311	Electricity transmission services (on a fee or contract basis)
				86312	Electricity distribution services (on a fee or contract basis)
12	Maritime ports & support activities for maritime transport				
		4290	Construction of other civil engineering projects		
				53232	Harbours, waterways and related facilities
				53233	Dams
				53269	Other constructions for manufacturing
				53270	Outdoor sport and recreation facilities
				53290	Other civil engineering works
				54232	General construction services of harbours and similar waterworks
				54233	General construction services of dams
				54269	General construction services of other industrial plants
				54270	General construction services of outdoor sport and recreation facilities
				54290	General construction services of other civil engineering works
		5210	Warehousing and storage		
				67210	Refrigerated storage services
				67220	Bulk liquid or gas storage services
				67290	Other storage and warehousing services
		5222	Service activities incidental to water		

			transportation		
				67511	Port and waterway operation services (excl. cargo handling), on coastal and transoceanic waters
				67521	Pilotage and berthing services on coastal and transoceanic waters
				67531	Vessel salvage and refloating services on coastal and transoceanic waters
				67590	Other supporting services for water transport
		5224	Cargo handling		
				67110	Container handling services
				67190	Other cargo and baggage handling services
		5229	Other transportation support activities		
				67910	Freight transport agency services and other freight transport services
				67990	Other supporting transport services n.e.c.
13	Ocean scientific research & development				
		7210	Research and experimental development on natural sciences and engineering		
				81111	Basic research services in physical sciences
				81112	Basic research services in chemistry and biology
				81113	Basic research services in biotechnology
				81114	Basic research services in engineering and technology
				81115	Basic research services in medical sciences and pharmacy
				81116	Basic research services in agricultural sciences
				81119	Basic research services in other natural sciences
				81121	Applied research services in physical sciences
				81122	Applied research services in chemistry and biology
				81123	Applied research services in biotechnology
				81124	Applied research services in engineering and technology
				81125	Applied research services in medical sciences and pharmacy
				81126	Applied research services in agricultural sciences
				81129	Applied research services in other natural sciences
				81131	Experimental development services in physical sciences
				81132	Experimental development services in chemistry and biology
				81133	Experimental development services in biotechnology
				81134	Experimental development services in engineering and technology
				81135	Experimental development services in medical sciences and pharmacy
				81136	Experimental development services in agricultural sciences
				81139	Experimental development services in other natural sciences
				81301	Interdisciplinary basic research services
				81302	Interdisciplinary applied research services
				81303	Interdisciplinary experimental development services
				81400	Research and development originals
		7220	Research and experimental development on social sciences and humanities		
				81211	Basic research services in psychology
				81212	Basic research services in economics
				81213	Basic research services in law

				81219	Basic research services in other social sciences and humanities
				81221	Applied research services in psychology
				81222	Applied research services in economics
				81223	Applied research services in law
				81229	Applied research services on other social sciences and humanities
				81231	Experimental development services in psychology
				81232	Experimental development services in economics
				81233	Experimental development services in law
				81239	Experimental development services in other social sciences and humanities
				81301	Interdisciplinary basic research services
				81302	Interdisciplinary applied research services
				81303	Interdisciplinary experimental development services
				81400	Research and development originals
14	Marine & coastal tourism				
		5011	Sea and coastal passenger water transport		
				64133	Sightseeing services by water
				64232	Coastal and transoceanic water transport services of passengers on cruise ships
				66021	Rental services of passenger vessels for coastal and transoceanic water transport with operator
		5510	Short term accommodation activities		
				63111	Room or unit accommodation services for visitors, with daily housekeeping services
				63112	Room or unit accommodation services for visitors, without daily housekeeping services
				63113	Room or unit accommodation services for visitors, in time-share properties
		5510	Short term accommodation activities		
				63114	Accommodation services for visitors, in rooms for multiple occupancy
		5520	Camping grounds, recreational vehicle parks and trailer parks		
				63120	Camp site services
				63130	Recreational and vacation camp services
		5590	Other accommodation		
				63210	Room or unit accommodation services for students in student residences
				63220	Room or unit accommodation services for workers in workers hostels or camps
				63290	Other room or unit accommodation services n.e.c.
		5610	Restaurants and mobile food service activities		
				63310	Meal serving services with full restaurant services
				63320	Meal serving services with limited services
				63399	Other food serving services
		5629	Other food service activities		
				63392	Contract food services for transportation operators

				63393	Other contract food services
		5630	Beverage serving activities		
				63400	Beverage serving services
		6810	Real estate activities with own or leased property		
				72111	Rental or leasing services involving own or leased residential property
				72112	Rental or leasing services involving own or leased non-residential property
				72121	Trade services of residential buildings
				72122	Trade services of non-residential buildings
				72123	Trade services of time-share properties
				72130	Trade services of vacant and subdivided land
		6820	Real estate activities on a fee or contract basis		
				72211	Residential property management services on a fee or contract basis except of time-share ownership properties
				72212	Non-residential property management services on a fee or contract basis
				72213	Time-share property management services on a fee or contract basis
				72221	Residential building sales on a fee or contract basis, except of time-share ownership properties
				72222	Non-residential building sales on a fee or contract basis
				72223	Sale of time-share properties on a fee or contract basis
				72230	Land sales on a fee or contract basis
				72240	Real estate appraisal services on a fee or contract basis
		7710	Renting and leasing of motor vehicles		
				73111	Leasing or rental services concerning cars and light vans without operator
				73112	Leasing or rental services concerning goods transport motor vehicles without operator
				73114	Leasing or rental services concerning other land transport equipment without operator
		7721	Renting and leasing of recreational and sports goods		
				73240	Leasing or rental services concerning pleasure and leisure equipment
		7911	Travel agency activities		
				85511	Reservation services for air transportation
				85521	Reservation services for accommodation
				85523	Reservation services for cruises
				85524	Reservation services for package tours
		7912	Tour operator activities		
				85540	Tour operator services
		7990	Other reservation service and related activities		
				85512	Reservation services for rail transportation
				85513	Reservation services for bus transportation
				85514	Reservation services for vehicle rental
				85519	Other transportation arrangement and reservation services n.e.c.
				85521	Reservation services for accommodation

				85522	Time-share echange services
				85531	Reservation services for convention centres, congress centres and ehibition halls
				85539	Reservation services for event tickets, entertainment and recreational services and other reservation services
				85550	Tourist guide services
				85561	Tourism promotion services
				85562	Visitor information services
		9000	Creative, arts and entertainment activities		
				38961	Paintings, drawings and pastels; original engravings, prints and lithographs; original sculptures and statuary, in any material
				73320	Licensing services for the right to use entertainment, literary or artistic originals
				96210	Performing arts event promotion and organization services
				96220	Performing arts event production and presentation services
				96230	Performing arts facility operation services
				96290	Other performing arts and live entertainment services
				96310	Services of performing artists
				96320	Services of authors, composers, sculptors and other artists, except performing artists
				96330	Original works of authors, composers and other artists except performing artists, painters and sculptors
		9102	Museums activities and operation of historical sites and buildings		
				38963	Collections and collectors' pieces of zoological, botanical, mineralogical, anatomical, historical, ethnographic or numismatic interest; antiques
				96411	Museum services except for historical sites and buildings
				96412	Preservation services of historical sites and buildings
		9103	Botanical and zoological gardens and nature reserves activities		
				96421	Botanical and zoological garden services
				96422	Nature reserve services including wildlife preservation services
		9200	Gambling and betting activities		
				96921	On-line gambling services
				96929	Other gambling and betting services
		9311	Operation of sports facilities		
				96520	Sports and recreational sports facility operation services
		9319	Other sports activities		
				86132	Support services to hunting
				96511	Sports and recreational sports event promotion services
				96590	Other sports and recreational sports services
				96610	Services of athletes
				96620	Support services related to sports and recreation
		9321	Activities of amusement parks and theme parks		
				96910	Amusement park and similar attraction services
		9329	Other amusement and recreation activities n.e.c.		
				96930	Coin-operated amusement machine services
				96990	Other recreation and amusement services n.e.c.

Annex B. Methodology used to approximate the global contribution of ocean economic activity

In the absence of data that isolates ocean economic activities in country-level national economic accounts, the OECD has developed a simple methodology for approximating the contribution of ocean economic activities using existing, internationally comparable datasets. Data from the OECD's repositories are prioritised over all other data sources and are accessed through the OECD's public data repository OECD.Stat. A mixture of the OECD Structural Analysis (STAN) Database and the OECD National Accounts Database are relied upon. Both databases are structured according to a classification system that corresponds to ISIC Rev. 4. The steps taken to build a global dataset are summarised below. Figure B.1 provides a simple schematic representation of the methodology.

Initially, source data are downloaded from the OECD repository. Missing values in the country-level annual time series for value added and employment are imputed by interpolation, as long as data are available in all relevant variables in the same year for at least six years between 2005 and 2015. Value added data are then expressed in constant 2010 USD by first converting the national currency in current prices into constant 2010 values using value-added deflators or relevant price indices where no deflator is available. In order to preserve growth rates in the constant national currency value-added series, an index is created by dividing the national currency constant value in each year by the national currency value in 2010. This index is then multiplied by the 2010 current USD value, which is converted from the national currency using the national currency to USD average annual period exchange rate for 2010. Employment data are left as number of persons engaged.

Figure B.1. Steps taken to build global dataset

Note: The five steps outlined in the figure are applied to each ocean related industry. There are however many differences in the manipulations carried out within each step arising due to nuances in source data availability and structure specific to each industry. Therefore, the broad methodology is rigid in its application while the details of each step differ by industry.

In order to increase country coverage beyond that available in OECD datasets, data are also extracted from alternative databases compiled by international organisations other than the OECD. Using the same routines as the OECD data, missing values are imputed and the value added series are converted to constant 2010 USD. The augmented OECD and broader sources datasets are then joined together. The

joint dataset contains value added and employment data in consistent, comparable values for as many countries as possible given the data manipulations described above.

In order to expand the datasets to include all countries where production in each activity is non-zero, a simple approximation methodology is adopted based on the following assumption. The ratios of industry-level value-added and industry-level employment to national GDP and national-level employment in non-reporting countries are approximately equivalent to the ratios in reporting countries at a similar level of economic development. In practise, data for non-reporting countries are approximated by first calculating the ratio of activity-level value added to GDP and employment to total employment for each country present in the joint dataset. The mean shares of industry-level to national level aggregates for each income group are then calculated. Income groups are categorised by the World Bank's Lending Groups classification. The mean share for each income group is then applied to each non-reporting country within each income group by weighting the average income group share by each country's national GDP to total income group GDP in each year.

The final step in the process requires splitting the isolating ocean economy activity from the broader categories. A number of methods have been considered in order to complete this split and a range of data sources consulted. Ideally some common metric of production would be used. However, production data that measure each sub-activity in common terms are not readily available. Where this is the case, suitable proxies have been deployed.

There are important limitations to this methodological approach and the key assumptions applied throughout its execution. The approximations for non-reporting countries require that each country in each income group is homogenous with regards to its relationship between activity-level metrics and their national totals.A further important limitation is that high income countries are far better represented in the joint datasets than low income countries. As a share of the total number of countries in each income group, there are far fewer lower-middle income and low income countries for which data are available at the required level of detail. In most cases, it is therefore further assumed that that the mean ratio of activity-level variables to national totals in non-reporting low income countries is equal to that in reporting countries in the closest income group available in the joint dataset. Often this means all low income countries are given the mean ratio of the reporting lower middle income countries.

Approximation methodology in countries for which no internationally comparable data are available

Non-reporting countries are those for which no data are available from internationally comparable sources. Each country is classified according to the World Bank's Lending Groups categorisation. Country groups are indexed by $I \in \{h, u, m, l\}$ where h stands for $h \in \{1, 2, \dots, H\}$ for high-income countries, $u \in \{1, 2, \dots, U\}$ for upper middle income countries, $m \in \{1, 2, \dots, M\}$ for lower middle income countries, and $l \in \{1, 2, \dots, L\}$ for low income countries. They form a partition of the set of all countries $j \in \{1, 2, \dots, 196\}$ such that $H + U + M + L = 196$.

It is assumed that values for non-reporting countries can be approximated by multiplying national level GDP and employment with the average ratio of the income group to which the country belongs, weighted by the country's contribution to total income group GDP and employment.

First, 'activity-to-national total' ratios for each variable are calculated in reporting countries

$$R_{V,i,j,t} = \frac{V_{i,j,t}}{V_{j,t}} \text{ where,}$$

- $R_{V,i,j,t}$ stands for the ratio of activity-level variable per total national variable $V \in \left\{\frac{VA}{GDP}, \frac{L}{L}\right\}$ in activity i, country j and in year t
- $V_{i,j,t}$ stands for activity-level variable for activity i, country j and in year t where $V_{i,j,t} \in \{VA_{i,j,t}, L_{i,j,t}\}$

- $V_{j,t}$ represents national variable for country j in year t where $V_{j,t} \in \{GDP_{j,t}, L_{j,t}\}$.

Second, income group specific weighted averages of $R_{V,i,j,t}$ are computed. The weights correspond to the size of the respective country's national variable divided by the sum of the national variables in that income group

$$R^{I}_{V,i,t} = \sum_{i=1}^{I} \frac{V^{I}_{j,t}}{\sum_{i=1}^{I} V^{I}_{j,t}} \times R^{I}_{V,i,j,t} \text{ where,}$$

- $R^{I}_{V,i,t}$ is the income group-specific average of the ratio of $R_{V,i,j,t}$ for activity i, in income group I, in country j and in year t
- $V^{I}_{j,t}$ represents the national variable for country j and in income group I in year t
- $R^{I}_{V,i,j,t}$ stands for the income group-specific average of the ratio of activity specific variable per national variable for variable V for industry i, in country j, in income group I, in year t where $V \in \{\frac{VA}{GDP}, \frac{L}{L}, \frac{K}{K}\}$.

Finally, in non-reporting countries only, the income group specific weighted average ratios ($R^{I}_{V,i,t}$) are multiplied by the relevant national-level variables to approximate the activity-specific variable. Values for reporting countries are left as is

$$VA^{I}_{i,j,t} = R^{I}_{\frac{VA}{GDP},i,t} \times GDP^{I}_{j,t} \text{ and } L^{I}_{i,j,t} = R^{I}_{\frac{L}{L},i,t} \times L^{I}_{j,t}.$$