Commissioned by

HIGH LEVEL PANEL *for*
A SUSTAINABLE
OCEAN ECONOMY

BLUE PAPER

National Accounting for the Ocean and Ocean Economy

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About the High Level Panel for a Sustainable Ocean Economy

The High Level Panel for a Sustainable Ocean Economy (Ocean Panel) is a unique initiative by 14 world leaders who are building momentum for a sustainable ocean economy in which effective protection, sustainable production and equitable prosperity go hand in hand. By enhancing humanity's relationship with the ocean, bridging ocean health and wealth, working with diverse stakeholders and harnessing the latest knowledge, the Ocean Panel aims to facilitate a better, more resilient future for people and the planet.

Established in September 2018, the Ocean Panel has been working with government, business, financial institutions, the science community and civil society to catalyse and scale bold, pragmatic solutions across policy, governance, technology and finance to ultimately develop an action agenda for transitioning to a sustainable ocean economy. Co-chaired by Norway and Palau, the Ocean Panel is the only ocean policy body made up of serving world leaders with the authority needed to trigger, amplify and accelerate action worldwide for ocean priorities. The Ocean Panel comprises members from Australia, Canada, Chile, Fiji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau and Portugal and is supported by the UN Secretary-General's Special Envoy for the Ocean.

The Ocean Panel's approach is both ambitious and practical. Collaborative partnerships are essential to converting knowledge into action. To develop a common understanding of what a sustainable ocean economy looks like, the Ocean Panel gathers input from a wide array of stakeholders, including an Expert Group and an Advisory Network. The Secretariat, based at World Resources Institute, assists with analytical work, communications and stakeholder engagement.

In the spirit of achieving the UN Sustainable Development Goals (SDGs), providing value to the UN Decade of Ocean Science for Sustainable Development and meeting the objectives of the Paris Agreement, the Ocean Panel commissioned a comprehensive assessment of ocean science and knowledge that has significant policy relevance. This includes a series of 16 Blue Papers and various Special Reports that offer a synthesis of knowledge, new thinking and perspectives, and opportunities for action. This body of work is informing a new ocean narrative in the forthcoming *Towards a Sustainable Ocean Economy* report. Together, this research and new narrative serve as inputs to the Ocean Panel's deliberations for its forthcoming action agenda.

Ultimately, these papers are an independent input to the Ocean Panel process and do not necessarily represent the thinking of the Ocean Panel, Sherpas or Secretariat.

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Foreword

The High Level Panel for a Sustainable Ocean Economy (Ocean Panel) commissioned us, the co-chairs of the Ocean Panel Expert Group, to produce a series of Blue Papers to explore pressing challenges at the nexus of the ocean and the economy to ultimately inform a new ocean report and the Ocean Panel's action agenda. The Ocean Panel identified 16 specific topics for which it sought a synthesis of knowledge and opportunities for action. In response, we convened 16 teams of global experts—over 200 authors from nearly 50 countries—who reviewed and analysed the latest knowledge. They then provided new thinking and perspectives on how technology, policy, governance and finance can be applied to catalyse a more sustainable and prosperous relationship with the ocean. In short, these Special Reports and Blue Papers provide the information needed to transition to a sustainable ocean economy.

The Expert Group, a global group of over 70 experts, is tasked with helping to ensure the high quality and intellectual integrity of the Ocean Panel's work. All Blue Papers are subject to a rigorous and independent peer-review process. The arguments, findings and opportunities for action represent the views of the authors. The launches of these papers, which are taking place between November 2019 and October 2020, create opportunities for exchange and dialogue between political leaders, policymakers, the financial community, business leaders, the scientific community and civil society.

Transitioning to a sustainable ocean economy will depend on better coordination and management of humanity's relationship with the ocean. This task requires the gathering and analysis of a large amount of information that is currently disorganised or missing. This Blue Paper scrutinises the role that national accounts can play in providing information in critical areas of the ocean economy. The paper emphasises the need to develop data structures to anticipate unintended consequences of decisions, such as inequity and habitat degradation. In response to this necessity, the paper proposes four principles of accounting for a sustainable ocean economy. These principles will allow us to move from the usage of a single marine GDP indicator and thereby account for the ocean's true contribution to society and the economy. We are delighted to be able to share this paper with you, as it offers accounting guidelines that can help promote a sustainable ocean economy.

As co-chairs of the Expert Group, we are excited to share this paper and wish to warmly thank the authors, the reviewers and the Secretariat for supporting this research. We are also grateful for the vision of the Ocean Panel members in commissioning this important body of work. We hope they and other parties act on the opportunities identified in this paper.

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Highlights

- Organised information provides the power to make good decisions and justify them. National accounts contain and organise the information that describes our economies and helps decision-makers, and the public, understand near-term policy outcomes and long-term sustainability. However, currently only a small fraction of the information in national accounts is used because the focus has been overly narrow—producing a gross domestic product (GDP) metric.
- Planning for and managing a sustainable ocean economy requires tapping into the rich information that national accounts can provide. A system of national accounts can provide information in three critical areas to ocean economy decision-making: output or national means—a measure of production; outcomes or policy ends—a measure of real income and its distribution; and sustainability—indicated by changes in the national balance sheet.
- Many countries already produce an ocean GDP, but ocean GDP is usually the wrong metric for measuring the outcomes of ocean policy or the sustainability of the ocean economy. Efforts to calculate ocean GDP or measure the ocean economy with GDP will often be misleading because of fundamental features of GDP.
- This paper discusses a system of national accounts with multiple indicators and how they should be applied to the sustainable ocean economy. The paper emphasises the need to develop the underlying data structures to anticipate unintended consequences of decisions such as inequity and resource depletion.
- The paper proposes four principles of accounting for a sustainable ocean economy, including a set of Opportunities for Action for unlocking the information from national accounts needed to secure a sustainable ocean economy.
    - Assess policy options and decisions about the ocean and ocean economy in terms of their impacts on (1) real income and its distribution, (2) ocean production and (3) changes in ocean wealth, including ecosystems. Changes in ocean wealth are the most important indicator of sustainability.
    - Develop ocean accounts that build on the existing internationally agreed framework and standards for national accounting.
    - Avoid overreliance on GDP, which is not a sustainability indicator or measure of benefits to people from economic activity.
    - Lead or contribute to collaboration efforts to improve national ocean accounting systems, including global partnerships to share best practices and build capacity.
- The paper concludes that developing national accounts to guide economic development for the ocean is critical but not as daunting as it may seem. Many of the data already exist in national accounts, in government agencies or in scientific databases. The knowledge to build the connections also exists but is dispersed throughout government, academia, business and nongovernmental organisations (NGOs). Furthermore, most governments have already committed to many of these steps, with the gaps largely in implementation.

1. Introduction

Realising the goal of the High Level Panel for a Sustainable Ocean Economy (Ocean Panel) to catalyse the transition to a sustainable ocean economy depends on coordinating and managing humanity's relationship with the ocean and the broader environment. This task requires organising information that currently is often disorganised, spread across multiple government agencies or in a few cases not yet available. National ocean accounts would provide countries with the information needed to guide ambitious and broad-based plans to develop ocean economies and to capitalise on marine opportunities (European Union Directorate-General of Maritime Affairs and Fisheries and Joint Research Centre 2018; Economist Intelligence Unit 2015), while protecting the ocean for generations to come in accordance with the Sustainable Development Goals, most notably SDG 14, 'Life below Water'. The 'blue-ing' of the ocean economy—or making the ocean economy sustainable—requires ensuring that the ocean continues to provide at least the current levels of opportunity; 'measuring the ocean economy gives a country a first-order understanding of the economic importance of the seas' (Economist Intelligence Unit 2015). The old adage goes that 'what gets measured, gets managed', or more accurately, that 'if you cannot measure it, you cannot improve it'. Sound decision-making requires organised information.

National ocean accounts provide a system to organise and process information to guide sustainable development. They can be characterised as a specific application and extension of the existing standardised System of National Accounts (European Commission et al. 2009) used by most countries, whose main objective is 'to provide a comprehensive conceptual and accounting framework that can be used to create a macroeconomic database suitable for analysing and evaluating the performance of an economy. The existence of such a database is a prerequisite for informed, rational policymaking and decision-taking.'

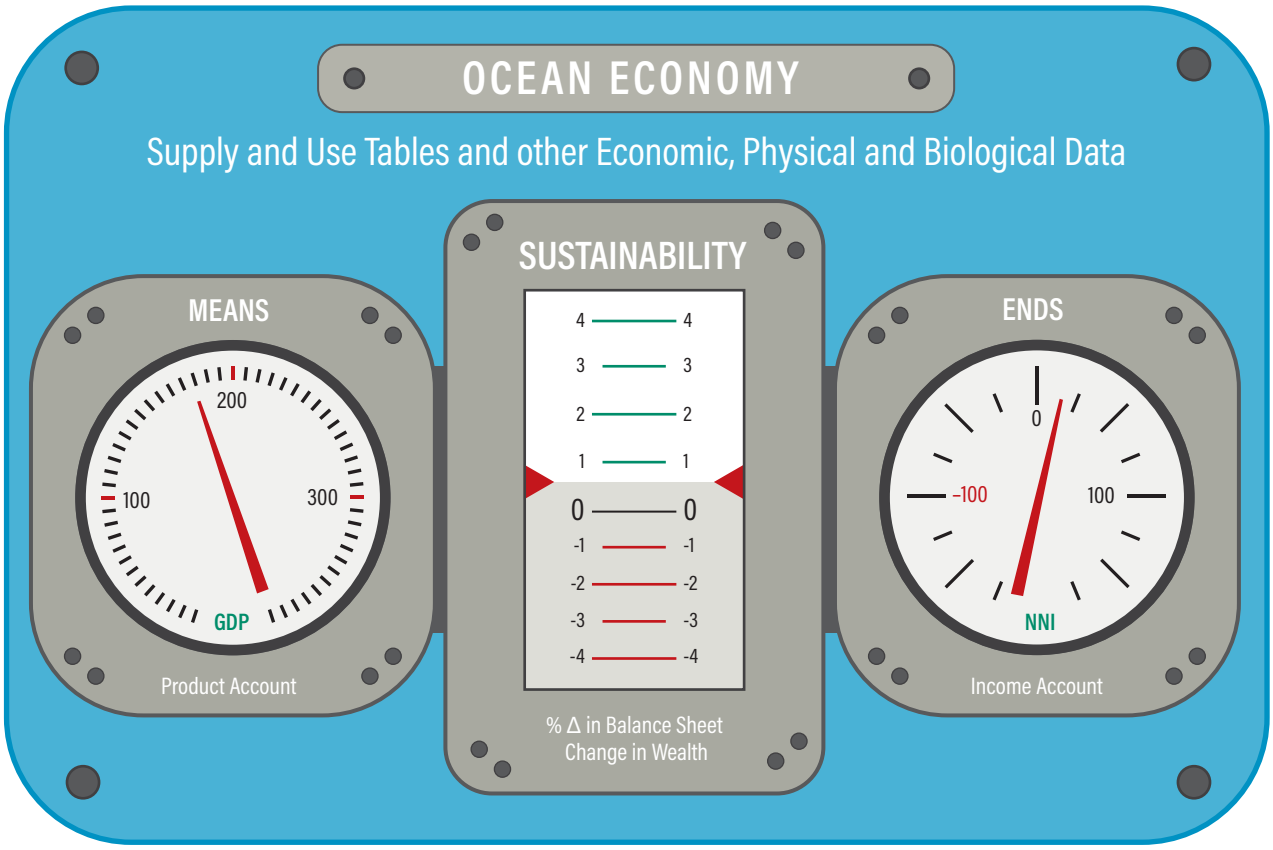
Box 1. Ocean or Marine to Blue

We use ocean, but marine could be used in its place throughout this report, to refer to large aquatic systems. This could include large lake systems. A sustainable ocean economy, or "blue economy" for short, accounts for biophysical processes and may include production outside of current national accounting boundary. A blue economy is one potential form of an ocean economy.

The ocean must be fully accounted for in this system to enable decision-makers around the world to balance between using the ocean today and conserving, restoring or enhancing it for the future to strengthen productivity, create jobs and reinforce food security and regional stability. Something as complex as the ocean economy cannot be managed by a single indicator. A complete set or 'sequence' of national ocean accounts provides three key high-level indicators: ocean product, changes in the ocean balance sheet and ocean income (Figure 1):

1. **Ocean product** measures the 'outputs' of human efforts on the ocean to provide 'means' or 'inputs' into achieving other social and economic goals; monetary components of the ocean product account aggregate to ocean 'gross domestic product (GDP)' or 'net domestic product (NDP)'. In environmental accounting standards, physical accounts are also important.
2. **Change in the ocean balance sheet** provides a sustainability indicator. A stable or increasing balance sheet is necessary for sustainability. This is because the balance sheet reports current and future potential

Figure 1. National Accounts: A Dashboard for Assessing the Ocean Economy



Source: Jamie Ficker with input from the authors.

for the ocean to provide products and benefits. The ocean balance sheet includes 'natural capital' like live fish populations, coastal wetlands and seabed minerals, which fall under the heading of 'non-produced' assets, in addition to 'produced assets', such as port infrastructure. Changes in the balance sheet integrate physical and monetary changes.

3. **Ocean income** measures benefits to nationals (people of a nation) from the ocean, the 'ends' or 'outcomes' of policy; income accounts aggregate to net national income (NNI), though in practice national statistics offices usually produce gross national income (GNI). Importantly, income measures can be disaggregated to show the importance of the ocean for different segments of the population. Furthermore, income can include non-monetary types of income, though these are often expressed in monetary equivalents.

The most important thing world leaders can do is to request reports on all three indicators and discuss information on national income and changes to national balance sheets along with changes in GDP in public addresses and policy meetings. All three indicators are important for directing a sustainable

economy, in the same way that altitude, airspeed and fuel in the tank are important for flying a plane (Matson et al. 2016). Certainly, the ocean economic system is at least as complex as an airplane. The primacy of GDP dates to the World War II crises and a need to measure means to carry out the war and rebuild after (Pilling 2018). If a plane is crashing, one would focus only on altitude for a short time, but flying from crisis to crisis is not the way to direct an economy. It is important to track relatively rapid changes in production. Changes in the balance sheet tell the story of sustainability, but balance sheets need to exist for a period of time before this information truly becomes useful. Few people would invest in a company without inspecting its balance sheet, yet countries' balance sheets are often an afterthought, and few include ocean assets. This is despite agreement that national balance sheets should include produced and non-produced assets. Greater leadership in asking about the ocean in national accounts and on the national balance sheet can change this.

National accounts connect information about the processes of generating, producing, consuming, saving and building wealth within an information system. The strengths of the System of National Accounts lie in its data, as well as the data's organisation and consistency, which enable comparisons, especially through time within a country. While imperfect, national accounts are uniquely able to connect existing ocean-related data systems so they can provide information on economic activities and guide decisions. This is a logical place to use the information generated as part of the UN Decade of Ocean Science and similar initiatives. Ocean accounts can support coherent and holistic assessment and reporting on a wide range of social, economic and environmental conditions related to the ocean. National accounts for the ocean provide information in a form consistent with the needs of macroeconomic decision-making to achieve sustainable development.

National ocean accounts provide three services. First, national accounts are a nation's information system. Aggregates such as GDP are representative of this information system, but GDP is just the tip of the iceberg. **It is important to avoid overreliance on GDP.** Second, national accounts provide a structured set of data about relationships among entities that provides the information needed to analyse policy, including ocean policy. For the ocean, many of these data exist, but they are currently distributed across different government agencies and international repositories. Third, the valuation component of national accounts facilitates analysis of policy trade-offs by organising ocean biological and physical data, many of which currently exist in disparate units, into a harmonised structure, evaluated in monetary terms with other economic data. Economic valuation helps answer important value-related questions such as the following:

- How is the value stored in the ocean changing through time?
- What is the expected net present value associated with current and alternative management of the ocean?
- How is income generated in an ocean sector interconnected with other ocean and non-ocean income?
- How could changes in ocean policy impact tax revenue?

The most important thing world leaders can do is to request reports on all three indicators and discuss information on national income and changes to national balance sheets along with changes in GDP in public addresses and policy meetings.

However, it is important to stress that **the idea of a *total value* of the ocean is neither meaningful nor useful in practice**. Without the ocean, life on Earth would be fundamentally different. To paraphrase World Bank economist Michael Toman (1998), attempting the find the total value of the ocean would be 'a serious underestimate of infinity'.

Existing economic and national accounting theory and concepts inform many sustainable development policy questions. However, there are questions that economic

and accounting theory do not answer. Moreover, the current existing international standards for national accounts—the 2008 System of National Accounts (SNA) and System of Environmental Economic Accounting (SEEA)—only partially address the concepts and theory. Some limitations result from economic questions that are not accounting questions, but others stem from design decisions in national accounts that merit revisiting. Furthermore, accounting practice often only partially implements the agreed international standards (Figure 2). This Blue Paper identifies the gaps between these layers to provide Opportunities for Action.

Section 2 of the paper reviews questions about the ocean economy that national accounts can inform. It then turns to concepts and theory and how these are, or are not, addressed in the existing, internationally agreed System of National Accounts (European Commission et al. 2009). This helps identify formal changes needed to the SNA and SEEA to guide a sustainable ocean or blue economy. At the end of Section 2, we address some important ancillary issues such as the role of technology and concerns about equity. In Section 3, we examine the gaps between the formal SNA and current convention and practice in order to understand the need for leadership to modify norms and practices. Section 4 provides Opportunities for Action.

Now is the time to upgrade national accounting to provide information about the sustainability of economic activities. A focus on the ocean can lead the way. Economies are changing. Policy is concerned with outcomes and sustainability, not simply managing monetary inflation, and '21st century progress cannot be measured with 20th century statistics' (Agarwala 2019). On the one hand, bringing the environment, natural resources and ecosystems into national economic assessments and planning is critical for future human well-being and the persistence of natural systems, and all parts of the ocean are now impacted by human activities (Díaz et al. 2019). On the other hand, the SEEA is being revised, there is discussion of revising the internationally agreed system of national accounts to focus on sustainability (UN Stats 2019), the 'valuation of natural resources' is an active area of discussion within national accounting (UN Stats 2017), and the development and pilot testing of technical guidance for ocean accounting is underway (UN-ESCAP n.d.).

Figure 2. Nesting from Needs to Practice

Source: Authors.

2. Questions, Concepts and Standards for Ocean Accounting

'What is the value of the ocean?' There are many reasons to ask this question, from concerns about specific ocean-related sectors to international commitments such as:

- The 2030 Agenda for Sustainable Development, including Sustainable Development Goal (SDG) 14 on 'Life below Water'.
- SDG Target 15.9, which calls for the integration of ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts by 2020.
- SDG Target 17.19, which calls for efforts building on existing initiatives to develop measurements of progress on sustainable development that *complement gross domestic product* and support statistical capacity building in developing countries by 2030.

However, this question it is far too imprecise for national accounts to answer. Notions of 'value' and 'ocean' are variable. National ocean accounting, in contrast, can answer specific questions like the following six, which we will return to throughout this paper:

1. How do industries, somehow connected to the ocean, create resources and products for use elsewhere? What jobs do these industries provide?
2. How do biological, chemical and physical ocean processes contribute to products for use elsewhere?
3. How does the ocean contribute to livelihoods and for whom?
4. How does the ocean provide welfare directly and for whom?
5. Is the ocean economy being developed sustainably?
6. How will a policy change affect aspects of the ocean economy? How will changes in the ocean affect the economy, or how will a use of the ocean in one location influence other industries and residents?

Questions 1–6 align with the dashboard in Figure 1. Questions 1 and 2 relate to ocean production and GDP metrics, though they require some disaggregation, with the difference between these two questions reflecting the gap between the 'ocean economy' and the 'blue economy'. Questions 3 and 4 relate to national income and welfare metrics, which are closely connected, but they also require disaggregation in some cases. These are questions about 'development'. Question 5 relates to future opportunities—sustainable development, which is a question about the national ocean balance sheet. Addressing Question 6 requires understanding relationships within and between ocean processes and the economy, which depend on information in national supply-and-use tables and the broader national information system.

Fortunately, there is a full a set, or 'sequence', of national accounts rather than a single, all-encompassing account. There are sub-accounts and satellite accounts to help answer all of these questions. It is easiest to focus on the four pieces illustrated in Figure 1: a product account, an income account, a balance sheet and an information structure derived from the economy itself. The actual system of national accounts has even more pieces that facilitate the reliable creation of these accounts. What is and what is not in measures differs somewhat from account type to account type. This, in theory, allows the different accounts to address different questions:

questions about means, ends or outcomes, sustainability and forecasting the impact of changes. All but Question 6 are retrospective in nature. It is important to ask the questions of the right pieces of the system of national accounts, otherwise the answers can be misleading.

Focusing on questions such as the six above narrows the question 'What is the value of the ocean?' For example, one could mean, 'How important is the ocean to indigenous cultures?' or 'What opportunities are being lost by current ocean management?' The first question is beyond the scope of economic theory and national accounts. The second requires assumptions about alternative ocean management. National accounts will reflect changes in the economic sphere made to address non-economic concerns, such as cultural preservation. Furthermore, national accounting information is useful for assessing the forgone economic opportunities associated with policies that advance non-market policy priorities. The accounts will not tell decision-makers what the correct trade-off is, but national account data help leaders to identify trade-offs and make informed, purposeful, defensible decisions by holding a mirror to past decisions. They do not tell leaders what choice to make, anymore than an airplane dashboard tells a pilot what the destination should be.

Many of the issues of national ocean accounting bring broader national accounting and national sustainability assessment issues into focus. However, the fact the ocean often contains the physical boundaries between countries leads to a unique challenge for developing national ocean accounts. In the context of production, gross domestic product is different from gross national product (GNP). GDP uses the physical boundaries of a country, whereas GNP uses its people as the basis for calculations. This raises the question of how to account for activities on the high seas or other areas beyond national jurisdiction. In practice, this can lead to confusion about how to account for activities within countries' exclusive economic zones (EEZs). These conceptual and practical challenges extend across the sequence of accounts. Furthermore, areas beyond national jurisdiction influence ocean processes within national ocean waters (Popova et al. 2019). This makes it hard to know where national data begin and end, which suggests the need for international cooperation to develop data systems.

Ocean accounts can answer at least six specific questions about the value of the ocean and ocean economy.

A seemingly natural place to start is by asking, 'What is the ocean economy?' and 'What needs to be included and what does not for a sustainable or blue ocean economy?' These questions, however, are rooted in an early 20th century reporting paradigm in which computing sums and aggregates was a major bottleneck to statistical reporting. Modern technology is changing this. Computing power, algorithmic development and new data-management structures make it increasingly possible to align the exact sectorial boundary with the question being asked. Apportioning certain industries into and out of the ocean economy is challenging; for example, should a seaside coffee shop be included? This concern is secondary and addressed at the end of this section. A modern national accounting infrastructure makes it easy for decision-makers to ask if such an apportioning decision is material to a specific policy question. Developing the information system so that it is robust to these shifts addresses this challenge.

2.1 Production as Means

Simon Kuznets, Lillian Epstein and Elizabeth Jenks (1934) compiled one of the earliest modern national accounts in focusing on the 'industrial branches' of the U.S. economy during the Great Depression.[1] Given, the dominance of Keynesian monetary policy in the 1940s, the system focused on the balance between total supply and demand and investment in produced or man-made capital (Maler 1991). This effort evolved into modern GDP. Formally, the gross domestic product is the monetised value of new goods and services that could in principle be exchanged in a market—value added. In other words, it is the means a country has at its disposal at a point in time, but it says nothing about the ends. Product measures are used to understand a country's tax base, how sectors are changing in relation to other sectors in the economy, how productive certain sectors are and how demand for capital in various

sectors might influence available money supply and inflation. These are all important questions, but aside from the ones about how the ocean sectors change in relationship to others, influencing potential tax bases, none of these questions are unique to the ocean or relevant to ocean policy.

Question 1 focuses on 'ocean-linked' market-like production, and Question 2 focuses on 'ocean-based' environmental contributions to market-like production. Neither is about outcomes for people or households. Colgan (2016) documents and discusses the confusion in various ocean accounting efforts between these two questions. Question 1 is the most common. It focuses on a group of firms or industries in an 'ocean' cluster and asks what means these firms generate. One can think of this as creating an ocean-affiliated industry class. The challenge is that often these firms are tangentially related to ocean processes (e.g. law firms provide maritime law services), and how much of any one industry to include is challenging. In practice, Question 1 is commonly used by industries for lobbying purposes—something along the lines of, 'We are an ocean industry, ocean industries are X percent of GDP, so the government should or should not enact a specific policy that will impact ocean industry.' The logic chain here is weak. First, means are not ends, and GDP measures the production or mobilisation of means. Public policy is concerned with means and ends. Second, ocean industries often are differentially influenced by policy. The purpose of lumping them together can, at times, be to inflate any one industry's perceived importance. It is often possible to analyse the affected industry directly and to examine changes to other influenced sectors. This errant lumping effect is even more perverse when nongovernmental organisations (NGOs) use aggregate ocean GDP to argue for the conservation of ocean biodiversity, which is not included in GDP at all. This use confuses the distinction between ocean-based production that is dependent on environmental processes and mere ocean-linked production, which may or may not depend on environmental processes. Most ocean GDP calculations focus on the latter.

Question 2 is harder to answer and less commonly asked. It addresses how production based on the condition of the ocean ripples through the economy to create means during a certain period of time. Answering this question requires connecting the detailed information contained within national accounts with biophysical data.[2] Few national statistics offices or marine affairs offices have the capacity to do this on their own—they often must collaborate. Such collaboration requires removing barriers between agencies with ocean and biophysical data expertise and national statistics offices with expertise and access to often sensitive economic data. This leads to two interconnected challenges, beyond the principal challenge of increasing collaboration. Marine affairs agencies may have a regulatory role that access to private economic data (e.g. tax returns) could enhance, therefore there is a need to (1) develop confidentiality protocols and (2) establish clear institutional separation between measurement and reporting functions, on the one hand, and regulatory functions, on the other.

Collaboration [compiling ocean accounts] requires removing barriers between agencies with ocean and biophysical data expertise and national statistics offices with expertise and access to often sensitive economic data.

In practice, the product account records activities producing goods and services—this piece of the account provides information for GDP. The scope of product accounts is defined by a 'production boundary', which is 'understood to be a physical process, carried out under the responsibility, control and management of an institutional unit, in which labour and assets are used to transform inputs of goods and services into outputs of other goods and services' (European Commission et al. 2009). This definition creates a challenge for ocean products. According to the SNA,

> *A necessary condition for an activity to be treated as productive is that it must be carried out under the instigation, control and responsibility of some*

institutional unit that exercises ownership rights over whatever is produced. For example, the natural growth of stocks of fish in the high seas not subject to international quotas is not counted as production: the process is not managed by any institutional unit and the fish do not belong to any institutional unit. On the other hand, the growth of fish in fish farms is treated as a process of production in much the same way that rearing livestock is a process of production.

This illustrates the need for national accountants to pair with ocean specialists to understand relevant governance structures that often bring marine resources within the scope of the production boundary. Most national waters have an institutional unit that regulates and 'exercises ownership rights over' marine resources, putting these resources inside the production boundary (Obst et al. 2019). For areas beyond national jurisdiction, the activities of regional fisheries management organisations like the Inter-American Tropical Tuna Commission arguably move relevant marine resources within the production and asset boundary.

An example of how ocean product enters a national account is helpful. The value added of harvested ocean resources, like wild fish, is measured using resource rent (Table 1). The basic value of production is equivalent to total revenues generated by fishers. The intermediate uses are the values of goods and services consumed or used up as inputs in production, such as fuel costs. Taxes on products are regarded as a part of the value that is created by the industry when the resource is extracted, while a product-specific subsidy is considered part of the costs of extracting the resource. A product specific tax paid by the specific resource industry is added to the resource rent, while product-specific subsidies, including price supports, are subtracted. Industry-specific taxes and subsidies are not included in the calculation of the resource rent because they are a transfer of the resource rent between the government and the industry and do not affect the bottom-line value of the resource rent.

Table 1. Calculation of the Realised Resource Rent

SIGN	TERM
+	Basic value of production
–	Intermediate uses
+	Taxes on products
–	Subsidies on products
=	**Gross product**
–	Non-industry-specific taxes
+	Non-industry-specific subsidies
–	Compensation of employees
–	Return on fixed capital
–	Capital consumption
=	**Resource rent of the sector**

Source: Authors.

Singular focus on the production account can be misleading. Repeated illegal fishing is formally within the scope of production accounts (European Commission et al. 2009). This is because illegally caught fish provide additional means in the current period, and if the illegal fishing is ongoing national accountants understand this as if the government, acting as a trustee, were voluntarily (implicitly) giving up fish to the unlawful fishers. Irregular piracy is not included in the production boundary because piracy does not create new means but shifts them involuntarily. However, defensive government expenditures preventing piracy are production in the current period. If increases in piracy increase government expenditure, then piracy indirectly adds to the product account. Increasing piracy or illegal fishing are not policy goals. These are just a few cautionary examples of why measures of means are not equivalent to measures of ends or outcomes.

2.2 Income as Ends

Economists—such as Dasgupta (2001); Jorgenson (2018); Kuznets (1973); Nordhaus and Tobin (1972); Solow (1993); Stiglitz et al. (2010); and Weitzman (1976)—have long understood the shortcomings of GDP for measuring human welfare or the ends or outcomes of policy. GDP is merely production, a 'means'. It is not an 'end' (Nordhaus and Tobin 1972), such as consumption or benefits to people, or sustainability (Solow 1993). Income is often associated with livelihoods. Livelihoods support household consumption (see Question 3 above). This is closer to the outcome goals of modern policy.

The standard starting place for considering the role of national accounts in measuring well-being is Nobel laureates William Nordhaus and James Tobin's (1972) 'measure of economic welfare', which responded to Kuznet's earlier calls to complete the consumption or well-being portion of national accounts (Jorgenson 2018). The renewed efforts by Joseph Stiglitz, Amartya Sen and Jean-Pierre Fitoussi (2010) to expand national accounts to provide welfare measures, 'beyond GDP', in their report to former French president Nicholas Sarkozy, are summarised by Marc Fleurbaey and Didier Blanchet (2013), both members of the Stiglitz commission. However, to our knowledge none of these efforts explicitly focused on ocean well-being, income, consumption or expenditure. If country leadership wants to link the ocean to well-being, then it is important to (1) support beyond GDP efforts and (2) prioritise their construction in a way that enables a disaggregation focused on ocean-related activities. Doing so may require more individual and time-use surveys along with expansion of the income or expenditure boundary.

Most scholars (e.g., Heal 1998) and national accountants define income following John Hicks's (1939) income concept, which applied to the ocean would define 'blue income' as the maximum amount a society can take from the ocean 'and still be as well off at the end of the week as at the beginning'. This includes 'non-monetary' benefits to being 'well off' (Krutilla 1967). Question 4 differs from Question 3 by acknowledging that services not acquired through market or market-like production matter. The ocean contributes many such services, such as leisure. Most economic theory related to national measures of income accommodates these services (Fleurbaey and Blanchet 2013).[3] This creates a challenge in accounting theory because it means that the 'boundary' of the income account is broader than the production account, yet the two are expected to balance. Nevertheless, it is possible to create balancing items to address this challenge. National accountants already face this challenge when calculating gross national income in comparison to gross domestic product.

Continuing with the wild harvest fishery example from the end of Section 2.1, when calculating compensation of employees, it is a goal to use wage rates that reflect the alternative value of the fishers. This analysis uses the likely wage of fishers if they had to find a job elsewhere at the start of their working career, such as the average wage rate on the mainland. Clearly, this creates a challenge in subsistence settings, and it imposes a set of highly restrictive assumptions about labour mobility. The compensation of employees is calculated as the number of hours worked times this wage rate. Vessel owner income is included as the number of hours worked multiplied by the employee wage rate. This illustrates the current shortcomings of national income accounts. Payroll taxes and other finely resolved data are used by countries that have those data.

If country leadership wants to link the ocean to well-being, then it is important to (1) support beyond GDP efforts and (2) prioritise their construction in a way that enables a disaggregation focused on ocean-related activities.

To capture the contribution of the ocean to national welfare or income requires including market and non-market benefits to people. Yet the divide between the market and the non-market is often the boundary for national accounts, leaving out economic activities, such as home production and flows from environmental public goods, that are often thought of as services. Insofar as these activities represent substitutes for market activities, their inclusion is necessary. Nordhaus (2006) writes, 'Probably the most difficult issue in design of augmented accounts is, where to draw the border.' Expanding the income boundary is important in enabling national ocean accounts to capture many of the services that lead people to care about the ocean. If the boundary is adjusted, then various methods to estimate the implicit income from non-market ocean services exist (Freeman 2003; Phaneuf and Requate 2017). It is more complicated to apply these methods than to use market data. Furthermore, the data analysis is often highly localised, and transferring results from one region to another is challenging (Boyle et al. 2010). Finally, the current version of income accounts is not a true measure of social welfare or economic well-being because they do not address distributional concerns

Changes in balance sheets provide the sustainable development report card.

(Fleurbaey 2009). Nevertheless, completing these accounts, with a broader boundary, would represent a substantial advance, and new technologies are enabling disaggregation. Dale Jorgenson (2018) argues that much greater information on distribution is needed for income, consumption and expenditure accounts. This is true for non-market services like many important leisure opportunities provided by the ocean and in cases where the ocean provides substantial subsistence opportunities. What is in and out of the account imposes a binary equity weighting. The ability of dashboards to enable disaggregation goes a long way towards addressing, or at least enabling informed discussion of, distributional concerns of 'fair allocation' of benefits associated with the ocean.

Leaders interested in policy outcomes, or 'ends', should be more interested in net national income (NNI) than GDP. NNI calculations require attention to the valuation of often hard-to-value assets, and NNI over a period of time is expected to balance with changes in national wealth reflected on a balance sheet.

2.3 Sustainable Development and the Balance Sheet

Production provides means, income is ends, but a sequence of balance sheets provides information to assess whether development is sustainable (Arrow et al. 2004; Hamilton and Clemens 1999; Maler 1991) and whether ocean development is sustainable or 'blue'.[4]

The balance sheet shows a country's wealth—the present value of the country's current and future economic opportunities conditioned on the current or most likely future institutional arrangements. Changes in national balance sheets are expected to balance with net changes in net national income. Ocean balance sheets reflect current and future economic opportunities afforded by the ocean. **Changes in balance sheets provide the sustainable development report card**, that is, 'meeting the needs of current generations without compromising the ability of future generations to meet their needs' (World Commission on Environment and Development 1987).[5] Kirk Hamilton and Michael Clemens (1999) put it succinctly, 'Achieving sustainable development necessarily entails creating and maintaining wealth.' A physical account complements the balance sheet that shows the current stock of assets.

Infrastructure and environmental assets, including natural resources, belong on national balance sheets (European Commission et al. 2009; Hulten 2006). This includes marine capital. Port infrastructure falls under the heading of produced assets. Other ocean assets from live fish populations to coral reefs to deep-water oil reserves are non-produced assets. The inclusion of natural capital in national accounts is not a novel or controversial idea. The idea of natural capital was well established by the early 1900s, long before the term natural capital was used. Irving Fisher (1906) used an ocean asset, Newfoundland fish stocks, as the first example of capital in his seminal 1906 text. U.S. president Theodore Roosevelt (1910) spoke of natural resources as assets as early as 1910. The current system of national accounts makes frequent mention of natural resources as capital (European Commission et al. 2009). Many Nobel laureates in economics, including William Nordhaus, Joseph Stiglitz, Robert Solow, James Tobin, Amartya Sen and Kenneth Arrow, have advocated greater inclusion of the natural environment in national accounts. Comprehensively completing the balance sheet is currently being piloted as 'wealth accounting' by the World Bank and UN Environment (Lange et al. 2018; Managi and Kumar 2018). The key innovation in these comprehensive wealth measures is that human and natural assets are given equal footing with produced assets. Recent versions of these reports include some ocean assets. The indicators for a sustainable ocean future will be contained in an ocean account balance sheet. Canada, Australia and other countries are already producing wealth reports, but we are unaware of any that are well developed for ocean sectors.

The boundary of the balance sheet is one of the most challenging pieces of national accounts (Hulten 2006). The 2008 SNA (European Commission et al. 2009) states that 'natural resources such as land, mineral deposits, fuel reserves, uncultivated forests or other vegetation and wild animals [fish] are included in the balance sheets

provided that institutional units are exercising effective ownership rights over them, that is, are actually in a position to be able to benefit from them.'

Most countries exercise effective ownership over their marine assets, by virtue of their assertion of national maritime zones, and related management activities. It is telling, however, that in the current system of national account documents (European Commission et al. 2009, §10.167), 'ocean' only appears in the mention of 'certain naturally occurring resources, however, maybe such that it is not feasible to establish ownership over them, for example air, or oceans.' This suggests that informal conventions within national accounting require amendment to improve their consistency with prevailing realities of ocean governance.

Producing comprehensive balance sheets, including non-produced assets, is a first step to verifiable sustainable development. In the ocean economy, non-produced assets are especially important given the role of non-produced ocean assets in growing food, storing minerals, sequestering carbon and generating many other services. It is also not possible to calculate net measures or income or production without measuring changes in stored wealth.

An important challenge to creating balance sheets is the valorisation of ocean assets. National accounts primarily focus on the consumption of fixed capital, which is the amount of an asset used to produce a good or service (Obst et al. 2019). For produced capital, consumption of fixed capital is often computed using market prices or the perpetual inventory model, and consumption of fixed capital does not include depletion or degradation of non-produced capital (European Commission et al. 2009).

In the fishery example from 2.1, what capital makes it to the balance sheet? The focus is on port infrastructure, the fishing vessels and other 'fixed capital'—not the fish population. When there are no market prices, the perpetual inventory method works by adding capital each year based on the cost of new investments (e.g. spending on boats or port maintenance), and capital is subtracted based on an estimate of the lifetime and depreciation profile. In practice for fishery capital, the lifetime is set to 20 years, and the depreciation profile is geometric, with a 10 percent annual rate. This is assumed to reflect the wear of this kind of capital. The claim is that the analysis takes a long-term perspective and essentially asks what the return on the capital would have been if it were not invested in the fishery sector in the first place. However, this is inconsistent with assessing the current state of the world. For something like fishing capital, this clearly ignores complementarities with the non-produced capital, which is the fish stock. Ignoring marine non-produced capital can lead to errors in valuing marine-produced capital, such as port infrastructure. New Zealand has introduced a novel solution by creating a market place for the rights to use non-produced capital, that is, fish stocks, known as individual tradable quotas or catch-shares. These programs were developed to align fisher incentives with regulatory goal (Grafton et al. 2000), but they create the added benefits of enabling the living fish population to be tracked on the national balance sheet (Hammond 2005).

The 2008 SNA provides little guidance for valuing non-produced assets, but methods exist. Fenichel et al. (2018) and Fenichel and Obst (2019) provide guidance for valuing non-produced assets in the form of natural capital, which can be applied to ocean non-produced assets. Yun et al. (2017a) provide a software package, called capital asset pricing for nature (capn) to facilitate implementation of these techniques. These techniques use observed behaviours but do not assume a constant flow of services. The approach accounts for economic and ecological feedbacks in the valuation process. The core challenge is to group strongly interacting pieces of the ocean ecosystem and economy to capture the most important feedbacks. Yun et al. (2017b) apply these techniques to develop balance sheet components for the Baltic Sea cod-herring-sprat fishery based on Polish data. When all data are not available, simplifying assumptions may be used that are as reasonable as those used in the perpetual inventory model.

Producing comprehensive balance sheets, including non-produced assets, is a first step to verifiable sustainable development.

Charles Hulten (2006) makes the real problem clear: 'When it comes to capital, however, it is more a question of what to do than how to do it.'

2.4 Analysing Policy and Marine Planning

Headline indicators, the gauges in Figure 1, are retrospective measures. They can provide lessons from the past, but 'past performance is no guarantee of future results'. National accounts organise data to enable analyses that can inform future decision-making. This is the main goal of national accounts (European Commission et al. 2009). Question 6 above is about the future. A national ocean account can provide information to develop economy-wide models, including economy-wide models with fine spatial resolution. This is because national accounts are the system for processing information to coordinate national activities, provide business forecasts and evaluate policy outcomes. National accounts provide a commonly agreed set of facts for shared understanding and decision-making. These accounts are built on extensive data, with high resolution, potentially down to a beachside ice cream parlour's tax reports. New technologies and reporting paradigms are making data increasingly easy to access and disaggregate to answer questions about specific sectors of the economy—including the ocean economy.

The three gauges in Figure 1 report the condition of the national (ocean) economy. The detailed data are stored in many structures, chief among them a set of supply-and-use tables. These tables provide the material to produce the aggregated, sector-level input-output tables commonly used in economic analysis and projects. These are critical for understanding the interconnections within an economy and connecting the science of ocean processes with the traditional economy. Furthermore, supply-and-use tables are regularly produced at fine spatial scales. Indeed, in many countries the limits of publicly available spatial disaggregation are set by ethical and confidentiality concerns rather than data resolution.

The supply-and-use tables record the production and demand structure of an economy by describing the goods and services brought in through domestic production or through imports from outside the economy. The tables describe how those goods and services are used, such as through intermediate consumption, final consumption at the household or government level, gross capital formation or exports (Department of Economic and Social Affairs 2018; Kazemier et al. 2012). The tables provide the foundation for developing input-output (IO) tables. IO tables and supply-and-use tables may be in physical or monetary units. Supply-and-use tables allow analysts to verify that the underlying data used in national aggregate calculations are consistent, complete and balanced. IO tables aggregate goods and services to industry or sector levels and track value flows between and within industries or sectors for intermediate consumption and final expenditure. Therefore, the IO tables are used in all sorts of economic analyses and forecasts. The supply-and-use tables can be expanded to include services and consumption currently outside of the income or production boundary to get a better handle on true national income and on ocean income and can ultimately be linked to similar structures for environmental processes taking place in the ocean. Natural production from the ocean could be treated as an economic sector.

Analysis to support sustainable ocean economic policy requires reducing the barriers between experts and data generators from different agencies. **Connecting assets with supply-and-use tables will make it easy for analysts to analyse how economic activity changes the ocean and how changes in the ocean influence economic activity.** Scientists already build models of the marine environment, such as Atlantis and EcoPath/EcoSim (Audzijonyte et al. 2018; Collie et al. 2016; Steenbeek et al. 2016), that use structures similar to IO tables. Establishing a central accounts structure could enable macro-environmental-economic policy analysis based on an integrated platform that links data and models and brings the environment into standard macroeconomic modelling frameworks (Finnoff and Tschirhart 2003). Currently, the expertise for much of this work sits outside national statistics offices, while those with biophysical knowledge struggle to connect their data and understanding to macroeconomic models.

Connecting ocean and economic experts is imperative because the ocean economy is strongly influenced by the performance of non-produced assets. Many

natural assets may directly interact and influence each other's value, just like firms interact in an economy where automobile manufacturers influence the market value of suppliers—predators affect the value of prey. The value of services or the value of assets depends on substitutes and complements to those services or those assets. The ocean generates many services, but these services are produced through interconnected processes, and some of these services are regenerating assets. These connections can enable substitutions or create complementarities. Interactions can be physical or biological (such as ecosystem interactions between species), technical or market-driven. In an era of globalisation, markets connect the incentives for using various components of the ocean worldwide (e.g. fisheries, tourism). For example, coastal resources enable swimming and recreational fishing, which may be complements in producing tourism services. Sites that enable both may be of greater value than the sum of sites that only enable swimming or recreational fishing. In another example, unharvested prey fish biomass may seem of little value but actually have great value in supporting a harvested predator fish (Yun et al. 2017b). At the same time, one species of prey fish may be a good substitute for another species of prey fish, so the value of that prey fish species in a system with many species may be lower than if that prey fish species were the only prey source. This means that changes in the value of ecosystems may not be the sum of the changes in the value of the parts if the parts are measured independently. Measuring the parts independently may lead to double counting or undercounting. It is important to account for interactions, which often depend on policy decisions and institutions as well as ecology and natural processes.

2.5 Satellite Accounts

The term *satellite account* is used for separate accounts of interest that are not part of the central structure of the System of National Accounts. Most satellite accounts are rearrangements of items already included in a central account. They do not influence national aggregates. However, some satellite accounts allow items to be treated differently, such as with a different boundary than the central accounts.

One important system of satellite accounting is the System of Environmental Economic Accounting (SEEA), which is coordinated by the UN Statistical Division. The SEEA Central Framework (SEEA-CF) is an internationally agreed standard for accounting for environmental assets and their supply to and use in the economy. It provides guidance for services from non-produced assets, such as fisheries, in greater detail than the System of National Accounts. The SEEA-CF provides the specific guidance on fisheries, forests and agriculture, which reflects the SNA guidance with additional details for natural resources. The SEEA also has a system of Experimental Ecosystem Accounting (SEEA-EEA) that is currently being revised, with the goal of establishing an international standard by 2021. The experimental ecosystem accounts focus on the biophysical condition of ecosystems and interactions among non-produced assets. The SEEA-EEA will likely also provide guidance on ecosystem services that can be counted as income beyond the current income boundary, though this guidance is still in development. The revisions working groups have produced working papers, which are available on the SEEA webpage, https://seea.un.org/.

Connecting ocean and economic experts is imperative because the ocean economy is strongly influenced by the performance of non-produced assets.

A second important set of satellite accounts consists of satellite ocean accounts developed by individual countries with guidance from the Organisation for Economic Co-operation and Development (OECD), EuroStat or in coordination with the UN Economic and Social Commission for Asia and the Pacific (UN-ESCAP). The UN-ESCAP program is also associated with ongoing efforts, coordinated by the UN Statistics Division, to maintain and develop the SEEA. Some countries also produce satellite transportation and tourism accounts with ocean-related components or coverage.

2.6 Related Issues

Before assessing the current state of national ocean accounting, we should examine some common issues that we have not yet addressed. These include boundaries and existing discussions of the ocean economy, data and technology, and equity concerns.

2.6.1 Conceptual and spatial boundaries

Ocean accounts need to address three types of boundaries: (1) accounting boundaries, which determine what types of services to include and which we have already discussed, (2) the marine economy boundary and (3) spatial boundaries within the marine system. This section focuses on the second and third boundary types.

Of the six established and five emerging blue sectors outlined by the European Union Directorate-General of Maritime Affairs and Fisheries and Joint Research Centre (2018) and by the OECD (2016), three major sectors—extraction of marine living resources, coastal tourism and biotechnology—are likely impacted, in some cases severely, by changes in the ocean's biological condition. These sectors depend critically on the biological natural capital of marine ecosystems. All sectors may be impacted by physical changes that alter access to the ocean by changing the distribution of storms, waves, wind and so on. Therefore, all sectors depend on physical natural capital, but it is less clear that the physical capital is ocean capital as opposed to climate.[6] It is likely that all sectors influence changes in the biological and physical condition of the ocean, which ultimately influence the accounting price of critical forms of ocean capital. Finally, 'marine and coastal' protection is often included as a sector of the blue economy. But this sector would be better thought of as investments or maintenance of ocean natural capital, which is how the current System of Environmental Economic Accounting treats this sector.

From shipbuilding to biotechnology to clean energy, the ocean spurs innovation and encourages human capital formation.

From shipbuilding to biotechnology to clean energy, the ocean spurs innovation and encourages human capital formation. Of course, the ocean is one of many contributors. More work is needed to partition the incremental contributions of the ocean to knowledge generation. Ocean accounting initiatives should be integrated with accounts that cover broader sections of the economy. Experiences with individual tradable permits for fisheries suggest there are regulatory structures that increase the value of natural capital (Fenichel and Abbott 2014) while increasing the value of human capital through safety improvements (Birkenbach et al. 2017; Pfeiffer and Gratz 2016). Such property rights may be important in marine mining and other extractive industries as well (Libecap 1994).

The issue of national boundaries, made acute by the ocean, is a somewhat unique issue for national accounts. Currently there is no institution maintaining a balance sheet for ocean areas beyond national jurisdiction. Many countries do not even include assets in their own EEZs on their balance sheets. Another concern is vessels operating in the territorial waters of other countries. The production and income are usually attributed to the vessel's home country, while any impacts to the balance sheet would occur to the geographic location. This could lead to the changes in wealth not balancing with NNP.

A global emerging issue is marine spatial planning.[7] National account data are useful to marine spatial planning in ways that parallel regional development modelling—a common use of national account data. National account data enable input-output, integrated assessment and computable general equilibrium modelling. These sorts of models have a role in marine spatial planning.

2.6.2 Data and the digital revolution

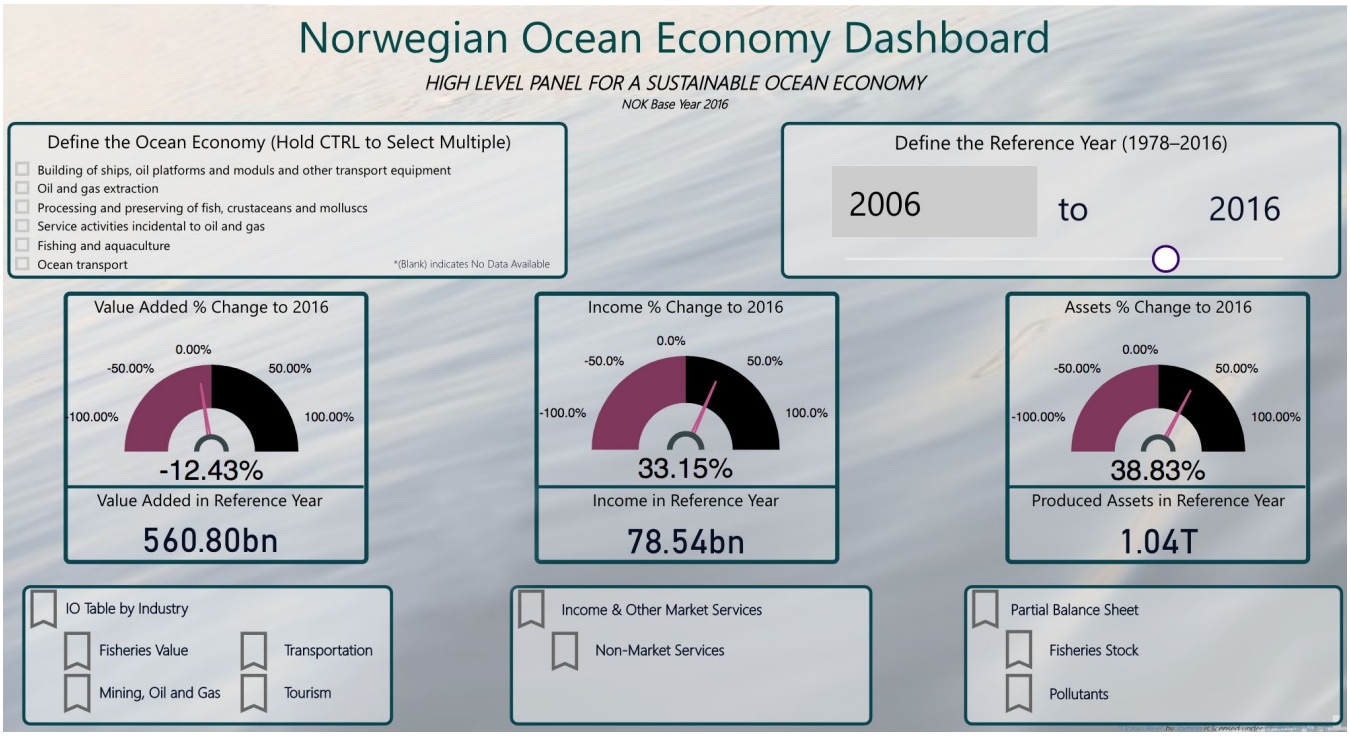
The key strength of national accounts is their organisation of data. The digital revolution is changing the way people interact with data, and this is especially relevant for national ocean accounts.[8] National accountants already use 'big data' and detailed business statistics from multiple sources, and they are experimenting with remote sensing. Aggregates are often built from very fine scale measurements, such as business receipts. This is important because environmental data will likely also not come from a

single source. However, the national account reporting paradigm, with a heavy focus on headline GDP, is based on 1930s technology, now in the early stages of a radical update involving online digital dashboarding that makes headline numbers less essential (Figure 3).

Marine conditions and activities are often 'far away' from observers, but remote sensing and in situ techniques are making it easier to observe the ocean. There is substantial untapped potential to monitor and measure the biophysical condition of the ocean through 'earth observation' (Ramirez-Reyes et al. 2019), and technology exists for these data to flow directly into national ocean accounts. Earth observation is defined as the union of diverse data sources, including from satellite, airborne, in situ platforms and citizen observatories (GEO 2015), for improved monitoring and forecasting of Earth's physical, chemical and biological conditions. The Group on Earth Observations (GEO) provides physical, chemical and biological information at increasingly fine scales, including at a few metres and hourly. Earth observation provides rapid, repeated and long-term synoptic observations that provide a platform for a nested ocean observing framework at global, basin, regional and local scales.

The Framework for Ocean Observing (Lindstrom et al. 2012), implemented under the auspices of the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural

Figure 3. Example of a Live Interactive Digital Dashboard for Norway



Source: Working version at https://environment.yale.edu/data-science/norwegian-ocean-economy-dashboard/.

Organization and coordinated by the Global Ocean Observing System, seeks to meet the need for ocean data that support governance, management, science and other ocean uses. It proposes the coordination and integration of routine and sustained observations of physical, biogeochemical, geological and biological essential ocean variables (Bojinski et al. 2014).

Through its marine and coastal (GEO Blue Planet) and biodiversity observatory network initiatives, the international Group on Earth Observations is working to improve the availability, access and use of ocean-related Earth observations. This includes work on a framework for a set of essential biodiversity variables for use in monitoring programs to understand patterns and changes in Earth's biodiversity (Navarro et al. 2017; Pereira et al. 2013) as well as on ecosystem essential ocean variables, a set of observable ecological quantities that contribute to the assessment of the ocean ecosystem (Miloslavich et al. 2018).

These efforts categorise specific ocean parameters that should be monitored continuously in order to identify key processes and determine the sustainability of the ecosystem as a whole, thereby addressing the challenge of evaluating the ocean's status in a synergistic way (Muller-Karger et al. 2018).

The biophysical data present two main challenges. First, expertise for working with Earth observations (which include ocean and coastal data) often resides outside national statistical offices, though some national statistics offices do possess this expertise (e.g. Canada's). It is imperative that national accountants collaborate with Earth observation experts to acquire physical data of ocean flows and measures of non-produced ocean assets. Coverage can vary, and some countries lack capacity for accessing these data altogether. Many habitats, including the deep sea, ocean trenches, ice-bound waters, methane seeps and even coral reefs, remain poorly studied at the global scale. Costello et al. (2010) shows that geographic gaps in biodiversity data are particularly acute for many parts of the global ocean, including coastal areas of the Indian Ocean, the southern and eastern Mediterranean Sea, polar seas and much of the South American coastal ocean.

There is a critical need to inventory data to quantify natural stocks, audit the data's usability for accounting for non-produced assets and identify priority data gaps. Data gaps need to be articulated with clear measurable and feasible observable units; such measures should be prioritised over derived measures like biodiversity. Data quality needs to be checked against academic data sets such as 'The Sea around Us' (http://www.seaaroundus.org/) (Pauly and Zeller 2017), and discrepancies should be documented, explained or remedied. Physical measures need to be linkable to human transactions and decisions for valuation. As part of the UN System of Environmental Economic Accounting, substantial progress has been made in defining the extent of ecosystem and other natural assets within basic spatial units (BSUs).[9] But data must go beyond spatial delineation to track condition through time. For example, the spatial extent of the Great Barrier Reef has not changed much over the last 30 years, but the reef's biological condition has.

Second, the amount of Earth observation data leads to computation challenges. The Copernicus Earth Observation Programme Sentinel satellites of the European Union (EU) produce approximately 20 terabytes of data per day (Esch et al. 2018). The geospatial community has developed solutions that 'bring the user to the data instead of the data to the user'. Technological advances in cloud technologies, the development of data cube technologies, the availability of analysis-ready datasets and the development of web-based platforms providing access to these services make this possible. These solutions may not work for national statistics offices that may need to match ocean data with confidential microeconomic data. National accountants and statisticians, led by economy and finance ministers in cooperation with transportation, marine affairs and fishery ministers, need to negotiate a platform that serves the needs of ocean accounts.

The digital revolution is aiding the understanding of human activity on the ocean and the implicit income that people gain or lose as the ocean changes. Many vessels are tracked by satellite. The International Maritime Organisation monitors maritime traffic through a regulation requiring the Automated Identification

System (AIS) on all ships over 300 gross tonnes on international voyages, on cargo ships over 500 gross tonnes and all passenger ships irrespective of size. AIS reports the ship's identity, type, position, course, speed, navigational status and other safety-related information—automatically to appropriately equipped shore stations, other ships and aircraft. Vessels engaged in fisheries activities also report their locations. The vessel monitoring system (VMS) is a satellite-based monitoring system that provides data to the fisheries authorities on the location, course and speed of vessels (https://globalfishingwatch.org/). AIS and VMS data are key elements for measuring maritime transport.

Human transactions increasingly involve a digital footprint, and these data are increasingly useful for imputing the non-market income received from the environment, such as social media posts, administrative time-use surveys, voluntary recording on recreation, activity tracking and digital consumption of complement and substitute market goods. A number of difficult ethical concerns must be addressed with these data, but national accountants already grapple with these issues for business reporting data. All of these data could greatly improve determination of the precise value of non-market services provided by the ocean and nature more broadly. Digital transactions are already improving the precision of market data, and in some countries national accountants and economists are already working with these sorts of data for measuring the ocean economy. National statistics offices increasingly invest in the infrastructure and algorithms to support information from the digital world and lower barriers to bring in data from other data-collection agencies without loss of resolution. In the context of the ocean, this means that agencies must find ways to incorporate biophysical data and associate shore-based transactions with the marine physical environment. It is also important that national statistics agencies draw on the expertise of marine sector experts to understand the complex institutional arrangements and assignments of 'economic ownership', which often differs from 'physical ownership' in the marine context.

New technology makes national account data more accessible and more useful for policy analysis. For instance, an ocean proto-account for Norway can be displayed as an interactive dashboard (Figure 3), and the United States hosts an interactive ocean proto-account (https://coast.noaa.gov/digitalcoast/tools/enow.html). Such dashboarding aligns with the recommendations of Stiglitz et al. (2010) for going beyond GDP. New interactive dashboarding technology makes decision-makers less dependent on specific aggregates like gross or net ocean product and enables them to drill down quickly to indicators of interest.

2.6.3 Equity and national accounts

Equity and inclusion are cornerstones of the sustainable development agenda, and distributional concerns are a limitation of only focusing on national income aggregates—though when used with care these can be an important piece of addressing equity (Fleurbaey 2009; Jorgenson 2018; Jorgenson and Slesnick 2014).[10] 'Equity' refers to the distribution of benefits and costs of resources (distributional justice). Conservation and changes in wealth are central to intergenerational equity (Dasgupta 2007; Solow 1974).[11] Intragenerational equity is also important (Adler 2013; Hart 1974; Sikor 2013; Stiglitz et al. 2009), and the ocean can contribute to poverty alleviation, especially for small island developing states and coastal least developed countries, providing food, jobs, livelihoods and cultural spaces (World Bank and UN-DESA 2017). It is a reasonable aspiration for ocean accounting to support 'equity measures', while being agnostic as to the 'correct' distribution or measure.

National accounts are denominated in national monetary currencies and thus depend on the distribution of money income and wealth. While not reporting directly on equity, national accounts can provide some data to generate equity indicators and help countries meet international sustainable development reporting commitments. In order to do so, it is important

The digital revolution is aiding the understanding of human activity on the ocean and the implicit income that people gain or lose as the ocean changes.

Turning attention towards the data structures and away from the aggregates is imperative to address environmental concerns while answering forward-looking policy and business questions.

to be able to disaggregate and apply politically chosen equity weights. Microeconomic and survey data are also important (Jorgenson 2018). The boundary of the account limits potential equity weights. Anything left out of the account is implicitly weighted at zero.

A clear limitation for policy analysis concerned with distributional outcomes is the ability to disaggregate reporting. Current national accounts vary from country to country in this respect, but technology is making it easier and easier to disaggregate data. The technical challenge is to build the data structure in a way that it can be disaggregated and recalled quickly. However, perhaps the greater change will ultimately be balancing ethical issues that emerge from the identifiability of fine-scale disaggregation (e.g. linked to data protection) with the ethical imperatives of using disaggregation to address equity concerns.

2.7 Aspirations for the System of Ocean Accounts

The ocean plays a major role in market and non-market services. The ocean unites and divides countries, and it links people through a common heritage and regulated climate. It also brings people together through trade and travel. A substantial number of services from the ocean rely on production underpinned by natural capital. In principle, much of this natural capital should already be on national balance sheets and within national accounts. The asset and production boundaries of national accounts may require adjustment to justify adding other stocks of natural capital to the balance sheet. **However, of first-order importance is generating balance sheets with the produced and non-produced ocean assets currently within the production and asset boundaries. This is not being done, but it would provide an immediate gauge of the ocean economy's sustainability.**

Furthermore, many ocean-provided services are not traded on the market. Therefore, they are missing from production and income accounts. Account boundary adjustments are required to provide clearer measures of the 'ends' in terms of economic well-being. It is **important to work towards a broader income boundary that includes broader ocean services**, such as household-produced services, leisure services and carbon sequestration and storage. The money boundary is a subset of this broader boundary.

Finally, the accounts must be more than summary statistics. Analysts must be able to get into the details of the data. Integrating the economic and biophysical data into a single platform will make it easy for economic analysts to consider the role of the ocean and perhaps help physical scientists better understand the economic trade-offs with biophysically based recommendations. Turning attention towards the data structures and away from the aggregates is imperative to address environmental concerns while answering forward-looking policy and business questions.

3. Current State of Accounts for the Ocean

It is not enough to review concepts and investigate official guidance for national accounting for the ocean. We must also look at what countries are doing with respect to ocean accounting. This section surveys the current state of ocean accounting and relates practices to frameworks for ocean accounting and the suite of actors implementing frameworks. The goal is to identify gaps between the formal structure and practice. Assessing the current state of the accounts helps (a) show what is currently feasible, (b) identify important gaps where alternatives may exist or where resources are required and (c) identify areas where novel approaches to ocean accounting are needed.

There are three main components to the current practice of ocean accounting:

1. The set of internationally agreed frameworks for national accounting systems.
2. Countries that engage with these frameworks to provide national accounting information related to the ocean.
3. Programs and outside actors who link, filter or otherwise engage and support the set of existing frameworks and/or countries that are producing these national accounts.

3.1 Internationally Agreed Frameworks

A growing range of ocean accounting initiatives, frameworks and studies exists. It is useful to think about their articulation with the System of National Accounts (European Commission et al. 2009). Most countries' national accounts comply with this system. Relevant frameworks developed through intergovernmental systems include the following:

- The System of Environmental Economic Accounting (SEEA) Central Framework, developed through a UN Statistics Division process.
- The SEEA Agriculture, Forestry and Fisheries (AFF), which applies and expands on the SEEA–CF. This system is developed through the Food and Agriculture Organization of the United Nations (FAO).
- The SEEA Experimental Ecosystem Accounting (SEEA-EEA), which incorporates physical indicators of ecosystem conditions and services, as well as measures of ecosystem value. This system is developed through a UN Statistics Division process.
- The UN Technical Guidance on Ocean Accounting for Sustainable Development, which applies the SNA and SEEA, with additional guidance focusing on accounting for ocean governance and social circumstances within an integrated Ocean Accounts Framework. This guidance is developed through the UN Economic and Social Commission for Asia and the Pacific (UN-ESCAP), in collaboration with several governments and other actors.

- The Integrated Maritime Policy Database, a proposal/pilot refinement of ESA 2010 guidance that is a European-tailored version of the SNA.

The broadest of the international accounting frameworks is the System of National Accounts (European Commission et al. 2009), developed through the Inter-secretariat Working Group on National Accounts. The SNA aims to provide a framework for creating a sequence of national accounts that is 'comprehensive', 'consistent' and 'integrated'. Much of Section 2 focused on this system, and the SNA is clearly relevant for the ocean economy. Sections 6.136–42 address the output produced by sectors that operate in part within the marine economy. Many of the same challenges addressed by the SNA—for example, those having to do with home production—apply in the marine economy.

The SEEA-CF informs monetary measurement of economic activity related to the environment as well as physical measurement of environmental stocks and flows. The SEEA-CF complements and expands the SNA. Physical asset accounts are a key way in which the SEEA-CF expands the boundaries defined by the SNA. The SEEA-AFF provides more specific standards for physical and monetary accounting and measurement of fish and other aquatic products within the SNA. SEEA-CF adopts the notion of countries, firms or asset owners as economic units. The SEEA-EEA, in contrast, takes an ecosystem-centric perspective focusing on spatial units grounded in ecological rather than administrative boundaries (Chow 2016; FAO n.d.). The UN Technical Guidance on Ocean Accounting for Sustainable Development, developed through UN-ESCAP, focuses on the application of the SNA and SEEA in marine and coastal contexts, providing methods and approaches for developing satellite accounts for the ocean environment and economy that allow for spatial disaggregation. It also provides experimental guidance on accounting for contextual factors such as ocean-related social circumstances and current modes of governance. Ocean systems, given variation in depth, currents and boundary types, present specific challenges to the notion of an ecosystem-based spatial unit for a given terrestrial system. The UN-ESCAP guidance includes ecological and technological detail needed to define ocean spatial units and physical measurement standards tailored to measure marine assets. The community of practice surrounding UN-ESCAP ocean accounts includes Australia, Canada, China, Fiji, Indonesia, Malaysia, Portugal, Samoa, Thailand, Vanuatu and Vietnam. These accounts can be constructed at the national or subnational level. Together, the SNA, SEEA-CF and SEEA-AFF guidance constitute the internationally agreed framework applicable to ocean accounting. The SEEA-EEA and UN-ESCAP provide more detailed guidance produced through the same mechanism, but they have not yet been adopted as international standards.

The conceptual design of national accounts suggests that it should be possible to extract substantial information about the state of the ocean and the ocean economy.

3.2 Implementation of Ocean Accounting

The conceptual design of national accounts suggests that it should be possible to extract substantial information about the state of the ocean and the ocean economy. Greater detail requires more complex national accounts. It is important to develop a consistent framework for categorising economic activities to prevent double counting of flows from economic activities. Double counting and undercounting are surprisingly easy traps because of the many ways countries can group these activities. Increasing the level of detail in national accounts exposes important linkages across industries and early indicators of economic health.

The Ocean Panel member countries are diverse and clearly invested in the ocean, but not all have high-profile national ocean accounts. Therefore, they constitute a useful sample to examine the state of national ocean accounts. We focus on these 14 countries in this section and in the following section review other selected high-profile efforts. A survey of the Ocean Panel countries' treatment of the ocean in their national accounts provides a representative, if optimistic, view of the

state of national ocean accounting. We provide specific examples, so that practitioners can find examples of steps being implemented. We investigate four questions:

1. Do member countries explicitly account for the ocean economy? If so, to what extent?
2. Which accounting tools—production, income, balance sheets and supply-and-use tables—are produced? Are the accounts usable to inform services, sustainability, and conduct economic analysis or are only production accounts produced?
3. How are non-produced ocean assets (ocean natural capital) treated in the accounts?
4. Is the current level of national account detail sufficient to produce a set of satellite accounts and aggregate statistics for the ocean economy?

We were able to find ocean-related data in national accounts for all 14 Ocean Panel member countries.[12] National ocean accounting is not starting from zero in any of these countries. Nevertheless, Ocean Panel member countries' national ocean accounting data vary greatly and are only comparable at a broad level. A variety of specialised reporting is already evident. For example, Fiji's national accounts maintain detailed reporting on the *bêche-de-mer* (sea cucumber) industry and have an extensive structure for the harvest of biological organisms from the ocean. The same economic activity in other countries' national accounts in principle may only exist in an aggregate of the entire agriculture, fishing and forestry sector. Harmonising ocean accounting would facilitate intercountry comparison; more important, it would also facilitate capacity building and knowledge sharing.

3.2.1 Product and income accounts

Macroeconomic *production aggregates* exist across three of the four principal ocean-related sectors: (1) fisheries and (2) mining/oil and gas and (3) transportation or commerce (Figure 4). Many, but not all countries report aggregates for tourism or hospitality, however, these estimates are often provided in a satellite account

Figure 4. Ocean Sector Aggregates for Ocean Panel Countries

	Production Accounts Disaggregated to Ocean Economy	Physical Production Accounts Only at Level of Ocean Economy	Physical/Monetary Production Accounts Somewhat Disaggregated	Contribution of Ocean Economy to Production Unable to be Reported
Fisheries	13	1	0	0
Tourism	10	1	2	1
Transportation	3	4	1	6
Mining, Oil and Petroleum	2	1	0	11

Source: Authors' tally based on publicly available national count data

GDP is the wrong tool for assessing the sustainability of the ocean.

given the potential for double counting. Furthermore, the existing data are reorganisations of data from the countries' main sequence of national accounts and do not extend the income boundary. Therefore, accounting for the ocean does not change countries' headline GDP. Countries with explicit ocean accounts include additional sectors in their 'ocean accounts' beyond the four we focus on. These may include all coastal activities, maritime law, research on the ocean, restoration activities, ocean governance, bio-prospecting, and the list goes on. Such accounts aim to answer Question 1 in the initial set of 'value of the ocean' questions.

Some countries use spatial data on reporting location to partition marine-related coastal tourism and hospitality. Some countries, such as Portugal and Canada, go a step further and provide dedicated satellite accounts for the ocean (see INE n.d.; and Fisheries and Oceans Canada n.d.a). Other countries, such as Fiji and Indonesia, have expressed interest in or are in the process of developing ocean satellite accounts. The production accounts are relatively complete, sufficient to provide marine GDP, if the boundary of the marine economy can be defined and data can be disaggregated. Marine GDP can be, and often is, created by reorganising items contained in standard national accounts, and many countries already produce a marine GDP.[13] The statistical offices for countries such as Norway have computed a statistic that is essentially marine GDP as a one-time exercise. In the marine affairs agencies of other countries, such as Canada, the Department of Fisheries and Oceans generates this sort of calculation. These marine GDP aggregates do not account for depreciation or degradation of marine produced assets (e.g. port infrastructure) or non-produced assets (e.g. fish stocks), because GDP calculations do not consider capital depreciation or degradation of any kind. Existing marine GDP statistics leave out changes in ocean capital because of the design of GDP and not necessarily because of a lack of information or an effort to conceal or ignore these changes. GDP is the wrong tool for assessing the sustainability of the ocean economy.

There are supply-and-use tables for the included sectors products, but these seldom connect to underlying ocean processes. It is not clear how ocean processes influence tourism, but ocean processes likely influence fisheries, and physical ocean processes may influence transportation.

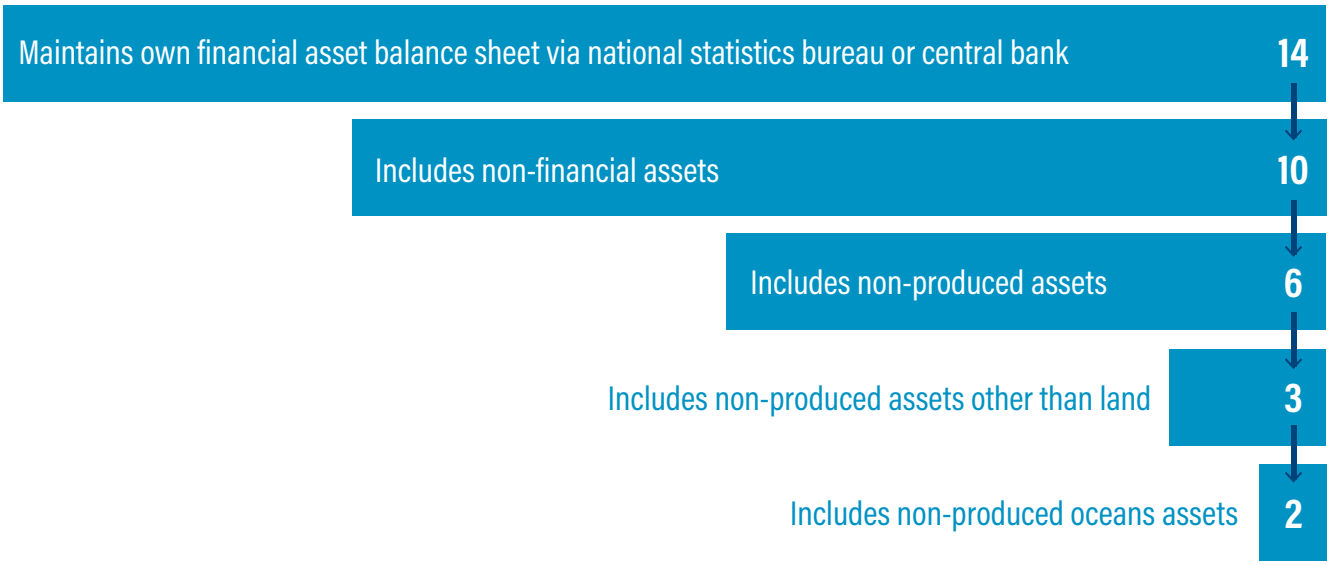
With respect to the ocean, most national accounting effort goes into the national production account. Marine GDP does not provide insights into the well-being people derive from the ocean or ocean sustainability. This is insufficient for the accounts to inform how ocean policy is or is not contributing to well-being or whether or not ocean policy ensures a sustainable ocean future. Including the non-market contribution to welfare, which would generally sit in the income, consumption or expenditure account, is important for understanding well-being, even if it is not part of 'economic production'. The Australian Bureau of Statistics (ABS) has presented headline indicators for the environment, characterising trends in terrestrial biodiversity, the atmosphere and land use for 2006. Yet, for the marine and coastal regions, the ABS (2007) simply states that 'these regions are also important to Australian society and the economy. Many of the ways in which we use the ocean, beaches and estuaries can affect the quality of the ocean's water and the diversity of life within it.' However, no headline indicator is reported for this sector through the program's reporting, which ends in 2012. There are national accounts efforts to track wages in industries that can be identified as ocean-related, such as in Portugal. Other sectors, such as tourism, can be difficult to disaggregate. Furthermore, it is often impossible to tell what fraction of the wage is attributable to various attributes of the ocean. For example, even if beachfront resources were their own category, it would be impossible to tell how much the ocean's biological capital was contributing to wages or revenue without greater survey data that exist in national accounts. Furthermore, the few attempts to measure income beyond the current boundary (Jorgenson 2018) have not focused on the ocean or have taken place outside the purview of formal national accounts, and often not at a scale sufficient for national accounting.

3.2.2 Balance sheets, natural capital and supply-and-use tables

Balance sheets are essential for national ocean accounting. All 14 countries make an official national balance sheet available online. Six countries include non-produced assets, and Japan and Mexico include non-produced assets that are potentially non-produced ocean assets (Figure 5) (OECD 2019). However, a number of other countries reference programs that might involve natural capital accounting or measure non-produced assets (e.g. Jamaica and Canada). However, these efforts do not appear to make it to the official statistics on the national balance sheet.

Half of the 14 Ocean Panel countries have some form of physical account paired with their monetary accounts—physical production sheets—for these aggregated sectors, but we found no complete balance sheets with ocean assets. For example, Kenyan fisheries accounts track physical and monetary flows that are disaggregated by freshwater fisheries, marine fisheries and aquaculture. Ideally, physical accounts would be paired with indicators of the quality or condition of the assets on balance sheets. These are typically not included in national accounts but are critical for natural capital accounts and are part of the UN System of Environmental Economic Accounting guidance. Indicators, such as those for environmental quality, can provide a missing link between physical and monetary accounts. Ocean acidity, for example, can impact oyster biomineralisation, leading to smaller and therefore less valuable oysters (Fitzer et al. 2018). Indeed, these sorts of linkages are similar to those described above about how the condition of a prey fish stock may raise or lower the value of the predator stock. The 2008 System of National Accounts is clear that prices that

Figure 5. Balance Sheets among Ocean Panel Countries



Note: Descriptions are not sufficiently precise to classify fully all non-produced assets. There may be some misclassification, but the pattern appears robust to misclassification.

Source: Authors tally based on publicly available national count data.

come from markets include these 'general equilibrium' interactions (European Commission et al. 2009). Price-influencing interactions are also important for 'non-produced' natural asset valuation. Qualitative changes matter in physical accounts of resources and on the asset balance sheet.

Environmental processes, much like income distributions, are often not characterised adequately by a single number. Namibia is the only member country of the Ocean Panel to link environmental indicators such as sea surface temperature and plankton abundance explicitly with fisheries. The ocean transport sector influences regional ocean acidification (Hassellöv et al. 2013). However, for many countries the data for the transportation or commerce sector in supply-and-use (or input-output tables) are not disaggregated by transport mode. As a result, the share of commercial activity that occurs via maritime transportation is not available in the account. The link between ocean transport, regional ocean acidification and seafood product value (i.e. shellfish), is lost due to low data resolution. The greater the aggregation in the supply-and-use tables, the less useful they are for economic modelling and forecasting and the harder it is to link economic activity and biophysical changes in the ocean.

The ability to disaggregate monetary accounts, physical accounts and environmental indicators is important for characterising the overall state of the ocean economy. For some countries or sectors, maritime activity likely comprises such a large share of the sector that disaggregation is unnecessary. For example, mining and oil extraction in Norway is almost exclusively marine.

Environmental processes, much like income distributions, are often not characterised adequately by a single number.

3.2.3 Satellite accounts

Ten of the 14 countries have a tourism satellite account. In contrast, only two Ocean Panel countries, Portugal and Canada, have dedicated ocean satellite accounts. Only Portugal's is currently produced by the national statistics office. Portugal's efforts often are promoted as a national ocean accounting example, so it is useful to discuss them in a bit more detail.

Understanding what share of the tourism sector's contribution to the economy is due to ocean-related products and services depends, in part, on which ocean-related product and service values are considered. Portugal's ocean account considers 65 different products and services across nine groups. The recreation, sports, culture and tourism group captures a range of activities including recreational and sport boating, cultural events related to the sea, coastal tourism (including state spending on advertising) and imputed rents from second homes on the coast.

Portugal creates a complete set of production, expenditure and income accounts and is able to produce a set of balanced national aggregates for the ocean economy. Portugal includes standard wage and employment data and household consumption information as part of the satellite account. Portugal includes non-produced assets on its national balance sheet, but these do not appear to include non-produced ocean assets.

Portugal's ocean account is one of the most advanced in the world, and is the model for many of the ocean accounting efforts underway. However, its headline numbers address Question 1, and it is less clear that additional effort has been made to address the other types of questions. Of the 65 sectors included, many are only tangentially related to the ocean. For example, shares of 'computer programming, consultancy and related services', 'legal and accounting services' and 'leather and related products' are included in the ocean account. These are industries that can be linked to the ocean but are hardly production from the ocean—Question 2. Using Portugal's 2013 numbers, we find that only 8 percent of the value added of 'sea products' seems to be clearly from the ocean, with another 34 percent possibly being from the ocean, as opposed to related industries. Linking industries to the ocean can mislead about the benefits from the ocean. For example, insurance is included in Portugal's ocean account. This is presumably insurance against ocean storms. It seems that, if anything, this is a cost of the ocean, not a benefit. This highlights the need to be clear about the question and enable disaggregation.

3.3 Country Implementation Globally

A growing number of countries are implementing national ocean accounting, with a focus on product accounts (Colgan 2016). Some individual countries or blocs of countries have further developed or expanded the frameworks for their own use. Eurostat's European System of Accounts 2010, for example, provided much of the methodological guidance for Portugal's Satellite Account of the Sea. However, for some countries interest or capability drives a wedge between framework and implementation. Other countries' capabilities and interest enable them to go beyond the international frameworks, providing experience, lessons-learned and guidance for future refinement of frameworks. These countries strive for backwards compatibility with internationally agreed frameworks, as in the case of China (Wang 2016). The guidance in international frameworks is seldom sufficient to address every scenario and provide complete production accounts for a nation's ocean economy, let alone asset balance sheets. In the case of asset balance sheets, it is likely that the lack of availability of guidance and data to create such balance sheets (which do not currently exist for any country's account of its marine economy) is a 'chicken or the egg' problem. Nevertheless, revision of internationally agreed frameworks is critical to avoid issues of interoperability of national accounts and the challenges of double counting (De Maio and Irwin 2016). Separation of physical and economic data also poses a challenge for balance sheets.

Consider the ocean accounting efforts of the United States, China, New Zealand, Portugal, the Netherlands and Australia. The National Oceanic and Atmospheric Administration's *Report on the U.S. Ocean and Great Lakes Economy* divides ocean productivity into six sectors: marine construction, offshore mineral extraction, tourism and recreation, living resources, ship and boat building, and marine transportation (NOAA 2019). Each of these sectors includes direct and indirect ocean production, where indirect contributions can be inferred using tools like input-output tables. Large gains are achievable using data already collected for national accounting or other national statistical purposes. The NOAA Economics: National Ocean Watch explorer represents a reorganisation of employment data from the U.S. Bureau of Labor Statistics that, coupled with imputed sectorial employment to GDP ratios, provides a first-order glimpse of contributions to the ocean economy by sector at the county (sub-state) level within the United States. Simultaneously, the U.S. Bureau of Labor Statistics reports wages in most marine sectors.

Large gains are achievable using data already collected for national accounting or other national statistical purposes.

Canada divides ocean production into direct, indirect and induced ocean production (Fisheries and Oceans Canada n.d.b). Direct and indirect production flows may depend on produced and/or non-produced assets.

China's Gross Ocean Product uses 12 major sectors to measure the gross value added of China's ocean economy.[14] Nearly half of this index is coastal tourism, just under 20 percent is transportation, and marine fisheries account for just under 15 percent.

New Zealand is a leader producing national balance sheets, but Stats NZ (2018) states, 'The SNA08 [2008 System of National Accounts] conceptually includes a wide range of natural resources beyond those included in New Zealand's accumulation accounts. The omitted natural resources need to be quantified and valued.' New Zealand focuses on land as a non-produced asset, like many other countries. However, New Zealand produces a satellite physical and monetary fish stock account, enabled by New Zealand's broad adoption of individual trade quotas (ITQs) for managing fisheries, which creates a market for the fish asset. Stats NZ claims this is an added benefit of ITQ management (Hammond 2005).

'Natural Capital Accounts for the North Sea: The Physical SEEA EEA Accounts', a pilot project in the Netherlands, represents an advancement towards paired physical and monetary asset accounts. Major headway in this project was achieved by defining boundaries with respect to economic and ecosystem activities and collating and repurposing existing data from Statistics Netherlands and external data sources. The conclusion of the pilot

Current national ocean accounting remains a some what bespoke process.

study was that it is feasible to pursue natural capital accounts for marine ecosystems and that it is possible to complete much of the work using extant data sources.

Determining which industries are and are not included in the ocean sector is not the challenge for the methodology employed in China, Canada, New Zealand and most all other countries that produce these aggregate measures, which define industries in a way that can be linked to the International Standard Industrial Classification of All Economic Activities (Wang 2016). However, some countries, such as the United States, attempt to partition at a scale of sub-classification schemes. It is clear that not all countries are making the same decisions, which is why within-country comparisons through time are more salient than cross-country comparisons. It is also clear that the aggregates do not provide sufficient information to evaluate questions of sustainability, but ideally measures of ocean production are comparable through time within a country.[15]

In practice, national ocean accounting remains a somewhat bespoke process. Reporting systems and frameworks have also been developed to either more easily use existing data sources at the country level, address areas of national interest or tackle unique country-specific accounting challenges.

3.4 Supporting Programs and Other Actors

Supporting programs and actors is a broad group of entities only connected by their interaction with at least two of the following: the ocean, countries and the formal internationally agreed frameworks for national accounting. Some groups exist to support their member countries and the suite of methodologies and other tools available to them (e.g. OECD, EU). Others have specialised agendas, such as the World Wildlife Foundation or the Great Barrier Reef Foundation. There are groups that aim to share information and expertise around national accounting among business and practitioners in a 'bottom-up' approach, such as the Capitals Coalition or the London Group on Environmental Accounting. There are finance organisations or country supporting partnerships aimed at developing technical capacity, such as the World Bank's Wealth Accounting and the Valuation of Ecosystem Services (WAVES), the UN Development Program's Biodiversity Finance Initiative (BIOFIN), the European Union's Mapping and Assessment of Ecosystems and Their Services and the partnership of the UN Development Programme, the Economics of Ecosystems and Biodiversity and the Convention on Biological Diversity (UNEP TEEB CBD).

These organisations can function as filters or mediators through which countries engage with central international accounting frameworks. Finance and capacity-building organisations like WAVES (https://www.wavespartnership.org/) facilitate development of institutional capacity. Regional supporting organisations like Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) can provide management solutions and partnerships for promoting sustainability among groups of countries.

Many of these organisations solicit academics, other NGOs and outside consultants to produce fact-finding, momentum-building reports or both that address gaps or areas of interest in national accounting practices for the marine sector. Alongside these reports exist evaluations, methodologies and estimates produced in peer-reviewed academic literature. Below, we address a few of these reports and studies produced by non-country organisations as they pertain to production accounts, balance sheets and income accounts. This is not an exhaustive survey, but it represents the use and misuse of national accounting for the ocean. We provide illustrations of three types of reports, though the categories are fluid: motivating reports, illustrative reports and policy reports. Decision-makers interested in the performance of the ocean or blue economy should

- make sure the results align with the question the decision-maker is asking;
- prefer a repeated series of reports or reports that document changes and enable disaggregation; and
- assess the agenda of the report's producer and if the claims align with the statistics and data used.

National statistics offices should pay attention to these reports to understand the information demands, especially demands that national statistics offices might be failing to satisfy. Jorgenson (2018) suggests this is a substantial problem once one moves beyond production questions.

3.4.1 Motivating reports

Most people have seen at least one of the motivating reports. The thesis of these reports is that the ocean is important, the ocean provides opportunity or the ocean is valuable. These reports at times misuse national accounting because of the belief that GDP or some economic number implies importance. Others, like the UN working group, the World Bank and other stakeholders' high-resolution Blue Economy report, highlight the importance of ocean resources for least developed countries and small island developing states without promoting a single metric or calculating an aggregate value. The Blue Economy report characterises the 'blue economy' by assembling a diverse reference list of sectors and constructing a case for their importance. It advocates expanding the boundary of the ocean economy beyond fisheries to include the extraction of marine non-renewables, commerce and trade, and indirect contributions to economic activities. The report provides a framework for mapping *ocean-related* activities to sectors and then to major drivers of demand and growth in these sectors. The **headline policy recommendation of the Blue Economy report urges countries to accurately value the contribution of natural ocean capital to welfare to better guide policy decisions and trade-offs**. This means focusing on net income and balance sheets, not GDP. Many countries have taken up this challenge.

Other motivating reports attempt to produce one-off 'large number' monetary valuations of ocean environments to attract attention. For example, the 2015 World Wildlife Fund (WWF) report *Reviving the Ocean Economy* argues that 'the future of humanity depends on oceans' healthy living conditions', drawing attention to the crucial point that ocean biodiversity contributes to human well-being (WWF 2015). The report presents an indicator of the annual value generated from the global ocean economy or a 'Gross Marine Product' of ~US$2.5 trillion and a total ocean asset value of US$24 trillion.

Another example is the 2017 Deloitte report on the value of the *Great Barrier Reef, at What Price: The Economic, Social and Icon Value of the Great Barrier Reef*, which provides a headline indicator that the Great Barrier Reef contributes A$6.4 billion to Australian GDP.

These reports should be treated as little more than 'calls to action'. First, because they tend to be one-offs, they provide little useful information about trends, though some reports do look at changes over time. More critical is the risk of their undercutting the message that ocean products and assets are uniquely important, and sometimes irreplaceable. In *Reviving the Ocean Economy* and similar studies, one of the chief methods for computing the total value of gross marine product is rescaling the gross value added from the ocean economy available from G20 countries. Despite countries' use of different sectorial boundaries, it is clear that for most countries shipping, tourism and recreation, and other activities only tangentially related to the biological condition of the ocean contributed the most to the gross value added figures (NOAA 2019). Most of the asset value is transportation, coastal capital and other forms of produced capital. These are important, but do not speak directly to the importance of the biology or 'living conditions' of the ocean. Assessing the sustainability of the ocean economy requires monitoring changes in the asset values or change in the balance sheet over time, coupled with assessment of the role of biodiversity in net national income, or development of a biological non-produced asset account tracked through time.

The numbers presented in the 2017 Deloitte report imply a gross value added of A$18,354 per square kilometre, given that the Great Barrier Reef covers approximately 350,000 square kilometres. This is almost equivalent to Australian

The headline policy recommendation of the Blue Economy report urges countries to accurately value the contribution of natural ocean capital to welfare to better guide policy decisions and trade-offs.

Sunken Billions is a benefit-cost analysis that highlights the potential gains of a policy change. This is not part of most national accounts.

agricultural GDP per square kilometre when dividing official statistics by the total agricultural land area (ABS 2018; Trading Economics n.d.). The report also provides an estimated asset value of A$56 billion, an asset value of A$1,606/hectare, right around the median price of agriculture land in Australia (ABC 2018). This would make the value of the Great Barrier Reef equivalent to that of the 10th-largest Australian public company, right behind BHP Billiton. While not trivially small, these numbers are shockingly small in the context of something as unique and irreplaceable as the Great Barrier Reef. Of course, if asset management can be improved, then the value will be lower than expected under optimal or improved management (Fenichel and Abbott 2014).

3.4.2 Illustrative reports

A second set of reports are illustrative reports. Good examples of these are the World Bank's *The Changing Wealth of Nations* and UN Environment's *Inclusive Wealth Reports* (Lange et al. 2018; Managi and Kumar 2018). These reports illustrate how comprehensive national balance sheets could be used to assess sustainability. However, they do not focus on ocean or blue assets. Moreover, the data used to produce these reports enter in a relatively aggregate form. National statistics offices should be able to do much better. Most academic studies fall into this category as well, where the goal is to illustrate methods rather than to provide regularly produced, definitive numbers.

3.4.3 Policy reports

The third set are policy reports. These reports would ideally take ocean accounts as their starting point, but historically they have had to generate national-accounts-style data that were not readily available. A good example is *The Sunken Billions: The Economic Justification for Fisheries Reform*, jointly published in 2009 by the World Bank and FAO (Arnason et al. 2009). The report focuses on the contribution of wild marine fisheries to the global economy and the economic production lost due to overfishing and depleted stocks by comparing potential and realised economic benefits. The report models the world's fisheries as a single stock and uses global aggregate data to estimate the production deficit at around US$50 billion per year (in 2004$). This number is similar in magnitude to the 1992 FAO study *Marine Fisheries and the Law of the Sea: A Decade of Change*, which estimated the aggregate production deficit incurred by the world's fishing fleet at $22 billion (in 1989$). Adding in the capital cost, this early FAO report estimated the deficit at $54 billion per year. To put these numbers in context, the estimated gross revenues of the global marine fish harvest in 1989 were $70 billion. The methodology employed a single-stock model to estimate the deficit, leaving many questions open about the spatial heterogeneity of the operating deficit. The follow-up, *Sunken Billions Revisited*, followed the same approach as its predecessor but delved further into the regional analysis to provide more disaggregated impacts and policy recommendations. This study found an $83 billion production deficit for the year 2012. ***Sunken Billions* is a benefit-cost analysis that highlights the potential gains of a policy change. This is not part of most national accounts.** However, robust national accounts would be a good starting point for this sort of analysis.

4. Guidance for a Path Forward

Developing national accounts to guide economic development for the ocean is critical but less daunting than it may seem. Many of the data already exist in national accounts, in government agencies or in scientific databases; the knowledge to build the connections exists, but it is dispersed throughout government, academia, business and NGOs. As we have seen, many countries already produce reports that are or are nearly marine GDP. These reports, however, make clear that GDP is about means, not about ends or sustainability. The ocean's biophysical assets are valuable. But marine GDP calculations do not and cannot measure this. Even as a measure of income, the dominance of shipping and coastal development in these sums could obscure the mostly unmeasured non-market income components. Academics and international organisations, such as the World Bank, do not have access to the fine-level data that most countries' statistics offices can access. Therefore, **country-level statistics offices need to develop a sequence of accounts reflecting Figure 1**, then partition out the ocean sections with reporting tools that enable adjustments to the ocean economy boundary. Changes in the country's ocean balance sheet are the country's 'ocean wealth index' for assessing the sustainability of blue development.

Experience implementing the System of Environmental Economic Accounting (United Nations et al. 2014) shows that even incomplete accounts can inform policy. For example, countries have started water accounts with available data on municipally supplied water. Subsequent revisions have added estimates of household, industrial and other use. Incomplete accounts highlight critical areas of data gaps and provide bounds useful for making policy decisions. It is likely that in the near future many more data sources will be available to populate ocean accounts. Indeed, this is a clear case of needing to plan for the data of the future rather than plan around existing data or the data of the past. With this in mind, we offer cross-cutting Opportunities for Action for developing national ocean accounts.

4.1 Four Principles of Accounting for a Sustainable Ocean Economy

1. Ask multiple questions and expect multiple answers, especially questions about income and sustainability (balance sheets) in addition to production. This means that the impacts of policies and decisions about the ocean economy should be evaluated based on at least three indicators: income, production and ocean wealth.

2. Build on the existing structure of the System of National Accounts and System for Environmental-Economic Accounting so that ocean accounts are compatible with existing national accounts, and with international statistical standards.

3. Avoid an overreliance on GDP, which is not an indicator of either sustainability or the societal ends of economic activity. Do not use a hammer when you need a wrench.

4. Lead or contribute to collaboration efforts to improve national ocean accounting systems, including global partnerships to share best practices and build capacity. Such efforts will likely involve creating new integrated data-management systems for ocean accounting and other purposes

[the ocean] is a clear case of needing to plan for the data of the future rather than plan around existing data or the data of the past.

4.2 Crosscutting Opportunities for Action for Developing Credible Ocean Accounting

Eleven general crosscutting Opportunities for Action support the implementation of these principles, with additional detailed Opportunities for Action in the areas of physical measurement and valuation:

1. National statistical offices, in partnership with marine agencies, need to develop a complete sequence of national ocean accounts: product, income, balance sheets and supply-and-use tables. This should be achievable by 2025. It is important to aggregate these to a few key headline indicators (Figure 1) and be able to disaggregate to examine specific sectors and constituencies nested within the ocean economy. The sequences of accounts provide a commonly agreed set of facts about the ocean and its relationship to human benefits. This is the starting point for ocean policy discussions.

2. Countries need to be able to track their own progress through time. Cross-country comparisons are of secondary importance and substantially more challenging to make.

3. Leadership needs to ask the right questions. National ocean accounts are only useful if national leaders use them to ask questions about the state of the ocean system and ocean economy. This needs to start now. Information on ocean income and changes in the ocean balance sheet, in addition to ocean GDP, needs to be considered in the decision-making process.[16] If asking for a hammer when you need a wrench is not helpful, worse is to then use the hammer to drive in the bolt. That aptly describes what is currently being done with GDP with respect to economic well-being and sustainability.

4. Avoid one-off accounts or reports. National ocean accounts increase in value the longer they are kept and the more frequently they are updated. The value of national ocean balance sheets may take years to fully materialise, but they would greatly enhance a country's ability to make decisions compatible with sustainable development.

5. The sequence of ocean accounts needs to be a structured compilation of consistent and comparable information concerning marine and coastal environments, social circumstances and economic activity. Standardisation enables a degree of third-party verification.

6. Ensure the compatibility of ocean accounting efforts with international statistical standards and approaches, mainly the System of National Accounts (SNA), the System of Environmental Economic Accounting (SEEA) and also other broadly accepted initiatives, such as those reviewed by Jorgenson (2018) (UN Stats n.d.a; SEEA n.d.).

7. Ensure the compatibility of ocean accounting efforts with the 10 Fundamental Principles of Official Statistics endorsed by the UN General Assembly in January 2014. These principles were designed as a reference point to ensure that official statistics are fit-for-purpose given their critical role in policy decision-making in support of sustainable development and securing public trust in governance (UN Stats n.d.b; UN-ESC 2013).

8. National governments should ensure that their national accountants, economic analysts and marine scientists participate in the workshops organised by the UN Statistical Division and associated organisations for developing ocean accounts. This helps to maintain standards and increase credibility. Furthermore, these international organisations need to evolve to provide a degree of third-party verification of accounts coupled with capacity-building assistance.

9. National statistics offices should use interactive dashboards (e.g. Figure 3) for ocean account reporting. Ocean accounts need to address a variety of questions broader than Questions 1–6. Therefore, it is important that users have the ability to explore the data, aggregate and disaggregate sectors and groups of people, alter the account boundaries and access ethically acceptable disaggregation by digital means.

10. National leaders need to take the time to 'play with and explore' these dashboards to learn about the state of the ocean economy. This recommendation is intended to empower decision-makers. In the

past, such dynamic structures were not feasible and would have required volumes of reports that no decision-maker had time to read. Old print media required statisticians to make decisions to generate 'hard copy'. This constraint is vanishing rapidly. New data-management and visualisation software is allowing these changes to be made through a user-friendly interface in real time, which allows the important political decisions to be shifted back to the policymakers and away from national statisticians and scientists. Corporations are already shifting to interactive dashboards for decision-making. National governments need to do so as well. This transition requires decisions by leaders to dedicate funds in national budgets for upgrades to national account reporting.

11. Governments need to invest in data architecture and engineering at levels surpassing global multi-national companies. These investments are necessary to connect fine-scale data about the marine environment with detailed economic data into supply-and-use structures and other data structures for national accounting and forecasting the ocean economy. These investments should build on existing Earth observation programs when possible. Investment must also include investments in people. Hardware and software alone will not solve the problem.

4.2.1 Know the condition of the ocean

- National statistics offices need to work with marine scientists, agencies or organisations to identify marine data and audit their feasibility for use in national accounts.
- Direct digital pipelines need to be developed from marine agencies to national statistics offices without first aggregating. For example, fish stock assessment data should be matchable to valuation data. Surveys conducted by marine agencies, such as fishing log books, need to be accessible to national statistics offices. There are confidentiality issues with such data, but many national statistics offices already access micro-level tax data. Safeguards and appropriate regulatory frameworks for data privacy, anonymisation and use need to be put in place.
- National accountants and country scientists need to assemble physical account measurements to provide easy-to-use data structures for prospective economic forecasts such as regional development analyses, general equilibrium models that include feedbacks with the environment (Kerry Smith 2012) and other forms of integrated assessment modelling (Kling et al. 2017). Decision-makers need to ask how non-market effects are treated in economic analyses.
- Not all data need to be produced locally. There is an increasing role for remotely sensed data. Various national governments are increasingly creating and using fine-scale global marine data sets derived from satellite-based sensors. Countries should consider using these data, but it would also be good for multiple nations or coalitions to produce and certify some of these products to reduce duplicate effort. This is not limited to geographic data but also includes physical, geo-chemical and biological data. Data should be assembled on a regular basis at reasonable time scales.

National statistical offices need to work with national marine scientists, agencies or organisations to identify marine data and audit their feasibility for use in national accounts.

4.2.2 Use valuation to understand economic interconnections and trade-offs

Valuation is critical in order to enable analyses in comparable units and to analyse explicit or implicit trade-offs. Furthermore, valuation forces society to 'look in the mirror' and observe the trade-offs being made. Valuation is not without controversy. Part of the confusion is that valuation is often misused in an attempt to estimate a 'total value' where the thought experiment asks what society would be willing to pay to avoid losing the natural asset or ecosystem service

completely. This is fundamentally different from the value added of a production process connected to the ocean, the additional economic well-being individuals experience with a change in the condition of the ocean or the expected change in net present value available given of an ocean natural asset under a specific management policy. These last three questions align with the types of questions one can query of national account data. National statistics offices should focus on these latter three questions, and decision-makers should interpret valuations as such.

- Heads of government need to start asking about changes in ocean balance sheets that contain produced and non-produced assets today. National statistics offices need to start producing these balance sheets. It is also important to accurately value produced marine capital. Some forms of produced marine capital, such as ships, are relatively easy to account for. There are market prices, but even some forms of marine produced capital are challenging, such as port infrastructure. For others it is important that national statistics agencies use methods to impute value (Hulten 2006) for produced and non-produced assets in general equilibrium systems (Carbone and Smith 2013; Fenichel et al. 2018). Including ocean non-produced natural assets on the balance sheet is important for two reasons:
  - The ocean's natural capital, non-produced assets, stores substantial wealth that is important for a sustainable ocean economy.
  - The valuation of produced ocean assets is influenced by the condition of ocean natural assets. Excluding natural assets runs the risk of mis-valuing produced ocean assets. For example, the value of fish-processing machinery may be influenced by a processor's ability to secure fish or the value of port infrastructure may depend on barrier islands and other natural protective features. Rouhi Rad et al. (2019) shows that the value of the locks in the Panama Canal, which transit close to 5 percent of global marine shipping, increases with the amount of water in the canal system during the dry season. Complementarity between natural and produced capital could be common.
- Heads of government and other policy leaders should encourage their national statistics offices (NSOs) to incorporate a broad definition of income to address ends because NSO heads are already engaging in these conversations. This should be in addition to a more restricted money income boundary to balance with produced means. The SNA's income boundary is governed by the production boundary (European Commission et al. 2009). This is a shortcoming, because 'measures of welfare are needed to appraise the outcomes of changes in economic policies and evaluate the results' (Jorgenson 2018). Irving Fisher (1906) defined income as services, and the ocean provides substantial services outside of the market economy. These services are also income.[17] Heads of state should start asking heads of NSOs about revisions to capture these sources of income.
- The international national accounting community should provide technical guidance for country-level statistics offices on welfare measures beyond the current income boundary. This guidance should adapt the vast literature on non-market valuation intended for benefit-cost analysis (e.g., Freeman 2003) and be developed to make use of available micro-data. An important issue related to research is that valuation for national accounting needs to focus on existing or agreed-to institutions, even when these are 'inefficient'. This means care must be taken not to use hypothetical changes in management to compute potential changes in value. It is unreasonable to assume 'optimal' management that is inconsistent with prevailing institutions (Fenichel and Hashida 2019). There is a need to map into actual situations existing valuation methods that focus on potential changes, and to develop benefits-transfer libraries (Boyle et al. 2010).
- The accounts should be used to track progress over time, provide data to evaluate past programs and provide the starting point to analysis of alternative ocean policies. Furthermore, aggregate income statistics need to be able to be disaggregated because income and consumption is where equity is reflected (Jorgenson 2018). There is a need to know what money and non-money income stems from the ocean and to whom.

5. Conclusion

When the Wright brothers took flight in 1903 there was no dashboard. As planes became more complex, gauges and indicators were added. Today, nobody would fly on a plane where the pilot only looked at the air speed. It is unfathomable that the joint economic-physical-biological system of the ocean economy is not at least as complex as an airplane. So how can we expect to develop a sustainable ocean economy, the 'blue economy', with a single indicator, ocean GDP? The simple answer is we cannot. In this Blue Paper we have discussed **a system of national accounts with multiple indicators** and how they should be applied to the sustainable ocean economy. We have emphasised the need to develop the underlying data structures to anticipate unintended consequences of decisions that may increase production in the present at great cost to the opportunities afforded to future generations, or increase production to a select organised few at a cost to the great disorganised many. The opportunities for the ocean to spur production bring this challenge into focus. On the one hand, the OECD (2016) and others have raised the prospect of the ocean's spurring new means of production. On the other, there is great concern over the future of biophysical ocean processes, as highlighted in SDG 14 on 'Life under Water'. Without an accounting system capable of producing multiple, well-designed indicators it is unclear if these causes align, compete or simply coexist. Multiple indicators are needed, and the existing ***system*** of national accounts is a good place to start to look for them.

While terrestrial asset accounts capture the greatest fraction of the human population and manufactured capital, the sphere of influence that ocean assets have in governing global environmental systems (e.g. climate and weather) is unmatched. In addition to direct economic activities involving ocean resources, the ocean links the impacts of climate warming at the poles to critically important sources of food via ocean acidification, the resilience of infrastructure via sea level rise and many other facets of the global economy via interactions with atmospheric processes and weather events. Measuring the ocean economy in national accounts requires addressing the full suite of challenges of developing measures to determine if society is meeting the needs of current generations without compromising the ability of future generations to meet their needs. Using national accounts to measure 'ocean development' can be a model for using national accounts to measure 'sustainable development'.

Endnotes

1. In 1947 the United Nations began chairing the design of a standardised system of national accounts to measure the total product and income of a nation over a specific period of time (the first release was in 1953). Subsequently, the system, adopted by virtually all UN member states, has been used (often erroneously) to make broader statements about social progress. The international system has been revised multiple times. The current version is the 2008 System of National Accounts (European Commission et al. 2009).

2. These include biological, ecological, physical and chemical data.

3. The 2008 SNA admits to the arbitrary nature of including household produced goods but excluding household produced services. This is done to support traditional monetary and fiscal policy concerns.

4. It is often suggested to reformulate non-declining wealth as non-declining per capita wealth. However, it is unclear that per capita is the “correct” normalisation (Jorgenson 2018), for two reasons. First, some ocean services are non-rival, and all individuals experience the same service level. Therefore, the more people, the more service, the more wealth, and in such a case we should not divide by the total population. Second, per capita normalisation carries a certain distributional element that implies that distribution of access to ocean capital takes a certain form, but it is possible to increase per capita measures while reducing the most common (median) experience.

5. Nobel laureate Kenneth Arrow et al. (2004) formalise the definition of sustainable development as requiring constant or increasing opportunities, where the concept of wealth has evolved to be a measure of future opportunities. Wealth itself is the net present value of income.

6. The Blue Paper on "The Expected Impacts of Climate Change on the Ocean Economy" discusses the strong link between the ocean and climate.

7. The Blue Paper on "Integrated Ocean Management" focuses on marine spatial planning.

8. The Blue Paper on "Technology, Data and New Models for Sustainably Managing Ocean Resources" focuses on data and emerging technologies.

9. Ideally, BSUs covering marine and coastal locations should designate a three-dimensional volume including the ocean, the seabed and subsoil, combined with a shoreline vector delineating the ocean from land. Conditions that can be assigned to and accounted for within BSUs include, for example, acidification (pH), eutrophication (BOD), temperature (°C), and plastics (T), and the abundance of various species.

10. Fair sharing of the ocean is addressed in the Blue Paper on "How to Distribute the Benefits of the Ocean Equitably".

11. Measuring sustainability with balance sheets requires considering access to assets and going beyond per capita measures (Jorgenson 2018).

12. Our analysis is based on data we could locate online, so gaps in the analysis may reflect that the data are not easily located through the internet rather than that they are missing.

13. See volume 2, issue 2, of the Journal of Ocean and Coastal Economics for country-specific experiences.

14. China’s Gross Environmental Product index alters the production account boundaries, whereas the Gross Ocean Product is a conventional satellite account produced by China’s Ministry of Natural Resources.

15. Cross-country comparisons are challenging, as Jorgenson (2018) explains. Market exchange rates can be misleading, which leads the World Bank to produce purchasing power parity conversions. However, it is unclear how purchasing power parity can be developed when some goods or income-generating services are not market-based.

16. Some national statistics offices produced these or similar indicators in the past but stopped because they were not used.

17. The SNA makes the argument for excluding non-market income because the information is not useful for monetary policy. However, national accounts are used for much more than monetary policy.

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