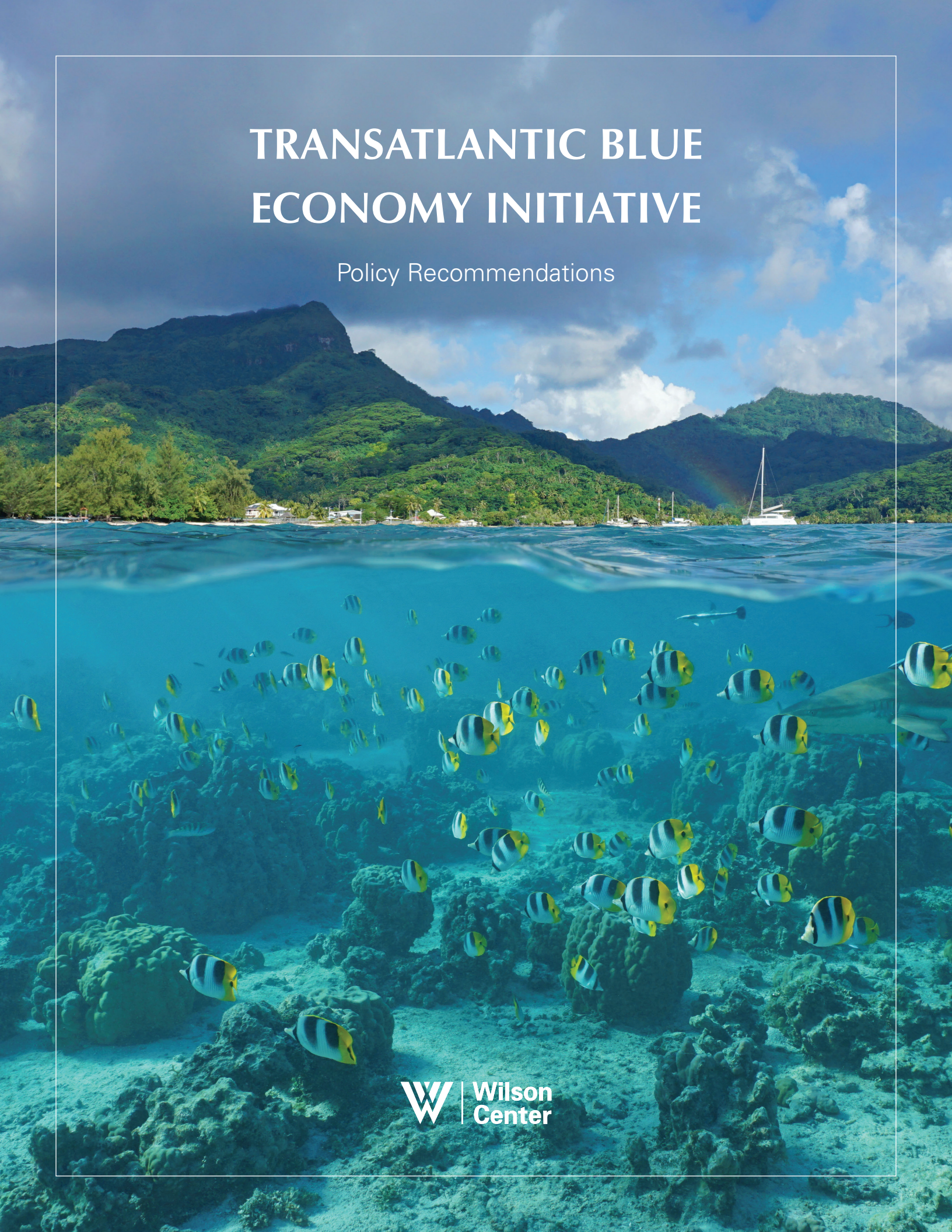
TRANSATLANTIC BLUE ECONOMY INITIATIVE

Policy Recommendations



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COVER IMAGE: The coast of Huahine island. Source: Shutterstock.com

ABOUT THIS INITIATIVE

The term "Blue Economy" has been used in different ways. A comprehensive World Bank Report defines the Blue Economy as "comprising the range of economic sectors and related policies that together determine whether the use of oceanic resources is sustainable. An important challenge of the blue economy is thus to understand and better manage the many aspects of oceanic sustainability, ranging from sustainable fisheries to ecosystem health to pollution."

Sustainable management of ocean resources requires collaboration across nation-states and across the public-private sectors. In the United States as well as in the European Union (EU), the governments have started to implement Blue Economy programs on the national, regional, and local level. The challenges vary in each country, and there are different tools needed for maritime industries such as fisheries, transport, and tourism. The Konrad-Adenauer-Stiftung USA (KAS) and the Wilson Center's Global Europe Program partner and propose the creation of a joint "Transatlantic Blue Economy Initiative" that would enable key decision-makers and policymakers in the United States and the EU to collaborate and work on concrete initiatives by sharing best practices as well as lessons learned from Blue Economy policies.

This initiative has several components, among them a recorded speech and Q&A with EU Commissioner Virginijus Sinkevicius, two webinars, and this publication of policy recommendations. For the full output of this cooperation, please visit the Wilson Center's Global Europe Program webpage or the Konrad Adenauer Stiftung's website.

This report was made possible by support from the Konrad-Adenauer-Stiftung. The views, conclusions and recommendations expressed in this report are solely those of its author(s) and do not reflect the views of the Konrad-Adenauer-Stiftung, or its employees.

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View of the European Space Research and Technology Center (ESTEC) from ESA in the dunes of Holland. On the horizon the beach and sea Noordzee.
Aerovista Luchtfotografie/shutterstock.com

The Role of Ocean Clusters in Growing the Transatlantic Blue Economy

by Michael Conathan, independent ocean policy consultant
and a Senior Policy Fellow for Ocean and Climate at the
Aspen Institute's Energy & Environment Program

The rise to prominence of the concept of the Blue Economy throughout the past decade has led to development of numerous economic development opportunities that sustain and grow the triple bottom-line principles of people, planet, and profit in the marine environment. As technology has developed, and new markets have emerged, opportunities to develop new ocean-based industries, adapt existing marine dependent operations, and find new uses for products and byproducts of mature industries to provide additional efficiency and capital are expanding rapidly, particularly for communities looking to pivot away from unsustainable past practices and launch the industries of the future.

One tool that has taken root and is beginning to show significant results and return on investment is development of hubs of operation and entrepreneurship, known as innovation clusters. While the mythology of successful economic development often centers around individual genius creators, there is an emerging school of thought, and increasingly of practice, that recognizes the value of multiple

innovators with similar, often complimentary ideas, who operate in close geographical and ideological proximity and as a result end up creating a whole that is greater than the sum of its individual parts. This cluster model has emerged as a center of innovation and entrepreneurship in the Blue Economy, initially in Europe, and now increasingly in North America and around the world.

The result, so-called ocean clusters or BlueTech clusters, have begun to serve marine and maritime dependent businesses and innovators. These organizations can be fundamental to growing regional and national Blue Economies and spurring international collaboration. However, at present there is a lack of capacity to monitor, quantify, and communicate the economic benefits that have accrued from these partnerships that can, if documented, drive even greater collaboration and innovation.

This paper will explore the definition of what constitutes an ocean cluster, provide examples of Transatlantic collaboration among cluster organizations with a particular focus on the relationship between Iceland and New England, and identify opportunities for additional research and greater investment in this emerging, dynamic sector.

Several products released in early 2021 with the support of The Ocean Foundation provided a detailed overview of the development of Ocean or BlueTech Clusters. The first of these, The Blue Wave: Investing in BlueTech Clusters to Maintain Leadership and Promote Economic Growth and Job Creation, written in partnership with The Maritime Alliance, details the economic rationale for greater government investment to spur the innovation they inspire. This work led to two storymap pieces. The first details BlueTech Clusters of America, an overview of regions in which this cluster model has begun to take root, the particular methodologies of each, and a comparative overview of regional growth and opportunity in the Blue Economy. The second expanded this reach to define and compare BlueTech Clusters in the Northern Arc of the Atlantic, including descriptions of how different models have grown in mainland Europe, Iceland, Canada, and the United States.

There is no single accepted definition of an ocean cluster, and many models have emerged in different regions of North America and Europe which will be the geographic focus of this review. Most, but not all, include an element of sustainability in their work, and support the World Bank definition of the Blue Economy as "the sustainable use of ocean resources for economic growth, improved livelihoods, and jobs, while preserving the health of the ocean ecosystem." Others are open to entities that do not limit themselves to a sustainability focus. Some clusters broaden their definition of the Blue Economy to include freshwater as well as ocean-focused industries. Many have physical infrastructure of some kind whether it be shared collaborative office space or workshop locations, while others are exclusively virtual networks. Most are organized as non-profit entities, though some also have for-profit arms, while still others are exclusively for-profit ventures. Each of these models has its own benefits and costs.

The storymap focused on the Northern Arc of the Atlantic, defines a BlueTech Cluster as "a specific type of cluster organization focusing on innovation, research, and business development in ocean-related industries. They work to bring together stakeholders from across the triple-helix comprised of 1) academia and education; 2) business and industry; and 3) government and policymakers… serv[ing] as hubs of innovation for development."

What they all share, regardless of organizational structure, subject matter focus, or membership, is a desire to innovate and the recognition that there is great opportunity in co-location and collaboration.

In Europe, multiple examples demonstrate how Blue Economy development has led to transboundary partnership. One example of this work comes from the Nordic countries of Denmark, Finland, Iceland, Norway, and Sweden. In 2019, the leaders of these nations adopted an agreement known as Vision 2030 with the aim to "make the Nordic Region the most sustainable and integrated region in the world by 2030." The economic and societal changes of the Covid-19 pandemic have only served to accelerate and deepen their commitment to this vision, and they opted to make the Sustainable Ocean Economy one of their eight primary initiatives for the first component of this work for 2021-24.

Not coincidentally, this region is also home to several early adopters of the ocean cluster model that have emerged with varying degrees of governmental support. The government of Norway in particular has made clusters a focus of economic development dating back to the first years of the 21st century with its Norwegian Innovation Clusters program, which has spawned numerous ocean-focused cluster organizations receiving differing degrees of government support with members engaged in everything from traditional topics like fisheries and aquaculture to offshore renewable energy to cybersecurity and digitization in the marine economy. Sweden and Denmark are also home to ocean cluster organizations with varying degrees of national certification and support.

Similar efforts have been established in southern Europe as well, most notably in Portugal, France, Spain, and the United Kingdom.

The United States has only recently begun supporting Ocean Cluster development, pegging the Blue Economy as an area of focus for its Build to Scale grant program in 2020 that resulted in several six-figure awards being allocated to ocean clusters in Washington, Alaska, and Mississippi to support establishment and expansion, with a second round of funding announced in September 2021.

The United States has only recently begun supporting Ocean Cluster development, pegging the Blue Economy as an area of focus...

International collaboration has been baked into the BlueTech cluster model as well. The Blue Tech Cluster Alliance, launched in 2017 brings together ten organizations from eight different countries in North America and Europe, "committed to collaboration, developing joint projects, promoting each other's member companies, and sharing information." Its membership generally takes a broader view of the Blue Economy than the World Bank's definition, remaining inclusive of all ocean economic activity regardless of its inherent sustainability (i.e. including offshore oil and gas production, mining, and other extractive activities) as well as freshwater-focused industries.

Meanwhile, the Iceland Ocean Cluster (IOC) has followed a different pathway to innovation in Transatlantic collaboration, particularly in partnership with the northeast United States. After launching with an initial coterie of 12 companies when the Iceland Cluster House opened its doors in 2012, it is now over 70 organizations strong. Its membership growth has been driven by the chance to work in close proximity to other start-ups in a

welcoming, collaborative, environment in which all participants share the collective goal of creating new businesses with a triple bottom-line approach of valuing people, planet, and profit. It receives no government funding, and is completely self-sustaining.

This model includes a built-in foundational principle of sustainability—a true Blue Economy tenet—and has found a willing audience in the United States. Four different ocean cluster models have sprung up in the U. S. following, at least in part, the for-profit model pioneered in Iceland. These include the Alaska, New Bedford, and Long Island Sound Ocean Clusters, each of which either has additional external partners, is focused more directly on specific industries, or is based on a non-profit business model, thereby not making them true analogs of the IOC. Yet all do share a focus on sustainability and similarities in their branding elements to the IOC's business model.

The organization most directly linked to the IOC, and thus the example of the closest relationship among clusters on the east and west coasts of the Atlantic is between the IOC and the New England Ocean Cluster (NEOC). The NEOC is based in Portland, Maine, a city which itself has developed a rapidly deepening relationship with the IOC's hometown of Reykjavik following the establishment of Portland as the U.S. headquarters of Iceland shipping company Eimskip in 2013. According to Iceland Ocean Cluster founder, Thor Sigfusson, these partnerships allow nations to "mutually benefit each other in manifold ways, forging new opportunities even as they acquire additional strengths when competing on international markets."

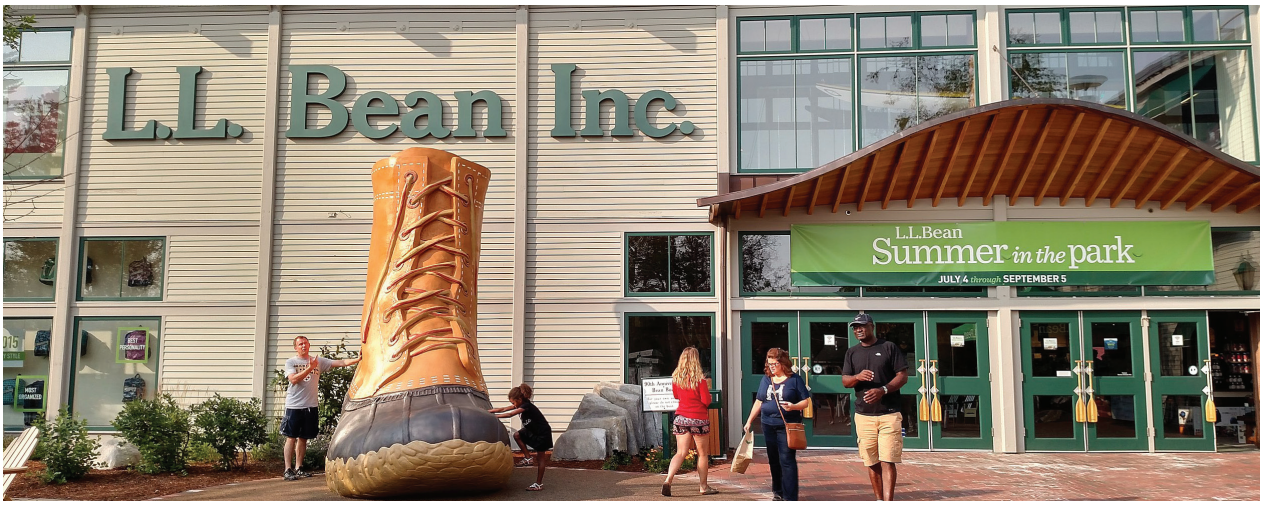
The partnership between the NEOC, founded in 2016, and the IOC has led to two elements that illustrate the power of this kind of like-minded, Transatlantic collaboration, both of which are based in the inherent—albeit difficult to measure—value of relationships and personal interaction: 1) an academic exchange program, and 2) a business development network, grounded in the value of physical infrastructure as a catalyst for partnership and innovation. This burgeoning bond between the two cities provided the fertile ground that has allowed the academic and professional exchanges to flourish, and both have led to significant successes in terms of the exchange of ideas, expertise, and ultimately economic development.

The academic exchange was initiated in 2016 when the NEOC enlisted Maine-based university leadership to build meaningful connections with academic institutions across the North Atlantic and Arctic region. The goal was to plant the seeds of an emerging, international workforce, well versed in the Blue Economy and its crossover points with the cultures and value structures of each region. Since its initiation as a binational arrangement, this program has subsequently expanded to include participation from Norway and Greenland, and U.S. universities in Connecticut and Massachusetts. NEOC and IOC now host annual graduate student gatherings at the annual Arctic Circle Assembly in Reykjavik, and largely as a result of this program, Portland has been selected to host the 2022 UArctic Assembly, the flagship event of a coalition of Arctic-based universities. Over the past five years, this program has become a point of attraction for entrepreneurs and innovators throughout the north Atlantic region who come to the organizers for undergraduate and graduate interns to assist their companies with business, legal, and regulatory compliance issues, and ultimately transition to key employees and leverage their experience to bring their understanding to start-ups and established businesses alike.

As the success of this academic exchange program illustrates, the growth of the Blue Economy is contingent on multiple actors coming together, and the development of interpersonal and inter-organizational relationships are paramount. An example of this at a professional scale comes from a multi-week event that the NEOC convened in the early days of its existence. In 2017, its leadership organized a group of Maine business development leaders for a 10-day bicycle race around Iceland, ending with a celebration of Maine culture featuring the Maine Beer Box, a shipping container delivered by Eimskip and packed with Maine-made microbrew kegs and dozens of taps pouring right out of the container itself on the Reykjavik waterfront.

The experience and the relationships it fostered, chronicled in this video, have resulted in demonstrated successes: LL Bean, one of Maine's biggest manufacturers, has reimagined its international trade model, including opening its first United Kingdom outlet in 2019, and sales of Maine craft beer have soared in Iceland. Additional collaborations have emerged including innovative vessel navigation systems, collaboration among seafood processors and aquaculturists, and companies finding new uses for ocean-based products and by products, such as the 100% Fish Project that Sigfusson is building out of his IOC experience. Other collaborations in the works include:

- Emerging relationships between entrepreneurship organizations Startup Iceland, Icelandic Startups, and the Maine Center for Entrepreneurs;
- NEOC providing domiciling services to companies from Iceland and the Faroe Islands as they look to break into and grow sales in the U.S. marketplace, with a third company providing AI-informed vessel navigation assistance services intending to launch in the U.S. in June 2022;
- Facilitating efforts by an Icelandic company to acquire Maine lobster byproducts in 2019 to conduct research & development using their own proprietary techniques for extracting enzymes from cod byproducts. In 2022, this company will be seeking partners in the U.S. to license their technology to create a value added product from waste in Maine's signature natural resource commodity.



LL Bean Store, Main. Wikipedia.org

Both NEOC and IOC leadership credit the success of these programs to their shared ethic as private sector operations focused on Blue Economy development. As NEOC Chief Operating Officer Chris Cary put it, "this intentional centralization of relationships allows for each organization to support people and businesses as its needs arise. The idea is that if an entrepreneur is facing a barrier, he or she can plug in, seek mentorship from other members, capacity from the universities, or the transfer of technologies/ideas from international parties."[1]

While the benefits of both the academic exchange and the industry-led collaboration are intuitive, they have not yet been chronicled, studied, or published in traditional, peer-reviewed journals that can quantify the metrics of their success to an adequate degree. This kind of analysis and metric establishment is a vital next step for this emerging and promising economic sector. Entities such as the Center for the Blue Economy at the Middlebury Institute of International Studies could be well-equipped to take on as growth in the Blue Economy is being increasingly touted by leaders in industry, government, and the NGO sectors.

As the Blue Economy grows in both size and prominence on both sides of the Atlantic and around the globe, cluster organizations of all types are poised to accelerate this growth and facilitate a transition to the industries of a more sustainable future. As the world opens its eyes to the existential challenges of climate change and environmental degradation, demand for triple bottom-line solutions will only grow, and there is an imperative to make this pivot as quickly as possible. In this "all hands on deck" scenario, the collaborative ethic of cluster organizations has the potential to accelerate the pace and create a rising tide of innovation that will truly lift all boats.

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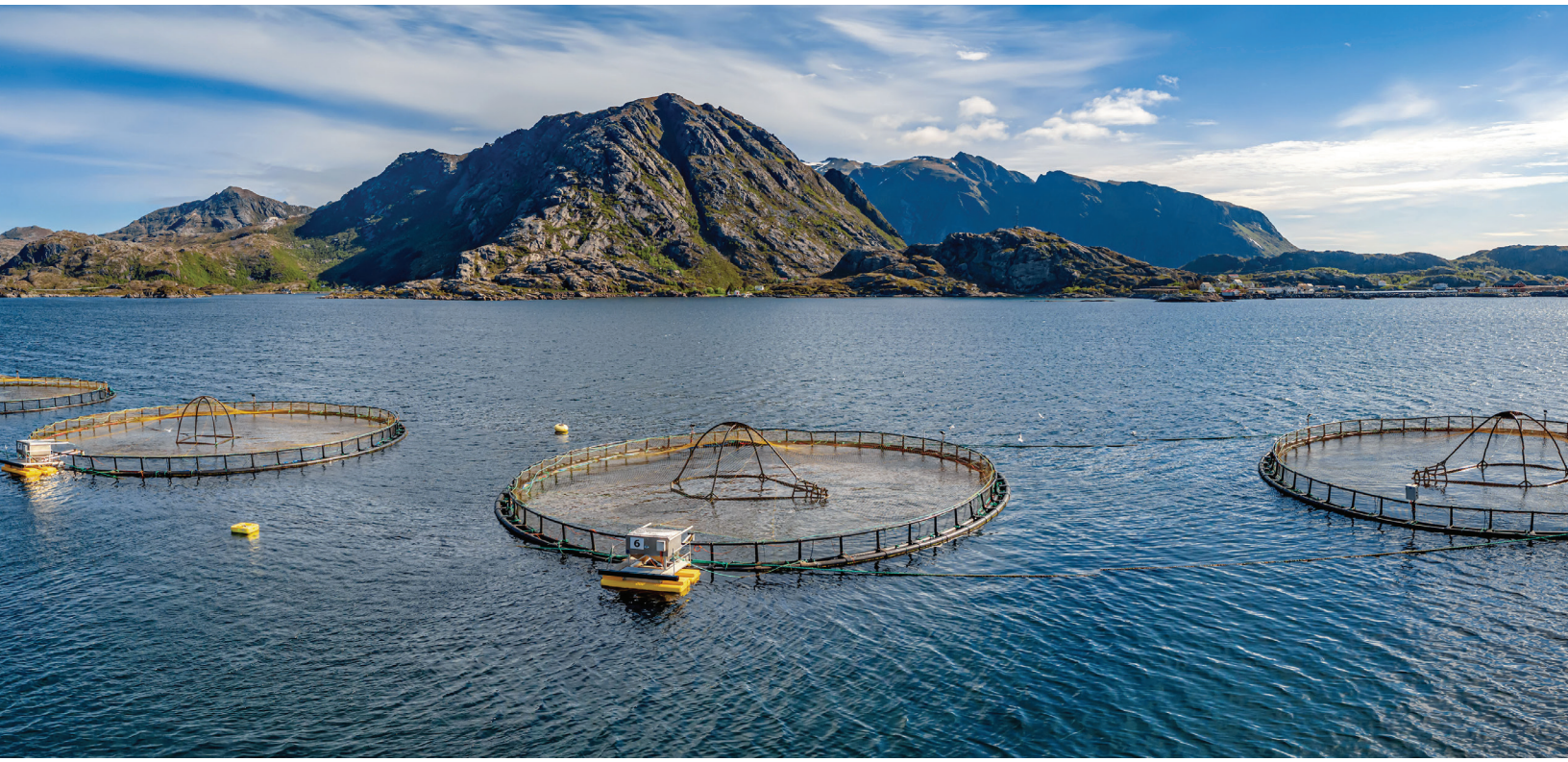


Farm salmon fishing in Norway. shutterstock.com

The New Blue Economy Seafood Sector

Sustainable Aquaculture, Cultivated Seafood, and Plant-based Seafood Alternatives

by Jason Scorse, Director, Center for the Blue Economy[1]

I. Introduction

According to the World Bank, "the Blue Economy is sustainable use of ocean resources for economic growth, improved livelihoods, and ocean ecosystem health."[2] While the ocean economy represents all economic activity that makes use of ocean resources, the Blue Economy is a narrower subset of ocean economic activities that are sustainable and/or regenerative. While the concepts of 'sustainable' and 'regenerative' are not precisely defined and disagreements persist about their boundaries, a thorough discussion of these terms is beyond the scope of this policy brief. For an activity to be considered part of the Blue Economy, a credible case must be made that it helps mitigate climate change, helps communities adapt to coastal climate impacts, or plays a role in promoting/restoring marine ecosystem health and resilience; and if the activity requires resource extraction from the ocean it must be done in a manner that does not degrade marine ecosystems or threatened species.

Given this definition, it is clear that a large portion of industrial (and other commercial) fishing activity as currently practiced *does not* meet the standards of the Blue Economy; many species are currently fished at unsustainable rates, marine ecosystems are being degraded, threatened species are being negatively impacted, and the climate footprint of much of the industry (once all transport, refrigeration, and processing are tallied) is high relative to protein generated from lower trophic level sources.[3]

Therefore, there is tremendous opportunity for global seafood production that is truly "blue" and can provide sustainable protein for a growing population without the myriad negative externalities of industrial fishing. The remainder of this brief will outline the three sectors that can meet this challenge: sustainable aquaculture, cultivated seafood, and plant-based seafood alternatives, followed by a short discussion of the policy responses required to accelerate this transition.

II. Sustainable Aquaculture

In many environmental and marine conservation circles aquaculture is viewed unfavorably because of the many negative impacts associated with large fin-fish marine aquaculture systems, which include increased disease, potential escape of genetically modified fish species, lower quality product, and most importantly, the high feed to conversion ratios which require more than a pound of wild caught fish to produce a pound of farm raised product.[4] While this skepticism towards aquaculture is warranted, aquaculture operations currently produce more than 50% of all the seafood that is consumed globally, and given that we are already overfishing many wild species, aquaculture is likely to grow even more in the coming decades due to the rising demand for seafood.[5]

It is therefore necessary to promote *sustainable* aquaculture so that as the industry expands its environmental footprint can be minimized with efficient systems that have the potential to restore marine ecosystems and provide not only seafood but other sustainable materials.

Two of the most promising forms of sustainable aquaculture produce sea vegetables and shellfish, both of which can purify ocean water, help mitigate local ocean acidification, provide critical habitat for marine life, require minimal inputs and energy, grow rapidly, and can provide materials as varied as biofuels, industrial chemicals, and reef building materials (e.g., used shells from oysters, mussels, and clams).[6] Humans have been growing seaweeds and shellfish for centuries, most notably throughout Asia, but as their benefits have become clearer, entrepreneurs around the world are beginning to show renewed interest. There are very few such operations in the US, but in the past decade companies have established new projects in Maine, Southern California, and Florida, and many state and local governments, as well as environmental NGOs, are bullish about future prospects.[7]

Mike Graham, a professor of phytology at Moss Landing Marine Laboratories (MLML) in Central California, and president of the California Aquaculture Association, is a strong proponent of sustainable seaculture technologies. He owns an aquaculture business—Monterey Bay Seaweeds—that grows seaweeds and abalone in tanks on land with water siphoned from the Monterey Bay and specializes in high-end varieties for restaurants and chefs. His systems use almost no energy, thereby producing almost no greenhouse gases, and the water that leaves his tanks is cleaner when it reenters the bay than when he extracted it. He is in the process of setting up a Center for Sustainable

Aquaculture within the California State University system and he currently leads the aquaculture program at MLML.

Land-based mariculture systems, such as Dr. Graham's, can exist at the interface of the land and ocean (e.g., in estuaries), in completely freshwater systems, or in constructed tanks and ponds. One of the most impressive largescale land-based systems, popularized by chef Dan Barber in his 2010 Ted Talk, is the Veta La Palma aquaculture facility in Southern Spain. Using a complex system of canals and irrigation systems over 8,000 acres, the facility produces large quantities of fish with no inputs at all. The project instead relies on the health of the ecosystem to sustain both the commercial species and the other biodiversity that are both predator and prey in a unique balance that is economically profitable.

Using a complex system of canals and irrigation systems over 8,000 acres, the facility produces large quantities of fish with no inputs at all.

Both low trophic level systems that produce vegetables and/or shellfish and ecological finfish systems that don't require wild fish feed, provide great potential for seafood production that does not exacerbate the unsustainable practices endemic to the commercial fishing industry.

III. Cultivated Seafood

Cultivated meat and seafood (also referred to as cell-cultured or cell-cultivated) uses samples of tissue from animals to reproduce these cells at scale in industrial facilities to produce meat that is identical to the animals from which they are sampled.[8] The process doesn't involve slaughtering animals, or in the case of most fin-fish aquaculture, feeding them in a highly inefficient manner. Most of the media attention around this new technology has focused on cultivated beef and chicken, but there is equal potential to produce cultivated seafood, including the highly prized and threatened bluefin tuna.

Two companies, Finless Foods and Blue Nalu, are developing cultivated bluefin tuna that is soon expected to be price competitive with wild caught tuna. Finless Foods plans to launch its cultivated product in 2022 and is also working on a plant-based version (more on this below), along with other cultivated species. Although this new industry doesn't operate in the ocean it utilizes ocean genetic resources, it derives feed for the cultures from ocean vegetation, and it has the potential to relieve pressure on wild capture species; therefore, it should be considered part of the Blue Economy. If successful, cultivated seafood could end decades of unsustainable practices that have devastated marine ecosystems and brought many keystone species to the brink of extinction. If prices drop far enough it could also provide high-quality seafood to an ever-greater population, and regional facilities could produce seafood for local populations. In addition, cultivated seafood doesn't suffer from traceability issues, and labor rights will be much easier to monitor in land-based production systems than in the highly unregulated, open ocean, where labor rights abuses are widespread.[9]

Of all the potential new Blue Economy seafood sectors, cultivated seafood has the greatest potential to alter the composition of the seafood industry, as most consumers want seafood that has the exact taste and texture of the real thing.[10]

One can view cultivated seafood akin to state of the solar industry was 20 years ago; no one expected costs to come down as rapidly as they did nor for the high speed of innovation in the enabling battery technology.[11] Cultivated seafood is an industry to keep a close watch on in the years ahead.

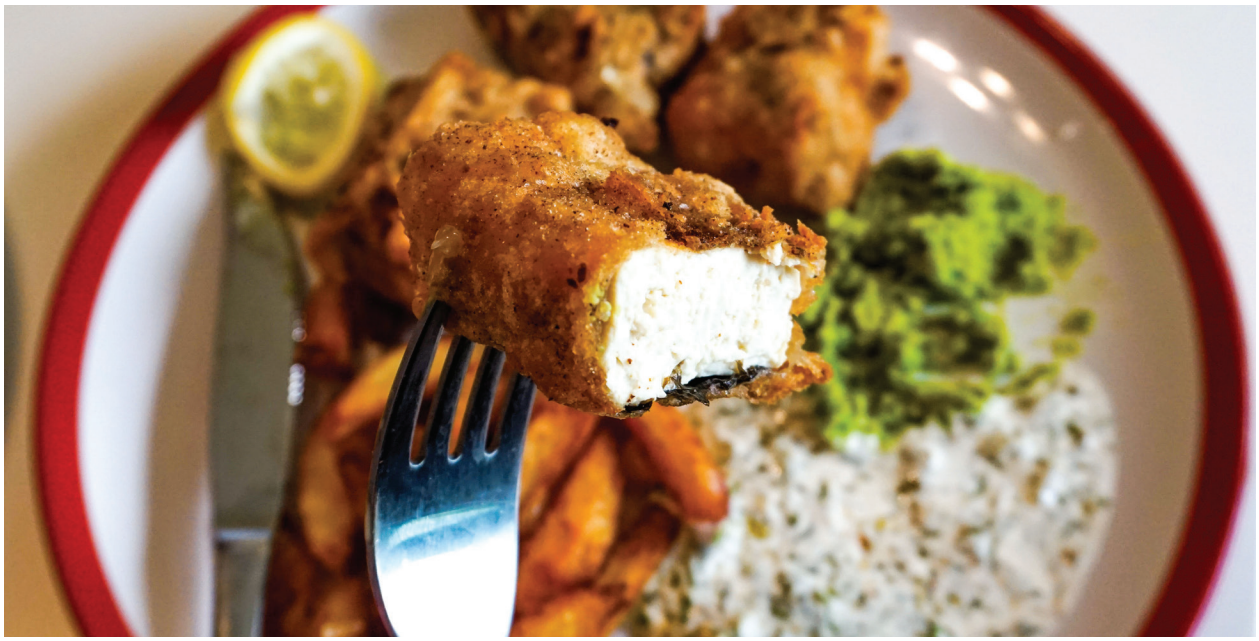
IV. Plant-based Seafood Alternatives

Several new companies are producing 100% plant-based alternatives to traditional seafood products and/or new stand-alone products, such as kelp jerky, pasta, and burgers (see Akua Kelp). Kuleana's plant-based tuna was just chosen as one of the best inventions of 2021 by Time Magazine and they are currently working on a plant-based salmon product. Good Catch (which has a partnership with Bumble Bee), Sophie's Kitchen, and Gardein make a variety of breaded alternative seafood products, such as fish fillets, shrimp, and crab cakes—all from plants. Most of these products contain seaweeds or sea algae to give the products that 'fishy' taste, and therefore, while not predominantly made from ocean products, they do contain them. Large multinationals, such as Tyson and Nestle are also entering the space, investing in alternative protein research and plant-based tuna and shrimp products.

Finless Foods, which set out to be a cultivated seafood company, is developing technology to make plant-based tuna as an offshoot of their work making plant-based scaffolding for their cultivated tuna product.[12] This product will also be available in 2022.

The hope is that these products will be able to sufficiently mimic the flavor of raw fish to win over flexitarian seafood consumers in significant numbers (currently, these products are most popular with vegans and vegetarians).[13] Already, the breaded products taste sufficiently close to their real seafood counterparts that they can serve as substitutes for traditional seafood consumers.[12]

As with cultivated seafood, this industry is in its infancy, and rapid innovation is expected in the coming years that will result in ever-better tasting products with textures that mimic real seafood. It



vegan fish and chips with vegan sauce, tofu and chips. Shutterstock.com

should be considered part of the Blue Economy because the products contain ocean ingredients and are sold as direct seafood alternatives.

V. Recommended Policy Reponses

There are a host of policies and initiatives that can help to advance sustainable aquaculture, cultivated seafood, and plant-based seafood alternatives. Below is a short summary for each of the key sectors:

a. Government Actors

Regulators should prioritize permitting for sustainable aquaculture operations and provide incentives, such as tax breaks, proportionate to the degree of sustainability in each operation. For example, it is difficult to acquire aquaculture permits for operating in US federal waters, so streamlining the process for highly sustainable operations would be very valuable to the industry.

Governments should also provide R&D investment and tax incentives for cultivated meats of all kinds, given their incredible potential to provide low-impact proteins at scale; the Good Food Institute is calling on the US Congress to invest up to $2 billion in basic research and other governments should do the same. R&D should be extended to innovation in plant-based and fermentation technology as well.

Recently in the US, the USDA provided its first ever grant to the cultivated meat industry with $10 million to seed the National Institute for Cellular Agriculture; this is a great initial step, but much more should be done.[15] Singapore and Israel are currently pursuing policies favorable to the cultivated meat industry and many startups are opening in these countries. (For example, the Israeli Innovation Authority established two FoodTech incubators that helped launch Aleph Farms, which produced cultivated steak in 2020; also in 2020, Singapore approved cultivated chicken for human consumption and committed to providing a favorable policy environment for future cultivated meat products.)

Governments can also get a head-start in setting up the regulatory process for approving cultivated meat for mass consumption; since the products are nutritionally identical, this should be relatively straightforward. To date, companies have been extremely transparent with regulators about their production processes, which should aid in speeding up approval. In addition, developing a consistent, clear, and sensible labeling regime to create a fair and even playing field for all the actors in the alternative meat and seafood industry will help accelerate acceptance and adoption by consumers.

b. Environmental NGOs and Foundations

Some environmental groups, such as the World Resources Institute, are out front in charting a course for a new sustainable food system, but many, especially in the marine space, are still focused almost exclusively on improving practices within the industrial fishing industry. While this is commendable, the reality is that 8-10 billion people will not be able to eat wild fish sustainably, especially as increasing numbers enter the middle class.

Dedicating staff to follow the trends in the industries outlined above and lobbying for more government support for these sectors are crucial. NGOs and foundations should also urge the seafood companies with whom they currently work to get involved in the alternative seafood space, expand their product lines, and invest directly in companies and organizations that can have the greatest impact. In addition, given their large memberships and outsized influence, they should educate the public about new alternative seafood

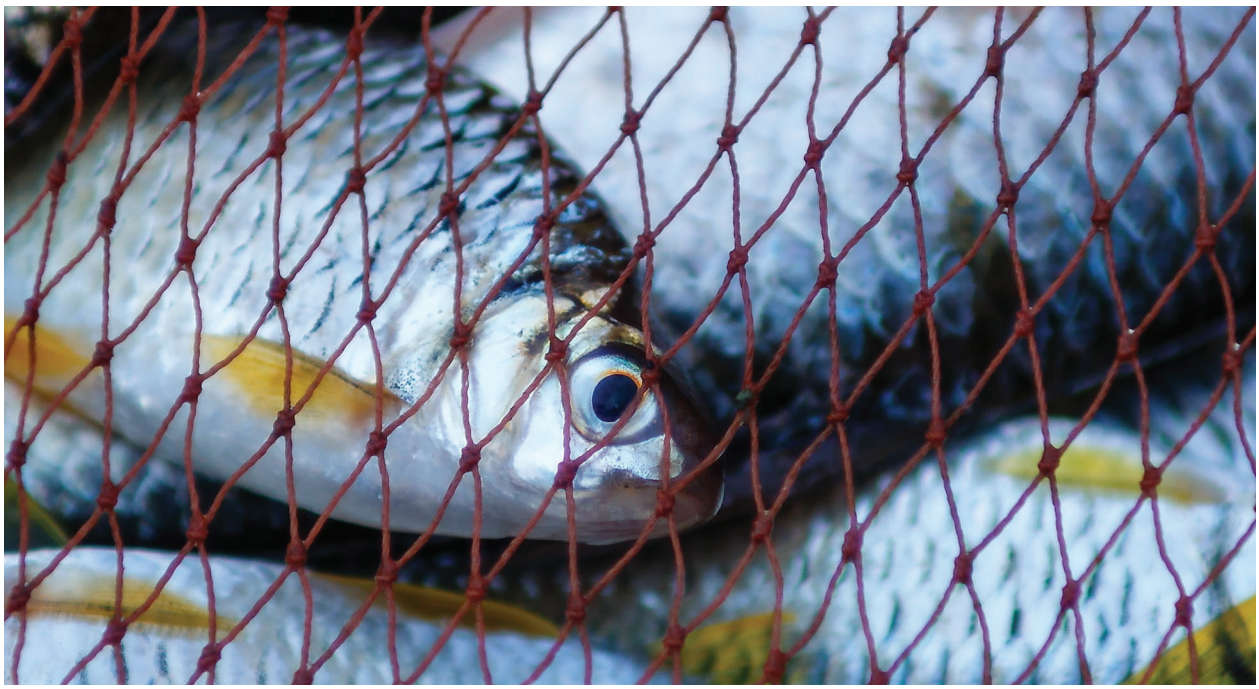
products and showcase them at their conferences and events.

c. Academic Institutions

Forward-looking research universities like UC-Berkeley are leading the way in developing the protein sources of the future (see UCB's AltMeat Lab) and other universities should follow suit. Even if a university doesn't have the bandwidth to create new majors or devote sufficient lab space to alternative protein research, allowing students to minor in the field or even adding an introductory course, would go a long way towards increasing the number of students who might pursue a career in this space, providing the crucial intellectual capital to help the industry grow. (The Good Food Institute is helping facilitate the development of student groups for those interested in alternative protein research at universities.)

d. Private Sector

Significant venture capital is already entering these spaces, but more is needed to scale production sufficiently to drive prices down. Investors looking for social impact opportunities couldn't find much better investments given the incredibly high environmental footprint of the industrial fishing industry. In addition, large private companies with dining halls and large events should make sure to include products from these emerging Blue Economy seafood sectors throughout their operations; with their buying power they can help move markets and attract even greater capital investments. Large meat and seafood companies should consider investing in and forming partnerships with alternative seafood producers to diversify their product lines, create more resilience in their supply chains, and diversify their investment portfolios.



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VI. Conclusion

The commercial fishing industry, dominated in most of the world (and the High Seas) by large industrial operations, has provided tremendous amounts of seafood to consumers for decades, but with tremendous environmental costs. New and expanding Blue Economy sectors—sustainable aquaculture, cultivated seafood, and plant-based seafood alternatives—have the potential to dramatically increase seafood production while easing (or even completely removing) pressure on wild species and sensitive marine ecosystems, while reducing the overall climate footprint of the seafood sector. The question is not so much 'if' but 'when' these sectors will mature and capture significant market share; the more the global community can do to accelerate these sectors the greater the benefits to the ocean and human health.

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Measuring Sustainable Ocean Economy Investing

by Mark J. Spalding, President, The Ocean Foundation

Although the exact definition of the blue economy is still being developed, there seems to be strong consensus that it relates to the ocean, or to water more broadly, and that it must be sustainable. Just as green business is the subset of all business, the blue economy is the subset of the ocean economy that is leading with solutions that are sustainable, have an ocean-positive benefit, and will be part of a global circular economy. While this is self-evident as a goal, how can investors get there? What are those of us leading this effort doing? In what should one invest? And, how will investors know if they are succeeding? Allow me to briefly answer these questions to help investment advisors and asset owners (e.g., high net worth individuals, investment banks, pension funds, or sovereign wealth funds) play a role in creating the best outcomes for the ocean, and for those people who depend upon her.

How should investors enable a sustainable blue economy?

To enable a blue economy approach to support ocean protection, and argue in favor of restoration of coastal and ocean ecosystems, we must be convincing and clear about the value generated by healthy ocean and coastal ecosystems for food security, storm resilience, tourism recreation, etc. While coastal

communities and small island nations are all too aware of their "gifts from the sea," global markets generally externalize the true costs of activities that harm the ocean. The Ocean Foundation's goal is that those costs will be internalized to governments and businesses—and that the profits and benefits go to those who steer a path towards minimizing and mitigating harmful activities while capitalizing on positive activities.

So, part of our work is to promote consensus on how to quantify what often are called non-market values: provisioning (such as food for subsistence fishers), regulating (storm surge and waves), supporting (pollution filtration and oxygen production), and cultural (aesthetics, recreation, fun, and inspiration). And at the same time, TOF works to ensure that those non-market values are not just quantified, but also protected and even enhanced. For example, adding both a blue economy and an ocean-climate value to ask if current regulations protect seagrass meadows, mangroves, and salt marsh estuaries that are critical carbon sinks and mitigate the greenhouse gas emissions and other effects of human activities, while replenishing ocean life.

On the flip side, there is the issue of establishing the risk to human activities (and costs) if we fail to adopt "bluer" economic activities or incentivize reducing negative activities by ensuring that companies and governments internalize those costs. Thus, TOF will continue to identify and quantify the cumulative effects of negative human activities, such as air pollution, land-based sources of marine pollution, including plastic loading; and extraction of resources from fish to fossil fuels. These and other activities are a threat to the marine environment themselves, but also to any coastal and ocean generated value to the global economy at every level.

Ocean generated value is threatened by cumulating human activities

- CO2 emissions (acidification)
- Over-fishing/by-catch
- Decimation of top predators
- Open pen fish farming
- Noise pollution from shipping, etc.
- Minerals and petroleum extraction
- Coastal wetlands, mangroves, and seagrass destruction
- Tropical reef and deep, cold water coral destruction
- Deliberate and accidental toxic dumping
- Toxic run-off from roads, farms, and other human settlements (algal blooms –hypoxia)
- Plastic loading

With a firm understanding of the values generated or at risk, investors have begun to design the blue finance mechanisms to pay for conservation and restoration of coastal and ocean ecosystems. This can include philanthropy and multilateral donor support via design and preparation funds; technical assistance funds; guarantees and risk insurance; and concessional finance. There is also likely a part to play for private and public investment capital. Such finance instruments must respect cultural heritage, limit risk to vulnerable communities and nations, and ensure that benefits accrue at the source. For example, new emerging values, such as those related to biotechnology, will require both legal oversight and start-up financing to ensure their development is equitable and ocean-positive. More can be done.

What are we doing?

On the public equity side, The Ocean Foundation (TOF) and I are the exclusive expert ocean and climate advisor and research collaborator to Rockefeller Capital Management. As such, we provide due diligence and scientific validation on how companies may affect the coasts and ocean, to enhance idea generation, research, and engagement process. TOF and our investment partners engage the private sector so that business activities are collaborative and regenerative, enable environmental and climate resilience, integrate into local economies, and generate economic benefits and social inclusion of communities and Indigenous Peoples. This covers two ocean-centric portfolios:

- The "Rockefeller Climate Solutions Fund" launched 2012 was the first ever ocean-centric climate solutions fund (with $220m AUM it is now a mutual fund in the USA, UCITS in Europe), evolving from its origins as the Rockefeller Ocean Strategy. Through this unique, globally diversified impact investing opportunity for the ocean-climate nexus with all-cap, private placement in active, long-only global publicly traded securities, we have created a triple-screened fund.
- In collaboration with Credit Suisse (CS) and Rockefeller Asset Management (RAM), The Ocean Foundation launched the Rockefeller Credit Suisse Ocean Engagement Fund (September 2020, $780m AUM) to meet the increasing demand from institutional and private investors to invest in the Blue Economy. This thematic equity strategy focuses on the UN Sustainable Development Goal 14, and employs constructive engagement with portfolio companies to generate alpha and positive ocean health outcomes. We advise and steer portfolio companies away from ocean-harming practices, through dialogue with their management teams. For this fund, I participate in engagement calls or meetings with portfolio companies around the world, push such companies toward operating in more ocean and dependent community friendly ways (and on the development of metrics with Rockefeller for measuring such change). Regarding coastal and ocean ecosystems this engagement to change corporate products or behavior can include work to reduce plastic pollution, land-based sources of marine pollution, fishing practices etc. It can also include sustainable travel and tourism practices (for which I also have a depth of experience).

And, in parallel with these two public equity funds, TOF, Rockefeller, and Credit Suisse are developing a private equity portfolio and a fixed income strategy that will complement and work in parallel.

In what should one invest?

Let us propose seven major categories of sustainable blue economy investments, which are at varying stages and can accommodate public or private investment, debt financing, philanthropy, and other sources of funds.

- **Coastal Economic & Social Resilience.** This can include restoration of coastal "blue carbon" sinks (sea grass, mangroves, and coastal marshes), and making coastal infrastructure (utilities, roads, etc.) more resilient. It also includes working to ensure our communications systems, seafloor telecommunications cables, utilities, and solid waste management facilities are storm ready, including re-design for inundation and buffering with restored mangroves or marshes. Resilience means updating risk and insurance products in ways that reduce incentives to build or design without consideration of risk. This also means making sure coastal and marine tourism is both built and operated to be sustainable and not causing more harm. We've tried to help communities meet the need for ocean acidification monitoring and mitigation projects—through both policy and science—especially where shellfish production is a key part of the coastal economy or subsistence diets. This includes taking on significant blue carbon conservation and restoration projects. All these investments represent diverse industries or emerging industries, and diverse supply chains, generating economic activity as well as sustaining existing economies by making them less vulnerable. Many of these coastal resilience projects are public interest projects, may meet the definition of "climate actions" and thus are more likely to be financed via government-issued bonds.
- **Improving Ocean Transport.** Shipping is ocean-positive in the sense that moving a ton of product by water has the lowest carbon footprint—which is not to say no carbon footprint. The ocean transport sector is under significant pressure to reduce emissions and

Mangrove seedlings being grown to replenish forests at Samsarn Island, Chonburi.Thailand. Shutterstock.com

to increase the sustainability of their operations (including ocean noise, waste streams, and energy efficiency)—from portside to high seas. The blue economy lens for shipping offers many kinds of investment opportunities: New engineering solutions to develop zero-emission vessels; Fuel substitution (electric, di-methyl ether, green hydrogen, ammonia); Alternative fuel propulsion systems (computer aided sails, for example); and new more efficient hull coatings and navigation systems. Ship builders can reduce chronic ocean noise with quiet ship technology. And, governments can make sure all ports are more sustainable in their energy use, cargo management operations, and waste management.

At TOF, we have done substantial research synthesizing the many ways investors can help make the maritime industry more sustainable.[1] This sector is great for selective investment in those companies leading with solutions, or in companies whose alfa can be improved by changing their products or practices. For example, via the Ocean Engagement Fund, we have been engaging with major shipping firms to reduce their greenhouse gas emissions via new propulsion systems or fuels, as well as improving their shipbreaking (end of life ship recycling) practices.

- **Ocean Renewable Energy** (such as power generated by waves, tides, currents, OTEC, and wind). This kind of investment can include both expanded R&D and increased production. And, investors can explore integrated ocean management to balance needs of other ocean users, as well as the potential effects of increased ocean noise and other operations on sea life and coastal and island communities. The monitoring equipment itself represents an investment opportunity. Investment in this sector can be both private and public equity in energy firms, fixed income instruments for public utilities, and in some cases, government bonds for extremely large projects.

- There are real and urgent **Ocean-Sourced Food** investment opportunities: Sustainable aquaculture, as well as coastal and oceanic fisheries. These sectors have significant embedded equity and related issues that can be addressed by appropriate investment with a true blue economy lens. In these sectors, investors can explore opportunities for returns from emissions reductions from fisheries operations, including aquaculture, wild capture, and processing (e.g., low-carbon or zero-emission vessels), energy efficiency in postharvest production (e.g., cold storage and ice production), and alternative aquaculture feeds (algae, microbial, fungal, insect). Investors can also analyze new emerging sub-sectors including new cellular manufactured seafood (such as BlueNalu), kelp farming, as well as fisheries byproduct transformation. Meanwhile NGOs and others who are concerned about ocean health can seek related regulatory changes that eliminate fuel subsidies for fishing fleets, and call for vessel and gear improvements that increase efficiency, while strongly constraining catch to sustainable levels. Again, this sector is great for selective investment in those companies leading with solutions or with tools to increase monitoring and enforcement, or in companies whose alfa can be improved by changing their products or practices. At TOF we have engaged with retailers and fishers and intermediaries to improve sustainability through transparent, credible traceability of sources among other improved practices.

- Fifth, investors can explore financing **Ocean Biotechnology** – the innovative marine molecules sector that uses living systems and organisms from the marine environment to develop or make products, which can include: nutraceuticals (dietary supplements and food additives that provide a medicinal benefit, or improve well-being); and cosmetics (marine biotechnology raw materials for cosmetics, holds huge potential for sustainability). Right now, this will be private equity in companies at the pre-competitive (seed or "angel" funding) level, early stage risk investment (venture capital) level, or late stage private equity (where going public is the likely exit strategy). In addition, there may be opportunities for investing in joint-ventures or corporate facilitations—especially when engaging the community to ensure that biological and cultural heritage are not only respected but monetized to the extent that ensures that communities are not losing livelihood while profits are generated elsewhere.

- Sixth, there is a tremendous demand for investing in **Cleaning Up the Ocean**. Humankind needs to work quickly to transition away from offshore oil and gas, and clean up its legacy infrastructure. All communities must pursue pollution reduction in coastal waters to remove contaminants and excess nutrients to restore ecosystem function. Island and coastal communities are facing unusual dead seaweed events in tourism areas, as well as other nutrient-fueled harmful algae blooms (smelly, unsightly, and costly to clean up). With climate change kindled storm surge, investment is needed in removing and disposing of post-storm debris, as well as in storm-resistant sewage management systems (for example). It is great to see rising investment in cleanup of marine debris, especially plastic pollution in our waterways and ocean. Addressing marine debris must include thoughtful island nation waste management solutions and increased awareness of the potential harm from ship groundings, and other at-sea accidents to improve container management. Plastics management is top of mind for many consumers as well as investors. We envision investments in recycling and upcycling technologies, preventive management, microalgae that can eat plastic, as well as redesigning plastic to develop next generation materials that have potential to be part of the circular economy / sustainable blue economy. Plastic must become safe, standardized, and simplified to be managed. Like biotech, a lot of these investments are private equity opportunities, but there are also many public equity companies making a play in the space. And, this sector is especially opportunistic for selective investment in those companies leading with solutions, or in companies whose alfa can be improved by changing their products or practices. Hence, TOF and our investment partners are engaging consumer goods / brands on eliminating unnecessary/problematic plastic packaging; transitioning to reusable packaging; ensure all packaging is reusable, recyclable, or compostable; and incorporate or increase recycled content in plastic packaging. Alongside this, we ask all companies about their plastic footprint, recycling practices, as well as environmental justice aspects of plastic production, consumption, and improper disposal.

- Finally, investors must anticipate **Next Generation Ocean Activities**. At TOF we predict this will include investing in infrastructure-based adaptation to relocate and diversify economic activities; sensors and other equipment to monitor unseen harm from rising sea levels and saltwater intrusion, and when and how to relocate people and infrastructure. Investing to expand nature-based solutions for carbon capture and storage technologies, and improv-

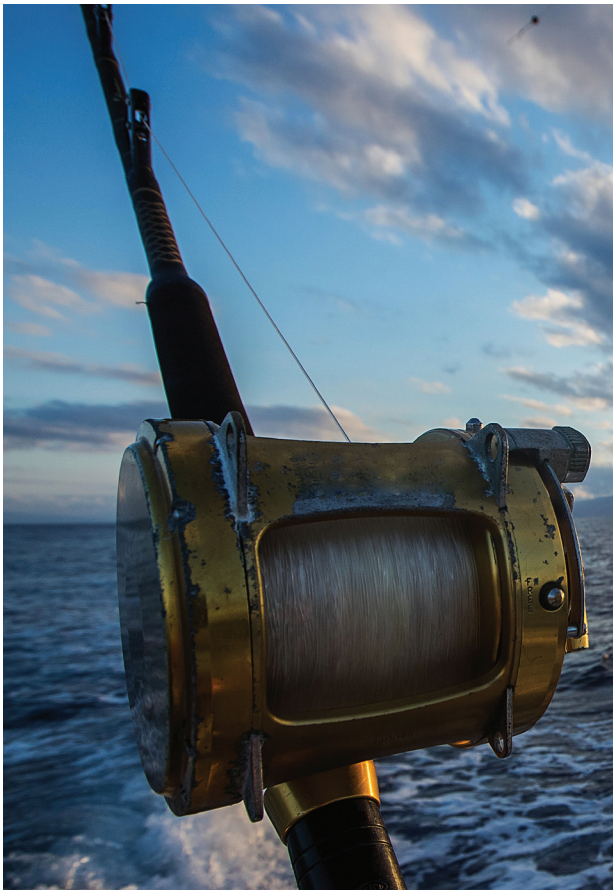
ing our ability to map and identify the best places to initiate restoration/planting where water levels change. Pursuing research and development of other nature-based solutions that take up and store carbon (micro and macro algae, kelp, and the biological carbon pump of all ocean wildlife). We also believe that many of the ocean-based activities outlined above will need redesigning with new technologies to adapt to changing conditions, minimize harm to sea life and human communities, and achieve an ocean-positive goal in operations. And there will be some investment needed to exercise care that geoengineering technology solutions are examined carefully for their efficacy, economic viability, and potential for unintended consequences.

How will investors know if we are succeeding?

Meaningful blue economy investing must have real, measurable positive outcomes. Financial institutions, such as banks, insurers, and investors, are critical to the long-term health of our global ocean, however they are often poorly informed about (i) the impact of their investments on the ocean economy and (ii) their portfolio exposure to financial risks from the decline in marine ecosystem health. In some cases, it's understandable: It's hard to build in the air we breathe as a cost or a risk—but it is the outcome if we don't improve the human relationship with the ocean. In other cases, it's just a question of adjusting the lens. Something that takes time, but is achievable.

I sit on the UNEP Guidance Working Group for its Sustainable Blue Economy Finance Initiative, which has developed "Sustainable Blue Economy Finance Principles."[2] These 14 principles, constitute a broad framework for investing in the blue economy. They are useful and are intended to get investors to state up front that they care about the health of the ocean, not just a return on their investments. However, the Principles are not designed to measure results of such investing.

Similarly, the Blue Natural Capital Positive Impacts Frameworks[3] identifies opportunities, and looks at how to assess potential investments. It has developed a Blue Natural Capital Positive Impacts Framework to guide the monitoring of projects and measure positive impacts. However, it is narrower than the entire blue economy as it is focused on key performance indicators relating to the positive effects on ecosystems and species directly, i.e., the natural capital found in coastal and marine environments which provide ecosystem services.



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If all those in favor of ocean health and abundance are seeking to establish a global standard for measuring a portfolio's exposure to sources of "blue" revenue, such as fishing, shipping, offshore wind, maritime and coastal tourism, and marine biotechnology then I would humbly suggest a 3 tier approach:

The **first tier** is perhaps obvious, but sadly sometimes things can go imperfectly as the result of fraud, mismanagement, or irreproachably fail as the result of uncontrollable events. Thus, investor self-evaluation starts with asking whether the investment was consummated, and, whether it made an ocean business better / more sustainable through a change of product, practice, or service? For example, if one is investing in better fishing gear, were funds invested or spent as directed, and in a timely manner. And, if so, did it make the company fish in what is expected to be a more sustainable fashion?

The **second tier** asks if such better fishing gear, and thus theoretically more sustainable practice provide for a positive ocean return? For the fishery, in the short term, this might be evidenced by less by-catch, less target species wasted, more focus on the right age or size of fish. For the longer term, did the new gear and practices result in greater biomass abundance within the fishery, and or for related or adjacent species? For the ocean more generally (and depending on the investment), this efficacy measure would call out a measurable direct environmental condition improvement / carbon sequestration or other ocean positive outcome? In fact, given the unquestionable urgency of addressing human disruption of the climate, reducing or eliminating greenhouse gas emissions, or promoting carbon sequestration should be critically included elements of all investments going forward.

The **third tier** asks about economic and social sustainability. For without such sustainability the investor, the fishing company, and ocean-dependent communities will conclude that the effort was not worthwhile and it will fade away. So, in this last tier, the investor will unsurprisingly ask herself if she received a positive economic return on her investment. And, was that return as good or better than any other investment that might have been made. When the investor is a government pursuing the public good, such an economic return can also include a reduction in exposure to financial risks from the decline in marine ecosystem health. And the conscientious investor will seek to keep social sustainability co-equal with whether the investment created outsized returns when compared to key benchmarks. This means asking whether any nearby ocean-dependent communities benefit from an improved economic resilience / food security / human health etc.? This can be indirect, through the transition to more sustainable livelihood projects that will support the development of profitable activities based upon the ecosystem services provided by healthy coastal and ocean ecosystems like ecotourism, commercial fishing, and beekeeping in the medium- and long-term. This must include asking if disparities in diversity and equitable opportunities and practices are addressed such that benefits are justly distributed. And, because all projects should highlight the necessity of local support for successful projects, an investor should deliberately engage members of traditionally marginalized groups in decision making.

These three tiers can be fleshed out further, and when doing so can draw upon best practices from other finance and investment sectors such as those looking at performance standards on environmental and social sustainability. As we do so, we need to keep in mind what measurable outputs investors

can deliver themselves, versus the outcomes that depend on others to occur, we can often confirm these when another actor responds to our outputs (e.g., a report that leads to a legislature adopting a new policy) and/or something materially changes (e.g., more sea turtles are saved). And, we need to acknowledge our need to measure both.

Conclusion

Financing and investing activity is growing rapidly across asset classes and sectors that make up the blue economy. Many see it as a new source of economic growth, with new sub-industries and opportunities emerging to meet demand. In some ways, such activity is getting out ahead of definitions, benchmarks, and efficacy measurements. And, as we have seen too many times in the past, blindly chasing growth can risk a result with unintended consequences including reductions in, or loss of, natural capital, and deepening inequity in affected communities.

As the understandable effort to define the sustainable, equitable, and just blue economy continues to roll out, I have tried to explain how investment advisors and asset owners can support investment in the blue economy, including by engaging companies and pulling them toward better behavior, products, and services. After describing seven broad potential investment sectors, I have begun to articulate how to measure, evaluate, and learn from our investments in a way that gets beyond a simple "rate of return" metric of an investment over a specified time period. Thus, those of us working on investing in the blue economy must measure our direct outputs, and indirect outcomes that all build toward our goal of a healthy and abundant ocean.

The good news is that I believe the blue economy offers a major opportunity for the financial and investment sectors to deliver on climate commitments and other established Environmental, Social, and Governance investment objectives, whilst tapping into new blue sources of economic and social sustainability. The blue economy is not just about driving superior risk-adjusted returns; it also provides for the protection and restoration of more intangible blue resources such as traditional ways of life, carbon sequestration, and coastal resilience to help vulnerable states tackle the often devastating effects of climate change and biodiversity loss together.

References

1 Mark J. Spalding, Angelica E. Braestrup, and Alexandra Refosco "Greening the Blue Economy: A Trans-disciplinary Analysis" for a book "Sustainability in Maritime Transportation: Towards Ocean Governance and Beyond" (Springer, 2021)

2 https://www.unepfi.org/blue-finance/the-principles/

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A rising tide lifts all boats: How policy makers can summon the wave energy needed to enable the captains of blue economy businesses

by Nicole Baker Loke and Sara Aubery, Net Your Problem

Executive Summary

Net Your Problem LLC, a blue economy business, has contributed to economic development and environmental stewardship in 12 communities over the past four years. For fishing gear recycling, and indeed recycling in general, to be the preferred disposal option for materials at their end of life, the following policies and incentives could be introduced to make recycling competitive to other options for disposing of waste: develop the infrastructure and capacity of domestic recycling programs, protect our ocean resources through a focus on the prevention of plastic pollution, encourage the demand for recycled plastic, reduce subsidies for oil extraction and broaden the focus on plastics to include more than just "single use plastics". Improving and supporting domestic recycling programs directly lowers greenhouse gas emissions, decreases the amount of space needed for landfills, contributes to supply chain consistency, reduces water pollutants, conserves resources, saves energy, and creates jobs. Fishing gear in the ocean is a waste management issue that can be solved by providing incentives for fishermen to deliver their nets to a centralized location.

Key Recommendations – Balancing Stewardship and Growth

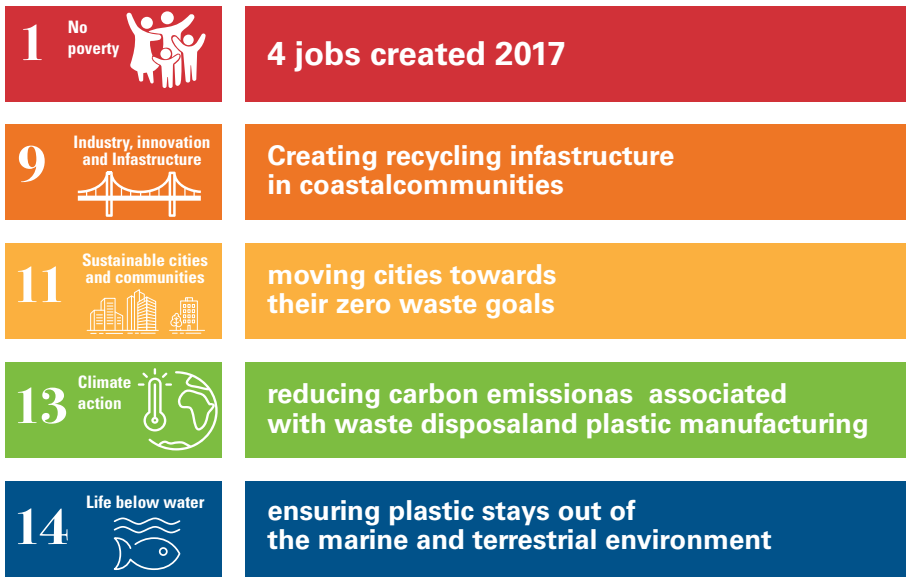
1. Develop general US recycling processing capacity to include fishing gear which can generate jobs, strengthen and shorten supply chains and lower costs overall.
2. Include "not single use plastics" in discussions about plastic waste, given that 2/3 of plastic production is not for single use products
3. Include recycling or manufacturing with recycled content as a carbon emissions reduction solution. The link between plastic waste and carbon emissions is clear, and recycling offers a solution to both.
4. Encourage the demand of recycled content (not just in single use products) which can help overcome the disparities in price with virgin plastic, drive the whole recycling system and justify investments in collection schemes.
5. Future policies need to align with our collective values; subsidizing the extraction and refining of oil (to the tune of $20 billion USD per year! according to EESI) does not support economic growth that is good for our country, environment and citizens.

Background and Context

Why care about blue economy businesses?

Blue economy businesses are those that use the ocean's resources in a sustainable way to generate economic growth, improve livelihoods and jobs while preserving the health of ocean ecosystems and may include renewable energy, tourism, waste management, fisheries and maritime transportation. Supporting the blue economy allows societies to derive real revenue while focusing on regenerative rather than extractive industries. In fact, the OECD estimates that in 2030, its contribution to the global economy will have doubled from $1.5 trillion USD in 2010 to $3 trillion USD.

Figure 1. SDGs addressed through fishing gear recycling programs



Reviewing relevant policies and initiatives

In 2015, the United Nations adopted the 2030 Agenda for Sustainable Development and the Sustainable Development Goals (SDGs) which formed a blueprint for businesses and governments to ensure peace and prosperity, for people and the planet, now and into the future. See Figure 1 for examples of how fishing gear recycling advances five of the 17 SDGs. Much like how oceans and seas are interconnected bodies of water, businesses in the worldwide blue economy are interconnected and interdependent. 96% of the material we have collected has been shipped to Europe where the capacity to recycle, market and resell the plastic material is in place. Table 1 lists relevant global policies that support the circular economy and the blue economy when it comes to recycling fishing gear.

Table 1. Examples of legislation and their functions

Legislation	Description	Summary	Effect
Basel Convention: Controlling transboundary movements of hazardous wastes and their disposal	Basel Convention Amendments	Only homogenous loads of plastic waste can be exported/imported	Plastic waste is pre-processed and sorted before export, ensuring the importing country has the capacity to recycle the waste
Single Use Plastics Directive	Extended Producer Responsibility (EPR)	Producers of plastic are financially responsible for the disposal at the end of life	Provides sustainable funding for the collection, processing and recycling of waste into a raw material ready for the manufacturing supply chain
Vary by state in the US.	Recycled Content Mandates	Required percentage of recycled content in new products	Increased demand for recycled plastic
Packaging and Packaging Waste Directive	Virgin Plastic Tax	Taxes on the use of virgin plastic	Discourages the use of virgin plastic in manufacturing

The rest of this brief will focus specifically on a subset of blue economy businesses concerned with the sustainability of fisheries, and the collection and export of plastic fishing gear for recycling. The role of fishing gear recycling in the blue economy is extremely relevant to US legislators because of the global significance of the US fishing fleet for nutrition, food security and economic revenue, and the growing attention being paid to plastic waste, especially fishing gear, as a pollutant in the ocean.

Is fishing gear waste a problem in the US?

According to the Food and Agriculture Organization of the UN, there are 2.8 million motorized fishing vessels in the world, with 80,200 of them registered in the US. Although the US only operates <3% of the world's fleet, it ranks sixth in the world in terms of tons of catch (after China, Indonesia, Peru, India and the Russian Federation) landing about five million tons in 2018 (SOFIA, 2020). The types of species caught range from salmon and pollock to lobster, crabs and shrimp which are caught in gear like trawl nets, gillnets, seine nets and pots. A majority of these landings occur in Alaska, but there are ports in Virginia, Mississippi, Louisiana, Oregon, Washington, Massachusetts, New Jersey and California that contribute over 50 million pounds annually to the 9.3 billion pounds (worth $5.5 billion USD) that were caught in 2019 (Fisheries of the US, 2019). All of the gear types used to catch this healthy, nutritious, sustainable, wild food are made from plastic, and should be recycled at their end of life. Dumping fishing nets and ropes into the landfill, incinerating or leaving them in a yard indefinitely, are all disposal options that waste precious resources. There are solutions for recycling HDPE (high density polyethylene), PP (polypropylene) and PA6 (nylon) and making these solutions accessible and affordable will increase motivation for behavior change.

Insights: What we know from what we have learned

The following insights are based on our work building end of life fishing gear collection programs in the US for the past four years:

Build regional infrastructure

Working with small, remote communities, multiple different types of plastic, and changing regulations

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governing the global waste trade required us to open regional warehouses to aggregate types and quantities of plastic. We now have warehouses in Washington, Maine and soon in Massachusetts. By having a centralized place where we can accept, weigh, process, do quality control checks and organize nets and ropes, we can comply with Basel regulations which require exported plastic waste loads to be homogenous. Fishing nets are made with multiple types of plastic, which need to be separated into different components - similar to the sorting of household recyclables. Our regional warehouses enable us to offer our services to smaller entities, be it private businesses or small cities, to aggregate gear until we reach 20 tons—the amount of fishing gear needed to fill a 40' export container if you load it correctly, and the amount needed to efficiently ship a product long distances over multiple oceans. Acquiring these facilities brings an added cost, and it is especially difficult to find medium-sized buildings, with industrial power requirements, in coastal cities where real estate can be prohibitively expensive.

Secure sustainable funding

The most critical part of any new idea or initiative challenging the status quo is to secure sustainable financing, and our business was no exception. Some of our more recent customers are single-vessel, family-run fishing operations, where fishing licenses are passed down generation after generation, and costs and expenses are tightly controlled. As a result, we have considered a variety of types and sources of funding, from the most obvious, like having a port pay for waste disposal using a portion of slip fees, to the most creative, like plastic credits (similar to carbon credits, businesses can pay to offset their plastic production and use by paying an organization to collect the same amount, thereby becoming "plastic neutral"):

- **Grants**. In the for-profit world, all businesses need some form of initial investment to get started, build out their idea, hire staff and make equipment purchases. Typically, these investments are financed by private investors who get involved because they believe there will be a return on their initial investment, but governments benefit from the success of blue economy businesses and therefore government funded grants should be available as an initial public investment to for profit entities doing social and environmental good. This will enable more businesses to simultaneously consider people, planet and profit, ensuring they have the resources they need to explore new business models.
- **Extended Producer Responsibility** (EPR). Although this does not exist for plastic in the US currently, it is being considered. The EU provides an example as fishing gear is covered under the Single Use Plastics Directive along with other types of plastics commonly found on beaches. An EPR scheme seems to be a silver bullet solution to the ubiquitous problem of plastic littered on our lands and in our oceans, but it places all the responsibility on the plastic producer, when in fact many organizations benefit from the responsible disposal of waste. Shared EPR schemes on the other hand, involve many stakeholders, and distribute the costs so that one entity does not bear the entire burden.
- **Tribes and community groups.** Many non-profits and tribes have chosen to develop recycling programs in their communities, when the local government has been unable to offer them. Robust fundraising schemes and utilizing dedicated solid waste funds can be ways to pay for recycling.

- **Local governments.** Many, if not all, local and state governments have detailed landfill diversion goals. The State of Maine, for example, has a Statute that requires them to recycle 50% of their waste, and we are not currently meeting this Statute. If governments want to make progress towards meeting legally required goals, sufficient funds need to be made available for programs with a proven track record of diverting waste, and again, including for profit companies in the eligibility criteria.
- **Brands and plastic manufacturers**. According to an article published in the Harvard Business Review in July of 2021 entitled "the green economy has a resource scarcity problem", 45% of the demand for recycled PET will be unmet by 2025. Brands and companies that have declared their commitments to source recycled plastic, green hydrogen and sustainable cotton, need to make investments in the supply chains and processing capacity needed to get these raw materials to their manufacturers. With a growing demand by customers for sustainable products, companies using the waste as raw materials should share in the cost of its collection along with communities and waste generators.

In an ideal world, we would build a coalition of all of these user groups, and additionally include other fishing industry stakeholders and blue economy businesses like ports, seafood processors, gear manufacturers and vendors. Because of the complicated logistics and time needed to collect and deliver materials, manage a warehouse and build coalitions to sustainably fund recycling efforts, the last essential piece of the puzzle is a local representative.

Figure 1b: pot warp from Maine

Figure 1a: shots of retired line in Alaska

Hire and enable a local representative

Having local representatives is critical to gaining stakeholder buy-in, keeping gear disposal at the top of the collective agenda and learning the nuances and vocabulary of each new fishing community. For example, crabbers in Alaska call a wound-up bunch of rope a "shot" (Figure 2a) and lobstermen in Maine call it "pot warp" (Figure 2b). How were Mainers supposed to understand what Net Your Problem was even offering when all our marketing materials talked about was shots of line? Local representatives need to feel empowered to follow leads, build relationships and come up with and try (and fail) new ideas as they learn the ropes (pun intended) and become a fixture in the community.

Positive, authentic relationships are absolutely essential to our business operations, and come with added legal and financial costs, but are worth every penny. Now that we have gone over what enables the blue economy business we have built, let's discuss topics that have made it more challenging.

Now that we have gone over what enables the blue economy business we have built, let's discuss topics that have made it more challenging.

Move away from focusing on port reception facilities

Many high level meetings, webinars and policy documents focus on the inadequacy of port reception facilities to handle waste given the MARPOL requirements that dictate such. We have collected over 450 tons of fishing gear in the last four years, and have not needed to rely on port reception facilities to collect and recycle fishing gear. Fishing gear in the ocean is a waste management issue that can be solved by providing incentives for fishermen to deliver their nets to a centralized location (that does not have to, but can be, run by a port). Continuously reporting on the lack of port reception facilities does nothing to establish them, create public private partnerships with ports, or find alternative ways to solve the problem.

Critically evaluate gear marking initiatives

Secondly, initiatives that have focused on marking fishing gear in case it is lost at sea as a solution to the problem of fishing gear in the ocean have introduced an added difficulty in the proper disposal of this gear. Mandates in the Canadian lobster fishery to include a thread in rope to identify the fishery would make it more difficult to recycle by introducing another type of plastic that would need to be removed and processed before recycling was possible. It is imperative that secondary ramifications of new policies be considered, and that while trying to solve one problem we do not create another.

Split hairs between end of life gear and ghost gear

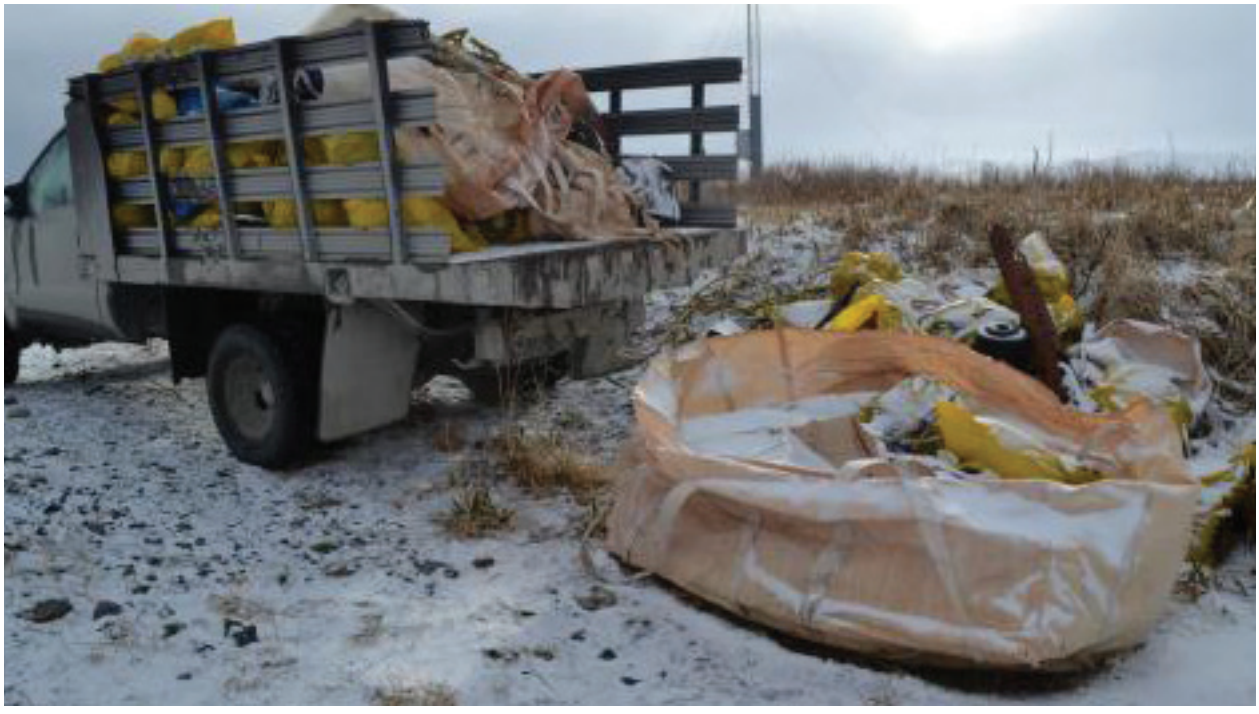
There is a lack of distinction between abandoned, lost and discarded gear (ALDFG) and end of life gear. They are commonly lumped together but in reality have different solutions, different audiences (ALDFG can rarely be identified back to its owner), different disposal options (ALDFG is not mechanically recyclable) and different operational challenges (retrieving gear from the water is considerably more difficult and dangerous than moving gear around on land). Policies or incentives that promote the success of one are unlikely to cause significant changes to the challenges faced by the other. This segways to our next topic of discussing the disparity between programs that prevent marine debris and those that focus efforts on clean up.

Prioritize prevention vs. clean up

There is a bias in the quantity of funding provided to prevent waste pollution and the quantity used to clean it up. The US West coast alone spends over half a billion dollars each year cleaning up marine debris (The United States Federal Strategy for Addressing the Global Issue of Marine Litter). Our programs that have successfully collected and recycled over one million pounds of gear have cost approximately $350,000. In the NOAA Marine Debris Program 2020 Accomplishments report, 100% of the prevention projects funded focused solely on education and did not include capacity building nor infrastructure investments to improve waste management. Furthermore, within the Marine Debris Program, an investment of $11 million USD resulted in the removal of 18,800 metric tons of debris, at a cost of $3.76 per pound (including the removal of extremely heavy items like concrete docks and derelict vessels). Our programs cost $3.33 per pound of plastic recycled without it ever entering or causing damage to the environment.

What we learned from our biggest success - Dutch Harbor

Initially, we modeled the collection of gear based on our first experience in Dutch Harbor, Alaska. Fishermen paid to responsibly manage their waste and we provided this service. Subsequent challenges arose when we realized the alternatives, willingness and ability to pay were not uniform across the industry and across geographies. Our first success relied solely on charging the fishermen for disposal, and we did not (and still don't) encounter much resistance to this arrangement. We contract with a company to load the gear into shipping containers, and export large amounts of nets to our processing partners in Europe without any kind of formalized



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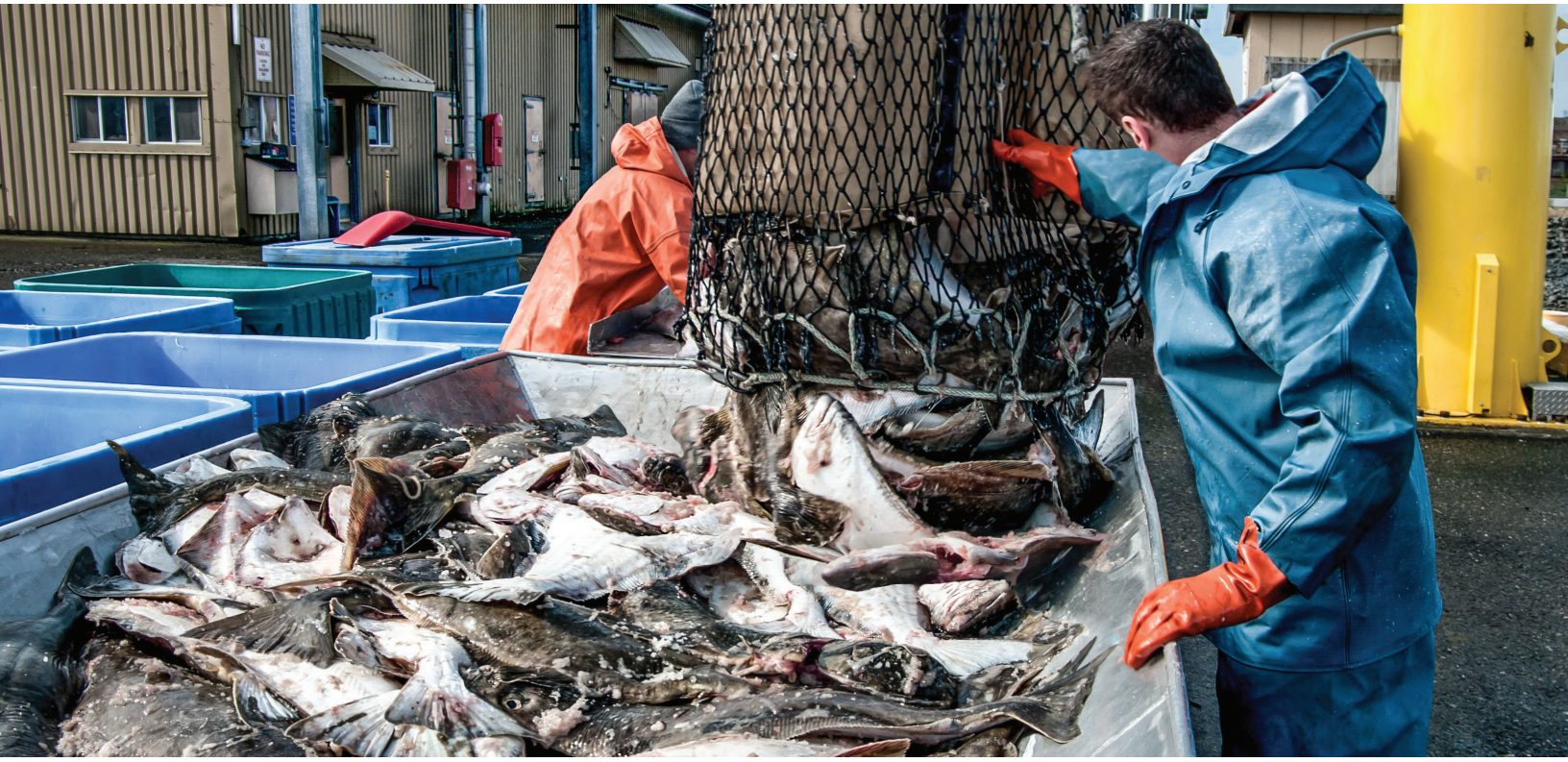
infrastructure. Doing business in Dutch Harbor is very expensive, fishing operations are very profitable, and run by large corporations, a dynamic not present in every fishery in the US which makes the model uniquely suited to this location only.

What we learned from our biggest failure - Connecting Collection to Pellet Production

Convincing brands and manufacturers to support the collection part of the circular economy has been difficult. Despite compelling arguments, flashy marketing tools, and attempts to build relationships, we have not successfully gained a partnership where a brand using recycled plastic in their products pays a portion of our costs. There are two primary reasons for this: 1) we are one step removed from the material used in the manufacturing process. The fishing gear we collect is the raw material that needs to be processed and recycled into pellets, which is what later gets made into a product and 2) The price of virgin plastic is generally lower than the price of recycled plastic, making it already a more expensive material to use and leaving little room in the budget for other external costs.

Acknowledgements

This report was made possible by support from the Konrad-Adenauer-Stiftung. The views, conclusions and recommendations expressed in this report are solely those of its author(s) and do not reflect the views of the Konrad-Adenauer-Stiftung, or its employees. Net Your Problem LLC acknowledges that this brief was written while on the land of the Coast Salish, Duwamish, Suquamish, and Luiseño peoples. The following experiences, education and accolades give us the authority needed to share our thoughts with a global policy audience. Nicole Baker Loke, the Owner of Net Your Problem LLC has a masters degree in biological oceanography from the University of Puerto Rico, Mayagüez and worked on commercial fishing boats for five years before starting Net Your Problem. Nicole received the Alaska Ocean Leadership Award for Stewardship and Sustainability, given by the Alaska Sea Life Center in 2021, and has been asked to share her expertise and insights at many domestic and international meetings including the Arctic Council, has been featured in Forbes magazine, completed (along with Sara Aubery) the Maritime Blue Accelerator program in April 2020 and the Plug and Play End Plastic Waste Accelerator program (along with Sara and Erin Adams) in May 2021. Nicole and Erin are the co-chairs of the Cordage Institute's Life Cycle Management Committee and all three women and their new colleague Ashley Zullo, work tirelessly as a small business owner and employees, to understand the best way to provide a solution as a blue economy business.



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Towards ocean-centric climate adaptation in the Arctic

by J.C. Sternberg, Alaska Blue Economy Center, University of Alaska Fairbanks; J.H. Edmondson, Alaska Blue Economy Center, University of Alaska Fairbanks; and S.B. Moran, College of Fisheries and Ocean Sciences, University of Alaska Fairbanks

For many years economists have recognized the need to value the planet's ecosystem services to make informed financial and policy decisions based on nature's contributions to the global economy. While understanding of ecosystem services has improved through increased scientific focus and technological advancements, the acceleration of climate change has continued. Regenerative business models that protect and restore the ecosystems in which they operate have never been more important and offer valuable solutions to address the predicament the planet is experiencing. Nowhere is this truer than for the oceans, Earth's largest heat and carbon sink.

Nonetheless, current estimates indicate that just 1% of global climate finance is dedicated to the oceans, which represents a significant opportunity for capital investment. Now is the time to rethink current climate policies and redirect investment towards an ocean-centric strategy.

As of 2011, the value of the planet's ecosystem services to humans was estimated at over $120 trillion annually. While this valuation is subject to debate and not thought of as absolute, it is in part limited by the ability to assign a price to those ecosystem services that can be scientifically quantified. In this regard, it has been anecdotally

noted that more is known about outer space than about the oceans, and it stands to reason that marine ecosystems are significantly undervalued. Nonetheless, new technologies are rapidly advancing understanding of the oceans through the ability to observe, measure, map, and predict ways that benefit climate mitigation strategies.

In the United States, Alaska has more coastline than the rest of the country combined and accounts for one-third of the nation's Exclusive Economic Zone. The state is home to some of the largest fisheries in the world, with approximately two-thirds of the nation's landings harvested off Alaska's coast. Additionally, Alaska is home to diverse biological ecosystems and world-class wind and tidal renewable energy resources. Coastal tourism is a pillar of the state economy and reflects its status as a preeminent destination for travelers seeking access to numerous pristine natural environments. However, much of Alaska's natural heritage is threatened by accelerating environmental change due to a rapidly warming Arctic. Declining sea ice, ocean acidification, warming ocean temperatures, melting glaciers, and thawing permafrost have resulted in dramatic changes in the arctic food webs.

Alaska's seafood industry and its brand has been built on the integration of science-based principles. While far from perfect, the state's fisheries management is considered to be best in class and globally recognized for its effectiveness in addressing long-term sustainability. In the face of climate change, management at the top levels of major seafood industry stakeholders recognize the need for sound science to navigate the difficult decisions facing fisheries. These challenges go beyond climate and include aging infrastructure, high-energy costs in remote coastal communities, and an aging workforce with a lack of new workers. The COVID-19 pandemic has served to exacerbate these issues, but it has also changed the calculus on the opportunity for technological solutions.

Whereas previously, automation, artificial intelligence, machine learning, and blockchain were viewed as early stage and expensive, largely due to the cost of computer scientists and lack of investments in these areas, these tools are now being recognized as essential components of the industry's future long-term strategy and viability. Initially, advances in Moore's law and the commodification of data storage moved from what was once the realm of large government agencies to the general public. During the nascent period, large teams would be required to do what is now considered trivial and efficiently accomplished by a single individual. In the same way businesses have been able to leverage cloud-computing platforms, thereby freeing them to focus on core business, expertise in the architecture that is the foundation of artificial intelligence and deep learning has been commoditized.

Only in the last five years has innovation enabled practical access to such powerful technologies. Expertise in infrastructure, data engineering, data science, data visualization and full stack engineering was once a barrier to entry. Now, fully managed services exist where domain experts can focus solely on the problem space with confidence that the underlying architecture is sound and introduces no upstream error. Like a racecar driver, a pit crew and mechanics handle the building and tuning of the vehicle. Also, businesses have learned not to be limited by geography during the pandemic. Rather, they have embraced remote working arrangements that unlocks a talent pool interested in working on the most important problems facing the planet. When combined with the dramatic reduction in cost to develop

sophisticated models, which is estimated to be roughly fifty percent annually, this presents a game changing opportunity.

Novel technologies such as blockchain are breaking down data silos, allowing for transparent, incorruptible, distributed, and decentralized historical records, thereby enhancing interdisciplinary collaboration. Use cases central to Alaska's blue economy such as improved trade, public health and safety, strengthened sustainability practices, regulatory compliance, and increased consumer trust are all well addressed by distributed ledger technologies. From ocean-to-plate provenance, to frictionless operationally efficient transactions, to new market creation, the fervor in the space among the most motivated engineers, venture funds, academic institutions, governments, and entrepreneurs is self-evident and in the early innings.

Against this backdrop, science and economics is building capacity for valuing ecosystem services. As one example, scientists have attempted to account for why krill populations decline when whales are removed from an ecosystem. Roughly speaking, because whales consume krill, it stands to reason that reducing their predation would increase the krill population – yet, the opposite can occur. Recent research suggests that as whales frolic, they distribute nutrients in the water column through diving, while their fecal plumes fertilize the ocean with significant amounts of nutrients. These activities then spur the growth of phytoplankton, which in turn feed krill, which are then consumed by whales. Furthermore, phytoplankton blooms as a keystone create feeding events for the entire fishery as whales move the baseline nutrients to areas that are otherwise nutrient-depleted regions of the ocean's surface.

For context, phytoplankton produce nearly half of the oxygen and account for roughly one-third of carbon sequestration on the planet. Water blankets the majority of the planet and provides a vast canvas for the occurrence of plankton blooms, which are roughly equivalent to four Amazon rainforests, and, unlike trees plankton provide an improved climate investment because they cannot burn. However, plankton's symbiotic relationship with large cetaceans can threaten these ecosystem services. At full capacity, it is estimated that the earth can support a population of 5 million whales, but this number has been reduced to only 1 million. Over the past 40 years, most whale deaths are attributed to humans, due to ship strikes and entanglement.

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Witness global powers convening to forge agreements in an attempt to reduce atmospheric emissions and hence mitigate the impacts of global climate change. Clearly, reduction in future atmospheric emissions is important, which is in addition to sequestering anthropogenic carbon within the ocean-atmosphere system. The notion that a solution to the climate dilemma can be engineered through new technologies may be considered ironic because at least a partial, time-tested solution exists, and without the potential for unexpected consequences associated with new engineering approaches; namely, let the whales frolic.

Important advances have been accomplished in calculating the current value of the ecosystem

services that whales provide in the form of carbon sequestration, which is estimated at over $80 billion annually worldwide. Each whale is estimated to produce $2 million in ecosystem services over the course of its life. Yet, that amount is based only on carbon sequestration provided and low-balls an average 60-year lifespan. Also, this estimate does not consider the multiplier effect that whales have on fish stocks by increasing the available food within the oceanic trophic chain.

In addition to the role that economists have in pricing services, an important accounting of resources is necessary. Proposing that these services can quite literally be put on the balance sheet of a state or country, it has been advocated that investing in nature-based technologies and solutions can create a marketplace to support ecosystem services. Continuing with the whale example, whales can be tracked with non-invasive sensors, identified by their unique voices, tokenized using blockchain, and their services valued in carbon markets. Carbon offset credits can be traded based on the services rendered. Shipping companies would then have a financial incentive to avoid collision with whales. Motivated entrepreneurs would see opportunities to build solutions to help track and predict migration patterns. Insurance companies could then price in the risk profile of the shipping companies and reward good behavior, or raise premiums based on intelligence captains receive in transit to help safely navigate. New markets could emerge provided there were no longer impunity for injuring these massive gardeners of the sea.

In addition to large cetaceans, mangrove forests, seagrasses, and seaweeds all provide significant ecosystem services including carbon sequestration, nursery habitat for juvenile fish, and removal of excess nitrogen loads. These are all examples of regenerative solutions to erosion and rising sea level. In Alaska, which is home to some of the world's largest kelp beds, seaweed farming is an emerging industry that could dramatically expand the footprint for kelp ecosystems to the benefit of fisheries and marine ecosystem health. Seaweed requires no arable land, fresh water,

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fertilizer, and little maintenance during the grow season. Studies have shown a localized reduction of ocean acidification as the crop absorbs carbon. Because it is a fast growing organism, with some kelp species capable of growing two feet per day, seaweed farming offers tremendous potential for generating ecosystem services. Kelp mariculture is also highly scalable, with researchers identifying over 60 million acres of ocean suitable for seaweed farming in Alaska and 6 million acres within 50 miles of a port.

While scientists are actively studying the carbon cycle of sinking seaweed to the seafloor after harvest, other studies indicate a higher value add and a significant multiplier for climate adaptation strategies. For example, the addition of certain kelp species to animal feed, some of which are readily found in Alaska, can reduce methane emissions from livestock by as much as 80%. Consider, too, that methane is known to have a global warming potential of approximately 85 times that of carbon dioxide over a 20-year period. This year, the Biden administration pegged the price of carbon at $51 per ton vs. $1,500 per ton for methane. Further, seaweed provides livestock with superior nutrients that makes them healthier and better tasting.

In addition, seaweed is an excellent fertilizer for agricultural crops. Seaweed has a high content of minerals, vitamins, and enzymes, including naturally occurring growth hormones that account for the rapid growth cycle of seaweed. Pricing and availability currently limit its use to certain high value crops, but greater mariculture production would facilitate regenerative farming practices that could restore soil health and improve the nutrient value of food supply chains. Further, the use of seaweed as a fertilizer is not limited to agricultural crops. As global temperatures warm, large-scale emissions of methane trapped in permafrost across the Arctic pose a major problem that could tip the scales of climate change. In this regard, one solution proposed is to better insulate the permafrost during the seasonally warmer months by increasing tundra growth on the surface through the application of seaweed fertilizers.

Large-scale seaweed farming can be co-located within offshore wind farms and adjacent to other renewable energy resources such as geothermal and tidal energy projects. Alaska's world-class renewable resource potential is largely a stranded asset, meaning there is little to no electricity demand in remote areas where resources are located. Processing the massive amounts of seaweed biomass into food, feed, fertilizers and biofuel could address this issue, and project development would also benefit from permitting synergies and shared infrastructure costs.

These examples illustrate what is possible through an economic approach that values ocean ecosystem services. By investing in natural aquatic ecosystems, it is possible to slow and perhaps reverse the most severe effects of climate change. Alaska is arguably an ideal location to study and test these methodologies because the ecosystems are pristine and relatively intact compared to other coastal areas. A potential first step would be to inventory the natural environment and ecosystem services provided in Alaska's coastal waters. Researchers in Alaska have been conducting such work for decades, but an applied approach to address climate change should focus on interdisciplinary outcomes that build on numerous basic research studies. Once inventoried, the ecosystem services could then be valued and assessed through a carbon lifecycle analysis.

Over time, carbon valuation could be expanded to account for multiplier benefits, or by developing new methodologies to value biodiversity. Alaska

is home to some of the world's most diverse cold-water ecosystems. While tropical waters are known for high levels of ecological diversity, cold climate species are recognized for the development of medicines, cosmetics, and nutraceuticals due to high concentrations of bioactive compounds, such as antioxidants, and novel molecular compounds that may promise a cure for cancer or anti-aging therapies. As our understanding of ecosystem services expands, value could be assigned to biodiversity, recognizing unknown and underexplored species and ecosystems as a bank for future research and development.

Inventorying ecosystem services and accounting for their value will require new science-based policy and investment. With ocean-based industry increasingly aware of the need for better science to inform decision-making, it is important that researchers include an economic analysis to address return on investment. Public-private partnerships between industry and academia are mutually beneficial when: 1) industry-based challenges are prioritized and addressed; 2) outcomes are continually quantified against investments; 3) universities provide research at a cost below what industry would otherwise pay and; 4) actionable insights emerging from research serve as inputs that can be engineered into solutions. Recent financing innovations, including blue bonds, corporate social responsibility (CSR), debt-for-nature swaps, and blended financing will further support this transition as governments prioritize blue sustainability as a primary pathway towards carbon sequestration.

Importantly, it must be acknowledged that Alaska is home to 229 federally recognized tribes and 40% of the total U.S. tribal population. In coastal regions, approximately 37% of the population identifies as Alaska Native or American Indian, according to 2020 census data. Coastal Alaska is almost entirely rural and faces a multitude of challenges, not the least of which is being at the forefront of a changing climate. Over 200 Native villages in Alaska are affected to some degree by flooding and erosion made worse by climate change. A significant number of communities depend on fishing for their livelihoods and subsistence to feed their families. These communities and cultures have stewarded the lands and oceans where they live for thousands of years and there is much to be learned from such traditional ecological knowledge. Market mechanisms should be devised to incentivize and fully compensate Alaska Native communities for their stewardship.

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