United Nations
Global Compact

BLUE RESILIENCE BRIEF: TOWARDS A MORE RESILIENT AND SUSTAINABLE BLUE ECONOMY

OPPORTUNITIES FOR SCIENCE-INDUSTRY JOINT ACTION AND COLLABORATION

Sustainable
Ocean Business
Action Platform

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CHALLENGES PRESENTED BY COVID-19 CAN ADVANCE SCIENCE-INDUSTRY COLLABORATION AND PROMOTE THE RESILIENCE OF OCEAN INDUSTRIES AND THEIR WORKERS.

The COVID-19 pandemic and its spread across borders has resulted in a public health, economic and social crisis. The ocean and its industries have been strongly impacted. COVID-19 restrictions and guidelines curtail travel and restrict border movements, affecting entire maritime transport hubs, routine crew changes and the flow of global goods. The fishery and aquaculture sectors have been hit through disrupted markets and supply chains. Ocean research expeditions have been cancelled, resulting in the interruption of critical long term datasets, and ocean tourism has been profoundly curtailed.

The challenges presented by COVID-19 can advance science-industry collaboration and promote the resilience of ocean industries and their workers.

Crucially, accelerated collaboration is also essential to balance the need for a clean, healthy and productive ocean with the strong growth in ocean industries required to achieve the future we want, as laid out in the Global Goals. Ocean industries are dependent on thriving ocean ecosystems and marine resources for their economic wellbeing.

These ecosystems are rapidly degrading due to climate change effects, such as ocean warming, acidification and deoxygenation, as well as biodiversity loss.[2]

The private sector and its ocean industries can help drive the innovation needed to address these challenges, as well as new challenges brought about by the pandemic.

> Better ocean science has numerous benefits for the private sector, ranging from cost savings and operational efficiency, to predictable, stable supply chains and increased market shares.

Last month, together with IOC-UNESCO, the UN Global Compact published the paper *"Advancing Science for Sustainable Ocean Business"*.[1] This brief outlines the numerous benefits better ocean science has for the private sector, ranging from cost savings and operational efficiency, to predictable, stable supply chains and increased market shares.

The upcoming UN Decade of Ocean Science for Sustainable Development (Ocean Decade), scheduled to start in 2021, offers a unique opportunity for the private sector to lead in taking catalyzing transformative actions for a healthy and a sustainable ocean, providing a pathway for businesses to demonstrate their purpose by committing to build a sustainable future.

As a collaborative framework, the Ocean Decade will be uniquely positioned to convene stakeholders from scientific disciplines and ocean industries to work together, leverage expertise and resources, as well as accelerate ocean knowledge creation and the implementation of impactful solutions.

1. Advancing Science for Sustainable Ocean Business (2020): https://www.unglobalcompact.org/library/5744
2. IPCC (2019) The Ocean and Cryosphere in a Changing Climate: https://www.ipcc.ch/srocc/

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OVER THREE MEETINGS, SCIENCE AND INDUSTRY PARTNERS DISCUSSED WAYS IN WHICH MUTUAL COLLABORATION COULD ENHANCE THE RESILIENCE OF THE OCEAN ECONOMY AND CONTRIBUTE TOWARDS A MORE SUSTAINABLE FUTURE.

This brief is the outcome of a COVID-19 Task Force initiated by the Action Platform for Sustainable Ocean Business to help address some of the challenges facing the blue economy through science-based solutions. Over three meetings focusing on three areas of the blue economy, science and industry partners, as well as policy representatives, discussed ways in which mutual collaboration and scaling-up joint action could enhance the resilience of the ocean economy and contribute towards a more sustainable future.

In a first meeting, industry and science partners from aquaculture considered ways to improve existing production systems, as well as ways to develop sustainable, complimentary production systems to meet ever-increasing demand for sustainable seafood and aquaculture. Experts working in taxonomy, biodiscovery, drug development and international policy were brought together in a second meeting to understand how marine genetic resources are contributing to the COVID-19 response and what can be learned from the response to date in order to build a more resilient and productive ocean science and marine biodiscovery landscape.

Our final meeting brought together ocean industries, ranging from ports and shipping to offshore energy, with ocean researchers and technology experts to discuss how we can advance technology and data-sharing for a more robust ocean economy.

This brief not only aims to give an overview of how resilience can be enhanced through collaboration, but serves as a reminder of the importance of convening cross-disciplinary stakeholders to address the need for a clean, healthy and productive ocean, while concurrently growing sustainable ocean businesses, to build back better.

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Martha Selwyn, Associate, UN Global Compact

KEY MESSAGES

1 The science-industry nexus is crucial to sustain economic activities and healthy marine environments.

Ocean industries depend on healthy ecosystems for their economic wellbeing. Declines in ocean health underscore the need to leverage knowledge synergies across scientific, industrial and regulatory disciplines, in order to address challenges ranging from ocean acidification to biodiversity loss. This will in turn help to mitigate business risks and explore new opportunities.

2 Strengthening science-industry collaboration could increase industry robustness to COVID-19 challenges.

Several challenges resulting from the COVID-19 pandemic could be addressed through science-industry cooperation. In the face of disrupted maritime trade, joint science-industry cooperation could work on the implementation of a global marine track and trace program for crew and ships, incorporating geofencing.

The aquaculture industry could be strengthened by creating shared data resources that define raw materials to increase feed and food supply chain robustness, harnessing science-industry collaboration to integrate practical measures: Resilience, Sustainability, Regionality. Increased science-industry collaboration could also accelerate the development of biomedical applications from marine genetic resources with antiviral properties.

3 Sharing data across industries and scientific disciplines could significantly enhance blue economy resilience.

While several industries are already pro-actively contributing to data-sharing initiatives, vast amounts of data that could contribute significantly to blue economy resilience are either not being collected or remain siloed, inaccessible and unused.

Having active data streams is paramount for ocean resilience in facing up to COVID-19 and could contribute significantly to safer at-sea operations.

Scaling-up of the marine biotechnology industry also depends on increased international data-sharing to facilitate rapid screening. Moreover, accelerating sustainable growth in the global aquaculture industry could benefit from increased data sharing for optimally efficient and robust supply chains.

4 The Ocean Decade provides a framework to foster and facilitate international dialogue on ocean data-sharing.

This cross-sectoral and multidisciplinary effort must include the development of new norms, harmonization standards, and the creation of new innovative revenue models and data-sharing platforms that link knowledge generators to users to ensure and enable open data practices.

5 Harnessing technological innovation could increase blue economy resilience and robustness.

Accelerating the digitalization of maritime trade, such as through Port Community Systems, just-in-time arrival, and inspections by remote vehicles, and developing advanced contact-tracing capabilities, could ensure safer, more sustainable and resilient maritime trade.

Moreover, investing in and increasing ocean bandwidth, telepresence and autonomy could enhance blue economy robustness to risks.

Harnessing cloud-based software solutions could ensure greater traceability and transparency in seafood supply chains, as well as strengthening small-scale aquaculture through connecting industry expertise with Artificial Intelligence (AI).

6 Capacity development across sectors and borders is key to ensure technology and innovation benefits are shared equally, in turn strengthening the blue economy.

Sharing best practices across sectors and disciplines will be key to supporting international progress. Capacity development initiatives are vital to support countries and communities with less technological advancement. For instance, less developed port communities could be assisted with technical facilities and human resources; these supportive frameworks are particularly crucial for vulnerable developing countries, such as SIDS, that are critically dependent on ports.

Similarly, small-scale aquaculture production could be supported through local capacity building, for instance through training local facilitators who know local communities and hold scientific and business expertise.

7 Joint science-industry responsible policy engagement could inform enabling legislation aimed at scaling-up science-based sustainable business.

Joint information-sharing on economic and environmental opportunities could shape national policy frameworks. For instance, frameworks incentivizing the production and consumption of more diversified seafood from low trophic level species, such as spatial planning for ocean-scale seaweed farms.

On an international level, robust science-industry dialogue would also be of benefit in the ongoing BBNJ negotiations,[4] whereby industry could provide practical input on commercialization activities associated with marine genetic resources.

8 Intermediary organizations and global collaborative networks are crucial enablers for science-industry cooperation.

International collaboration is a crucial avenue for building up capacity and embedding equity and inclusiveness across the blue economy.

Developing and establishing marine genetic resource research networks to pool resources or global networks of ocean arks could, for instance, accelerate international collaboration and science-industry cooperation. The framework provided by the Ocean Decade can encourage science-industry collaborations towards the Decade's goals and help to overcome barriers to cooperation.

4. BBNJ (Intergovernmental Conference on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (General Assembly resolution 72/249)). See: https://www.un.org/bbnj/

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ADVANCING TECHNOLOGY AND DATA-SHARING FOR A RESILIENT AND SUSTAINABLE OCEAN ECONOMY

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The COVID-19 pandemic has laid bare global discrepancies in technological capability and the pressing need for a unified approach to data-sharing for the ocean.
Ports that still rely on paper-based processes and lack a Port Community System face disruption that reverberates up the supply chain,[5] and ocean research expeditions have been extensively curtailed,[6] resulting in interruptions to critical time series data that is essential for long-term predictions and forecasts.[7] Moreover, although more ocean data was collected in 2018 than in the entire 20th century,[8] vast amounts of data that could contribute significantly to safer at-sea operations are either still not being gathered or remain siloed.

Overall, having active data streams is paramount for ocean resilience. The increased urgency in tackling this issue requires acceleration of technological innovation, data-sharing and international and cross-sector cooperation. Initiatives pursued in this regard will furthermore have longer term benefits in helping prepare resilience in the face of climate change.

CHALLENGES

- **Data-Sharing:** vast amounts of data that could contribute significantly to safer at-sea operations are either not being collected or remain siloed, inaccessible and unused.
- **Technology:** there is substantial international and cross-sector variability in technological capabilities and digitalization that creates "weak links" in global supply chains.
- **Collaboration:** barriers to international and cross-sector collaboration that inhibit knowledge sharing persist.

5. See recent International Association of Ports and Harbours (IAPH) call to action to accelerate digitalisation: http://www.iaphworldports.org/iaph/wp-content/uploads/2020-06-02-Maritime-Industry-Policy-Statement-Acceleration-Digitalisation-FINAL.pdf
6. The German research vessel Polarstern of the Alfred Wegener Institute was delayed at a crucial phase: https://phys.org/news/2020-05-virus-early-ice-arctic-science.html.
7. For the first time in 70 years, the interdisciplinary CalCOFI time series was interrupted: https://www.st.nmfs.noaa.gov/copepod/time-series/us-50301/
8. Brett, A. et al. (2020) Ocean data need a sea change to help navigate the warming world. Nature: https://www.nature.com/articles/d41586-020-01668-z

OPPORTUNITIES FOR SCIENCE-INDUSTRY ACTION TO ACCELERATE WIDESPREAD DATA-SHARING

While several industries are already pro-actively contributing to data-sharing initiatives,[9] the tendency is still for data to be held closely for security, legal and proprietary interests. For widespread usage, it is important that data be free of restrictions of usage for commercial purposes. To shift this tendency, three elements are key:

1. NEW STANDARDS

2. NEW NORMS

3. NEW REVENUE MODELS

FIGURE 1: Adapted from Brett, A. et al. (2020)

INDUSTRY CAN:

- Initiate cross-sectoral benchmarking processes to review company data-sharing practices and identify new opportunities and best practices for improved data-sharing.[10]
- Sign the Sustainable Ocean Principles[11] and commit to sharing scientific data where appropriate to support research.
- Innovate new business models that cover the costs of data access and develop platforms to make data collection less expensive.

SCIENCE CAN:

- All data and resulting knowledge to be provided in an open access, shared, discoverable manner and appropriately deposited in recognized data repositories.
- Recognize new forms of attribution for publishing data sources.

SCIENCE-INDUSTRY JOINT ACTION:

- Develop data-gathering and data-sharing initiatives that better utilize current infrastructure and data sets by increasing inter-operability and accessibility.
- Engage with new data sources, including, for example, from the deep ocean; for instance via the International Seabed Authority.
- Engage in and promote private-public partnership approaches, which may ensure that ocean data solutions are financially sustainable in the long-term and meet increased need for commercial applications, converting data to useful knowledge.
- Make use of new models and enabling tools that protect legitimate interests (e.g. data tagging and federated networks[12]) in order to encourage mutual data-sharing.

THREE OPPORTUNITIES FOR SCIENCE-INDUSTRY ACTION TO SUPPORT TECHNOLOGICAL ADVANCEMENT AND INNOVATION

In broad terms, digitalization offers the opportunity to seamlessly share and structure data. Approaches such as Artificial Intelligence and Machine Learning can turn this data into knowledge. Three key topics for action:

1. **Autonomy and Ocean Bandwidth**
   Increase autonomous collection of data from the ocean, increase telepresence for ocean vessels, and increase ocean data bandwidth to support these activities; this initiative must go beyond the basic installation of technology to the acceptance of new norms and operational protocols.

2. **Accelerating Ports**
   The widespread development and implementation of technological advancement and innovation at ports in support of IMO's Facilitation Convention (e.g. Port Community Systems, just-in-time arrival, inspections by remote vehicles for classification societies).

9. See the following projects: ODISCat; Seabed2030; iAtlantic project; SERPENT; SIMORC. Elaborated upon in references.
10. For instance, by aiming to maximise the provision of open access data and including data in recognized repositories.
11. Sustainable Ocean Principles of the UN Global Compact
12. See: Brett, A. et al. (2020)

3 Contact-Tracing

Implement and establish a global marine track and trace program for crew and ships, incorporating geofencing.

THREE OPPORTUNITIES FOR SCIENCE-INDUSTRY ACTION TO INCREASE KNOWLEDGE SHARING AND CAPACITY BUILDING ACROSS SECTORS AND BORDERS

1 Share Best Practices

Sharing best practices across sectors, disciplines and borders will be key to supporting progress. For instance, in helping to bridge the enormous discrepancies between ports across and within countries, or taking learnings on COVID-19 responses for at sea operations from industry and relaying them to science, and vice-versa.

2 Research-Commercial Partnerships

Agreements should be pursued with major private companies operating at sea to gather and share ocean data for research, particularly as research vessels are more affected by COVID-19. Such initiatives could build on experience gained by IOC-UNESCO with commercial shipping operators and competitive sailing vessels.

3 Capacity Development Frameworks

Such frameworks will be vital, for instance to support smaller and less developed port communities with technical facilities and human resources,[13] particularly in vulnerable developing countries, such as SIDS, that are critically dependent on their ports.

THREE FACTORS TO INCORPORATE WHEN PURSUING OPPORTUNITIES

1 Ensure Grassroots Research and Innovation are Supported

Grassroots research of ocean technology has been impacted by COVID-19. It is vital to keep talent (e.g. scientific crew, technical engineers) engaged, as losing this capability would be a major setback.

2 Plan for Cyber-Risks

Cyber-risks are likely to grow significantly as a result of an increasing shift to digitalization and virtual interactions; this increases vulnerabilities across the globe, with the potential for crippling effects on critical supply-chains, infrastructure and services. Coordinated efforts at developing protection against cyber-crime and attacks need to be pursued. This may require significant scaling up of investment and capacity building, including the development of skilled human resources.

3 Incorporate Climate Change Adaptation Considerations

These must be incorporated into technological advancements and their strategic development and use, such as enhancing the resilience of critical transport infrastructure assets. For example, ports, which are at increasing risk of coastal flooding, and reducing Greenhouse Gas emissions from ships through advancing zero-emission vessels. Infrastructure inventories, higher resolution data, as well as technologies that help improve the understanding of coastal processes under climate change, are needed for effective risk-assessment and adaptation planning for critical transport infrastructure, particularly in SIDS.[14]

13. See International Association of Ports and Harbours (IAPH): http://www.iaphworldports.org/iaph/wp-content/uploads/2020-06-02-Maritime-Industry-Policy-Statement-Acceleration-Digitalisation-FINAL.pdf
14. See the work of UNCTAD in this area: https://sidsport-climateadapt.unctad.org/

THREE PRIORITIES FOR THE OCEAN DECADE AND GOVERNMENT POLICY FRAMEWORKS

1 Strive Towards the Implementation of Global Data Standards

To ensure standardization, an overarching data program is key.

The Ocean Decade presents an opportunity to have an international dialogue with global stakeholders on the development and implementation of a global set of standards, for instance for data-tagging, in collaboration with private partnerships.

Governments and Industry can support this process by constructively taking part in international dialogues on data standardization, offering best practices and input where required, and subsequently implementing new global standards.

2 Enable and Encourage Open Data Access

Data made available should be restricted only when absolutely essential for protecting legitimate interests.

The Ocean Decade can be harnessed to improve the sharing and access to data and information. IOC-UNESCO is already leading a new data initiative to improve sharing and access to ocean data; a first workshop was conducted last April with UN agencies. Partnerships and collaborations will be central to this initiative.[15]

Governments can release oceanographic data and make data-sharing a pre-condition for government permits for ocean-related projects or for research projects funded by governments, for instance, coastal development. Governments can also encourage companies to participate in the Ocean Decade's data initiative.

3 Remove Hurdles and Barriers to Cooperation and Participation

Encourage blue industry technology development and deployment as part of partnerships to co-design and co-deliver projects and programs of the Ocean Decade.

The Ocean Decade can facilitate collaborations between industry and science, thus connecting knowledge generators and users.

These relationships are often fraught with administrative, logistical, and legal challenges, ranging from misunderstandings on intellectual property rights to inaccurate assumptions about the legal implications of establishing partnerships.

Governments can provide support and training to ensure coastal communities and developing countries with less experience in data handling are not left behind.

15. Note that all Actions proposed as part of the Decade will need to demonstrate how they are providing data and resulting knowledge in an open access, shared, discoverable manner and depositing data in recognized data repositories.

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RESILIENCE IN THE AQUACULTURE INDUSTRY

DR. MATTHEW SLATER, HEAD OF AQUACULTURE RESEARCH GROUP, ALFRED WEGENER INSTITUTE

Growing from relative obscurity in the 1950s, aquaculture is now a key global food source providing the majority of fish, shellfish and seaweed for human consumption. Global aquaculture production attained a record high of 114.5 million tonnes in live weight in 2018 and a total farmgate sale value of USD $263.6 billion.[16]

The industry is now integrated into global commodity supply chains and its end-products are traded at high values. The diverse species and production models of aquaculture have been developed over the past decades through close science-industry collaboration, linking novel biological, engineering and ecological knowledge developed in many different nations.

The expectations, including those of the Ocean Decade, that future aquaculture in the marine environment will sustainably contribute to meet the Sustainable Development Goals, are extremely high.[17] Meeting future expectations and facing current challenges require the industry to maintain its proven ability to grow, to further strive for environmental maturity and to fully realize its potential through science-industry integration.[18]

CHALLENGES

The aquaculture industry has been impacted by the COVID-19 crisis in three main areas:

- **Logistics:** supply shortages of raw materials for feeds and seed stock have created bottlenecks in fish production.
- **Labour:** shortages of labour and specialist services have affected operations. Farming and processing staff have been affected by COVID-19 infection and reduced mobility.
- **Demand:** consumer demands have changed, with increased interest in traceability and sustainability of aquaculture products. The closure of markets, gastronomy and processing facilities has led to a collapse in demand for fresh products.

16. FAO (2020). http://www.fao.org/state-of-fisheries-aquaculture
17. Boyd, CE, D'Abramo, LR, Glencross, BD, et al. Achieving sustainable aquaculture: Historical and current perspectives and future needs and challenges. J World Aquacult Soc. 2020; 51: 578–633. https://doi.org/10.1111/jwas.12714
18. Engle, C.R., D'Abramo, L., Ponniah, A. and Slater, M. (2017), Global Aquaculture 2050. J World Aquacult Soc, 48: 3-6. doi:10.1111/jwas.12400

The crisis disruption has driven reflection about supply chain resilience and efficiency as well as the future direction of a rapidly growing industry.[19] The COVID-19 crisis can thus also create new opportunities for the industry to enhance resilience.

FIVE OPPORTUNITIES FOR SCIENCE-INDUSTRY JOINT ACTION TO ENHANCE RESILIENCE IN THE AQUACULTURE INDUSTRY

1 Share data for robust raw material supply chains, making data on regional and sustainable raw materials sources available through knowledge transfer channels.

- Both science and industry can provide data on all potential material sources for aquaculture diets through open access practices, feeding into supply chain diversity and allowing for robust responses to raw materials shortages.
- Large-scale feed producers can share and adapt existing databases of raw materials for key diet ingredients.
- Interdisciplinary aquaculture scientists can survey local feed mills and agro-industrial suppliers to determine suitable alternative suppliers and materials.
- Intermediary organizations, such as the Food and Agriculture Organization of the United Nations (FAO) or the World Aquaculture Society, can act to collect and disseminate data.[20]

2 Accelerate meta-analysis of existing data for resilient supply of raw materials and ensure a local/global balance by facilitating and enabling optimal resilience and efficiency in global trade.

- Jointly create recommendations for regional and local raw materials linked to key regions and their key aquaculture species in those regions.
- Scientists can define practical measures of raw materials - Resilience - Sustainability - Regionality - and aid industry in integrating these into raw materials databases.
- Researchers can test and identify further raw materials globally that correspond highly to the Resilience – Sustainability – Regionality measures.
- Industry can identify synergies, whereby supply chains can remain efficient while increasing resilience by integrating new raw materials.

3 Monitor supply chains closely through digitization, harnessing data tools for fully traceable seafood and supply chain resilience.

- Utilize cloud-based software solutions collecting data across value chains to identify weak points where cross-industry partnerships are needed to maintain supply.
- Develop industry-wide platforms for supply chain monitoring to quickly implement adaptive actions (e.g. alternative markets, alternative raw material sources).
- Assist in wider implementation of electronic harvest documentation schemes, including real-time data delivery for remote compliance inspection.
- Industry and retailers can create digital consumer access to traceability measures.

4 Enable and support efficient small-scale aquaculture production capacity, financially, technologically and professionally.

- Co-deliver science-industry capacity development programs, such as the collaborative communication of modern aquaculture methods, or by jointly training local facilitators who know local communities and hold scientific and business expertise.
- Harness artificial intelligence (AI) to provide farm-specific feedback, combining help from AI with the expertise of industry leaders, such as emerging online communities of fish farming experts[21] or IT marketing tools for alternate sales channels.
- Jointly advocate for enabling legislative frameworks in developed and developing nations, including the financing of small-scale aquaculture.

19. van Senten, J., Smith, M.A. and Engle, C.R. (2020), Impacts of COVID19 on U.S. aquaculture, aquaponics, & allied businesses. J World Aquacult Soc, 51: 574-577. doi:10.1111/jwas.12715
20. For instance: International Aquaculture Feed Formulation Databas: https://www.iaffd.com
21. XpertSea Ecosystem, for instance, combines artificial intelligence and expertise from Zeigler, industry leader in animal nutrition, farmers receive precision feeding advice directly through the Growth Platform: https://www.xpertsea.com/technology

5 Invest in the farming of and research on low trophic level species, including sustainable algae and detritus feeding animals (e.g. bivalves), to spread risk, increase environmental benefits, produce high value products and promote local biodiversity.

- Embark on joint science-industry information-sharing and emphasis on economic and environmental opportunities to encourage policy frameworks which enable more diversified seafood from low trophic level species.[22]
- Industry investment in "high-risk" research to diversify knowledge base can ensure growers make better judgements on species investment and aquaculture diversification.
- Undertake consumer research harnessing behavioural sciences on preferences regarding ocean vegetables and alternative algae products.
- Pursue ocean farming science-industry partnerships at larger scales, ranging from marine engineering, modelling, and biology, to develop large-scale seaweed cultivation and systems for a maximum yield per hectare to capture carbon in a short-term carbon sink; science will be required to establish ecosystem capacity for seaweed cultivation.[23]

POLICY RECOMMENDATIONS AND ENABLING LEGISLATIVE FRAMEWORKS

1 Incentivizing more diversified seafood: facilitate the production and consumption of more diversified seafood from low trophic species.

- Policy facilitating aquaculture permits for low-trophic species to incentivize industry development.
- Joint science-industry advocacy to strongly promote spatial planning for ocean-scale seaweed farms, large-scale offshore aquaculture systems and multi-trophic aquaculture.[24]
- Deploy context-specific messaging targeting behavioural change to educate consumers and expand consumption of diversified seafood with its nutritional benefits.[25]

2 Small-scale aquaculture: facilitating policy is essential for small-scale and sustainable aquaculture in developed and developing nations.

- Streamlining multiple policy strings into one aquaculture policy, providing "one-stop-shop" contacts for administrative activities could make compliance and development possible.
- Encouraging capacity building by sharing digital (mobile) solutions between developed/non-developed nations.
- Realizing the potential of small-scale and medium scale seaweed and low-trophic species cultivation in developing countries.

3 Digital traceability: policies that encourage transparency by prescribing simple but trustworthy digital traceability of seafood supply chains, based on consumer requirements.

- Applying available digital resources to increase seafood supply-chain transparency.
- Communication policies outlining health and environmental benefits, including the avoidance of illegal, unreported and unregulated (IUU) fishing, in order to drive positive purchase choices and promote sustainable and traceable industry practice.

4 Incentivizing robust and resilient supply chains: policy frameworks promoting raw materials mixes, which increase feed and food supply chain robustness.

- Requirements for aquafeed producers to adhere to Resilience – Sustainability – Regionality measures or to maintain a specific spread of risk.
- Policy supporting local added-value products including geographical indication of highest value aquaculture and seafood products.[26]

22. See: https://aquavitaeproject.eu/ - new species, processes and products contributing to increased production and improved sustainability in emerging low trophic, and existing low and high trophic aquaculture value chains in the Atlantic – Horizon 2020 Atlantic Aquaculture Funding
23. D'Abramo, L.R. and Slater, M.J. (2019), Climate change: Response and role of global aquaculture. J World Aquacult Soc, 50: 710-714. doi:10.1111/jwas.12643
24. Gentry, R. R., Lester, S. E., Kappel, C. V., White, C., Bell, T. W., Stevens, J., & Gaines, S. D. (2017). Offshore aquaculture: Spatial planning principles for sustainable development. Ecology and Evolution, 7(2), 733-743. doi:10.1002/ece3.2637
25. Ocean Stewardship 2030 (2020) UN Global Compact. https://unglobalcompact.org/library/5742
26. For example, Scottish Salmon fed with Scottish feedstock: Council Regulation (EC) No 510/2006 on protected geographical indications and protected designations of origin: Scottish Farmed Salmon 2007.

Photo: Stephan Kerkhofs on Shutterstock

DEVELOPMENT OF BIOMEDICAL APPLICATIONS FROM MARINE GENETIC RESOURCES

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Life has existed for some 3.7 billion years in the ocean, which covers over 70 per cent of the Earth's surface and is on average four kilometres deep. Regardless of where researchers have looked in this vast space, they have found life thriving, not just in coral reefs and seagrass beds, but even in the most seemingly inhospitable conditions of total darkness, extreme pressure, cold, heat and chemistry. The capacity to survive in such a variety of conditions is encoded within the genetic information of an estimated 2.2 million marine species, of which the majority have not been characterized by science.[27]

The ocean has been a particularly rich source of inspiration for new pharmaceuticals as well as a range of other biotechnology applications.[28] Almost 70 per cent of drugs are derived or inspired by natural products — i.e. molecules and compounds naturally produced by organisms. For instance, Remdesivir, one of the only treatments approved for treating COVID-19, is an antiviral whose development can be traced back to nucleosides identified in sea sponges.

The COVID-19 pandemic has resulted in unprecedented levels of cooperation and collaboration spanning research centres around the world,[29] contributing to 194 different COVID-19 vaccines currently in development and 15 in human trials as of late June 2020. These positive signals also underscore the substantial potential for industry and science to work together on moving towards a better consolidation of information and materials that can aid in biomedical advances.

CHALLENGES

The exploration of marine genetic resources and their subsequent development for biomedical use is not a simple, rapid or cheap process.

- **The drug discovery process** can take up to 20 years with costs of up to USD $2 billion;
- **Uneven research** effort has resulted, for instance, in limited focus on the development of marine antivirals, despite their proven potential;
- **Lack of investment** to move potential products from the discovery to the licensing and production stage;
- **Regulatory barriers** to collection of genetic material in some jurisdictions and regulatory uncertainty associated with areas beyond national jurisdiction;
- **Lack of human capacity** to investigate these bioactive compounds;
- **Limitations in taxonomic** knowledge about marine life, in particular deep sea life.

27. Blasiak et al. 2020. https://doi.org/10.1038/s41893-020-0522-9
28. Gerwick and Moore 2012. https://pubmed.ncbi.nlm.nih.gov/22284357/
29. Le et al. 2020. https://www.nature.com/articles/d41573-020-00073-5

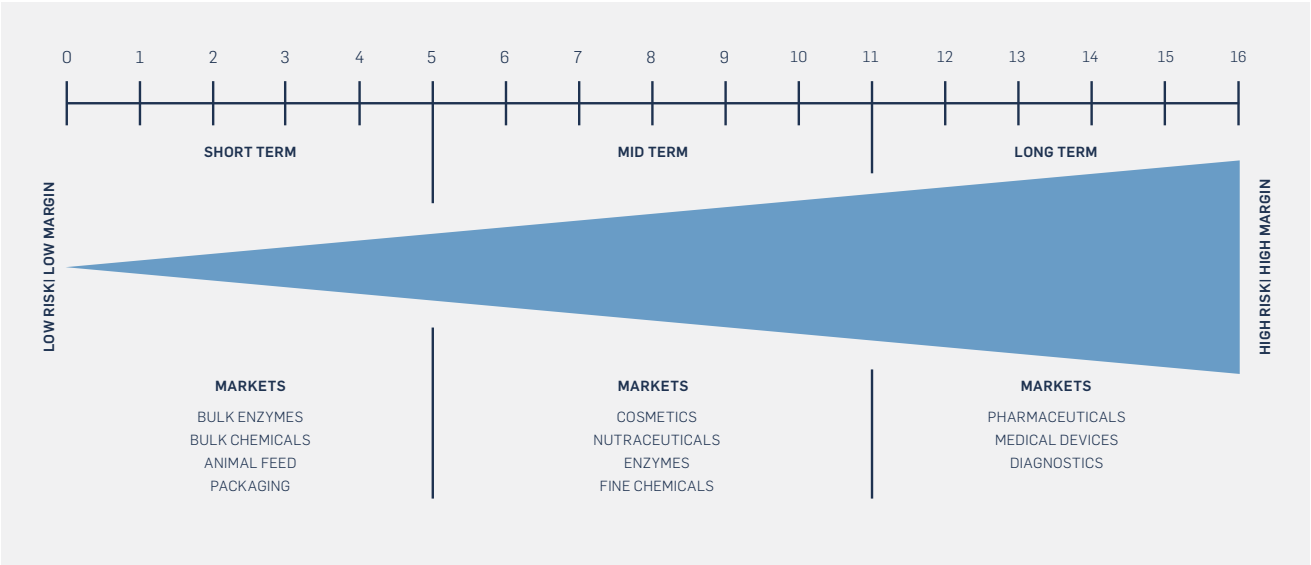

FIGURE 2: Risk, Profit Margins and Timelines (in years) for Commercial Activities Associated with Marine Genetic Resources.[30]

THREE OPPORTUNITIES FOR SCIENCE-INDUSTRY JOINT ACTION AND COLLABORATION

1 Ensure a rapid screening and trial pipeline for treatment developments by moving towards a better consolidation of information and materials.

- Contribute to and help develop relevant overview databases/portals,[31] utilize open-screen platforms,[32] open up compound libraries for open innovation,[33] and contribute more to open source drug discovery.[34]
- Support the development of a global platform for storing specimens of marine organisms for screening of marine genetic resources, to enable the tracking of samples from the point of collection through to discovery and patenting of a product; system could interface with existing biodiversity databases.[35]
- Establish international compound libraries with an antiviral, antiparasitic or antibacterial focus for rapid deployment into relevant biological screening systems; resource could be housed by the World Health Organization.
- Both specialized research groups and relevant SMEs can contribute towards quick prototyping.
- Industry collaboration and partnerships are necessary to scale-up production.

2 Encourage robust science-industry dialogue and engagement with Member States in support of the BBNJ negotiations.

- Industry could explore ways to come up with solutions to avoid unintended consequences, for instance, legislation covering the rights of international scientific teams during times of crisis.
- Industry could provide input on conservation measures in the treaty, such as area-based management tools and environmental impact assessments, and the proposed institutional arrangement.
- Industry could provide insights as to the proposed text, access and benefit-sharing associated with marine genetic resources, particularly with regard to developing countries.

30. Figure from Blasiak, R., R. Wynberg, K. Grorud- Colvert, S. Thambisetty, et al. 2020. The Ocean Genome: Conservation and the Fair, Equitable and Sustainable Use of Marine Genetic Resources. Commissioned by The High Level Panel for a Sustainable Ocean Economy. Courtesy of World Resources Institute. All rights reserved.
31. For instance, the Natural Products Atlas. https://www.npatlas.org/joomla/
32. For instance, the EU-OPENSCREEN. https://www.eu-openscreen.eu/index.html
33. The company Eli-Lilly's open innovation platform is such an example. https://www.lilly.com/
34. For instance, the Open Source Drug Discovery database. http://www.osdd.net/
35. For instance with UNESCO-IOC's Ocean Biodiversity Information System OBIS

- Science as sparring partner, joint advocate and honest broker in dialogue throughout, supporting open discussion.

3 Establish and develop intermediaries to help facilitate and offer opportunities for partnerships between science-industry.

Marine genetic resource research networks: to pool resources and accelerate international collaboration.

- Industry to actively seek partnerships with such networks and programmes.[36]
- Increase capacity-building in natural products research through offering training to young scientists through such programs.
- Networks as third-party/intermediary organizations to help facilitate industry-science partnerships.

Global networks of "ocean arks": as facilities for the long-term archiving of samples of tissue and DNA of marine organisms for marine genetic resource research.

- Could act as regional or national centres for marine genetic resource research and training as insurance of preservation of the ocean genome against future extinctions of marine species.
- Location of such facilities would be within, or close to, institutions such as museums, although they could also be self-contained.[37]
- Arks as intermediary industry-science organizations providing opportunity for co-benefits from industry partnerships.

Investment funds and development centers: to assist with bridging the gap between the stages of marine bioproduct development.

- Centres to bridge the "valley of death" between discovery of a new marine bio-product with potential and the final licensing and/or production of new drugs.[38]
- Such centres could be regional, associated with ocean arks and act as intermediaries between science-industry.

36. One past example is provided by the International Cooperative Biodiversity Groups (ICBG) program in Panama
37. For instance, Svalbard seed bank
38. Lange et al. 2015. http://norden.diva-portal.org/smash/get/diva2:900582/FULLTEXT02.pdf

POLICY RECOMMENDATIONS AND ENABLING LEGISLATIVE FRAMEWORKS

1 Promote robust science-industry dialogue and engagement with Member States in the framework of the BBNJ[39] negotiations with regard to marine genetic resources.

Some 64 per cent of the ocean is beyond national jurisdiction; here, access to marine genetic resources is currently unregulated and no obligations exist for sharing benefits arising from their study or commercialization.[40]

Addressing this legal gap in the BBNJ negotiations has proven challenging due to diverse perceptions of current and future benefits, equity concerns, and rapid scientific and technological advances.[41] Tapping the expertise of industry actors and scientists engaged in commercialization is crucial.

2 Develop and establish marine genetic resource research networks to pool resources and accelerate international collaboration based on principles of responsible and inclusive research and innovation.

International collaboration can be a crucial avenue for building up capacity and embedding equity and inclusiveness across the ocean science community, helping to transform marine biotechnology into an element of the Blue Economy for an expanding number of states. This will depend, among other things, on transparent and interactive processes to link diverse stakeholder groups,[42] and the development of incentives to support research activities that could result in benefits for marginalized and vulnerable communities (e.g. treatments for diseases that disproportionately affect certain groups but which have not been researched due to low economic incentives).

3 Mobilize mainstream finance and establish investment funds and development centres to assist with bridging the gap between the stages of marine bioproduct development.

In addition to mobilizing additional and predictable financing, incorporate sustainability and transparency criteria into all associated loan covenants[43] to ensure that non-sensitive genetic and genomic data is made available in public databases, with disclosure of origin[44] to ensure transparency and to support taxonomic and conservation efforts.

39. BBNJ (Intergovernmental Conference on an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (General Assembly resolution 72/249)) https://www.un.org/bbnj/
40. Rabone et al. 2019. https://www.frontiersin.org/articles/10.3389/fmars.2019.00520/full
41. Collins et al. 2020. https://www.frontiersin.org/articles/10.3389/fmars.2020.00265/full
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43. Jouffray et al. 2019. https://advances.sciencemag.org/content/5/10/eaax3324
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BOX 1: THE OCEAN DECADE: DOCUMENTING THE OCEAN GENOME AND ITS SUSTAINABLE USE OF RESOURCES AS A FLAGSHIP EFFORT

- The Decade could provide the framework to ensure mechanisms are in place to document sample collections regardless of whether they are in coastal waters or areas beyond national jurisdiction in a way that allows access and benefit sharing.
- Ensure that biological material is collected and archived in a way that is conducive to future research on marine genetic resources through existing institutions e.g. museums

BOX 2: THE OCEAN DECADE: A UNIQUE OPPORTUNITY FOR ENGAGING INDUSTRY AND OCEAN SCIENCE

The Ocean Decade is organized around 10 Ocean Decade Challenges which represent the most immediate priorities for the Decade. These can be translated into concrete actions framed as programs, projects, activities, in-kind or financial contributions. Challenges range from the development of knowledge and solutions to support a sustainable ocean economy, to ensuring the ocean can sustainably contribute to feeding the world's population and the development of an accessible, holistic digital representation of the ocean ecosystem.

Through regular "Calls For Action", the Ocean Decade will seek proposals for transformative ocean science, data management and capacity development initiatives that contribute to addressing the challenges and achieving the Decade's vision and goals. Endorsed initiatives will form part of a collective, global effort to revolutionize ocean science and ensure its contribution to sustainable development.

Industry will be a key player in initiating, co-designing and co-delivering Decade Actions, working in close collaboration with Government, scientists and policy makers.

This brief identifies several examples of Decade Actions that could be collaboratively put forward by industry and other stakeholders including programs, projects or contributions which:

- Support the development of a holistic, digital representation of the ocean ecosystem through developing or enhancing data and knowledge management platforms and services that increase the interoperability of data systems, in turn, linking knowledge generators to users and increasing data accessibility.
- Facilitate capacity development programs that help to link universities to the professional world, existing and future ocean professionals can develop skills that are relevant to working in industry, government or academia.
- Co-deliver specific programs in marine genetic research, aquaculture or ocean data and knowledge management with a focus on skill sets sought by industry partners to train the next generation of ocean professionals.
- Contribute to the mapping of the ocean genome and the sustainable use of the resources that it represents.
- Develop innovative approaches to enhance the sustainability of aquaculture, including:
    - The development of knowledge and solutions to help growers make better judgements on species investment and aquaculture diversification;
    - To better understand and respond to preferences regarding ocean vegetables and alternative algae products;
    - Develop large-scale seaweed cultivation and systems.

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RESOURCES

Data-sharing initiatives and projects

iAtlantic project: https://www.iatlantic.eu/
A multidisciplinary research programme seeking to assess the health of deep-sea and open-ocean ecosystems across the full span of the Atlantic Ocean. It aims to deliver knowledge that is critical for responsible and sustainable management of Atlantic Ocean resources in an era of unprecedented global change - 2019 - 2023, 33 scientific partners, 11 international associate partners. Industry has the capability to provide QAQC'd data (bathymetry, metocean, biology, chemistry, seabed habitats) from previous surveys undertaken in the iAtlantic study areas as well as provide opportunities on planned future marine surveys during project period.

ISA DeepData: https://www.isa.org.jm/deepdata#block-seabed-page-title
The primary repository for environmental information collected in the area, containing information on mineral resource assessment (geological data) and environmental baseline/assessment data. It provides a unique platform to facilitate data gathering, transmission and sharing of data.

Seabed2030: https://seabed2030.gebco.net/
A multi-stakeholder project led by The Nippon Foundation and the General Bathymetric Chart of the Oceans (GEBCO). The project aims to map the world's seafloor by the year 2030 and to compile high resolution bathymetric data into the freely available GEBCO Ocean Map. The work will contribute to safe navigation, disaster management, weather prediction, biodiversity conservation, and resource development. It is now formally supported by more than 100 organizations. Companies are contributing data and collecting data free of charge.

SERPENT project "Scientific & Environmental ROV Partnership using Existing industrial Technology":
www.serpentproject.com
Project aims to make cutting-edge industrial ROV technology and data more accessible to the world's science community, share knowledge and progress deep-sea research. This is now a global project hosted by the DEEPSEAS group, within Ocean Biogeochemistry and Ecosystems (OBE) at the National Oceanography Centre, Southampton (NOCS).

SIMORC project "System of Industry MetoOcean Data for The Offshore and Research Communities":
www.simorc.com
Established to stimulate wider sharing and application of these industry metocean data sets for further use. The SIMORC service aims at improving a common awareness of available data sets and a systematic indexing and archival of these data sets within the industry. It also aims at improving considerably reporting and access to these data sets and results of field studies for other parties, in particular the scientific community.

The ODIS "Catalogue of Sources": https://catalogue.odis.org/
Aims to be a searchable catalogue of existing ocean related web-based sources/systems of data and information, as well as products and services.

OCTOPUS "Ocean Tool for Public Understanding of Science": https://octopus.zoo.ox.ac.uk/toc
A gateway to multiple ocean datasets which are harmonised and presented geospatially and across time. As well as the ocean data viewer application for visualization of data, it also includes a habitat suitability modelling application. Further tools are in development.

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DISCLAIMER

THE TEN PRINCIPLES OF THE UNITED NATIONS GLOBAL COMPACT

HUMAN RIGHTS

1 Businesses should support and respect the protection of internationally proclaimed human rights; and

2 make sure that they are not complicit in human rights abuses.

LABOUR

3 Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;

4 the elimination of all forms of forced and compulsory labour;

5 the effective abolition of child labour; and

6 the elimination of discrimination in respect of employment and occupation.

ENVIRONMENT

7 Businesses should support a precautionary approach to environmental challenges;

8 undertake initiatives to promote greater environmental responsibility; and

9 encourage the development and diffusion of environmentally friendly technologies.

ANTI-CORRUPTION

10 Businesses should work against corruption in all its forms, including extortion and bribery.

The Ten Principles of the United Nations Global Compact are derived from: the Universal Declaration of Human Rights, the International Labour Organization's Declaration on Fundamental Principles and Rights at Work, the Rio Declaration on Environment and Development, and the United Nations Convention Against Corruption.

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