APPLIED ECOLOGY

The Ocean 100: Transnational corporations in the ocean economy

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The ocean economy is growing as commercial use of the ocean accelerates, while progress toward achieving international goals for ocean conservation and sustainability is lagging. In this context, the private sector is increasingly recognized as having the capacity to hamper efforts to achieve aspirations of sustainable ocean-based development or alternatively to bend current trajectories of ocean use by taking on the mantle of corporate biosphere stewardship. Here, we identify levels of industry concentration to assess where this capacity rests. We show that the 10 largest companies in eight core ocean economy industries generate, on average, 45% of each industry's total revenues. Aggregating across all eight industries, the 100 largest corporations (the "Ocean 100") account for 60% of total revenues. This level of concentration in the ocean economy presents both risks and opportunities for ensuring sustainability and equity of global ocean use.

INTRODUCTION

Governments have increasingly focused their attention on economic activities linked to the ocean in some manner, identifying them as a discrete segment often labeled as the "ocean economy" in national accounts (*1*, *2*). The Organisation for Economic Co-operation and Development (OECD) has defined the ocean economy as the sum of the economic activities of ocean-based industries, and the assets, goods, and services of marine ecosystems, and has presented the concept as a lens through which to view the diverse industries that share the ocean (*2*). Some scholars, practitioners, and policy-makers have used the term "blue economy" synonymously, to encapsulate international interest in ocean-based economic development, while others have noted a wider range of definitions, resulting in contested terminology at the heart of the global discourse (*3*, *4*).

The ocean economy has been predicted to grow faster than the global economy from 2010 to 2030 (*2*), contributing to widespread aspirations of an unprecedented era of blue growth (*5*), particularly among coastal and island states (*3*, *6*). The prospect of such growth has raised concerns about ocean industrialization and the subsequent transformation of marine ecosystems, further privatization of ocean resources conceptualized as public goods in many states, and inequitable distribution of the benefits from ocean use (particularly for traditional users) (*5*, *7*–*12*). Viewing the ocean as an engine for future economic growth may conflict with both the social and environmental dimensions of goals for sustainable ocean use agreed over the course of decades in international commitments and treaties (e.g., the United Nations Convention on the Law of the Sea, Agenda 21 of the 1992 United Nations Conference on Environment and Development, and the United Nations 2030 Agenda for Sustainable Development). For instance, global progress is behind schedule for achieving Sustainable Development Goal 14 (SDG 14—"Life Below Water") and associated targets for reducing overfishing and pollution, addressing ocean acidification and securing access for small-scale fisheries, among others (*5*, *13*). Slow progress in ocean conservation and sustainable use is also expected to have detrimental implications for achieving other international policy goals, such as ending poverty and hunger (SDGs 1 and 2, respectively) (*14*).

Aligning the activities of the growing ocean economy with global policy goals for more sustainable ocean use and conservation will require not only improved governmental regulations (*8*) but also increased cooperation among governments, civil society, scientists, and the private sector (*15*, *16*). The context for such engagement with the private sector is a global economy in which consolidation among a small number of transnational corporations (TNCs) has become a dominant feature and where relatively few corporations control a large market share of the overall output or sales for a particular product or service (*15*, *17*, *18*). Industries are increasingly characterized by global scope and complexity, with large TNCs operating across extended supply chains and exercising a unique capacity to capitalize on and monopolize markets (*19*). This relatively small number of the world's companies has been compared to keystone species in an ecosystem and conceptualized in the age of the Anthropocene as "keystone actors" functioning within an interconnected biosphere (*20*) or alternatively referred to as "keystone companies" by the World Benchmarking Alliance to illustrate their importance for achieving SDGs (*21*).

Because of their disproportionate size and power, these TNCs may generate large environmental and social externalities that slow progress toward achieving sustainability goals (*22*). They may also have operational strategies at odds with the principles of sustainable ocean use and may fall short of delivering results in the absence of enhanced regulation and enforcement (*23*). The organizational complexity of many TNCs, with large networks of subsidiaries and international operations, also creates a level of opacity about which actors are of decisive importance for global sustainability. For this reason, we suggest that identifying the extent of concentration in the ocean economy (Table 1) and the TNCs that function as keystone actors in the ocean is a necessary step toward increasing transparency and accountability for better ocean governance. Given their potential to be more flexible and agile than governments (individually or collectively), identifying TNCs whose viability is dependent on ocean use could provide a basis for exploring if such companies are willing

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Table 1. Ocean economy industries. The definitions are according to the OECD (*2*). Revenues are for 2018, with percentages representing the respective industry's share of the total revenues in the ocean economy from these eight industries. See section S1 and table S4 for details on estimates and sources.

Industry	Definition	Revenues (USD billion)	Notes
Offshore oil and gas	Exploration and production of offshore oil and gas, including the operation and maintenance of equipment related to this activity	830 (45%)	This revenue figure does not include onshore oil and gas operation
Marine equipment and construction	Manufacturing of marine equipment and materials	354 (19%)	Examples include machinery, valves, cables, sensors, ship materials, aquaculture supplies, and wind farms
Seafood	Industrial capture fisheries, aquaculture, and fish processing activities	276 (15%)	Includes farm production of seafood and micro- and macro-algae, economic activity related to catch production, and the preparation and preservation of fish, crustaceans, and mollusks, production of fishmeal for human consumption and animal feed, as well as processing of seaweed. Does not include small-scale or artisanal fisheries
Container shipping	Transportation of containerized freight through the ocean	156 (8%)	Does not include the building and repair of vessels, nor oil and gas cargo, dry bulk cargo, or car carrier/RORO
Shipbuilding and repair	Building, repair, and maintenance of ships and boats	118 (6%)	
Cruise tourism	Transportation of passengers through the ocean for tourism and recreation purposes	47 (3%)	Serving as a potential measure of ocean-related tourism and recreation activities, although it does not include activities located in a place near or adjoining the coast, which are often aggregated with tourism and recreation data not related to the ocean
Port activities	Cargo handling, logistics, security, employment, as well as maintenance, development, and construction of port infrastructure	38 (2%)	
Offshore wind	Production of electric power from offshore wind	37 (2%)	Encompasses companies that own and operate offshore wind farms. Offshore wind turbine suppliers are included in the marine equipment and construction industry

to mainstream stewardship principles across their operations to enhance the social and environmental sustainability of the ocean economy.

RESULTS

The 10 largest TNCs in each of the eight core ocean economy industries generated, on average, 45% of the respective total industry revenues in 2018 (Fig. 1 and table S1). The ocean industries with the highest level of concentration were the cruise industry (93%), container shipping (85%), and port activities (82%). Yet, individual industries were characterized by vastly different revenue volumes (Table 1). For instance, each of the top 10 offshore oil and gas production TNCs had annual revenues exceeding any of the largest TNCs in the other industries, except for container shipping (table S1).

It is therefore of interest to consider not only concentration across individual industries of the ocean economy but also concentration within the ocean economy as a whole. Across the industries assessed here, the top 100 companies (i.e., the "Ocean 100") generated a total of USD 1.1 trillion in revenues in 2018, representing 60% of the total revenues of USD 1.9 trillion generated by these ocean industries (Fig. 2).

The biggest industry in the Ocean 100 was offshore oil and gas, whose TNCs accounted for approximately 65% of the total revenues, followed by shipping (12%), shipbuilding and repair (8%), maritime equipment and construction (5%), seafood production (4%), cruise tourism (3%), and port activities (2%). Only one TNC in the offshore wind industry was big enough to be included in the Ocean 100 list, generating <1% of total revenues of this group. The

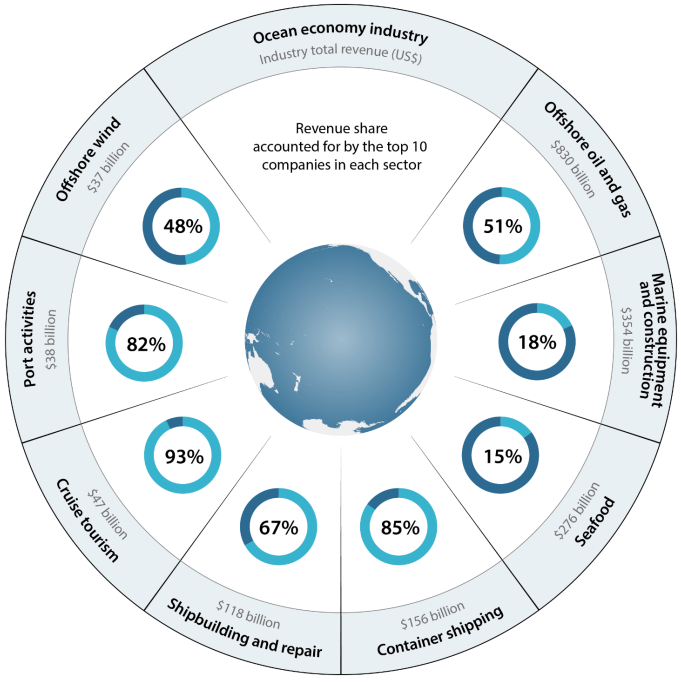

Fig. 1. Concentration in the ocean economy. Revenue share accounted for by the 10 largest companies in each of the eight core industries of the ocean economy. The outer band indicates the respective industry total revenue in 2018 USD. Note that the level of concentration for "marine equipment and construction" is highly conservative due to the use of the higher end of total industry revenues, which we estimated between USD 83 and 354 billion. See section S1 for details on estimates and sources.

biggest company in the ocean economy by annual revenues was the oil and gas company Saudi Aramco, and 9 of the 10 largest companies in the ocean economy were in the offshore oil and gas industry (Fig. 2). Sixty of the 100 TNCs are publicly listed on stock exchanges (though several are majority state-owned), and these companies generated 63% of the 2018 revenues of the Ocean 100 (with 21 of the remaining 40 TNCs being state-owned enterprises, and the other 19 private companies).

Given the prevalence of offshore oil and gas TNCs in the Ocean 100 (and subsequent volatility in oil prices), an alternative list of the Ocean 100 excluding the offshore oil and gas industry was also developed to show the distribution of revenue among TNCs in the rest of the core ocean economy industries (fig. S1). Excluding offshore oil and gas, the biggest company was A.P. Moller-Maersk, and 5 of the 10 largest companies were container shipping TNCs. Overall, the biggest non-oil and gas industry was container shipping (30%), followed by shipbuilding and repair (23%), maritime equipment and construction (16%), seafood production (13%), cruise tourism and port activities (8% each), and offshore wind (2%). A majority of these TNCs (62%) are listed on stock exchanges and generated 68% of the total revenues of the non-oil and gas Ocean 100 (30 of the remaining 38 TNCs being private companies, and the other 8 state-owned enterprises).

Although transnational in operations, the location of the headquarters of the TNCs can provide some indication of the geographic distribution of the ocean economy revenues and benefits. Of the Ocean 100, TNCs with the highest share of the total revenues were located in the United States (12%), followed by TNCs headquartered in Saudi Arabia and China (8% each), Norway (7%), France (6%), the United Kingdom (5%), and South Korea, Brazil, Iran, the Netherlands, and Mexico (4% each) (Fig. 3 and table S2). Ocean economy industries exhibited distinct regional patterns of distribution, with Saudi Arabia, Brazil, Iran, Mexico, and the United States, respectively, hosting the largest offshore oil and gas TNCs; China, South Korea, and the United States hosting the largest shipbuilding and repair TNCs; and South Korea, China, and Italy hosting the largest maritime equipment and construction TNCs (Fig. 3 and fig. S2).

DISCUSSION

The level of concentration of TNCs found in the ocean economy is consistent with the structure of the global economy and its extended supply chains (*15*, *18*). While our findings are comparable with recent estimates showing high degrees of concentration for terrestrial industries and commodities (e.g., 3, 4, 5, and 10 companies account for 60, 84, 90, and 40% of commercial crop seeds, pesticides, palm oil, and coffee global markets, respectively) (*15*), the eight industries of the ocean economy assessed here represent relatively mature industries with global supply chains. High levels of technical expertise and capital that are needed to operate in the ocean environment may pose further barriers to entry for smaller companies operating in these established ocean industries, as well as in more recent ones such as marine biodiscovery, offshore renewables, or deep-sea mining. Similarly, geographical patterns of ocean industry dominance, where TNC headquarters were found to be clustered by industry and location (Fig. 3 and fig. S2), may reflect the influence of distinct political contexts shaping their development (e.g., as governments are the largest beneficiaries of offshore oil and gas revenues, capturing 41% of total industry revenues, or given patterns of government subsidies to develop shipbuilding, public investment in port infrastructure, etc.).

The risks of a concentrated ocean economy

High levels of concentration in the ocean economy pose clear risks to achieving widely shared goals for sustainability by contributing to inequality in access to ocean benefits and resources (*10*). The dominance of a small number of TNCs, headquartered in a handful of countries and regions, can enable targeted lobbying of regulators to weaken social or environmental standards (e.g., the alleged lobbying of shipping companies to avoid regulation of greenhouse gas emissions) (*24*) or to set barriers to entry in an industry that hinder sustainable practices across national or international levels (*15*). This risk may be particularly high in areas characterized by weak ocean governance or substantial levels of corruption (*25*). Such concentration has contributed to imbalances in political power and, in some cases, "ocean grabbing," where the benefits from use of finite ocean space and resources characterized as public goods are captured by a few (*11*, *26*), while traditional ocean users (who are often politically marginalized) lose access to resources and a just operating space within the ocean economy (*9*). For example, loss of access for small-scale fisheries, which are by far the ocean's largest employers (*9*), has threatened human rights (*27*) and exacerbated inequity (*10*). Similarly, because of the interdependent nature of the SDGs, a loss of access to ocean benefits and resources would also compromise progress toward other goals such as ending poverty (SDG 1) and hunger (SDG 2) (*28*).

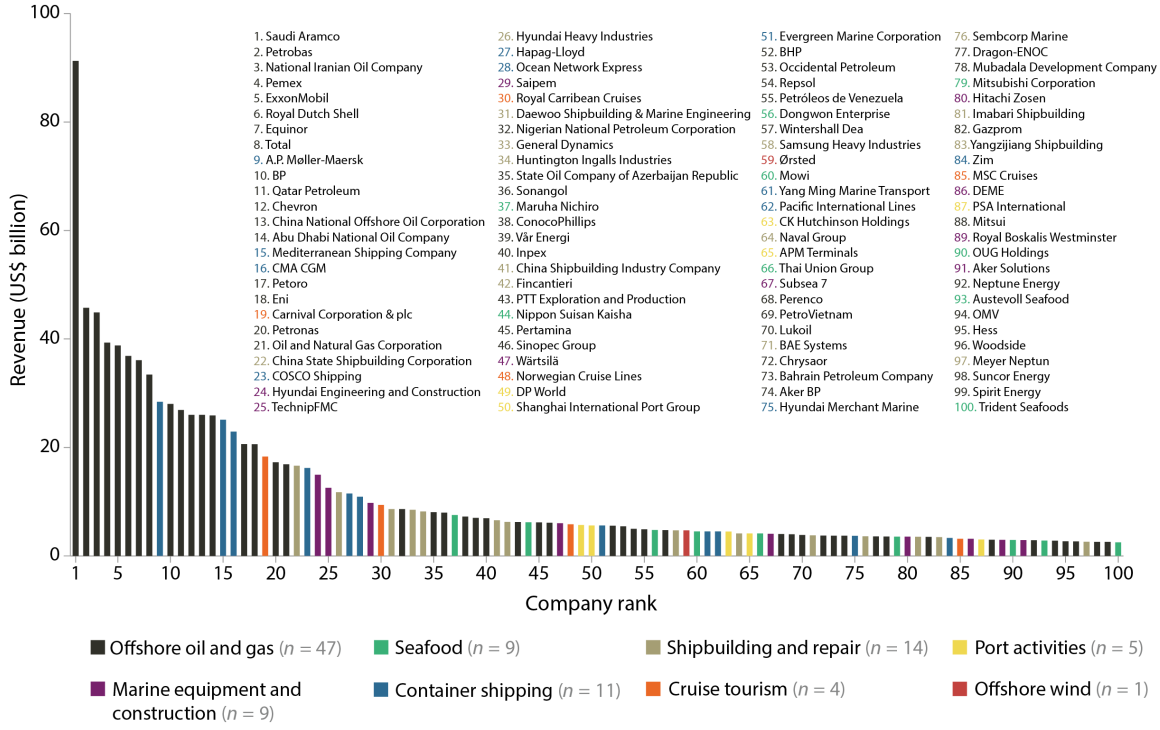

Fig. 2. The Ocean 100. The hundred largest TNCs in the eight core industries of the ocean economy by annual revenues in 2018. Only revenues that could be explicitly linked to the ocean economy were included (see details in Materials and Methods).

Studies of governance have typically pointed to regulatory responses to concentration (e.g., antitrust laws), to strengthen current rules for ocean use, or to devolve power and incorporate local voices and visions (*10*, *29*, *30*). Yet, from a practical perspective, the relatively small number of large corporations in the ocean economy could facilitate maximum attention from regulators on the minimum performers, a "maxi-min strategy" used to target polluters—as compared to the challenges of regulating a large number of smaller and widely dispersed companies (*31*).

Incentivizing stewardship among the Ocean 100

If increasing concentration within the global economy remains the status quo, engagement with TNCs to explore if their influence might be used to leverage large-scale change could lead to a form of "corporate biosphere stewardship" (*15*). The Ocean 100 list identifies the largest TNCs benefitting from ocean use and hence those with potentially the greatest influence and capability to effect such change. The Ocean 100, however, are highly heterogeneous: Some of the industries are focused on extractive resources, while others rely on renewable resources; some depend on mobile operations, others on stationary. The future trajectories of these industries also vary markedly, with some characterized by limited future growth potential (e.g., capture fisheries) (*32*), and others by exponential growth [e.g., a 50-fold growth in offshore wind production by 2050 (*33*)]. Given this heterogeneity, the motivations of the TNCs can be expected to differ, as will their agency and effectiveness (*34*). Recognizing these dynamics is crucial, as the Ocean 100 are characterized by industry dominance and large networks of subsidiaries—the top 10 companies in each industry have, on average, more than 2000 subsidiaries (table S1). A shared understanding of their role in the ocean economy and subsequent sustainability commitments by the Ocean 100 could set new industry norms and rapidly cascade throughout the ocean industries.

Yet, evidence of large TNCs leading sustainability efforts to meet long-established goals is scant (*15*), underscoring the challenge of positioning the Ocean 100 in a seemingly unfamiliar new role of corporate biosphere stewards. However, a number of factors may be converging to facilitate this shift, including growing perceptions that such a role would help companies secure future legitimacy and continued social license to operate (*10*). TNCs are also increasingly engaged in reputational risk management as part of corporate strategy, responding to pressure from external stakeholders such as nongovernmental organizations or financiers (Box 1) (*35*–*37*), meeting the demands of a growing number of transparency initiatives aiming to increase corporate accountability in global supply chains (*38*), and adapting to rapid innovation in business norms and practice (*15*). Because 60% of the Ocean 100 are publicly listed (data file S1), stock exchanges and shareholders could play an important role in motivating stewardship (*39*). Stock exchanges can act as powerful gatekeepers by requiring TNCs to address sustainability via their listing rules, both at the time of the initial public offering (IPO) and on a continuing basis for listed companies. They also provide a unique window of transparency into a firm's operations. A recent example can be found in the case of China Tuna's IPO on the Hong Kong Stock Exchange, which was suspended in 2014 after scrutiny of its prospectus revealed the environmental risks had been overlooked, including the use of outdated stock status and fishing operations exceeding catch limits (*39*). Likewise, shareholders have the ability to encourage better practices by exercising voting rights at shareholder meetings and by engaging directly with corporate leadership on governance

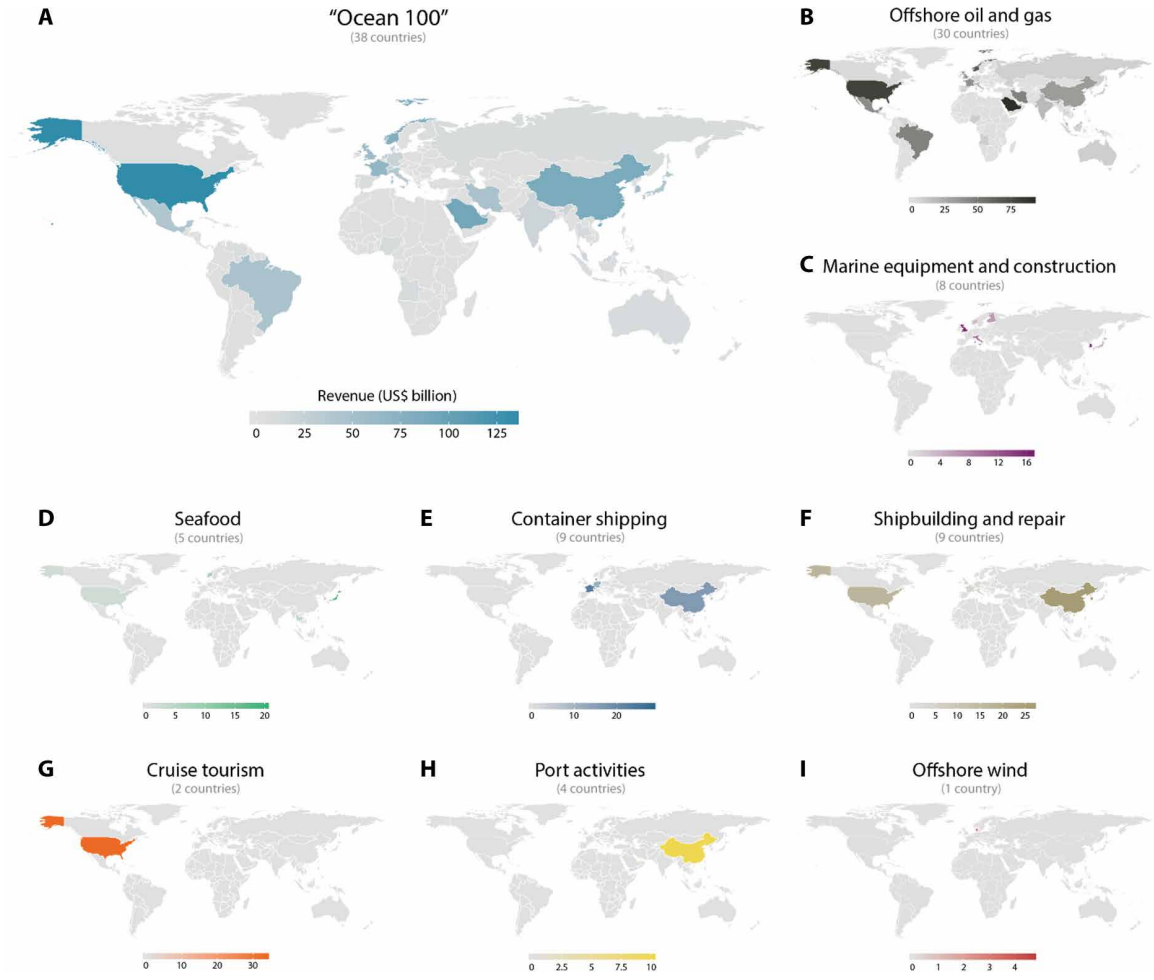

Fig. 3. Geographic distribution of TNCs in the ocean economy. Revenues (2018 USD) are aggregated based on the location of the Ocean 100's main headquarters. (**A**) All industries combined. (**B** to **I**) Within each industry. See table S2 and data file S1 for exact values and a list of countries.

and policy or indirectly through chains of ownership and threats of divestment. For example, Norway's Government Pension Fund, the world's largest sovereign wealth fund, has recently pledged to divest from ocean-polluting corporations as they did with companies involved in unsustainable palm oil production after deforestation became an ethical criterion (*40*, *41*). In sum, emerging evidence suggests that improved legislation and consumer demands, combined with economic incentives from financiers (Box 1), could stimulate TNCs to integrate environmental and social responsibility in their operations, not as an act of altruism, but rather as an informed, forward-looking strategy (*15*, *27*).

In addition to enjoying financial incentives for prioritizing sustainable practices, the Ocean 100 could also play a stronger role in maintaining and protecting the ocean public goods that enable their operations (*42*, *43*). This could entail establishing or contributing to a global ocean funding mechanism to cover the costs of protection for coastal and marine areas (*44*) or cleanup of marine plastic debris (*45*). A more formal option was proposed in a scientific output of the High-Level Panel for a Sustainable Ocean Economy (which includes 14 current heads of state), namely, the creation of a global tax on the profits of ocean economy industries as an opportunity to fund public goods in the ocean (*10*). For reference, a 0.1% global ocean tax on the revenues of the Ocean 100 could yield USD 1.1 billion annually for ocean public goods, exceeding the combined annual funding for SDG 14 from the World Bank and Global Environment Facility in recent years (*46*). Extractive industries typically pay taxes on the resource rent, for instance, mining (*47*) and petroleum (*48*), as well as some fisheries such as tuna (*49*), all of which may provide relevant examples for the design of a global "ocean tax" in support of SDG 14 (table S3).

The potential and limits of voluntary corporate action

A mechanism open to TNCs in the Ocean 100 to engage in collective action toward achieving sustainability goals is "green clubs," namely, groups of companies that voluntarily commit to undertake sustainability measures (*50*). To be effective, green clubs should be designed to include (i) sponsorship to ensure that actors are motivated to invest resources in the effort despite incentives to freeride, (ii) incentives for participation through sufficient excludability, (iii) monitoring and enforcement mechanisms for participants, and (iv) motivation for customers and shareholders to reward TNCs for producing public goods with premiums (*51*). Examples of green clubs formed with the goal of promoting sustainable ocean use can be found at the industry or sub-industry level, while cross-sectoral green clubs

Box 1. A blue financial system.

Closely related to how TNCs operate, and how to influence them, is the question of their financiers. Much of the dialogue around sustainable ocean finance to date has focused on development finance (*66*) or innovative financial instruments (*67*), but limited attention has been directed toward existing mechanisms that account for the bulk of corporate financing (*39*). Banks, in particular, can promote sustainability given their ability to monitor companies in detail and to tailor loan terms. By incorporating sustainability criteria into loan covenants and binding companies to disclosure of nonfinancial information, environmental risk assessments, reduction in CO_2 emissions, establishment of science-based targets, etc., banks could incentivize responsible use of the ocean and accelerate transformation toward better practices (*39*). For instance, Rabobank recently arranged a USD 100 million "green and social" loan with Chile-based company AgroSuper, the country's leading salmon company and the second-largest salmon producer in the world. The loan agreement contains several environmental and social conditions that AgroSuper must comply with, such as a commitment to reduce antibiotic use and increase the number of eco-certifications. Likewise, Japan-based shipping company Nippon Yusen Kabushiki Kaisha (NYK) has been awarded a USD 456 million sustainability linked-loan for which the interest rate is adjusted according to the company's response to climate change, as determined by the score provided by the CDP (formerly Carbon Disclosure Project). The recently established Poseidon Principles (www.poseidonprinciples.org) further provide a sector-specific framework for integrating climate considerations into lending decisions and promoting shipping decarbonization. Overall, there is a whole ecosystem of emerging initiatives and principles that could inform and support a more sustainable ocean economy, including The Sustainable Blue Economy Finance Principles (www.unepfi.org/blue-finance/the-principles), The Principle for Investment in Sustainable Wild-Caught Fisheries (www.fisheriesprinciples.org), or The Task Force on Climate-related Financial Disclosures (www.fsb-tcfd.org). As pressures on the ocean mount, what is missing are norms and regulations that ensure a truly blue financial system, where these principles are strictly enforced and sustainability criteria systematically integrated into traditional financial services. Crucial to this process are the disclosure by TNCs of their nonfinancial activities and performance and the need to independently audit the information to ensure its reliability. Where it is not yet the case, national and international regulation regarding financial reporting and accounting should therefore be expanded to also include nonfinancial information (*39*). This would improve the efficiency of financial institutions with respect to the materiality of nonfinancial information and ultimately feed back to the financier, yielding financial and reputational benefits.

for ocean industries remain rare (Table 2). The relatively low participation of the Ocean 100 in ocean green clubs (Table 2) may reflect that many are relatively recent or simply the heterogeneity of the group, but raises questions about whether or not these TNCs focus their sustainability efforts on ocean stewardship or recognize their position as keystone actors in the ocean economy. Answers to these questions likely depend upon the extent to which these TNCs consider their future viability as being tied to the sustainability of ocean use.

Green clubs also have the potential to act as convening bodies for promoting engagement in sustainability initiatives and the setting of voluntary targets. For instance, of the 1616 voluntary commitments made since the first UN Ocean Conference in June 2017, only 116 were made by private sector actors, and none at all by members of the Ocean 100 (*52*). Yet, commitments were registered by the World Ocean Council, the Global Salmon Initiative, the Seafood Business for Ocean Stewardship, and the Global Ghost Gear Initiative, all of which count multiple Ocean 100 companies among their respective memberships (Table 2). Given their dominance in the current ocean economy, voluntary commitments issued by the Ocean 100, followed up with specific and measurable action, could collectively accelerate progress toward achieving elements of SDG 14. Voluntary actions are not, however, a panacea, and there has been no systematic accounting of progress toward achieving the commitments from the UN Ocean Conference (*53*). In addition, 68 of the 116 private sector commitments are associated with ocean pollution (SDG 14.1)—primarily reducing ocean plastics and participating in beach cleanups—underscoring that voluntary commitments are unlikely to cover the breadth of the targets within the Sustainable Development Agenda.

Another important layer of voluntary action is endorsement or adherence to public guidelines and frameworks of best practice. Examples of particular relevance to the Ocean 100 include the UN Global Compact's Sustainable Ocean Principles (*54*) and the Poseidon Principles, which aim to advance the goal of reducing greenhouse gas emissions from shipping 50% by 2050 (compared to 2008) (*55*). The latter example is timely, as the global carbon footprint of the ocean economy has yet to be measured and, now, only 38 of the Ocean 100 TNCs report to the CDP (formerly Carbon Disclosure Project) at a level enabling evaluation of emissions (fig. S3) and only 33 of the non-oil and gas Ocean 100 report at this level (fig. S4) (*56*).

One factor underpinning the credibility and efficacy of such voluntary actions is whether they are grounded in science or shaped instead by opportunity and convenience. The need for science-based approaches in green clubs and voluntary frameworks is closely aligned with recent calls for scientists themselves to engage more actively with the private sector (*16*, *57*). Such engagement carries substantial reputational risks for scientists but represents another opportunity to influence current trajectories of ocean use and degradation. Science-industry engagement with the Ocean 100 should encompass (i) science-based assessments of sustainability challenges, including impacts associated with corporate operations; (ii) co-design of voluntary corporate initiatives, with specific, measurable, and time-bound targets; and (iii) long-term monitoring and evaluation of progress, as part of continued learning and adaptation.

Ultimately, voluntary corporate efforts to operate sustainably cannot and should not be expected to replace public policy. An optimist would see voluntary corporate efforts as an opportunity for the private sector to showcase its capacity for swift and decisive action and to demonstrate to public officials the benefits and incentives of engaging in more effective management and stewardship of ocean resources (*58*). Governments therefore have a crucial role to play in not only providing a regulatory context that safeguards nonmarket ecological and social values but also creating incentives for rapid innovation in business strategy and practice toward corporate stewardship and codifying legal and regulatory frameworks accordingly (*15*).

Table 2. Prominent green clubs with a focus on promoting sustainable ocean business.

Initiative	Description	Examples of reported impacts
Association of Responsible Krill Fishers (ARK) www.ark-krill.org	Established in 2012, ARK brings together companies engaged in Antarctic krill fishing to ensure the long-term sustainability of the fishery and its dependent predators. ARK includes 1 of the Ocean 100 companies	Establishment of three voluntary restricted zones and 100% compliance by fleets during the 2019/2020 season www.ark-krill.org/ark-voluntary-measures
Global Salmon Initiative (GSI) www.globalsalmoninitiative.org	Established in 2013, the GSI is a leadership initiative situated at CEO-level that aims to promote sustainable salmon production while minimizing its carbon footprint. GSI includes 2 of the Ocean 100 companies	Commitment by members to 100% certification of farms by Aquaculture Stewardship Council. Growth from 0% in 2013 to 65% of production in 2020 https://globalsalmoninitiative.org/en/sustainability-report/asc-certification/
IPIECA www.ipieca.org	Established in 1974, IPIECA is the only global association of upstream and downstream oil and gas industry companies, with a focus on improving environmental and social performance. IPIECA includes 24 of the Ocean 100 companies	Standardization of reporting among member companies, with 82% of members producing corporate social responsibility (CSR) reports and 79% now using IPIECA reporting guidance http://www.ipieca.org/our-work/sustainability-reporting/member-sustainability-reports/
Ocean Renewable Energy Action Coalition (OREAC) N/A	Launched in early 2020, the OREAC has a focus on sustainable development of ocean-based renewable energy and mitigating the effects of climate change. OREAC includes 3 of the Ocean 100 companies	First report and roadmap to 2050 to be launched in late 2020 https://gwec.net/oreac-1400-gw-of-offshore-wind-is-possible-by-2050-and-will-be-key-for-green-recovery/
Seafood Business for Ocean Stewardship (SeaBOS) www.seabos.org	Launched in 2016, SeaBOS is a science-business initiative including 10 of the world's largest seafood companies with commitments to leading a global transformation toward ocean stewardship. SeaBOS includes 6 of the Ocean 100 companies	Set of 10 public commitments, including time-bound goals, and establishment of six task forces focused on addressing harmful practices within the seafood industry https://seabos.org/science/
Sustainable Shipping Initiative (SSI) www.ssi2040.org	Established in 2011, the SSI is a multi-stakeholder initiative aimed at improving sustainability in the shipping industry across social, environmental, and economic dimensions. SSI includes 1 of the Ocean 100 companies	Publication in 2011 of "Vision 2040" and associated roadmap to achieve a sustainable shipping industry, and covering energy efficiency, labor rights, enabling finance and policy, and other issues https://www.ssi2040.org/wp-content/uploads/2017/01/SSI_Vision_doc_web.pdf
United Nations Global Compact—Action Platform for Sustainable Ocean Business www.unglobalcompact.org/take-action/ocean	Established in 2018, this UN Global Compact Action Platform brings together a group of leading actors from business, academia, and governments to advance progress toward achieving the SDGs. The Platform includes 6 of the Ocean 100 companies	Ten-year roadmap of "critical ambitions" published in 2020 as "Ocean Stewardship 2030" report https://unglobalcompact.org/library/5742
World Ocean Council (WOC) www.oceancouncil.org	Established in 2008, the WOC is a global cross-sectoral industry leadership alliance focused on achieving ocean stewardship and "corporate ocean responsibility." The WOC includes 4 of the Ocean 100 companies	Convening of annual "Sustainable Ocean Summit" and other activities including the development of regional ocean councils and a Young Ocean Professionals initiative https://www.oceancouncil.org/global-issues-platforms/cross-cutting-issues/

Conclusions

The ocean economy is highly concentrated among a relatively small number of companies. The 100 TNCs with the highest annual revenues in 2018 from ocean use, labeled here as the Ocean 100, generated 60% of the total revenues from their respective industries, which collectively form the core of the ocean economy. Emerging ocean industries with high entry costs, such as deep-sea mining, marine biotechnology, and offshore renewable energy, are likely to reinforce this trend. This poses risks for achieving internationally agreed targets for conservation and sustainable use, most notably within the Sustainable Development Agenda and the Strategic Framework of the Convention on Biological Diversity.

Given that high concentration in the ocean economy is the current reality, identifying the Ocean 100 provides a basis for informed engagement, which can help to prioritize interventions and ensure that they are framed in the best available science (*16*). Illustrating to the primary corporate beneficiaries of ocean use that mainstreaming stewardship across their planning and operations is crucial for the long-term viability of their industries could spur large-scale change, reflected perhaps in (i) uniform reporting toward SDG 14 targets, (ii) leadership toward a low-carbon ocean economy, and (iii) additional financing for ocean public goods (e.g., through establishment of a global ocean funding mechanism such as a global ocean tax).

Much has been written about the failures of ocean governance and particularly of governments before the coronavirus disease 2019 (COVID-19) pandemic, but could the private sector, and specifically the Ocean 100, be part of a new narrative for the ocean (*59*, *60*) that subsequently emerges and helps accelerate humanity's progress toward achieving SDG 14? Given the mismatch between the current pace of change in humanity's use of the ocean and formal governance responses (*5*), the answers to these questions may determine whether or not a more sustainable and equitable ocean economy—a truly "blue" economy—can be achieved.

MATERIALS AND METHODS

Ocean industries

We used the typology of industries measured by the OECD (*2*) to estimate gross value added to the ocean economy: offshore oil and gas, maritime and coastal tourism, offshore wind, port activities, shipbuilding and repair, shipping, maritime equipment and construction, industrial capture fisheries, industrial marine aquaculture, and industrial fish processing. The OECD notes that this list is not exhaustive due to data constraints, for example, not including small-scale capture fisheries (which are often informal and poorly accounted in national economic statistics and, in some cases, considered as synonymous with "artisanal fishing"), emerging industries such as marine biotechnology or seabed mining, and ecosystem services for which markets do not exist yet (*2*). However, across 25 countries that have identified 54 industries as being part of the ocean economy, this list represents the core group that is consistently included (*61*).

From the OECD list of industries comprising the ocean economy (*2*), we consolidated industrial capture fisheries (i.e., excluding small-scale fisheries due to lack of data), industrial marine aquaculture, and industrial fish processing into one category: seafood production, based on the data available and the vertical integration in the seafood market (i.e., output from fish processing is often not separated from fish harvesting activities). In addition, the maritime and coastal tourism industry had to be limited to the cruise tourism industry, due to the lack of global data on the portion of other tourism-related companies' output that is linked to the ocean compared to inland activities (i.e., many TNCs operating within the maritime and coastal tourism industry do not distinguish in their financial reporting between maritime, coastal, and inland regions). According to previous research, marine recreational activities have been estimated to generate around USD 47 billion (*62*). Although the OECD estimates that the maritime and coastal tourism industry contributes roughly a quarter of the global gross value added from the ocean economy (*2*), the barriers to entry are lower and levels of consolidation among TNCs are likely more limited as well (though cruise ship tourism is an exception). Therefore, eight ocean economy industries were considered in this study: offshore oil and gas, maritime equipment and construction, seafood, container shipping, shipbuilding and repair, cruise tourism, port activities, and offshore wind (Table 1).

TNC identification and assessment

TNCs, defined here as large corporations operating across national boundaries and with international supply chains, were identified by searching publicly available industry reports for each of the eight ocean economy industries and subsequently examining company annual reports and other gray literature, with an average of 20 sources used per industry. TNCs identified in this process were entered into a database for subsequent analysis, with an average of 52 per industry to ensure that we captured the 10 largest TNCs in each (table S1 and section S1).

For each company, we investigated gross revenues as a consistent measure of output across different industries of the ocean economy. For TNCs that conducted both terrestrial and marine activities, only revenues from the latter were collected and analyzed (e.g., only offshore oil and gas revenues were included, while onshore oil and gas revenues were excluded). Hence, our identification of TNCs and revenues is likely conservative, reflecting only those linked to the ocean economy.

For each industry, we estimated the 2018 total revenues by either relying on industry reports and publicly available sources or by using the sum of all TNCs in our database (section S1, table S4, and data file S1). The company financial database Orbis was used to generate average annual revenue estimates, number of subsidiaries, and main stock exchange for each of the publicly traded TNCs (*63*). We cross-checked Orbis results with TNCs for which revenue data were available, finding close matches and any discrepancies typically limited to methods of currency conversion (with the exception of two state-owned enterprises in China, the China State Shipbuilding Corporation and the China Shipbuilding Industry Company, where Orbis data were used for consistency). When Orbis data were not available, we searched TNCs' annual reports as primary sources for revenues. In addition, a similar database, Privco, was used for a small number of privately owned TNCs based in the United States (*64*). Orbis is a leading global data resource on private companies (*63*), while Privco consolidates available data sources to provide accurate secondary financial and business information on private companies (*64*).

On this basis, the revenues from individual TNCs could be compared to the industry totals in each case, as a snapshot in time for 2018. Where necessary, revenues were converted into real 2018 USD for comparison, using the conversion rate for consumer price index in the United States, published by the Bureau of Labor Statistics (*65*). See section S1 for details on the estimates and sources for each industry and company revenues.

Limitations

Our paper illustrates concentration in the ocean economy and identifies the biggest corporate beneficiaries of ocean use, but it does not provide insight into their environmental impacts. While a rapidly accelerating ocean economy has numerous impacts on the marine environment (*5*), a specific assessment of TNC footprint and whether concentrated industries perform better or worse with respect to the environment remain avenues for future work. Furthermore, our findings do not reflect how intertwined land-based industries are with their ocean-based counterparts or that such divisions are less relevant in the interconnected context of a global production ecosystem (*40*). To avoid ambiguity in the division of revenues from ocean-linked activities, compared to non–ocean-linked activities for some TNCs, particularly those operating in the maritime equipment and construction industry, we only included TNC revenues that could be explicitly linked to the ocean economy. Excluding large TNCs with broad industry profiles likely leaves out some keystone actors in the industry, but does identify those TNCs most dependent upon the ocean economy, and with the clearest incentives for safeguarding long-term operations by achieving relevant targets under SDG 14 (table S3 and data file S1).

SUPPLEMENTARY MATERIALS

Supplementary material for this article is available at http://advances.sciencemag.org/cgi/content/full/7/3/eabc8041/DC1

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