

COUNTING ON OCEAN BENEFITS

A science briefing on the links between the ocean, our economy, and human well-being

The ocean provides valuable benefits to Americans and the U.S. economy.¹ Healthy fisheries contribute to strong, ocean-based economies and communities. Natural assets, such as clean beaches and abundant wildlife, drive recreation and tourism activities. The ocean also evokes awe, provides us with a sense of place, and inspires us to explore, discover, and conserve. As new ocean industries grow, we face decisions about how to plan for a world in which people benefit from ocean resources now and ensure abundant ocean wealth for future generations.

Long-term Economic Prosperity from Ocean Wealth

The ocean provides benefits free of charge — we don't have to pay for an ocean ecosystem to generate fish — but this does not mean the benefits are without value. When the ocean produces valuable goods and services for people, oftentimes money does not change hands, so we need to explicitly estimate, map, and account for ocean benefits. Losing ocean benefits can be incredibly costly, but viewing the ocean as a store of wealth that is worthy of investment helps mitigate the risks of depleting or degrading resources.

KEY TERMS

Natural capital assets are resources that can be used to produce things of value, such as economic goods and services.

Ocean benefits are the goods and services that the ocean provides to people. Scientists can estimate the value of some, but not all, ocean benefits in monetary terms. Researchers have also developed non-monetary measures of how the ocean contributes to human well-being.

Ocean wealth is a measure of the sum value of all capital assets and provides capacity for ongoing future economic productivity.

The U.S. is endowed with a great portfolio of ocean wealth that contributes to economic productivity. Measuring ocean benefits can help policymakers and managers:

- ▶ evaluate a more accurate balance sheet of our nation's assets;
- ▶ weigh the risks of depleting resources and the opportunities for growing ocean wealth;
- ▶ understand how decisions or actions can impact future ocean benefits and affect people; and
- ▶ estimate the return on investment in ocean planning, protection, and restoration.

What goes unmeasured, often underperforms and goes undervalued. A study in the Gulf of Mexico measured the value of marine assets and showed that market-oriented management could lead to large increases in value.² Such analysis can help ocean managers realize the full potential of the ocean, grow ocean benefits, and manage for ocean wealth performance, economic productivity, and natural heritage.



Image by Nicole Fuller, Sayo-Art

How can we take from the ocean to meet our needs, while ensuring its continued productivity? This timeline (log scale) shows how human influence on the ocean is intensifying as we rapidly develop new technology for exploring and using ocean resources, such as deep sea mining, power generation, and aquaculture.³ Spatial planning tools, monitoring and research, and policies that manage ocean wealth can fuel an industrial revolution for the ocean that provides economic benefits as well as clean water and healthy ecosystems.

New Science can Inform Ocean Policy and Management

- ▶ Economic approaches, like natural capital accounting, allow us to efficiently manage natural resources and ocean wealth.
- ▶ Maps show where the ocean provides benefits that underpin economic sectors, like tourism, and can support informed planning and decision-making.
- ▶ New technologies can leverage “big data” to assess ocean conditions, monitor changes in how people are using the ocean, and help us understand the distribution of ocean benefits at big scales.⁴
- ▶ Social science research reveals links between natural resources and human well-being, providing insights for creating durable policies that achieve policy objectives.



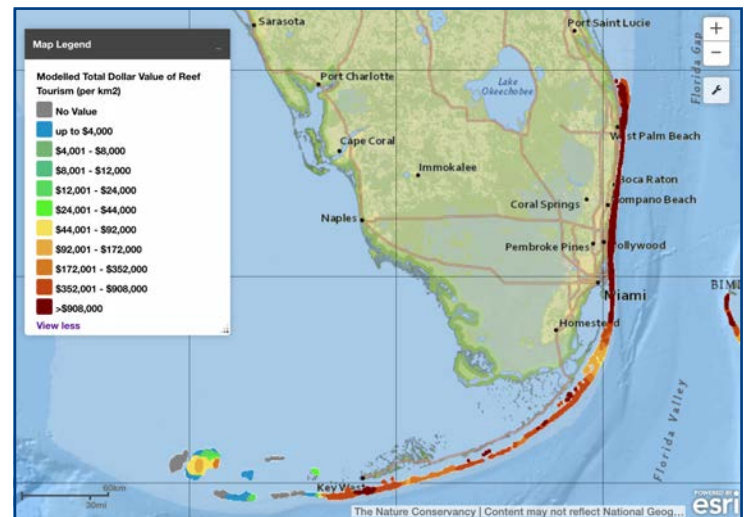
Benefits to Human Well-Being

The ocean also contributes directly to human well-being. For example, coral reefs are natural wonders worthy of investment regardless of whether we visit them, and many ocean resources underpin cultural practices and provide a sense of place. If we measure only economic benefits of the ocean, we risk basing decisions on an incomplete picture of who wins and who loses under different policy scenarios. A study of the Puget Sound in Washington State found that residents’ well-being depends on how decisions are made about managing the ocean and coasts.⁵ Governance of ocean benefits can affect people’s well-being by both enhancing the quality of the natural environment and ensuring people’s sense of control and social justice.

The Power of Maps

Maps can expand our view of the value of the ocean by showing where ocean benefits are produced and what opportunities for exploration lie ahead.⁶ Scientists can harness data about ocean benefits to map ocean wealth, monitor changes over time, and support planning for ocean benefits.

Combining economic data with spatial information about where the ocean produces benefits allows scientists to estimate the value of different types of ocean benefits in specific places. For example, maps could show the value of coral reefs for tourism in Florida (see map image to the right), storm protection along coasts, and habitat for growing fish. In the case of tourism, the value of ocean benefits can be further understood as on-reef tourism (diving, snorkeling, and boat tours) and adjacent reef tourism (coral sand beaches, calm seas, ocean views, and seafood).



Mapping Ocean Wealth, a project of The Nature Conservancy, can visualize and simplify ocean benefits for use in planning and policy decisions. This map shows where coral reefs generate over \$1.15 billion (USD) per year to the tourism sector in Florida.

References

- ¹ Kildow, J.T., et al. 2016. State of the U.S. Ocean and Coastal Economies. National Ocean Economics Program and the Middlebury Institute of International Studies at Monterey.
- ² Fenichel, E.P. and J.K. Abbott. 2014. Natural Capital: From Metaphor to Measurement. *Journal of the Association of Environmental and Resource Economists*, 1 (1): 1-27.
- ³ McCauley, D., et al. 2015. Marine Defaunation: Animal loss in the global ocean. *Science*, 347 (6219): 1255641.
- ⁴ Costello, C., et al. 2016. Global fishery prospects under contrasting management regimes. *PNAS*, 113 (18): 5125–5129.
- ⁵ Biedenweg, K. et al. 2017. How does engaging with nature relate to life satisfaction? Demonstrating the link between environment-specific social experiences and life satisfaction. *Journal of Environmental Psychology*, 50: 112-124.
- ⁶ Spalding, M.D., R.D. Brumbaugh, and E. Landis. 2016. Atlas of Ocean Wealth. Arlington, VA: The Nature Conservancy.

SELECTED REFERENCES

¹ Kildow, J.T., et al. 2016. State of the U.S. Ocean and Coastal Economies. Monterey, CA: National Ocean Economics Program and the Middlebury Institute of International Studies at Monterey.

The ocean and its resources provide valuable inputs to the national economy. This report compiled time-series data that track economic activities, industries, natural resource production and values, some non-market values, and federal expenditures related to the ocean and coasts. The ocean economy represented over 2% of employment and GDP in the U.S. in 2013 — significantly larger than other natural resource sectors such as agriculture and forestry.

² Fenichel, E.P. and J.K. Abbott. 2014. Natural Capital: From Metaphor to Measurement. *Journal of the Association of Environmental and Resource Economists*, 1 (1): 1-27.

The authors estimated accounting prices for Gulf of Mexico reef fish as a capital asset under real-world management conditions. They concluded that natural capital may be a large share of the wealth of nations, but in many cases it remains underpriced in markets and unaccounted for in public accounts, contributing to the poor management of many natural capital stocks. They also examined feedbacks between the state of natural capital stocks, human behavior, and institutions that guide behavior.

³ McCauley, D., et al. 2015. Marine Defaunation: Animal loss in the global ocean. *Science*, 347 (6219): 1255-641. Also see video online: McCauley, D. 2017. Worlds Underwater. Presented at Davos during the World Economic Forum.

Humans depend on marine wildlife and healthy ocean ecosystems. At the same time, humans have significantly decreased the abundance of marine animals, both large (e.g., whales) and small (e.g., anchovies). Comparing patterns of human impact on marine and terrestrial systems can help managers and decision-makers navigate toward recovery. We face the opportunity of an industrial revolution for the ocean that provides economic benefits to people and maintains clean water and healthy ecosystems.

⁴ Costello, C., et al. 2016. Global fishery prospects under contrasting management regimes. *PNAS*, 113 (18): 5125–5129.

This study used data from 4,713 fisheries worldwide to estimate the status, trends, and benefits of implementing alternative approaches to fisheries management. The authors described the benefits and trade-offs of alternative approaches to fisheries management and found that in nearly every country of the world, fishery recovery would simultaneously drive increases in food provision, fishery profits, and fish biomass in the sea.

⁵ Biedenweg, K. et al. 2017. How does engaging with nature relate to life satisfaction? Demonstrating the link between environment-specific social experiences and life satisfaction. *Journal of Environmental Psychology*, 50: 112-124.

The natural environment contributes to human wellbeing in a variety of ways, including providing outdoor recreation venues and underpinning cultural practices. The authors found several positive relationships between the ocean environment and human well-being. Environmental governance was among the factors that affected people's life satisfaction. Ensuring the provision of tangible benefits is not enough for human wellbeing; the decision-making process can build trust and a sense of fairness.

⁶ Spalding, M.D., R.D. Brumbaugh, and E. Landis. 2016. Atlas of Ocean Wealth. Arlington, VA: The Nature Conservancy. Also see: Spalding, M.D., et al. 2017. Mapping the global value and distribution of coral reef tourism. *Marine Policy*, 82: 104-113.

The Atlas of Ocean Wealth shows how the ocean contributes to human well-being and illustrates the potential for the ocean to benefit people all around the world. The atlas provides maps that quantify the value of marine resources and information about the economic, social, and cultural values of the ocean, including fish production, tourism, coastal protection, and clean water. Understanding the full value of coral reefs to tourism, for example, demonstrates the importance of managing ocean wealth.

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Photo by Grace Orlava via Flickr



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Douglas McCauley began his career as a fisherman in the Port of Los Angeles before migrating to marine science. He now serves as a professor at the University of California Santa Barbara. Prof. McCauley has a degree in political science and biology from UC Berkeley. His PhD research was done at Stanford University where he studied the ecology of sharks and coral reef ecosystems. Research from the McCauley Lab has been published in leading research journals such as Science, Nature, and the Proceedings of the National Academy of Sciences USA and has been

featured in the New York Times, BBC, Time, US National Public Radio, and at the World Economic Forum. Prof. McCauley was named a Sloan Research Fellow in the Ocean Sciences.



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Dr. Rob Brumbaugh is the Director of Ocean Planning and Protection at The Nature Conservancy (TNC) and serves on the Global Oceans Team. In this role he oversees work on 'Mapping Ocean Wealth', generating a new kind of ocean knowledge about ocean benefits to transform ocean management and shape investment in both economic development and conservation. Ocean Wealth information is informing the design of new marine protected areas, helping to set goals for habitat restoration, informing investment in sustainability initiatives by private companies, and is being used in stakeholder-inclusive processes to develop marine spatial plans that provide an integrative framework for ocean management. Dr. Brumbaugh holds a Ph.D. in

oceanography from Old Dominion University in Virginia, and has worked at the interface of science and policy for more than 20 years. He lives in the Florida Keys, in the middle of the Florida Keys National Marine Sanctuary, and spends as much time as possible exploring the reefs, mangroves and seagrass flats that provide so much value to the communities of the Florida Keys.



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Dr. Eli Fenichel is an assistant professor of bioeconomics and ecosystem management at the Yale School of Forestry & Environmental Studies. He received a PhD from Michigan State University in 2007, and prior to joining Yale in 2012, he spent four years as a professor at Arizona State University. He conducts quantitative research that connects ecology and economics. His research approaches natural resources as capital assets, and Dr. Fenichel views natural resource management problems as investment decisions. He believes that framing resource management problems as investment decisions creates opportunities for creative 21st century natural resource management and policy. At Yale, Dr. Fenichel teaches graduate level courses in applied

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Kelly Biedenweg is a new Assistant Professor of Human Dimensions at Oregon State University's Fisheries and Wildlife Department. Kelly formerly held an NSF Science, Engineering, and Education for Sustainability postdoctoral fellowship with the Natural Capital Project at Stanford University and the Puget Sound Institute at University of Washington. Her research interests are in social values associated with the natural environment, social learning, natural resource management processes, and program evaluation and facilitation. Her work has focused primarily in Latin America and the Pacific Northwest. Kelly has consulted for The Nature Conservancy, the U.S. Forest Service's Pacific Northwest Research Station, the Puget Sound

Partnership, the Institute for Culture and Ecology, TetraTech ARD, University of Washington, King County, and Asociación Nacional de Exbecarios para el Desarrollo de Honduras. Kelly is a former NSF IGERT and American Association of University Women fellow. She received her PhD in 2010 from the University of Florida School of Forest Resources and Conservation with a certificate in Environmental Education and Communication and Latin American Studies, and a concentration in Tropical Conservation and Development. She holds a master of science in conservation biology and a bachelor of science in marine ecology.



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Christopher Costello is a professor of Environmental and Resource Economics at the University of California, Santa Barbara, USA, director of the Sustainable Fisheries Group, and a Research Associate with the National Bureau of Economic Research. Costello received his Ph.D from the University of California, Berkeley in 2000 and conducts research on natural resource economics and policy concerning property rights, with a focus on decision making under uncertainty, information, asset values, and natural resource scarcity. His work combines theoretical micro-economics with modeling and empirical analysis, often to inform policy on fisheries management, biological diversity, introduced species, industrial regulation, or marine

policy. Costello partners with others to translate his research into on-the-ground action in several countries including Peru, Chile, Mexico, Cuba, Indonesia, China, and Cambodia. Costello serves on several boards including Global Fishing Watch and Environmental Defense Fund's Board of Trustees, and has published over 80 peer-reviewed papers in journals such as Science, Nature, and the Proceedings of the National Academy of Sciences. He is the 2016 winner of the Peter Benchley Award in Ocean Solutions.



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