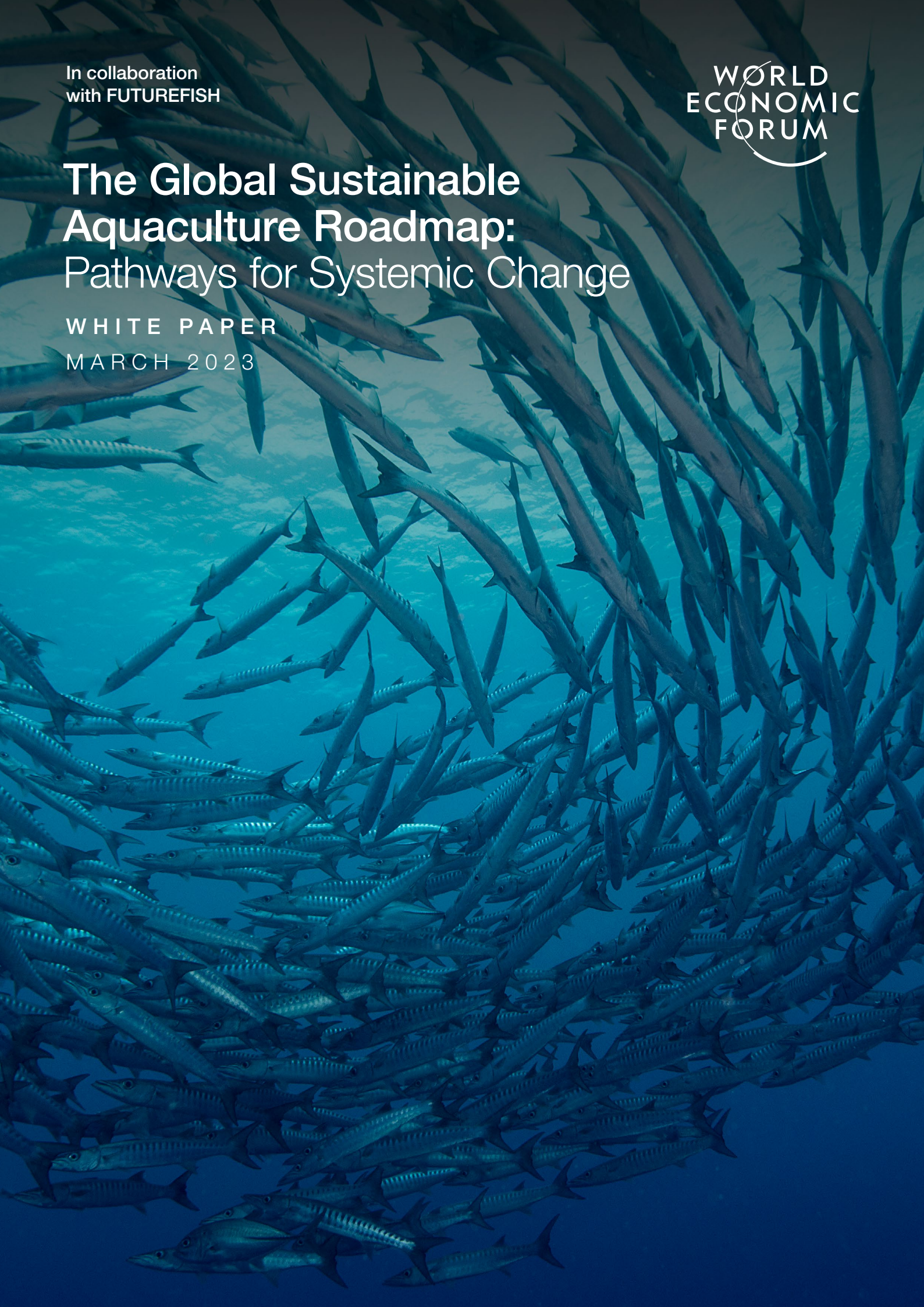
In collaboration
with FUTUREFISH

WORLD ECONOMIC FORUM

The Global Sustainable Aquaculture Roadmap:
Pathways for Systemic Change

WHITE PAPER

MARCH 2023



Images: Getty Images, Unsplash, Shutterstock, iStock

Contents

Foreword

Chris Ninnes
Chief Executive Officer, Aquaculture Stewardship Council

Kristian Teleki
Director, Ocean Action Agenda and Friends of Ocean Action, World Economic Forum

In 2022, our world population passed eight billion. With this set to continue growing in the coming decades, it is critical that we transform global food systems at speed and scale to meet the needs of people and the planet by 2030, in line with the United Nations' Sustainable Development Goals (SDGs) and the Paris Climate Agreement.

Meeting our increasing demand for healthy and nutritious food in more sustainable ways is a monumental challenge, yet great potential lies in the water. Blue foods – from our ocean, rivers and lakes – are the most highly traded food products in the world and already provide livelihoods for many millions as well as healthy and nutritious food for billions. Many varieties can do this with lower carbon footprints than terrestrial animal production and are therefore critical to climate resilience, and global food and nutrition security. Demand for these foods is expected to double by 2050, and much of this demand will be met through aquaculture production. Increased production must be undertaken from a nature-positive perspective to preserve critical habitats and biodiversity.

There is growing recognition that the aquaculture industry must play a more active, leading and collaborative role in addressing challenges. Some progress has been made by the collective efforts of various committed industry associations, but more needs to be done across the wide spectrum of aquaculture systems. Guidance towards the sustainable development and growth of aquaculture is now vital, as is the need for blue foods to be seen as an integral component of the global food system realizing its potential to deliver on the SDGs.

This *Global Sustainable Aquaculture Roadmap* is produced by the World Economic Forum's Blue Food Partnership in consultation with members of its pre-competitive initiative, the Sustainable Aquaculture Working Group, with generous support from the UK Government's Blue Planet Fund and the Aquaculture Stewardship Council. It is an instrumental guide for transformative action across aquaculture value chains and the sector overall.

The roadmap is informed by a systems change approach, which rightly considers that activities in aquaculture do not occur in isolation – instead, aquaculture is fundamentally connected to economies, nature, climate, nutrition and equitable livelihoods. The roadmap's development is grounded in a scientific review of *The Road to Sustainable Aquaculture* report, findings of the Blue Food Assessment, key recent global guidelines and strategies, such as the Food and Agriculture Organization of the United Nations' (FAO) *Blue Transformation Roadmap* and *Guidelines for Sustainable Aquaculture*, as well as other insights into research and innovation in aquaculture. Based on this foundation, four pathways with recommendations were defined for this roadmap and fine-tuned through consultations with a diverse set of stakeholders in the aquaculture sector.

One of our key opportunities, and indeed challenges, will be delivering on the responsible growth of aquaculture to scale the sector within nature's limits, all while achieving greater social, economic and environmental benefits. Success will depend on action taken in partnership by a range of actors in business, government and civil society to ensure that blue foods are a significant and interconnected part of food systems transformation.

We invite all relevant stakeholders engaged in aquaculture to view this roadmap as a community resource to be shared and applied to their own efforts. From there, we can collectively build momentum towards the sustainable growth of aquaculture for people, nature and climate. We have already seen the growing willingness of companies in the aquaculture industry to join us on this road towards a more sustainable future, and very much welcome others on this journey to 2030.

Executive summary

The sustainable growth of aquaculture can unleash greater social, economic and environmental benefits among the global population.

The opportunity emerging from the sustainable growth of aquaculture has been highlighted by prominent initiatives such as the Food and Agriculture Organization of the United Nations' (FAO) 2022 report (*The State of World Fisheries and Aquaculture*), the High Level Panel for a Sustainable Ocean Economy's 2020 report (*Ocean Solutions that Benefit People, Nature and the Economy*) and the Blue Food Assessment's 2021 report (*Building Blue Food Futures for People and the Planet*). This *Global Sustainable Aquaculture Roadmap* sets out a clear direction of focus areas to achieve sustainability, where to prioritize action and who needs to collaborate to make progress.

There is a great deal of work to be done by 2030 and more to do in the years that follow. Companies in the aquaculture sector will need to work in partnership and take concrete actions, alongside regulators, certifiers, policy-makers, investors, non-governmental organizations (NGOs) and intergovernmental organizations (IGOs), to create an environment conducive to change.

Using a systems change approach, this roadmap identifies four key pathways for action that can create change at scale and shift aquaculture systems towards a more sustainable future:

- **Responsible production**: With growing demand for blue foods, a planet-first approach to production can ensure that the long-term supply of nutritious and healthy food from aquaculture can be sustained. The diversity of aquaculture species and systems is key to underpinning resilience and the nutritional values of aquaculture in food systems. There is a need to develop and share best practices and innovations for sustainable production, which boost diversity of supply, allow inclusive growth, enhance nature-positive outcomes and contribute to global biodiversity goals.

- **Better livelihoods**: There is an imbalance in benefits and risks among people participating in the aquaculture sector. The people working across value chains and the communities impacted by the industry are often left out of decisions that can negatively affect their lives and well-being. With the growth of aquaculture comes livelihood opportunities, but more needs to be done to secure those opportunities, especially for women and young people. Systemic change is crucial to rebalancing inequalities, empowering collaboration and community cooperatives, reducing poverty and building a more just sector for people across value chains.

- **Healthy consumption**: Around the world, access to nutritious and healthy blue foods varies. A pivotal part of building sustainable aquaculture systems that address the growing demand for blue foods is improving the availability, access and affordability of these diverse blue foods to all consumers. Lower-trophic species – which require inexpensive and carbon-neutral feeds – can provide affordable and sustainable options for consumers. Advocates need to raise awareness among retailers, distributors and food service providers about the benefits of a variety of blue foods. Businesses need to find responsible solutions that allow all consumers to access the health benefits of nutritious blue foods.

- **Enabling environment**: The future of food, health and ecological systems requires a change in the business of aquaculture. To achieve the pathways of responsible production, better livelihoods and healthy consumption, policies, partnerships, certifications, innovations and investments are needed for aquaculture to sustainably grow and deliver on its potential for social, economic and environmental opportunity for all. The actions and outcomes in this enabling pathway will create the right conditions to make positive progress towards sustainable, inclusive and healthy aquaculture by the end of this decade, providing a solid foundation for the future.

There are many ways to take action. All those committed to the vision of a more socially, economically and environmentally sustainable future for aquaculture should consider how the roadmap applies to their unique efforts, context and geography. As the aquaculture sector evolves, the hope is that this roadmap can serve as foundational guidance for change.

Introduction

With a sustainable trajectory, aquaculture can contribute greatly to global food systems transformation.

❝ The FAO anticipates that aquaculture will continue to drive growth in global fish production, accounting for 106 million metric tonnes in 2030, an increase of 32% from 2020.

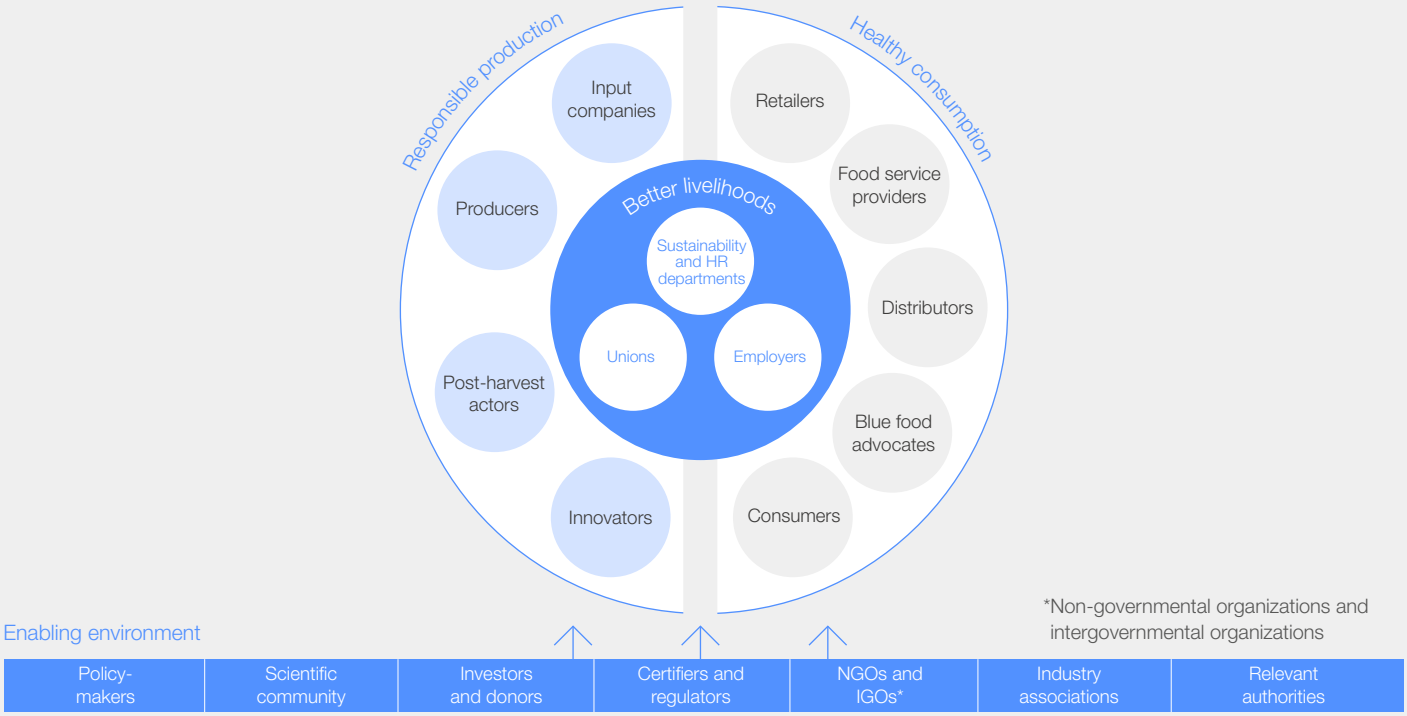
Demand for blue foods is growing, and much of that demand will be met through aquaculture production. According to the Food and Agriculture Organization of the United Nations (FAO), aquaculture is "the farming of aquatic organisms, including fish, molluscs, crustaceans, algae and aquatic plants".[1] The FAO anticipates that aquaculture will continue to drive growth in global fish production, accounting for 106 million metric tonnes in 2030 (compared to 87.5 million metric tonnes in 2020), an increase of 32%.[2] Yet, like all food systems, aquaculture presents both opportunities and challenges. Some current aquaculture practices are negatively affecting habitats and communities. It is crucial to ensure that as aquaculture grows, it does so sustainably.

The Blue Food Partnership's *The Road to Sustainable Aquaculture* report, produced in June 2022, took a critical first step in assessing the state of the aquaculture sector. The report aligned aquaculture's importance to achieving the Sustainable Development Goals (SDGs) and reflected the diversity of aquaculture species and actors – highlighting the complexities of the sector and opportunities for action across a range of stakeholders at global, national and local scales. This *Global Sustainable Aquaculture Roadmap* takes the next step. Grounded in a systems change approach – which followed a scientific review and stakeholder consultation process – the roadmap sets a framework for sector-wide progress and transformation by 2030.

By setting its sights on sustainability, the aquaculture sector can drive positive change towards healthy, nutritious and accessible blue foods that benefit people and the planet. This roadmap provides four pathways to motivate action towards the greater social, economic and environmental benefits that the sustainable growth of aquaculture can offer.

Blue foods cannot be integrated into the heart of sustainable food systems by working in isolation. Having aligned this roadmap through consultations with stakeholders across aquaculture value chains as well as from international and non-profit organizations, governments, and scientific and academic institutions, each pathway requires collaborative effort to shift the sector towards positive change, as illustrated in Figure 1.

FIGURE 1 **Key audiences of the *Global Sustainable Aquaculture Roadmap***



> All those engaged across aquaculture value chains and the sector are invited to view this roadmap as guidance on how to achieve greater sustainability.

Pathways for change: a roadmap for sustainable aquaculture

It is integral that the users of this roadmap interpret it as a holistic approach. This is not a linear process, nor is it step-by-step instruction. Actions and outcomes overlap and complement, often signifying progress along more than one pathway. This approach is essential for any progress to gain traction. Above all, an enabling environment of partnerships, policies, investments, innovative technologies and transparent knowledge-sharing can – and must – provide a consistent thread of support and action across aquaculture value chains.

Therefore, all those engaged across aquaculture value chains and the sector are invited to view this roadmap as guidance on how to achieve greater sustainability. All those committed to the sustainable growth of aquaculture should use innovative approaches that evolve as challenges do. This roadmap is a jumping-off point, and while the measures of success may need to adapt to new challenges, many key areas for improvement will remain consistent – as set out in detail in each pathway.

From a systems change approach, four pathways were identified that represent both the greatest challenges and greatest opportunities for the aquaculture sector and set the solutions needed to ensure significant progress is made by 2030.

Responsible production

Challenges: The sustainability of aquaculture production systems is a critical foundation for the responsible growth of aquaculture. However, the diversity of farming systems, management strategies,[3] scales of production[4] and farmed species[5] – which have complex and diverse interactions with the environment, economy and society – make this a challenging area to improve for the sector. Small-scale actors, for example, produce about two-thirds of blue foods for human consumption but operate in diverse ways and have varying access to quality inputs, training and best practices.[6] Due to the nature of their size and scale, larger companies also contribute to the complexity of this sector when it comes to production. Guidance on the integration of more responsible production practices is not an easy exercise and needs to be adapted to each context. Actors across aquaculture value chains have an impact on nature and climate, and more must be done to limit or mitigate negative impacts, such as runoff to surrounding ecosystems[7] and overreliance on wild-caught forage fish to produce fishmeal and fish oil.[8]

Opportunities: It is necessary to develop and share innovative solutions and best practices for responsible production that speak to the complexity of the sector and boost diversity of supply, biodiversity, climate adaptation and resilience. There are already production systems contributing to this – filter-feeders like oysters and mussels can remove excess nutrients from the water that may otherwise harm the ecosystem[9] and integrated agriculture-aquaculture systems create circular systems for nutrient exchange[10] – but wider adoption of nature-positive solutions is needed. For example, consider that small-scale actors produce significant amounts of a diverse range of farmed fish in aggregate. Large aquaculture companies can offer products and services to help such small-scale actors sustainably increase the productivity and quality of their efforts. This is not only a business opportunity but contributes to the inclusive growth of the sector. Clearly, small-scale actors have a central role to play in moving towards responsible production, therefore, innovation, finance and governance should be responsive to their diverse needs, circumstances and opportunities.[11]

Solutions: The sustainable intensification and expansion of aquaculture production systems will require technical innovation, incentives, governance and regulation along value chains.[12] For example, innovation around digital platforms as service providers has begun to aggregate and connect diverse actors, including small-scale actors, with timely information (e.g. management recommendations) as well as products and services (e.g. feed, seed, formal finance).[13,14]

In addition, innovation hubs, including incubators and accelerators, can help build capacity and networks while also unlocking capital for innovation by connecting aquaculture companies – especially small- and medium-sized enterprises (SMEs) – to investors. Industry improvement programmes and resources need to reach all actors, especially small-scale actors and SMEs across aquaculture value chains, to stimulate the development and implementation of innovative solutions, such as integrated approaches across feeds, genetics, health and data-led management. On top of action to improve production practices, a variety of species and systems is key to a climate-resilient future – especially harnessing naturally lower trophic or other environmentally restorative aquaculture systems.

Better livelihoods

Challenges: Despite growing pressure on businesses to seek a "social license to operate" (SLO) where community acceptance and the approval of incoming industry is seen as a necessity for any operations,[15] the benefits derived from blue foods livelihoods are still distributed unevenly. Currently, small-scale actors disproportionately bear the risk of market instability,[16] which can further compromise livelihoods and wider access to nutritious foods. Furthermore, the knowledge, resource management systems, roles[17] and rights of

Click on arrows to navigate to the pathway chapter

small-scale actors remain inadequately recognized and addressed in statistical data, policy, decision-making and governance.[18] This is a particular issue for women, who are disproportionately represented in the informal, lowest paid, least stable and least skilled segments of the workforce – especially in post-harvest processing and distribution. Despite making up about half of the overall workforce in fisheries and aquaculture value chains,[19] their contributions, knowledge and perspectives are often left out of decision-making processes. Similarly, young people are increasingly engaged in less secure work at a time when youth unemployment is on the rise. Additionally, strategies to address human rights and labour abuses, and their enforcement, need greater attention across the sector,[20] as does the fact that the wider impacts of the aquaculture sector on communities, especially on vulnerable groups, are not currently evaluated on a routine basis.[21]

Opportunities: Aquaculture companies are already making improvements in meeting decent work conditions through enhanced productivity and modernization,[22] but the long-term resilience of aquaculture value chains relies on investment in all people across aquaculture systems. This is particularly important for small-scale actors, who provide sustenance for about one billion people, support over 100 million jobs[23] and are strong multipliers of local employment. The incredible diversity of small-scale actors, as well as species and systems in associated value chains,[24] can be a critical strength in navigating supply chain shocks, including those induced by climate change or global events.[25] Similar to broader shifts towards gender equity across other industries,[26] the aquaculture sector has an opportunity to promote gender inclusion, including through networks like women's cooperatives, to support higher productivity and incomes, household fish consumption and nutrition,[27] as well as distribution of benefits and recruitment.[28] There is also unrealized potential for decent and meaningful livelihoods for young people in the sector, especially when it comes to innovation and entrepreneurship.[29]

Solutions: To deliver inclusive growth, systemic change is needed to empower collaboration and build a more just sector for actors across value chains. Large-scale actors and industry bodies must establish mechanisms to meaningfully include small-scale actors in decisions that impact them and interact with communities. Companies must encourage and invest in women and young people – who can safeguard the sector for years to come – and ensure the protection of human rights and decent work. To inform management and policy decisions that improve equity, consistent gender-disaggregated data on employment, income and wages in aquaculture value chains[30] should be collected as a first step to understanding the sector's impacts on its diverse actors and local communities.[31]

Healthy consumption

Challenges: There are huge disparities in access to nutritious and safe blue foods around the world.[32] In fact, healthy diets are out of reach for three billion people.[33] While nutrition-sensitive approaches have more recently been extended to aquaculture,[34] future growth could exacerbate barriers to access and further unsustainable consumption patterns if targeted policies and practices are not in place.[35] This comes at a time of increasing threats to food security and rising malnutrition, with women of childbearing age (especially pregnant and lactating women), infants, young children and adolescents most at risk. Poverty further amplifies these risks.[36] Making the most of the nutritional value of blue foods depends largely on access, which is influenced by production costs, distribution logistics, trade and market dynamics.[37] Diversity in species and source are key for both market access and resilience to supply chain shocks, yet current distribution channels do not reliably provide consumers access to enough diversity of blue foods.

Opportunities: Blue foods are already a vital part of food systems, providing a critical source of protein and other nutrition for more than three billion people.[38,39] These diverse foods provide key micronutrients and essential fatty acids and increase the bioavailability of other nutrients on the plate – meaning, they support the absorption of nutrients from other foods.[40] Varying access to diverse blue foods can dictate availability, so aquaculture actors like distributors, retailers and food service providers have an opportunity to enable access by offering more diverse products. Public guidelines and preferences also have strong influence. If the aquaculture sector gets this right, it could play a key role in contributing to achieving healthy lives and sustainable diets globally.

Solutions: Supplying a diversity of blue foods using a wide array of farming systems and strategies can enhance food and nutrition security by improving access, affordability and dietary diversity. Businesses need to find solutions that allow all consumers to access nutritious and safe blue foods, which should also address malnutrition.[41] Improved messaging about lower-trophic species[42] or more sustainably produced products can inform healthier and more responsible consumer choices, as well as public guidance and policies like national health guidelines that integrate farmed blue foods. Advocates in this sector need to raise awareness, among retailers, distributors, food service providers and policy-makers, about the benefits of a variety of blue foods to create a more sustainable aquaculture market.

> To deliver inclusive growth, systemic change is needed to empower collaboration and build a more just sector for actors across value chains.

Enabling environment

Challenges: The aquaculture sector will not achieve responsible production, better livelihoods and healthy consumption if it acts alone. Development and innovation must be underpinned by a better enabling environment of governance, regulation, investment and partnerships. There are numerous challenges to progress, for example, aligning and interpreting public and private data – which can provide vital information to value chain actors[43] – particularly at the granular level needed to inform decision-making. This has implications for communication between the public and private sectors when it comes to identifying crucial flows of investment. As the sector grows, rulemaking, implementation and enforcement must be balanced to enhance and incentivize positive outcomes and avoid negative consequences to the environment, social networks and local economies. For instance, where aquaculture is under-regulated, communities can experience negative impacts, but overregulation can stifle innovation and activities that provide benefits.[44]

Opportunities: As an industry producing $243.5 billion of blue foods annually, aquaculture has become the world's fastest-growing food production sector. Aquaculture holds great potential to meet growing global demand for more sustainable, nutritious foods and to support the transition to healthier oceans and freshwater ecosystems.[45] To reach its potential, there are a number of opportunities to be taken advantage of. For example, a strong enabling environment can help actors access robust and transparent data that can encourage knowledge-sharing, capacity building and proper guidance while improving the inclusion of small-scale actors. For instance, robust digital infrastructure can connect even more small-scale actors to knowledge and management recommendations to improve their business outcomes.[46,47] Furthermore, the emergence of technological innovations for data collection and management – such as sensors, satellites and digital platforms – are opening new ways to monitor change, assess risks and share knowledge across all roadmap pathways. Targeted research can measure progress towards and inform innovation goals. Setting up participatory and adaptive multistakeholder partnerships can improve dialogue across the sector and scope out financing strategies. Blended finance (including leveraging initial public funds for future private capital) and insurance can de-risk innovation and production,[48] particularly for SMEs.

Solutions: To achieve this potential, the creation of a robust enabling environment for sustainable aquaculture is essential. There is great need for policies, partnerships, certification and investments that enable the sustainable growth of aquaculture.

> Done right, aquaculture systems can become more efficient, adapt to climate change and biodiversity impacts, and contribute to communities, livelihoods and the economy for many years to come.

Ultimately, policies from local to international levels are needed to incentivize and enforce more responsible and inclusive practices. Policies also play a key role in stimulating private investment towards innovation and sustainable businesses using environmental, social and governance (ESG) criteria.[49]

There are a number of critical areas of focus for this roadmap, which, enacted simultaneously and supported by an enabling environment, can allow actors along aquaculture value chains to flourish:

- Companies transitioning to more **responsible production** systems would be best supported by a strong enabling environment of innovators, regulators, certifiers, policy-makers, investors, and non-governmental and intergovernmental organizations who can help share solutions, best practices, capacity-building resources and financing.

- The onus is on companies to take action to move towards **better livelihoods.** However, this progress needs to be underpinned by the actions of regulators, certifiers, policy-makers, investors, and non-governmental and intergovernmental organizations to tackle issues in policy-making and governance decisions, for example, by supporting the industry to adopt and share best practices on decent work.

- As part of a wider community of food, health and financing actors; regulators, certifiers and policy-makers should be prepared to work with organizations from distributors to food service providers to support **healthy consumption,** which allows consumers to make more informed buying decisions and have better access to affordable, nutrient-dense and sustainable species, for example, by displaying clear health and nutrition indicators.

How to read this roadmap

Each of the four pathways in this report begins with a long-term ambition, which has been broken down into two sections, including actions and outcomes. Under actions and outcomes, there are potential steps to take and envisioned results, respectively. Each pathway also highlights SDGs in the form of icons that especially resonate with its areas of ambition. While not noted in every pathway, SDG14: Life Below Water cuts across all ambitions. Each person and organization will contribute in a way that best suits their area of expertise and impact – these options should provide ideas for action as opposed to a prescribed list for everyone to take. Done right, aquaculture systems can become more efficient, adapt to climate change and biodiversity impacts, and contribute to communities, livelihoods and the economy for many years to come.

1

Pathway one: responsible production

Aligning responsible aquaculture practices in production is key to mitigating climate change and boosting biodiversity.

The aquaculture industry – especially "upstream actors" such as producers, post-harvest processors and traders – needs to accelerate the adoption of responsible practices and innovate towards a resilient future that enhances biodiversity and mitigates climate change. Investors and financiers aligned behind this step can create a powerful incentive for positive change.

FIGURE 2 **Innovate for future progress**

Action

Upstream actors along aquaculture value chains should promote innovative solutions to environmental challenges in aquaculture production.

Steps to take

- Establish innovation hubs that incubate, stimulate and accelerate the development of innovative solutions in key areas such as sustainable feeds, improved seed, productivity and integrated systems (e.g. agriculture-aquaculture integration, integrated multi-trophic aquaculture), and reduction of greenhouse gas emissions.
- Develop and distribute innovative technologies (e.g. digital platforms) and incentives for value chain actors that help address data gaps, support data-driven decision-making and/or connect or aggregate actors (e.g. service providers).

Outcome

Innovative solutions that tackle environmental challenges in production are developed and adopted through industry collaboration and capacity building.

Envisioned results

- Adopted climate-smart and nature-positive innovations improve efficiencies across aquaculture production and post-harvest.
- Targeted technologies are accessible to and adopted by relevant actors along the value chain, especially small-scale actors.

Action

Companies must implement and accelerate guidance, best practices and incentives that de-risk and enable the adoption of responsible practices in aquaculture production.

Steps to take

- Design and implement best practices with quantitative environmental performance indicators across commodities and industry value chains.
- Accelerate the development of production systems and value chains for low trophic or other environmentally restorative aquaculture species.
- Develop widely accessible capacity-building resources for upstream actors such as:
  - Climate and biodiversity risk assessment and mitigation guidance.
  - Training to improve data-led management to responsibly increase productivity.
  - Guidance on market incentives for environmental sustainability for small-scale actors and SMEs.
- Establish environmental codes of practice (e.g. biodiversity and climate dimensions).

Outcome

Climate change and biodiversity impacts of aquaculture production are reduced by implementing appropriate best practices and incentives.

Envisioned results

- Widespread improvements in the efficient and environmentally responsible farming of a diversified range of species.
- Established quantitative environmental performance indicators that can be used to assess diverse production systems.
- Aligned market and non-market incentives towards improvements and innovations in aquaculture production that include climate and biodiversity risk reduction.
- Defined codes of practice addressing climate change impacts and biodiversity protection.

2

Pathway two: better livelihoods

Unlocking the potential of people and communities is vital to ensure equitable aquaculture value chains.

This pathway requires large-scale actors and companies to support the engagement, integration and rights of small-scale actors, particularly women and young people, in order to ensure the equitable flow of benefits. Guidelines to report on social impact, human rights and the reduction of child labour, and gender-responsive policies are needed to show more equitable benefits along value chains. Once again, actors are needed all along aquaculture value chains, but especially require employers and relevant human resources or sustainability departments, unions and other producer, processor and trader organizations to collaborate to deliver change.

FIGURE 4 **Inclusion in aquaculture value chains**

Action

Large-scale actors and industry bodies must establish mechanisms for better engaging with small-scale actors and their communities along aquaculture value chains. Priority should be given to women and young people.

Steps to take

- Establish or support mechanisms for the inclusion of small-scale actors in aquaculture improvement programmes that lead to certification.
- Increase the number of small-scale participants organized through associations and cooperatives for greater market influence and visibility.
- Develop company guidance and strategies on social impact, including reporting metrics.
- Support cooperatives, associations and other relevant groups specifically geared for women and young people to create opportunities in aquaculture value chains.

Outcome

Small-scale actors are better integrated in aquaculture value chains and will see tangible social, economic and environmental benefits from responsible aquaculture growth.

Envisioned results

- More small-scale actors, especially women and young people, are employed or enabled by the industry along aquaculture value chains.
- Benefits from certification programmes reach small-scale actors.
- Companies regularly implement and report on social impact at an industry-wide level, and this could include:
  - Greater contribution to community development in areas where companies operate through corporate responsibility and sustainability programmes.
  - Greater leadership and entrepreneurship generated from women and youth associations, cooperatives and other such support networks.

FIGURE 5 | **Adopt human-centred, inclusive policies and practices**

Action

Companies in the aquaculture industry need to produce and adopt policies and practices on decent work and gender equity.

Steps to take

- Develop guidelines, in context-specific languages, on securing social license, labour, human rights and gender equity, and adopt these guidelines in social standards.
- Encourage first movers – e.g. the top 10 global seafood companies – to adopt practices and industry guidelines for decent work[50] in aquaculture.
- Make public commitments that respect all internationally recognized women's rights across company activities and implement gender-responsive policies.

Outcome

Decent working conditions and living wages for workers are commonplace in aquaculture value chains with reduced gender inequality for inclusive growth.

Envisioned results

- Greater employee well-being within companies, supported by gender-disaggregated data.
  - Evidence established of safeguards, displaying the elimination of human rights abuses and child labour.
  - Evidence monitored of wages paid along chains.
- Integrated gender-responsive policies in company practices that provide liberty for the formation of women's groups or associations across organizations.
- Established community grievance mechanisms that ensure communities have a forum to raise challenges with aquaculture companies operating in their local area.

3

Pathway three: healthy consumption

Consumers should have access to responsible and healthy blue food choices.

To increase responsible and healthy consumption of nutritious farmed blue foods, distributors, retailers, food service providers, processors, chefs, influencers, media and consumers must revolutionize the way blue foods are perceived, marketed and consumed. Public agencies – particularly in the food, nutrition and health fields – should develop policy and investment environments that create greater awareness of the role of blue foods in healthy and sustainable diets. Companies should align around the market opportunities and find solutions that allow all consumers to access the health benefits of nutritious blue foods that address malnutrition.[51]

FIGURE 6 | **Enable greater access**

Action

Retailers, distributors and food service providers need to focus on sustainable, diversified sourcing and distribution of farmed blue foods.

Steps to take

- Provide guidance by blue food advocates to retailers, distributors and food providers on how they can diversify and be more responsible about their procurement of blue foods, with the targeted inclusion of lower-trophic species that have a lower environmental footprint.
- Improve procurement channels to provide a more diversified, affordable and nutritious range of farmed blue foods to consumers, including vulnerable groups, such as women and children in some developing contexts.
- Include nutrition and health benefits as dimensions in sustainability indicators by influential blue food companies, certification bodies and standards.

Outcome

Retailers, distributors and food service providers improve their procurement channels and facilitate wider consumer access to a diversity of farmed blue foods.

Envisioned results

- Diverse farmed, affordable and nutritious blue foods (including lower-trophic species) on store shelves and dining tables.
- Greater contributions of aquaculture to healthy diets, particularly for women and children, and countries with fish supply-demand gaps.
- Increased responsible sourcing and marketing of blue foods with health and nutrition branding.
- Certification bodies, standards and corporate sustainability departments include health and nutrition indicators as part of their sustainability assessments.

FIGURE 7 | **Build awareness and demand**

Action

Companies need to partner with respected institutions and influencers to deliver marketing and communication campaigns and messages that increase public awareness about how consuming diverse farmed blue foods improves nutrition and health.

Steps to take

- Develop marketing and communication campaigns that make use of influencers, such as renowned chefs, and include affordable and accessible aquaculture products.
- Design and deliver targeted messages to policy-makers and other aquaculture enablers on the role of diverse farmed blue foods in nutrition and health for public guidance and relevant policies.

Outcome

A marked trend towards healthy and responsible consumption levels of farmed blue foods worldwide as evident in data and research.

Envisioned results

- Effective aquaculture marketing and communications campaigns lead to a more informed public and healthier and more varied blue foods choices of what people consume.
- Blue foods are integrated into public food and health guidance and policies that encourage and support the responsible consumption of diverse farmed blue foods among the general population.

4

Pathway four: enabling environment

Sustainability in aquaculture requires support from industry, government and civil society.

Policy-makers, industry associations, NGOs, IGOs, certifiers, regulators, investors, donors and the scientific community need to build an enabling environment that works for all. This environment should ensure inclusion, creating opportunities for small-scale actors and underrepresented voices in value chains, as well as for larger companies committed to positive progress towards roadmap goals. The enabling environment must focus on three key areas: 1) improving data and knowledge-sharing, 2) building wide-ranging partnerships, and 3) stimulating investment.

FIGURE 8 **Improve data and knowledge-sharing**

Action

The enabling environment must support the efficient coordination and development of aquaculture data systems, research outputs and innovative technologies that strengthen the evidence base for sustainable growth.

Steps to take

- Establish open-source, efficient and cost-effective datasets and/or data systems.
- Align existing datasets to quantify progress towards social and environmental outcomes, including greater opportunities for women and young people in aquaculture value chains.
- Integrate transparent data systems, data sharing and investments in interpreting such data[52] in public and private governance to facilitate knowledge-sharing.
- Develop platforms to enhance global aquaculture planning and monitoring that integrate advances in technology like satellite and mapping technology, ecological modelling, open-source data and connectivity.

Outcome

Policy-makers and the private sector are making better use of data, evidence and knowledge-sharing to inform aquaculture progress towards the SDGs.

Envisioned results

- Effective quantification of social and environmental outcomes through data sets and the collection of gender-disaggregated data to understand and recognize the role of women in value chains.
- Established policies for increased data sharing and transparency that build trust.
- Widespread evidence-based planning, monitoring and regulation, and learning in the sector, including progress towards the SDGs.

FIGURE 9 | **Build wide-ranging partnerships**

Action

The enabling environment needs to set up effective mechanisms for partnership-building across a range of stakeholders that support the responsible development of the aquaculture sector on multiple fronts.

Steps to take

- Design and establish multistakeholder partnerships that are facilitated by industry, government and civil society actors, which are participatory and adaptive in generating action plans that lead to supportive policies, regulations and certifications for the sustainable growth of the sector.[53]
- Influence governments through lobbying and other advocacy mechanisms to integrate blue foods including aquaculture into policies and to adopt gender-responsive and other enabling legislation for social inclusion.
- Improve certification schemes to include group certification for producers in emerging economies as well as more social indicators, particularly those related to nutrition and gender equality, in addition to environmental indicators like efficiency.

Outcome

Industry, government and civil society actors through sound multistakeholder partnerships have improved local, national and international policy environments, governance structures and certification schemes towards the sector's sustainable growth.

Envisioned results

- Policy-makers recognize and integrate blue foods (as it relates to broader agendas such as food security, climate change, and biodiversity) into development strategies and plans at local, national and global levels.
- Legislation includes approaches to enable opportunities for social inclusion of groups such as small-scale actors, women and young people in value chains.
- Certification schemes are more widely adopted and include improvements in social and environmental indicators, access to markets and efficiency.

FIGURE 10 | **Stimulating investment**

Action

The enabling environment needs to develop strategies for responsible investment in progressing sustainable aquaculture globally.

Steps to take

- Develop a coherent finance strategy based on a multi-stakeholder action plan, which prioritizes a range of investments to deliver systemic change in the sector, and takes into consideration ESG criteria.
- Target enabling blended finance[54] and investments from a range of institutions that set a foundation for, de-risk and/or accelerate inclusive and innovative solutions along aquaculture value chains.[55]

Outcome

Industry, government and civil society actors have stimulated a greater, diversified flow of investments.

Envisioned results

- A comprehensive assessment of appropriate financing schemes produced for different contexts and production systems.
- Widespread government, donor and investor financing options available to responsible actors, including small-scale, along value chains.
- Catalytic investments spark innovation that improves responsible production, better livelihoods and healthy consumption in the aquaculture sector.

Conclusion

Aquaculture is already delivering opportunities for transforming global food systems towards a healthy and sustainable future. Developed responsibly, aquaculture has the potential to deliver greater social, economic and environmental benefits – helping to feed a growing global population in a sustainable, nutritious and equitable way.

The sector, and the opportunities and challenges it faces, are complex. It is essential to recognize this complexity and embrace a diversity of blue foods, blue food actors and solutions. Critically, this will require collaborative effort – from within the aquaculture industry, as well as actors from government, international and non-profit organizations and scientific and academic institutions – to realize a vision for the sustainable growth of aquaculture.

This roadmap is global in nature, but one size does not fit all. Aquaculture value chains and how they operate should correspond to their own geographically specific context, responding to culturally appropriate and local needs. All steps outlined in this roadmap cannot be appropriate for every country but can be used as a starting point of recommendations to assess and apply at the national scale.

Actions for change

There are many ways to take action. Anyone committed to the vision of a more sustainable future for aquaculture is urged to consider how the roadmap might apply to their business, commodity, geography and other contexts. Though by no means exhaustive, here are some suggested applications for this roadmap:

- Bring roadmap recommendations into **business and operational strategies** of aquaculture companies across value chains.
- **Build capacity** based on the roadmap to ensure that all aquaculture stakeholders can make the necessary improvements in their own initiatives and value chains.
- Use the roadmap to inform private and public **investment decisions.**
- Integrate roadmap recommendations in **aquaculture project assessment, design and implementation.**
- Publish **stories and case studies** of lessons learned and best practices that show roadmap implementation in practice.
- Tailor blue food sustainability reporting by bringing roadmap targets into the **monitoring and evaluation** of aquaculture value chains.
- Develop **toolkits** that enable actors across aquaculture value chains and beyond to implement the roadmap in their own areas of work.
- Use the roadmap to inform **policy briefs, policies and international agreements.**

Whatever action you take, the four pathways in this roadmap (responsible production, better livelihoods, healthy consumption and enabling environment) highlight a range of opportunities and targets for the sustainable growth of aquaculture. While challenges will continue to evolve over time, the hope is that this roadmap can serve as foundational guidance for change.

Appendices

A1 Key aquaculture terms

Aquaculture production systems: Productive aquaculture systems require seeds and genetics, feeds, health and management, and integration of aquaculture into land and waterscapes and agriculture systems.

Blended finance: Blended finance harnesses public or philanthropic money to encourage the use of private capital to create positive change, typically in developing countries. Public money can be used to test innovations and higher-risk strategies to open the door to future private finance.[56]

Blue foods/aquatic foods: Blue or "aquatic" foods are derived from aquatic animals, plants or algae that are captured or cultivated in freshwater and marine environments. (Blue Food Assessment)

Codes of practice: Codes of practice set standards for responsible operations and behaviour to ensure that ecosystems and biodiversity are accounted for in marine conservation, management and development schemes. These practices include environmental considerations, as well as considering the impact on people and communities.[57]

Decent work: Decent work "sums up the aspirations of people in their working lives. It involves opportunities for work that are productive and deliver a fair income, security in the workplace and social protection for all, better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in the decisions that affect their lives, and equality of opportunity and treatment for all."[58]

Digital platforms: Digital platforms use technology to facilitate more profitable business exchanges and interactions.[59]

Integrated agriculture-aquaculture systems: These systems link aquaculture with one or more other agricultural activities, for example integrating livestock and fish.[60]

Improvement programme(s): A multistakeholder effort that uses the influence of the impacts to drive improvements in the aquaculture production systems and make these changes endure through certification and policy change.

Low trophic species: Low trophic aquaculture (LTA) can include "unfed shellfish, seaweed and some species of finfish, and can also include fed species that primarily depend on plant products in their feeds".[61]

Social license/social license to operate (SLO): Indicates the level of approval from the community that an industry has to operate.[62]

A2 Methodology

This *Global Sustainable Aquaculture Roadmap* draws on insights from independent research and stakeholder consultations and is based on a vision to realize greater social, economic and environmental benefits from the sustainable growth of aquaculture among the global population. The roadmap is grounded in *The Road to Sustainable Aquaculture* report as well as other research documents and analyses about the current state of aquaculture.

To realize this vision, it was necessary to identify actions that could create change at scale and shift aquaculture systems towards sustainability. The FUTUREFISH research team, in consultation with the World Economic Forum, took a systems change approach to identify key actions for change to inform four pathways in an overarching theory of change. They then further developed this theory of change through individual and group consultations and surveys with key stakeholders in the Blue Food Partnership's Sustainable Aquaculture Working Group and other sector experts identified through stakeholder mapping and current aquaculture initiatives to strike a balance in representation across geographies, commodities and enabling functions. Following the consultation process, a roadmap framework of pathways was then established, which became the basis of this report.

Contributors

World Economic Forum

Laura Chavez Anderson
Project and Communications Consultant,
Ocean Action Agenda and Friends of Ocean Action

Karen Demavivas
Lead, Ocean Action Agenda and Friends
of Ocean Action

FUTUREFISH

Nisha Marwaha
Science and Innovation Manager

Anna Eve Patel
Programme Manager

Michael Phillips
Co-Founder and Co-Director

Rohana Subasinghe
Co-Founder and Co-Director

Cast From Clay

Anne Murray
Senior Consultant

Production

Laurence Denmark
Designer, Studio Miko

Martha Howlett
Editor, Studio Miko

Oliver Turner
Designer, Studio Miko

Acknowledgements

Thank you to the following reviewers
and contributors to this roadmap.

Oluwaṣòótọ́ Ajayi
Communications and Engagement Specialist,
Ocean Action Agenda and Friends of Ocean Action,
World Economic Forum

Malcolm Beveridge
Aquaculture Expert Independent Consultant,
FUTUREFISH

Abigail Frankfort
Project Assistant, Blue Food,
World Resources Institute

Tom Hashemi
Managing Partner, Cast From Clay

Caroline Karwitha Kanyuuru
Monitoring and Evaluation Consultant, FUTUREFISH

Glenn O'Neil
Founder and Director, Owl RE

Tien Nguyen
Aquaculture Specialist, FUTUREFISH

Gemma Parkes
Communications Lead, Ocean Action Agenda and
Friends of Ocean Action, World Economic Forum

This roadmap draws on a broad spectrum
of partners, stakeholders and experts in the
aquaculture sector. Therefore, it does not represent
any individual view, and participation does not imply
endorsement of the report.

This roadmap was prepared by FUTUREFISH on
behalf of the World Economic Forum's Blue Food
Partnership. FUTUREFISH connects innovators,
businesses and industry leaders for sustainable
growth in aquaculture. The team works towards a
mission of driving business solutions by connecting
insights and innovations with networks and
investments for a sustainable food system.

The Blue Food Partnership and this roadmap are
made possible by the generous support of the UK
Government's Blue Planet Fund and the Aquaculture
Stewardship Council. The Blue Food Partnership
aims to catalyse science-based actions towards
healthy and sustainable blue foods value chains.

Led by Friends of Ocean Action at the World Economic Forum, in collaboration with the World Resources Institute, the Partnership brings together stakeholders from the private sector, non-governmental and intergovernmental organizations, the scientific community and government. The Sustainable Aquaculture Working Group is the Blue Food Partnership's first pre-competitive action.

Thank you also to the following partners and stakeholders, as well as all members of the Sustainable Aquaculture Working Group, and other experts in the aquaculture sector, for their insights during the consultation process, which have contributed to this roadmap: Aqua-Spark; Aquaculture Stewardship Council; Biomar; Cargill; FAIRR; FAO Fisheries and Aquaculture Division; Fed by Blue; Global Salmon Initiative; Global Sustainable Seafood Initiative; Iceland Ocean Cluster; Ijebu Development Initiative On Poverty Reduction; Qingdao Marine Conservation Society; Regal Springs; SeaBOS; Stanford Center for Ocean Solutions; Pacific Community (SPC) Noumea New Caledonia; ThinkAqua; University of Stirling; United States Agency for International Development (USAID); Wageningen University & Research.

Endnotes

1. "Aquaculture", *Food and Agriculture Organization of the United Nations (FAO),* n.d., https://www.fao.org/fishery/en/aquaculture.
2. FAO, *The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation*, 2022, https://doi.org/10.4060/cc0461en.
3. Custódio, M., S. Villasante, R. Calado and A.I. Lillebø, "Valuation of Ecosystem Services to promote sustainable aquaculture practices", *Reviews in Aquaculture*, vol. 12, issue 1, 2020, pp. 392-405, https://doi.org/10.1111/raq.12324.
4. Short, R.E., S. Gelcich, D.C. Little, et al., "Harnessing the diversity of small-scale actors is key to the future of aquatic food systems", *Nature Food* 2, 2021, pp. 733-741, https://doi.org/10.1038/s43016-021-00363-0.
5. Bianchi, M., E. Hallström, R.W.R. Parker, et al., "Assessing seafood nutritional diversity together with climate impacts informs more comprehensive dietary advice", *Communications Earth and Environment*, issue 3, article no. 188, 2022, https://doi.org/10.1038/s43247-022-00516-4.
6. Short, R.E., S. Gelcich, D.C. Little, et al., "Harnessing the diversity of small-scale actors is key to the future of aquatic food systems", *Nature Food* 2, 2021, pp. 733-741, https://doi.org/10.1038/s43016-021-00363-0.
7. Martinez-Porchas, M. and L.R. Martinez-Cordova, "World Aquaculture: Environmental Impacts and Troubleshooting Alternatives", *The Scientific World Journal*, vol. 2012, 2012, https://doi.org/10.1100/2012/389623.
8. Shakouri, B. and S. Yazdi, "The Sustainable Marine Aquaculture", *Advances in Environmental Biology*, vol. 6, issue 1, 2012, pp. 18-23.
9. Ibid.
10. Freed, S., B. Barman, M. Dubois, R.J. Flor, S. Funge-Smith, R. Gregory, B.A. Hadi, M. Halwart, M. Haque, S.V. Jagadish and O.M. Joffre, "Maintaining diversity of integrated rice and fish production confers adaptability of food systems to global change", *Frontiers in Sustainable Food Systems*, vol. 4, 2020, p. 207, https://www.frontiersin.org/articles/10.3389/fsufs.2020.576179/full.
11. Tigchelaar, M., J. Leape, F. Micheli, E.H. Allison, X. Basurto, A. Bennett, S.R. Bush, L. Cao, W.W.L. Cheung, B. Crona, F. DeClerck, J. Fanzo, S. Gelcich, J.A. Gephart, C.D. Golden, B.S. Halpern, C.C. Hicks, M. Jonell, A. Kishore and J.Z. Koehn, "The vital roles of blue foods in the global food system", *Global Food Security*, vol. 33, 2022, p. 100637, https://www.sciencedirect.com/science/article/pii/S2211912422000281.
12. FAO, *The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation*, 2022, https://doi.org/10.4060/cc0461en.
13. Rowan, N.J., "The role of digital technologies in supporting and improving fishery and aquaculture across the supply chain – Quo Vadis?" *Aquaculture and Fisheries*, vol. 8, issue 4, 2022, pp. 365-374, https://www.sciencedirect.com/science/article/pii/S2468550X22001010.
14. Some examples include platforms that collect key data for production at farm-level and use it to provide management recommendations, reliable fish supply and formal finance (e.g. eFishery) or platforms that improve market transparency and connectivity between farmers and buyers (e.g. Aquabazaar, as part of Aquaconnect).
15. Whitmore, E., M. Cutler and E. Thunberg, *NOAA technical memorandum NMFS-NE-287*, *Social License to Operate in the Aquaculture Industry: A Community-Focused Framework,* US Department of Commerce, 2022, https://doi.org/10.25923/htvb-s306.
16. Tigchelaar, M., M. Honig, G.M. Laidha, F. Octaviani, A. Setiawan, J. Landman, T. Grasso, K. Kelso, S.H. Thilsted, J. Leape and G. Llewellyn, "Integrating Blue Foods Into Food System Policy And Practice", *G20 Insights*, 2022, https://www.g20-insights.org/policy_briefs/integrating-blue-foods-into-food-system-policy-and-practice.
17. Weeratunge, N., K.A. Snyder and C. Poh Sze, "Gleaner, fisher, trader, processor: understanding gendered employment in fisheries and aquaculture", *Fish and Fisheries*, vol. 11, issue 4, 2010, pp. 405-420, https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-2979.2010.00368.x.
18. Bennett, A., X. Basurto, J. Virdin, X. Lin, S.J. Betances, M.D. Smith, E.H. Allison, B.A. Best, K.D. Brownell, L.M. Campbell, C.D. Golden, E. Havice, C.C. Hicks, P.J. Jacques, K. Kleisner, N. Lindquist, R. Lobo, G.D. Murray, M. Nowlin, P.G. Patil, D.N. Rader, S.E. Roady, S.H. Thilsted and S. Zoubek, "Recognize fish as food in policy discourse and development funding", *Ambio*, vol. 50, 2021, pp. 981-989, https://link.springer.com/article/10.1007/s13280-020-01451-4.
19. FAO, *The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation*, 2022, https://doi.org/10.4060/cc0461en.
20. Lewis, S.G., A. Alifano, M. Boyle and M. Mangel, "Human rights and the sustainability of fisheries", *Conservation for the Anthropocene Ocean*, 2017, pp. 379-396, https://www.sciencedirect.com/science/article/pii/B9780128053751000180.
21. Kruijssen, F., C.L. McDougall and I.J.M. van Asseldonk, "Gender and aquaculture value chains: A review of key issues and implications for research", *Aquaculture*, vol. 493, 2018, pp. 328-337, https://www.sciencedirect.com/science/article/pii/S0044848617325577.

22. FAO, *The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation*, 2022, https://doi.org/10.4060/cc0461en.
23. Short, R.E., S. Gelcich, D.C. Little, et al., "Harnessing the diversity of small-scale actors is key to the future of aquatic food systems", *Nature Food* 2, 2021, pp. 733-741, https://doi.org/10.1038/s43016-021-00363-0.
24. Ibid.
25. Tigchelaar, M., J. Leape, F. Micheli, E.H. Allison, X. Basurto, A. Bennett, S.R. Bush, L. Cao, W.W.L. Cheung, B. Crona, F. DeClerck, J. Fanzo, S. Gelcich, J.A. Gephart, C.D. Golden, B.S. Halpern, C.C. Hicks, M. Jonell, A. Kishore and J.Z. Koehn, "The vital roles of blue foods in the global food system", *Global Food Security*, vol. 33, 2022, p. 100637, https://www.sciencedirect.com/science/article/pii/S2211912422000281.
26. United States Agency for International Development (USAID), *Engendering Industries: Developing a Business Case for Gender Equality*, n.d., https://www.usaid.gov/sites/default/files/2022-05/USAID-Engendering-Industries-Guide-Business-Case.pdf.
27. Castine, S.A., J.R. Bogard, B.K. Barman, M. Karim, M. Hossain, M. Kunda, A.B.M. Mahfuzul Haque, M.J. Phillips and S.H. Thilsted, "Homestead pond polyculture can improve access to nutritious small fish", *Food Security*, vol. 9, 2017, pp.785-801, https://link.springer.com/article/10.1007/s12571-017-0699-6.
28. "Why gender equality matters in fisheries and aquaculture", *CGIAR*, n.d., https://fish.cgiar.org/why-gender-equality-matters-in-fisheries-and-aquaculture.
29. Fry, C., I. Arulingam, L. Nigussie, S. Senaratna Sellamuttu, M. Beveridge and N. Marwaha, "Youth in small-scale fisheries and aquaculture", *WorldFish*, 2021, https://digitalarchive.worldfishcenter.org/handle/20.500.12348/4752.
30. Kruijssen, F., C.L. McDougall and I.J.M. van Asseldonk, "Gender and aquaculture value chains: A review of key issues and implications for research", *Aquaculture*, vol. 493, 2018, pp. 328-337, https://www.sciencedirect.com/science/article/pii/S0044848617325577.
31. Weeratunge, N., K.A. Snyder and C. Poh Sze, "Gleaner, fisher, trader, processor: understanding gendered employment in fisheries and aquaculture", *Fish and Fisheries*, vol. 11, issue 4, 2010, pp. 405-420, https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-2979.2010.00368.x.
32. Hicks, C.C., J.A. Gephart, J.Z. Koehn, et al., "Rights and representation support justice across aquatic food systems", *Nature Food*, vol. 3, 2022, pp. 851-861, https://doi.org/10.1038/s43016-022-00618-4.
33. "The State of Food Security and Nutrition in the World: The world is at a critical juncture", *FAO*, 2021, https://www.fao.org/state-of-food-security-nutrition/2021/en/.
34. Thilsted, S.H., A. Thorne-Lyman, P. Webb, J.R. Bogard, R. Subasinghe, M.J. Phillips and E.H. Allison, "Sustaining healthy diets: the role of capture fisheries and aquaculture for improving nutrition in the post-2015 era", *Food Policy*, vol. 61, 2016, pp. 126-131, https://www.sciencedirect.com/science/article/pii/S030619921630001X.
35. Gephart, J.A., C.D. Golden, F. Asche, B. Belton, C. Brugere, H.E. Froehlich, J.P. Fry, B.S. Halpern, C.C. Hicks, R.C. Jones and D.H. Klinger, "Scenarios for global aquaculture and its role in human nutrition", *Reviews in Fisheries Science & Aquaculture*, vol. 29, issue 1, 2020, pp. 122-138, https://www.tandfonline.com/doi/full/10.1080/23308249.2020.1782342.
36. "Malnutrition", *World Health Organization*, 9 June 2021, https://www.who.int/news-room/fact-sheets/detail/malnutrition.
37. Fiorella, K.J., H. Okronipa, K. Baker and S. Heilpern, "Contemporary aquaculture: implications for human nutrition", *Current Opinion in Biotechnology*, vol. 70, 2021, pp. 83-90, https://www.sciencedirect.com/science/article/pii/S0958166920301816.
38. Pauly, D., "How the global fish market contributes to human micronutrient deficiencies", *Nature*, 2021, https://www.nature.com/articles/d41586-019-02810-2.
39. High Level Panel of Experts on Food Security and Nutrition (HLPE), *Sustainable fisheries and aquaculture for food security and nutrition. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*, 2014, https://www.unscn.org/uploads/web/news/HLPE-Report-7-EN.pdf.
40. "The vital roles of aquatic foods in the global food system", *World Fish Centre*, 27 May 2022, https://www.worldfishcenter.org/blog/vital-roles-aquatic-foods-global-food-system.
41. Tigchelaar, M., J. Leape, F. Micheli, E.H. Allison, X. Basurto, A. Bennett, S.R. Bush, L. Cao, W.W.L. Cheung, B. Crona, F. DeClerck, J. Fanzo, S. Gelcich, J.A. Gephart, C.D. Golden, B.S. Halpern, C.C. Hicks, M. Jonell, A. Kishore and J.Z. Koehn, "The vital roles of blue foods in the global food system", *Global Food Security*, vol. 33, 2022, p. 100637, https://www.sciencedirect.com/science/article/pii/S2211912422000281.
42. Bianchi, M., E. Hallström, R.W.R. Parker, et al., "Assessing seafood nutritional diversity together with climate impacts informs more comprehensive dietary advice", *Communications Earth and Environment*, issue 3, article no. 188, 2022, https://doi.org/10.1038/s43247-022-00516-4.
43. Mohammed, E., P.R. Hossain, J. Lau, W.M. Abdul, M. Beveridge and N. Marwaha, "Accelerating climate resilience of aquatic food systems", *WorldFish*, 2021, https://digitalarchive.worldfishcenter.org/handle/20.500.12348/4921.
44. Engle, C.R. and J. van Senten, "Resilience of Communities and Sustainable Aquaculture: Governance and Regulatory Effects", *Fishes*, vol. 7, no. 5, 2022, p.268, https://www.mdpi.com/2410-3888/7/5/268.
45. IDH, *Investment Guide for Sustainable Aquaculture*, 2021, https://www.idhsustainabletrade.com/publication/investment-guide-for-sustainable-aquaculture.

46. Rowan, N.J., "The role of digital technologies in supporting and improving fishery and aquaculture across the supply chain – Quo Vadis?" *Aquaculture and Fisheries*, vol. 8, issue 4, 2022, pp. 365-374, https://www.sciencedirect.com/science/article/pii/S2468550X22001010.

47. Some examples include platforms that collect key data for production at farm-level and use it to provide management recommendations, reliable fish supply and formal finance (e.g. eFishery) or platforms that improve market transparency and connectivity between farmers and buyers (e.g. Aquabazaar).

48. Organisation for Economic Co-operation and Development (OECD), *Making Blended Finance Work For Agri-SMEs: Lessons Learned From Selected Case Studies*, 2021, https://www.oecd.org/dac/financing-sustainable-development/blended-finance-principles/documents/Blended-Finance-in-Agriculture.pdf.

49. FAO, *Blue finance guidance notes: Aquaculture insurance for small-scale producers*, 2020, https://www.fao.org/3/ca8663en/CA8663EN.pdf.

50. "Decent work", *International Labour Organization (ILO)*, n.d., https://www.ilo.org/global/topics/decent-work/lang--en/index.htm.

51. Tigchelaar, M., J. Leape, F. Micheli, E.H. Allison, X. Basurto, A. Bennett, S.R. Bush, L. Cao, W.W.L. Cheung, B. Crona, F. DeClerck, J. Fanzo, S. Gelcich, J.A. Gephart, C.D. Golden, B.S. Halpern, C.C. Hicks, M. Jonell, A. Kishore and J.Z. Koehn, "The vital roles of blue foods in the global food system", *Global Food Security*, vol. 33, 2022, p. 100637, https://www.sciencedirect.com/science/article/pii/S2211912422000281.

52. FAO, *The State of World Fisheries and Aquaculture 2022: Towards Blue Transformation*, 2022, https://doi.org/10.4060/cc0461en.

53. Brouwer, H. and J. Woodhill, *The MSP Guide: How to design and facilitate multi-stakeholder partnerships*, Centre for Development Innovation, Wageningen University and Research, 2015, http://dx.doi.org/10.3362/9781780446691.

54. FAO, *Blue finance guidance notes: Blended finance*, 2020, https://www.fao.org/3/ca8744en/CA8744EN.pdf.

55. OECD, *Making Blended Finance Work For Agri-SMEs: Lessons Learned From Selected Case Studies*, 2021, https://www.oecd.org/dac/financing-sustainable-development/blended-finance-principles/documents/Blended-Finance-in-Agriculture.pdf.

56. FAO, *Blue finance guidance notes: Blended finance*, 2020, https://www.fao.org/3/ca8744en/CA8744EN.pdf.

57. FAO, *Code of Conduct for Responsible Fisheries*, 1995, https://www.fao.org/3/v9878e/v9878e.pdf.

58. "Decent work", *ILO*, n.d., https://www.ilo.org/global/topics/decent-work/lang--en/index.htm.

59. World Economic Forum, *Digital Transformation Initiative: Unlocking B2B Platform Value*, 2017.

60. Little D.C. and P. Edwards, *Integrated livestock-fish farming systems*, FAO Inland Water Resources and Aquaculture Service Animal Production Service, 2003, https://www.fao.org/3/y5098e/y5098e.pdf.

61. "Low Trophic Aquaculture", *Wageningen University & Research*, n.d., https://www.wur.nl/en/research-results/research-programmes/cross-wur-programmes/wageningen-aquaculture-research-education-w-are/low-trophic-aquaculture.htm.

62. "Social License to Operate", *Seafish*, n.d., https://www.seafish.org/responsible-sourcing/social-responsibility-in-seafood/social-license-to-operate.

WORLD ECONOMIC FORUM

COMMITTED TO IMPROVING THE STATE OF THE WORLD

The World Economic Forum, committed to improving the state of the world, is the International Organization for Public-Private Cooperation.

The Forum engages the foremost political, business and other leaders of society to shape global, regional and industry agendas.

World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org