Measuring the Impact of the Blue Economy

OCTOBER 2026

A Triple-Bottom-Line Framework for Innovators



MARITIME blue

EARTH ECONOMICS
Better decisions, naturally

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Earth Economics acknowledges that we operate on the lands of the Coast Salish peoples, specifically the ancestral homelands of the Puyallup Tribe of Indians, and the 1854 Medicine Creek Treaty.

Introduction

THE BLUE ECONOMY

Forty percent of the U.S. population lives in coastal counties, though these form just 10 percent of the nation's landmass. These counties produce $10 trillion in goods and services, employ 54.6 million people, and pay $4 trillion in wages. The concept of the "blue economy," which emerged at the 2012 UN Conference on Sustainable Development in Rio de Janeiro, is characterized by innovations and activities that make sustainable use of ocean resources to improve livelihoods, while preserving the health of marine and coastal ecosystems. A truly sustainable blue economy requires addressing interdependencies between environmental, economic, and social factors, often referred to as the "triple-bottom-line" (OECD, 2016). The central challenge is finding healthy equilibria between marine ecosystems, coastal communities, and ocean-based industries.

Emergent ocean-based industries can help to overcome economic, social, and environmental challenges facing communities by proposing alternatives to how society interacts with marine life, through innovations in aquaculture, renewable energy, biotechnology, etc. According to the *Ocean Impact Navigator,* the blue economy can lead to "rigorous and efficient ocean regeneration and protection, sustainable production, and equitable prosperity to serve people and the planet, both now and in the future" (Vincent et al., 2022). The ocean is a central pillar of the modern global economy—nearly all international goods (90 percent) are shipped overseas, the seafood sector employs 237 million people, and millions more work in ports and tourism. Three billion people rely on the ocean for protein and crucial nutrients, while coastal habitats protect hundreds of millions of people (Stuchtey et al., 2020). A truly sustainable blue economy provides jobs and food while addressing inequality and protecting marine and coastal ecosystems to reduce disaster risk.

ABOUT MARITIME BLUE

Maritime Blue is an independent 501(c)(3) strategic alliance that fosters collaboration among industry, government, academia, communities, and investors to create sustainable maritime and ocean industries and propel the Pacific Northwest toward global leadership in ocean-based innovation. It empowers regional actors to thrive in the Blue Economy by accelerating innovation and entrepreneurship, centering equity, addressing climate change, restoring marine ecosystems, and building a diverse workforce.

Maritime Blue has supported the development of clean hydrogen for port and maritime applications, the West Coast offshore wind supply chain, zero-emission high-speed hydrofoil vessels, and robust connectivity networks for port activities. Its incubator and accelerator programs produce technologies and approaches actively targeting the protection of marine life. Additionally, its youth and training programs integrate equity and inclusiveness to create and retain a diverse workforce as a critical pillar to the sector's long-term sustainability.



ALIGNMENT WITH THE UN SUSTAINABLE DEVELOPMENT GOALS

The United Nations' *Sustainable Development Goals (SDGs)* establish targets for human, societal, and planetary well-being. According to Littig and Griessler (2005), society, economies, and the environment are interconnected systems that achieve balance over time to encourage human achievement (Figure 1).

Although the blue economy is bound to impact every SDG, the following selections are relevant along with their practical significance in terms of sustainability and equity impacts color-coded by an environmental, economic, or social dimension in Table 1).

Figure 1. The Triple-Bottom-Line of Sustainability

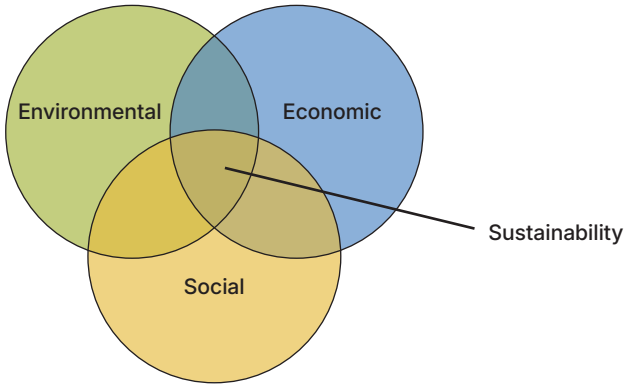


Table 1. SDG Impacts by Dimension

Sustainable Development Goals		Economic	Environmental	Social	References
	#2 Zero Hunger	Sustainable agricultural productivity		Improved nutrition; Health outcomes	2, 4, 5
	#3 Good Health and Well-Being			Better health; Longevity	5, 7, 9
	#5 Gender Equality	Increased economic participation; Productivity from women		Greater social justice; Equity	2, 5, 7, 9
	#6 Clean Water and Sanitation		Protection and sustainable management of water resources	Social well-being	1, 3, 5, 7
	#7 Affordable and Clean Energy	Reduced energy costs; Economic opportunities in renewable energy	Lower greenhouse gas emissions; Reduced environmental impact		1, 3, 5, 6, 8
	#8 Decent Work and Economic Growth	Sustainable economic development; Job creation		Improved livelihoods	1, 2, 4, 9
	#9 Industry, Innovation and Infrastructure	Enhanced productivity; Economic growth	Innovation in sustainable technologies		1, 3, 4
	#10 Reduced Inequalities	More equitable distribution of wealth		Greater social cohesion	2, 7, 9
	#11 Sustainable Cities and Communities	Efficient resource use; Economic resilience	Reduced environmental footprint; Improved urban ecosystems	Enhanced quality of urban life	1, 3, 9
	#12 Responsible Consumption and Production	Cost savings; Economic opportunities through efficiency	Minimized waste; Sustainable resource use		1, 3, 6
	#13 Climate Action	Mitigation of economic risks	Reduction of greenhouse gas emissions; Adaptation to climate change		1, 4, 5, 9
	#14 Life Below Water		Healthy marine ecosystems; Biodiversity		3, 6, 8

References: 1. WCED, 1987; 2. Littig and Griessler, 2005; 3. Kumar, 2012; 4. Slaper and Hall, 2011; 5. UN, 2015; 6. UN ESCAP, 2015; 7. UN DESA, 2017; 8. UN, 2019; 9. UN DESA, 2020

MARITIME BLUE FOCUS AREAS

The Washington State Strategy for the Blue Economy published in 2019 outlines a plan for a growing maritime economy spanning a wide range of sectors and supporting living-wage jobs, a healthy environment, and resilient communities. This led to development of strategic focus areas (Table 2).

Their broad scope highlights the diversity of blue cluster industries and stakeholders, spanning entrepreneurs, government (local, state, federal, Tribal), academia, nonprofit and community organizations, and investors. Around the world, blue economy innovations are emerging to provide economic opportunity and address social inequity and ameliorate climate and ecological crises (Quist and Roukouni, 2020; Schopmeyer et al., 2017; Saether and Moe, 2021; Swansea Council, 2023; New Zealand Ministry for Prime Industries, 2024) (Table 2).

Table 2. Five Strategic Focus Areas and Global Case Studies

1	**Sustainable Fishing and Seafood** The practices, policies, markets, and technologies that together ensure the long-term, just, and regenerative provisioning of food from the ocean.	Quota Management System, New Zealand • Local governments have established a system controlling fish harvests to prevent overfishing, promoting ecological balance while supporting livelihoods • Impacts food security and marine ecosystems
2	**Healthy Ocean Ecosystems** Ecosystems that are biologically diverse, ecologically functional, able to sustainably support subsistence and economic activity, and resilient to human pressures.	Coral Restoration Foundation, Florida, USA • The Foundation is designing and implementing scalable coral reef restoration techniques including coral farming and transplantation to combat coral degradation • Impacts biodiversity conservation, marine ecosystems, and educational outcomes
3	**Digital Transformation** The adoption of digital tools and data-driven processes to modernize business models, improve operational efficiency, insights, and create new value streams.	Port of Rotterdam's Digital Twin, Netherlands • Using advanced data analytics, the port has created a digital twin that models port activity to optimize logistics, reduce emissions, and increase efficiency • Impacts economic growth, food security, marine ecosystems, and collaborative partnerships
4	**Maritime Decarbonization** The transition of the maritime industry towards net zero emissions by 2050 through the broad adoption and deployment of low and zero emission vessels, supportive technologies, and infrastructure development.	Electric Ferry Project, Norway • The Ampere ferry operates in the Sognefjord and is the world's first battery electric ferry, generating significantly fewer emissions than conventional ferries • Impacts climate mitigation, marine ecosystems, economic growth, and community mobility
5	**Renewable Ocean Energy** Energy harnessed from oceanic sources in ways that are naturally replenished, such as wind, wave, thermal, and salinity gradients.	Renewable Ocean Energy: Blue Eden, Swansea, UK • The Swansea Council has laid the groundwork for a large-scale tidal energy project aimed at producing clean energy through underwater turbines and mitigating coastal erosion • Impacts renewable energy generation, climate resilience, and socio-economic inequities

REPORT AIMS

Blue economy stakeholders design and implement innovations that directly impact SDG outcomes; measuring such impacts can attract investment and support new technologies, to the benefit of communities and the environment. However, as the *Ocean Impact Navigator* highlights, defining and selecting appropriate metrics across blue clusters can be challenging.

The *Ocean Impact Navigator* convened 14 organizations to compare approaches in measuring sustainability and equity impacts in the blue economy. Each reported the lack of a unified impact framework (Vincent et al., 2022), and that although it was relatively straightforward to identify and leverage operational indicators (e.g., participation in training programs), tracing impact-oriented indicators was challenging (e.g., effects on destructive fishing).

The goal of this report is to develop a conceptual Blue Economy Impact Framework (BEI) that blue economy clusters and decision-makers can use in their efforts to assess the sustainability impacts of innovations and practices.

Guided by Maritime Blue's five focus areas, the BEI centers on the Pacific Northwest context and is intended as a tool to help stakeholders better understand blue economy impacts, synergies, and trade-offs.

The BEI also informs the design and implementation of ocean innovations, the impact of investments, and data collection, monitoring, and reporting processes. The framework helps blue clusters to compare, discuss, establish Key Performance Indicator (KPI) benchmarks, and implement strategic decisions.

KEY TERMS

BEI Framework = Blue Economy Impact Framework

TBL = Triple-Bottom-Line

KPI = Key Performance Indicator

Photon Marine deploys electric workboats at the Port of Friday Harbor.



Establishing a Key Performance Indicator Framework

DEFINING KPI FRAMEWORKS

Key Performance Indicators (KPIs) are measures of how effectively an organization, process, or project is achieving a key objective (Kantor et al., 2019). They can enhance communication, transparency, effectiveness, and accountability, and function as a readily understood tool to assess movement towards sustainable development objectives (FAO, 1999).

Relevant KPIs must match the needs of local stakeholders and projects and conform to local policies and political contexts. Accordingly, there are no universally accepted triple-bottom-line standards (Slaper et al., 2011). This is also true of the blue economy, which lacks an "off-the-shelf" KPI impact framework for evaluating the impact of innovation (Vincent et al., 2022).

According to Cardoso-Andrade et al., (2022) ideal KPIs are:

- relevant to policy objectives
- unambiguous, reliable, and accurate
- useful for monitoring and reflecting changing status
- linked to baseline data
- unique

BLUE ECONOMY KPI FRAMEWORKS

Literature review

Earth Economics reviewed over three hundred sources on blue economy innovations and sustainability, before selecting eleven frameworks with KPIs based on their relevance to the five focus areas and a Pacific Northwest context. Each framework addresses at least two sustainability domains and one focus area. The seven frameworks that offered quantitative KPIs became the initial basis of the Blue Economy Impact (BEI) Framework (Table 3). More than half include all three domains and three focus areas (Table 4).

Table 3. Seven Frameworks Aggregated into the BEI Framework

	Smart Port Index *(Molavi et al., 2020)*	**Maritime Economic Impacts** *(McKinley Research Group, 2023)*	**Digital and Marine Fishery Economies** *(Jiang et al., 2024)*	**Sustainable Marine Capture Fisheries** *(FAO, 1999)*	**Ocean Impact Navigator** *(Vincent et al., 2022)*	**Vital Signs Framework** *(Puget Sound Partnership, 2024)*	**Coastal MPAs** *(Cardoso et al., 2022)*
1 Sustainable Fishing and Seafood		●	●	●	●	●	●
2 Healthy Ocean Ecosystems	●		●	●	●	●	●
3 Digital Transformation	●	●	●				
4 Maritime Decarbonization	●				●		●
5 Renewable Ocean Energy	●				●		

INDUSTRIAL FOCUS ← SUSTAINABILITY → ECOSYSTEM FOCUS

Table 4. Blue Economy Frameworks and Associated KPIs, Metrics, Domains, and Focus Areas

Focus Areas: 1) Sustainable Fishing and Seafood, 2) Healthy Ocean Ecosystems, 3) Digital Transformation, 4) Maritime Decarbonization, 5) Renewable Ocean Energy

Source	Framework	KPIs	Metrics	Economic	Environmental	Social	Focus Areas
Anderson et al., 2015	Fishery Performance Indicators: A Management Tool for Triple-bottom-line Outcomes	68	No	●	●	●	1
Cardoso-Andrade et al., 2022	Setting Performance Indicators for Coastal Marine Protected Areas	132	Yes	●	●	●	1, 2, 4
FAO, 1999	Indicators for Sustainable Development of Marine Capture Fisheries	35	Yes	●	●	●	1, 2
Ashford, 2024	Selected interconnections between human health and activities in and around the ocean	39	No		●	●	1, 2, 5
Jiang et al., 2024	Digital economy and marine fishery economy quality indicator system	26	Yes	●	●		1, 2, 3
Kantor et al., 2019	Key performance indicators in industry and for industrial symbiosis	108	Yes	●	●	●	2
McKinley Research Group, 2023	WA Maritime Economic Impacts	19	Yes	●	●	●	1, 3
Molavi et al., 2020	A framework for building a smart port and smart port index	88	Yes	●	●		2, 3, 4, 5
OECD, 2025	Sustainable Ocean Economy Database	99	Yes	●	●		1, 2, 3, 4, 5
Puget Sound Partnership, 2024	Vital Signs Framework	72	Yes	●	●	●	1, 2
Vincent et al., 2022	Ocean Impact Navigator	30	Yes	●	●	●	1, 2, 4, 5

Spectrum of the blue economy

The literature review identified a broad diversity of blue economy focus areas, reflecting the richness and complexity of ocean sustainability. Several frameworks are oriented towards fishing and shipping industries, such as the Food and Agriculture Organization (FAO) Fishery Resources Division's four-part assessment (ecological, economic, social, institutional) of fishery status and performance (FAO 1999). Kantor et al., (2019) identified KPIs of synergies and trade-offs across a range of industrial sectors. Two frameworks leverage indicators for digital transformation: Molavi et al., (2020) focused on efficiency, decarbonization, and pollution abatement at "smart ports," while Jiang et al., (2024) combined digital economy and fisheries indicators.

Finally, the McKinley Research Group (2023) developed 19 economic indicators for Washington state's maritime industry, including ridership on ferries and cruise ships.

Several frameworks emphasize environmental health. 21 of 30 KPIs in the *Ocean Impact Navigator* concern habitat protection (see Figure 13 of Vincent et al., 2022); the remainder focus on economic growth and social well-being. The framework developed by Cardoso-Andrade et al., (2022) offers 132 indicators of ecological and socio-economic impacts, focused on implementing and managing marine protected areas (MPAs). Many KPIs address biodiversity impacts (e.g., population density, species richness).

Finally, the Puget Sound Partnership is a state agency established in 2007 to coordinate the efforts of citizens, governments, tribes, scientists, and businesses to restore and protect Puget Sound. They developed a set of quantitative and qualitative indicators to monitor ecosystem restoration and conservation progress (Puget Sound Partnership, 2018). Their *Vital Signs* framework is unique in combining 72 indicators for habitat, species, and human health, and offers a comprehensive and dynamic approach for protecting the Puget Sound ecosystem. *Vital Signs* indicators emphasize species of considerable regional cultural value (e.g., salmon, orcas).

Qualitative measures and indexes

While each of these KPI frameworks can inform blue economy stakeholders, Earth Economics chose to omit purely qualitative indicators (e.g., Ashford, 2024). Nevertheless, qualitative frameworks can be important for engaging local communities and incorporating their insights, especially regarding the complex relationships between sustainability factors.

Both the *Vital Signs* and Coastal MPA frameworks include qualitative indicators that require direct stakeholder input. For example, the status of local hunting, fishing, and foraging is determined by local stakeholders, as are perceptions about the value of MPAs. There are also several indicators bundled as composite indices (e.g., terrestrial bird populations, human-associated species, forest interior species).

BUILDING THE BEI FRAMEWORK

Synthesis and boundaries

Earth Economics assessed the relevance of the selected KPI frameworks to the five focus areas. Few KPIs addressed social equity or renewable ocean energy, so we identified additional sources incorporating metrics of equity (Österblom et al., 2020; City of Oakland, 2018) and renewable energy (Parker et al., 2025) impacts. Furthermore, Earth Economics consulted with Maritime Blue staff to identify and incorporate KPIs relevant to the growth of start-ups.

KPI frameworks must necessarily fall somewhere along a spectrum between universality and specificity. A list of KPIs applicable to any blue economy (regardless of context) would be impractical. On the other hand, a standardized framework must remain transferable and relevant to multiple blue economy clusters. Towards this end, Earth Economics designed the BEI with primary consideration for blue economy clusters in Washington State's maritime industries. While KPIs relating to the national economy (e.g., OECD, 2025) have been omitted here, in borrowing from frameworks based on SDGs and emphasizing diverse maritime sectors, the BEI strives to be transferable to other coastal regions.

Finally, to produce a succinct list of KPIs, Earth Economics applied the following filters:

- Duplicate KPIs were removed
- Minor variations were merged
- Indicators applicable to Washington State's maritime or estuarine contexts were prioritized
- Some indicators less relevant to sustainability dimensions or focus areas (e.g., operational safety) were omitted
- Qualitative indicators (e.g., public perceptions) were omitted

Results: KPIs and sustainability impacts

Table 5 highlights select KPIs from this synthesis (see Appendix B for full list). Sub-indicators detail greater specificity for each KPI. Relevant impacts from Table 1 are attributed to each KPI based on the sustainability area they directly or indirectly address.

Table 5. Highlighted KPIs (see Appendix B for full list)

Domain	KPI	Sub-indicator	Metric	Relevant impacts	Reference
Environmental	Volume of biomass preserved or restored		Cubic meters	Healthy marine ecosystems; Biodiversity	Vincent et al., 2022
Environmental	Nitrogen and phosphorus pollution mitigated	Marine/estuary waters	mg/L	Protection and sustainable management of water resources; Healthy marine ecosystems	Vincent et al., 2022
Economic	Number of ferries	With improved mobility/reduced emissions	Count	Economic growth	McKinley Research Group, 2023
Economic	Marine fishery output value		Thousand US$	Economic growth; Job creation; Improved nutrition	Jiang et al., 2024
Social	Average earnings per worker		US$/FTE/yr	Improved livelihoods	McKinley Research Group, 2023
Social	Policies supporting needs and rights of small-scale fishers		Number	Improved livelihoods	Österblom et al., 2020
Social	Percentage of workers who make less than the living wage	Accounting for race/ethnicity	Ratio	More equitable distribution of wealth; Greater social cohesion	City of Oakland, 2018

KPI frameworks help stakeholders to optimize sustainability goals across environmental, economic, and social domains. While the BEI provides a concise summary of key measures, it also highlights the level of effort required. For example, while the "volume of biomass preserved or restored" may increase biodiversity, stakeholders may need to assess "tons of ocean-based seaweed and bivalves produced", "abundance and biomass of groundfish" and "area of seagrasses protected or restored" separately to determine how individual species and/or habitats are faring.

Finally, the relative lack of social equity and renewable energy KPIs highlights a gap between the literature and innovations in the blue economy.

Applying the BEI to real-world applications will require that users determine the scope of monitoring efforts, timelines, historical baselines, and data collection. Each is discussed below. The following section applies the BEI's conceptual framework to individual and collective blue economy initiatives.

Applying the BEI Framework

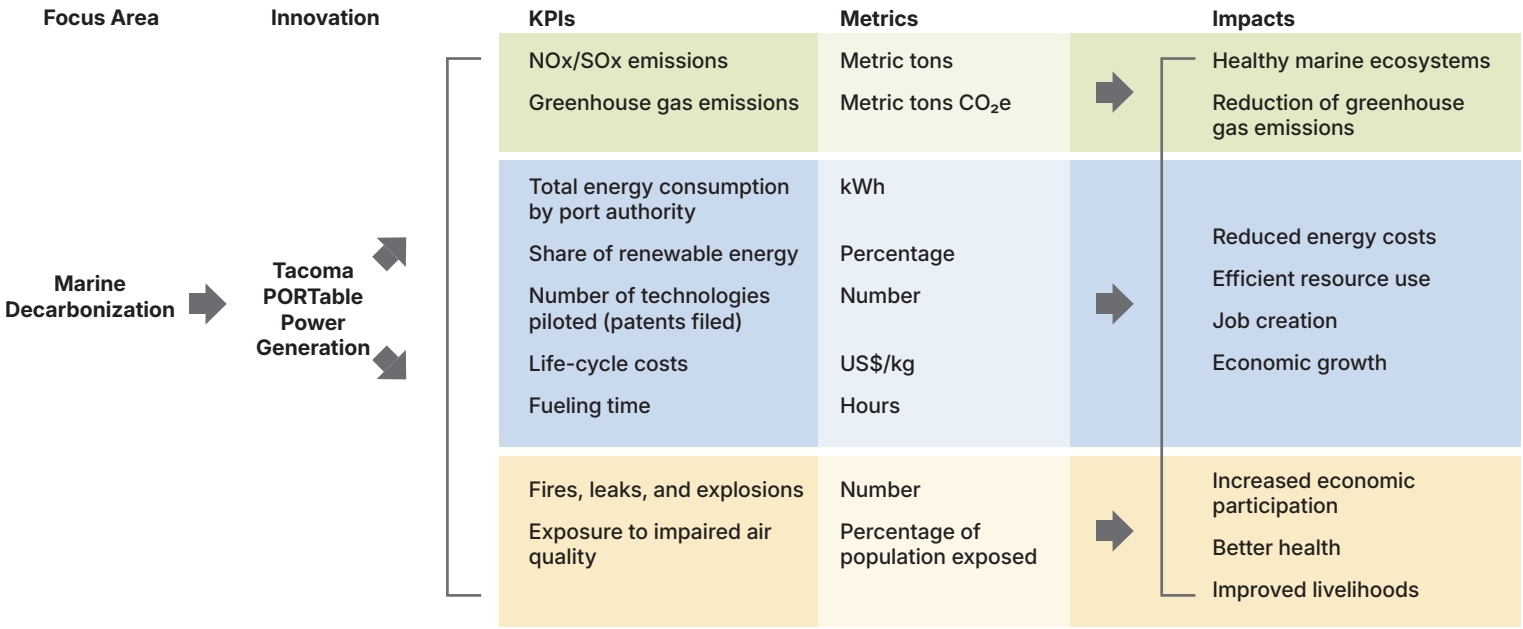
Case Study: Green Hydrogen

Maritime Blue members are advancing a broad portfolio of blue economy projects. This includes the Tacoma *PORTable Power Generation*, a Maritime Decarbonization project that seeks to shift a portion of the Port of Tacoma's fuel needs (largely electrical generation) from diesel generators to hydrogen formate, a liquid hydrogen carrier that is considered to be safer, cheaper, cleaner, and a more flexible source of stored energy. Portable hydrogen formate storage units would power various port infrastructures and operations.

Multiple KPIs can be applied to this project, highlighting its benefits relative to diesel or other energy sources. The following KPIs are likely relevant to an initial deployment of the technology:

- **Total energy consumption by port authority:** the energy potential of stored hydrogen formate and its impact on overall port energy portfolios
- **Lifecycle costs:** the total value chain costs (including production, distribution, and tax credits) as compared with other energy sources, including other means of hydrogen generation, distribution, and storage
- **Number of technologies piloted:** the number of patents generated by this pilot project
- **Energy from renewable sources:** the share of green electricity (primarily hydropower) used for hydrogen production
- **Fires and explosions:** reduced risk or safety incidents, compared with alternative energy sources such as gray-green compressed hydrogen, or gas-powered generators
- **Exposure to impaired air quality:** whether port workers and operators are exposed to lower pollutant loads
- **NOx/SOx emissions:** the degree to which transitioning to green hydrogen reduces emissions of these pollutants, relative to prior port operations
- **GHG emissions:** the degree to which transitioning to green hydrogen reduces emissions of climate-forcing substances (e.g., carbon dioxide, methane), relative to prior port operations

Figure 2. BEI Framework for Tacoma PORTable Power Generation at the Pilot Stage



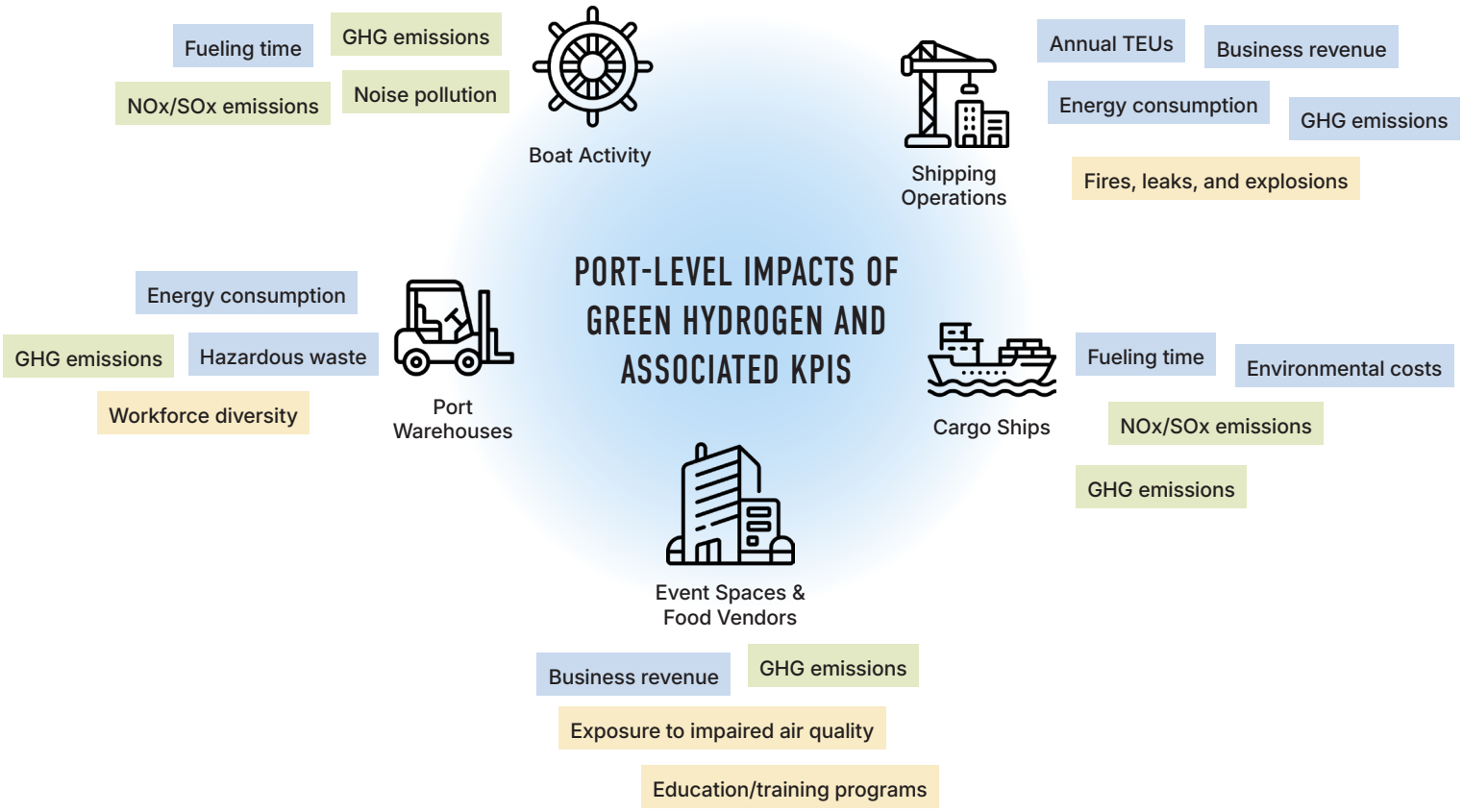
Should *Tacoma PORTable Power Generation* technologies be deployed at larger scales, they will likely influence other aspects of Port operations. Such impacts can be assessed with KPIs more relevant to commercial-scale applications. Figure 3 shows the potential for portable green hydrogen to support shipping and boat operations, manufacturing, community events, and food vendors.

As an example, the greenhouse gas emissions of shipping and manufacturing operations can be analyzed as they shift their operational energy needs to hydrogen. Other KPIs (e.g., education/training programs, business revenue) may emerge, should hydrogen be used to power conference spaces, or lead to lower operating costs.

While hydrogen technology is still evolving, these scenarios demonstrate the value of the BEI framework for analyzing the effects of blue economy innovations. It also improves our understanding of impacts as technologies shift from pilot phases to commercial deployment, as they affect individual technologies, operational sectors, and even entire ports.

Applying the BEI to blue economy innovations illustrates the strategic decisions necessary to delineate and understand sustainability impacts. Analyzing *Tacoma PORTable Power Generation* through a BEI lens can help other clusters understand the impact of investing in green hydrogen technologies. As Maritime Blue collects KPI data to monitor project progress, those data can be shared with other clusters, thus informing the wider blue economy investment journey.

Figure 3. Port-Wide Impacts of PORTable Power and Selected KPIs



Cluster-level innovations

Maritime Blue provides a rich environment for innovators, where triple-bottom-line analysis can be critical for understanding how sustainability goals are being met. Visualizing Maritime Blue innovations across all five focus areas highlights the complexity of understanding sustainability impacts (Figure 4). Each focus area has a distinct set of KPIs, impacting different sustainability areas. Technological innovations in the maturation pipeline include:

- Transitioning to clean hydrogen for port and maritime applications at the Port of Tacoma
- Development and deployment of an offshore wind supply chain in Washington to support turbines along the West Coast
- Commercial deployment of zero-emission high-speed hydrofoil transportation in Puget Sound
- Development of robust 5G networks for port activities enabling real-time environmental monitoring and supporting community safety

As innovations multiply, they may complement each other, work in parallel, or present potential trade-offs against some sustainability goals. KPIs can guide stakeholders in identifying synergies, trade-offs, and gaps among economic, environmental, and social priorities, helping them to optimize outcomes. Local and regional priorities and concerns are critical to this process. For instance, electrification of hydrofoil ferries or green hydrogen may increase aggregate energy demand, which could affect greenhouse gas emissions and air pollution, depending on the final energy portfolio.

Because each of these focus areas involves innovation in a commercial context, it is inevitable that they will share some common KPIs, especially those related to workforce development. Similarly, as Maritime Blue emphasizes prosperous and thriving maritime and coastal communities, KPIs reflecting progress towards these goals are also likely to be relevant to all focus areas.

Figure 4. Blue Economy Innovations Across the Five Focus Areas

1 Sustainable Fishing and Seafood

- 100% fish utilization
- Seaweed- and kelp-based product development
- Advanced seafood processing
- Vessel modernization (also 4)
- Digital tools for regulatory reporting, management, certification (also 3)
- Net recycling (also 2)
- Full supply chain management and product sustainability
- Bycatch reduction practices and technologies (also 2)

2 Healthy Ocean Ecosystems

- Underwater acoustics reduction (also 4)
- PFAS removal
- Ocean data collection and reporting (also 3)
- Marine carbon dioxide removal (also 4)
- Product design that supports improved storm and wastewater treatment
- Restoration through visitor finance
- Improved coastal resilience infrastructure
- Plastic remediation and alternatives
- Measurement, reporting, and verification tools (also 4)

3 Digital Transformation

- Industrial software development
- At sea connectivity
- Digital vessel data tools for tracking and maintenance
- Asset tracking technology
- Advanced manufacturing in maritime
- Digital twinning
- Tools for workforce training

(These support all other focus areas.)

4 Maritime Decarbonization

- Hybridization and electrification of vessel operations
- Optimization of ship design and engineering
- Alternative fuels production, use, and regulatory framework (also 2)
- Shoreside supply chain and infrastructure to support zero emission shipping
- Onboard carbon capture (also 2)

5 Renewable Ocean Energy

- Floating offshore wind supply chain (also 4)
- Tidal and wave energy demonstration and production
- Micro grid solutions for coastal communities
- Ocean thermal energy conversion (also 2)
- Ocean energy enabling services and supply chain
- Coastal community infrastructure innovation

THRESHOLDS, DATA, AND MONITORING NEEDS

The goals of each technology or innovation will contextualize KPI performance and make desired impacts more specific. Global, national, regional, state, or local institutions are all capable of establishing such criteria. For instance, the *2023 Seafood Stewardship Index* provides governance, ecological, economic, and social criteria for the global seafood industry (Packer and Beukers, 2022). More region-specific targets could also be established. For example, the Puget Sound Partnership aims that "by 2050, all Chinook Salmon populations increase and at least 50 percent of the populations reach their recovery goals" (2018).

Once innovators have identified KPIs relevant for their project, they will need to assess what is required to measure and track each KPI in terms of technical capacity, timelines, and overall effort. Baseline assessments are needed for identifying and understanding the impact of innovations as drivers of change. *Vital Signs* details monitoring procedures for each KPI, including the stakeholders in charge of collecting data, proposed methods, baseline data, and general guidance and resources (Puget Sound Partnership, 2024). Each step requires significant resources—including establishing the metrics themselves. Puget Sound Partnership has a $1 million grant competition for experts that can help further develop indicators, including defining baselines or biological thresholds and developing statistical and modeling methods for evaluation of status and trends. Although the BEI is conceptual, stakeholders can use it as an initial step before launching a more applied data collection and project monitoring plan.



Conclusion

IMPLICATIONS OF THE BEI

Innovation clusters will need the right tools to understand the degree to which blue economy innovation creates positive benefits for people, communities, and the environment. This BEI framework demonstrates the complex, interconnected nature of the blue economy, as well as the challenge of capturing the wide range of benefits across recreation, food security, climate stability, trade, transportation, and other sectors.

The BEI provides a guide for stakeholders to understand their project triple-bottom-line impacts and to assess performance relative to priorities, data availability, and specific KPIs. By facilitating an appreciation of the multi-dimensional impacts of each innovation, the BEI framework supports stakeholders to assess each project impact and to inform innovation, design, and implementation processes. The framework thus offers a foundation for strategic decision-making, data collection, stakeholder engagement, and technological development.

Maritime Blue can apply the BEI to current and planned projects, mapping logical paths from initial proposals to their ultimate environmental, economic, and social impacts to fully capture the sustainability performance of each. Individual or collective project performance (by focus area or across the full Maritime Blue portfolio) could steer future investment and demonstrate the cumulative triple-bottom-line impacts of the broader cluster.

APPLICATION BY OTHER BLUE CLUSTERS

The BEI has been designed to apply to the range of currently active blue economy innovations developed by Maritime Blue members, but other blue innovation clusters may follow a similar approach. Platforms seeking to strengthen partnership and collaboration can employ the BEI as a tool to maximize the potential around sustainability impacts awareness and delivery. As innovation clusters collect and generate data while deploying blue economy technologies, they have the opportunity to lead development of best practices in baselines, targets, and data collection.

FUTURE DEVELOPMENTS

This framework could be expanded and operationalized as an online or app-based decision-making tool, enabling stakeholders to identify their desired, planned, or implemented innovations and select desired impacts. Such a tool could then generate KPIs to help document how each innovation could impact sustainability goals.

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Appendix A: Limitations

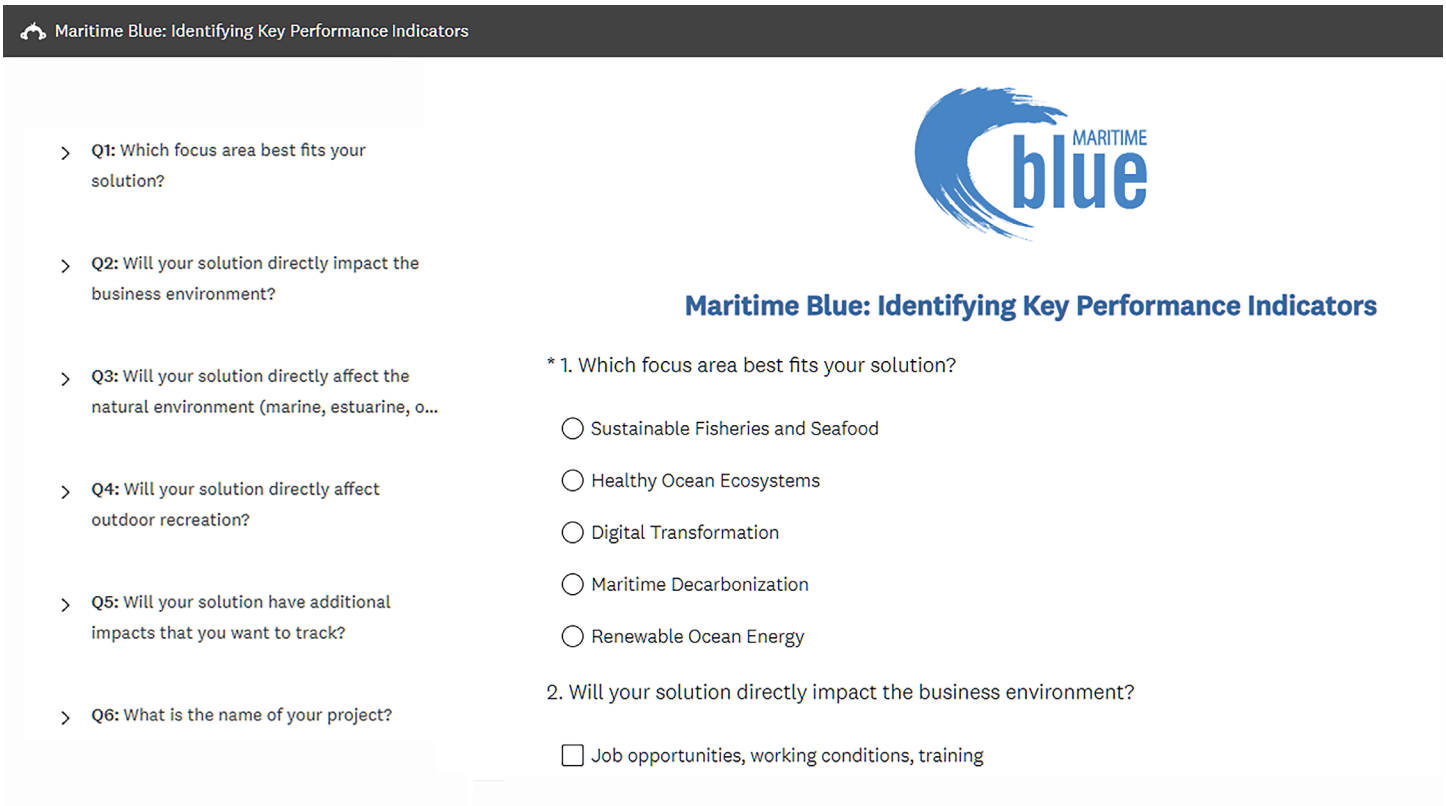
This report outlines a standardized, transferable, succinct, and balanced list of KPIs that address both SDGs and blue economy innovation priorities, which resulted in inevitable compromises. While a robust literature review informed this process, Earth Economics and Washington Maritime Blue teams made a purposeful selection of key studies. As such, the KPIs included here are non-exhaustive and may not capture the full breadth of innovations, practices, initiatives, or changes that may be measured.

Even so, Earth Economics has taken a broad approach when identifying KPIs and sustainability frameworks. Further research could produce and organize a more comprehensive set of KPIs (likely numbering in the thousands), possibly available as an online tool.

There has been one overarching limitation to this attempt to identify KPIs for blue economy innovations: there are relatively few indicators explicitly tied to the blue economy for either renewable energy or social factors.

Appendix B: Survey

Even after selecting KPIs relevant to Washington State's maritime industries, the Blue Economy Impacts (BEI) framework includes 75 performance indicators. With the intention of reducing the effort required of Maritime Blue partners, Earth Economics developed a brief survey to "pre-select" KPIs that are more likely to be relevant to each innovation. After completing the survey, respondents will receive a customized KPI report identifying the relevant indicators. The ultimate choice of indicators is left to participants.



Appendix C: KPI Summaries

KPI	Name	Description
KPI25	Efficiency: Reuse, recycling, or vaporization of waste	Both ports and vessels generate waste—plastics, organic materials, electronics—making their effective collection and recovery important for a circular economy. The productive reuse, recycling, or other recovery of waste (co-generation) can lower costs, reducing marine pollution, and protecting wildlife and water quality. Efforts can be tracked as the total amount of waste (by type) collected for reuse, recycling, or recovery, normalized to port area (tons/m^2). Diversion rates and trends over time can support performance assessments and help to identify opportunities for improvement (Molavi etal, 2020). This is related KPIs B1 and B2 of the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI26	Efficiency: Water consumption	Reducing water use can lower costs, conserve freshwater resources, and improve environmental performance. Water may be sourced directly by ports themselves (e.g., surface, ground, rain water), or purchased from utilities. Each can be increasingly important when and where water supplies are limited. Improvements in port performance can be measured as total annual use water for port activities such as cooling, cleaning, and other operations, normalized to the spatial extent of each port facility (m^3/m^2) (Molavi etal, 2020).
KPI31	Habitat: Ecologically enhanced hard structures	Many port structures—wharfs, piers, landings, jetties, revetments or breakwaters—can be designed to support marine life. By adding features such as textured surfaces or pooling areas, such structures can provide shelter, feeding, and breeding areas, helping increase biodiversity and ecosystem functions. Such improvements can be reported by the extent to which they increase the spatial extent of relevant structural features (m^2).
KPI22	Habitat: Pocket estuaries and embayments accessible to juvenile salmon	Pocket estuaries and embayments support the ecological health of Puget Sound, providing critical nursery habitat where juvenile salmon can feed, grow, and avoid predators. Increases in the number of accessible pocket estuaries and embayments (or facilitating their expansion) can be tracked, along with overall spatial extent, and qualitative assessments of habitat condition and salmon use (Puget Sound Partnership, 2024).
KPI2	Habitat: Protected or restored coastline	Protecting and restoring coastal ecosystems—reefs, kelp, seagrass, wetlands, dunes—can reduce risks from sea-level rise, storm surge, and erosion, protecting coastal communities, infrastructure, and freshwater supplies, while providing habitat and other ecosystem benefits. Solutions that support the protection or restoration of coastal ecosystems can be assessed by the extent of protected or restored coastline (miles), or the extent of affected habitat (acres). The type and location of activities may also be qualitatively reported. For engineered or hybrid solutions (breakwaters, revetments), potential impacts to coastal ecosystems should be reported, as well as any mitigation efforts. Alternate means of tracking include near-shore of Class I and II water quality (%) or coastal wetland extent (acres) (Jiang etal, 2024). This is KPI E1 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI19	Habitat: Protected or restored marine or estuarine habitat	Habitat protection and restoration can increase biodiversity, strengthening fisheries and coastal resilience. Seagrass, cold water reefs, kelp forests, and coastal wetlands provide nursery habitat, improve water quality, store carbon, and help to buffer coastal communities from storms. Improvements can be reported as the spatial extent of newly protected or restored habitat (m2, acres). Qualitative data may also include monitoring or enforcement activities, or restoration outcomes. This is related to KPI C3 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI3	Habitat: Sediment reuse	Beneficial sediment reuse can reduce the environmental impacts and the emissions associated with dredging and offshore disposal, while supporting coastal resilience. Sediment can be reused to restore habitat, strengthen shore protection, and provide material for port construction, potentially lowering capital costs. Track the total reused sediment (tons) each year, by project. Sediment quality, contamination controls, project type, and environmental outcomes can be described qualitatively. This is related to KPI C6 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI21	Habitat: Understory kelp abundance and condition	Kelp support diverse marine food webs, providing habitat and food for fish, invertebrates, and other wildlife while contributing to healthy coastal ecosystems and economies. Underwater surveys tracking kelp species distribution, abundance, community composition, and condition can record trends over time. Because understory kelp is difficult to survey, consistent methods and repeated sampling are important (Puget Sound Partnership, 2024). This is related KPIs C5 and C6 of the Ocean Impact Navigator framework (Vincent etal, 2022).

KPI	Name	Description
KPI23	Management: Environmental management systems	Environmental management systems (preferably based on recognized standards such as EMAS or ISO 14001) can help ports to reduce pollution, waste, resource use, and environmental risks while improving regulatory compliance, efficiency, and stakeholder confidence. These can be tracked as the number and proportion of port and terminal operators implementing EMS, including whether environmental-quality monitoring systems are in place, along with relevant physical metrics (waste diverted, total emissions, energy use, or water demand) and qualitative descriptions of implementation progress (Molavi etal, 2020).
KPI9	Management: Sustainable fishing gear	By reducing harm to non-target wildlife (bycatch, entanglement) and marine habitats, sustainable fishing gear can help to maintain resilient fisheries and healthy ecosystems, which in turn support fishing livelihoods and long-term seafood production. Such efforts can be measured by the proportion of fishing activity using sustainable gear (%), supplemented with data on bycatch, gear loss, and habitat impacts. Gear type and strategies to mitigate environmental risks can be reported qualitatively.
KPI24	Management: Vessels adopting sustainability measures	Sustainable practices on seagoing vessels can reduce physical disturbances and underwater noise, benefiting the broader Puget Sound ecosystem. Quieter waters can improve the ability of Southern Resident killer whale (SRKW) to communicate, navigate, and locate prey (NOAA Fisheries, 2024). The percentage of vessels adopting sustainability measures (participation rates), vessel speeds, underwater noise levels, and whale presence can be recorded to assess effectiveness over time (Matei etal, 2024).
KPI5	Natural-origin fish on spawning grounds	Sustaining abundant wild fish populations—especially salmon and steelhead—is vital to Puget Sound ecosystems, supporting food webs, cultural identity and tradition, commercial, recreational, and tribal fisheries, and local economies. Recovering their populations strengthens ecosystem resilience and benefits predators such as Southern Resident killer whales (SRKW). This can be tracked as annual counts of natural-origin monitored species returning to spawning grounds (excluding hatchery fish and harvested or predator-taken fish), or as annual percentage changes to reflect longer-term trends (Puget Sound Partnership, 2024).
KPI16	Pollution: Air pollution	Generating electricity from offshore wind turbines can improve air quality in comparison to other available generation sources (e.g., coal, gas). Improvements can be estimated based on annual generative capacity (e.g., number of turbines, total energy produced) and compared with typical annual emissions (e.g., tons of NOx, SOx, PM 2.5, PM 10) of alternative sources. This is related to KPIs D4 and D5 from the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI18	Pollution: Antibiotic use	Excess use of antibiotics in aquacultural systems can lead to broader ecological impacts, including the development of antibiotic resistance. It can be reported as reductions in the total volume of antibiotics administered each year. This is related to KPI B6 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI13	Pollution: Contaminated wastewater from land-based sources	Marine and estuarine waters can be impacted by contaminated wastewater from land-based sources. Reducing discharges (total mass, volume, concentrations) into coastal waters by ports can improve the ecological and economic health of coastal and marine ecosystems (Jiang etal, 2024). This is KPI B4 of the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI17	Pollution: Emissions intensity (well-to-wake)	The Poseidon Principles call for well-to-wake emissions from international shipping to drop to net-zero around 2050 (compared to 2008 levels), with interim targets in 2030 and 2040. The well-to-wake concepts is a lifecycle approach focused on emissions intensity—total greenhouse gas (GHG) emissions throughout each supply chain (CO2e emitted per metric ton-nautical mile). This is typically measured for multiple voyages over a year. Emissions intensity should be measured under real operating conditions, rather than design specifications (Parker etal, 2025). This is KPI D1 of the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI27	Pollution: General noise pollution	Excessive noises (sustained airborne sound above 70 dB, or above 120 dB underwater) generated by shipyard and industrial activities, ferries, and ships can negatively impact both aquatic ecosystems and nearby urban populations (Schenone et al., 2014). Tracking the effectiveness of measures to reduce noise pollution should monitor both volume (dB) and duration (Molavi etal, 2020).
KPI15	Pollution: GHG emissions from feedstock	Aquaculture feedstocks often have significant carbon footprints. More efficient feeding can reduce greenhouse gas (GHG) emissions (changed feed volume x emissions per unit of feed). Substituting seaweed-based feedstocks for higher-emission land-based feed may result in lower GHG emissions for equal caloric value. Because the emissions per calorie of all feedstocks may not be well-established, this KPI may reported qualitatively, with relevant supporting data provided where available (e.g., comparison of CO2 per kcal produced for seaweed-based product vs. substitute land-based product). This is KPI D1 in the Ocean Impact Navigator framework (Vincent etal, 2022).

KPI	Name	Description
KPI29	Pollution: Marine water temperature	Water temperature strongly influences Puget Sound ecosystems, affecting species growth, reproduction, distribution, oxygen availability, and food webs, with consequences for fisheries, wildlife, and coastal economies. Detecting marine heat events and conditions that may stress sensitive species is critical to informing ecosystem and climate adaptation decisions. Monthly water-temperature observations (throughout the water column) can be used to calculate deviations from long-term average temperatures (°C). Long-term monitoring is especially important, to distinguish natural seasonal variability from persistent change and extreme events (Puget Sound Partnership, 2024).
KPI28	Pollution: Median broadband sound pressure	Underwater sound pressures above 130 dB re 1 µPa can lead to behavioral changes in endangered Southern Resident killer whales (SRKW). Reductions the magnitude and duration of underwater noise in Washington waters may stem from technological innovation or best practices, such as voluntary slowdown for large commercial vessels (Matei etal, 2024).
KPI11	Pollution: Nitrogen or phosphorus pollution	Excess nitrogen and phosphorus can disrupt marine and estuarine ecosystems, causing harmful algal blooms and "dead zones" depleted of oxygen, which can have considerable impacts on tourism, fisheries, and human health. Excessive feeding in some aquaculture systems can increase nutrient pollution, while others (e.g., cultivation of bivalves, seaweed) can filter or metabolize nutrients and improve water quality. The Puget Sound Partnership (2024) recommends tracking ambient nutrient levels as concentrations (mg/L of nitrogen and/or phosphorus). This is KPI B3 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI12	Pollution: PCBs and PBDEs in marine species	Polychlorinated biphenyls (PCBs) and Polybrominated Diphenyls Ethers (PBDEs) are persistent organic pollutants that present considerable risk of bioaccumulating in marine food chains, especially Pacific herring, salmon, mussels, and English sole. While PCBs and PBDEs are not currently a major risk to Washington state residents, these pollutants can harm fish and other wildlife, including salmon and Southern Resident killer whales (SRKW). Minimizing contaminant levels in state waters (ppm) thus ensures healthy marine habitats, protecting fish and wildlife, and both recreational and commercial fisheries (Puget Sound Partnership 2024). This is KPI B6 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI1	Pollution: Plastics diverted from aquatic environments	Plastic pollution can degrade aquatic ecosystems and wildlife habitat with real economic and recreational costs for coastal communities; microplastics ingested throughout marine food webs, and entanglement with larger plastics can harm marine fisheries. The removal of plastics before they enter or accumulate in aquatic environments can be tracked as annual volumes (m3), as well as multi-year trends. NOAA recommends standardized, repeated monitoring to evaluate debris quantities, types, sources, and changes over time. This is related to KPIs B1 and B2 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI8	Productivity: By-catch	Bycatch is the unintentional capture of non-target marine life during commercial or recreational fishing operations. Reducing by-catch protects biodiversity, including threatened and endangered species, helps to maintain ecosystem health, supports sustainable fisheries, improving fish populations for future generations. Lowered by-catch (mass, by species) also reduces waste, strengthens fishing communities, and promotes more responsible and environmentally friendly fishing practices (FAO 1999).
KPI7	Productivity: Seafood waste	Early disease detection and stronger biosecurity are widely recognized as important for improving aquaculture productivity, food security, and sustainability. This KPI measures the improvements in fish health from monitoring, early detection, and rapid response to diseases outbreaks, estimated as the impact of reduced mortality (reported as aggregate change total mass per fishery). This is KPI A2 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI74	Public safety: Exposure to impaired air quality	Fine particulate matter (PM2.5) presents significant health risks (respiratory problems, heart attacks, and strokes, leading to increased hospitalizations and even premature deaths), with greater risks for children and older adults. Washington Ecology has a healthy air goal of 20 µg/m^3. Track progress as the percentage of coastal residents exposed to PM2.5 levels above this threshold, combining air-monitoring and population data. An alternative would be to track the number of exceedance days and any localized disparities (Puget Sound Partnership, 2024).
KPI6	Species: Southern Resident killer whales	Southern Resident killer whales (SRKW), a federally listed endangered species, are important indicators of Puget Sound ecosystem health. Excessive underwater noise can disrupt their ability to communicate and find prey; their diet is primarily Chinook salmon. The current status of SRKW can be recorded as the number of days they are detected, and the proportion of resident vs. transient orcas. Visual observations can be combined with hydrophone sensor data, especially when paired with vessel traffic and underwater-noise levels (Matei etal, 2024; Puget Sound Partnership 2024).

KPI	Name	Description
KPI3	Species: Bird populations	Bird abundance is an important signal of ecosystem health; diverse, stable bird populations contribute to ecosystem functions and local quality of life. Declines can indicate habitat losses, fragmentation, pollution, or other environmental pressures. Annual bird abundance can be tracked for coastal species using standardized survey data from the North American Breeding Bird Survey (BBS). Report annual abundance (count/m2) and longer-term population trends (Puget Sound Partnership, 2024).
KPI14	Species: Invasive species	Invasive marine species are living organisms—plants, animals, fungi, diseases—that are non-native species that disrupt marine, estuarine, or coastal ecosystems. Because they often lack natural biological controls (e.g., predators, parasites, pathogens), their populations can expand rapidly, driving significant costs, disrupting fisheries and damaging vessels and infrastructure. Limited data may mean that this KPI may be described qualitatively (e.g., avoided introduction), although where available (e.g., spatial extent of invasives), quantitative measures are preferred. This is KPI B5 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI4	Species: Marine or estuarine biomass	Washington waters are home to a complex food web of zooplankton, invertebrates, fish, seabirds, and other wildlife. Phytoplankton populations ultimately support threatened and endangered species, commercial and recreational fisheries, and broader ecosystem health. Chlorophyll-a can serve as a practical proxy for phytoplankton biomass (µg/L) although marine animal biomass (tons) may also be appropriate for benthic invertebrates, groundfish, or threatened or endangered species (Puget Sound Partnership, 2024).
KPI2	Species: Relative abundance of target species	Maintaining fishery stocks at sustainable levels supports healthy ecosystems and resilient fisheries. Declining stocks can threaten food webs, fishing livelihoods, food security, and long-term economic value. Abundance can be measured as catch per unit effort (CPUE) or, where available, fishery-independent surveys and stock assessments. These can be reported as ratios of defined reference points (such as the proportion of maximum sustainable yield), explicitly acknowledging the uncertainty inherent in these estimates, as well as changes in fishing practices (FAO, 1999).
KPI1	Species: Species richness/diversity	Marine biodiversity supports ecosystem resilience and healthy food webs, the foundation of sustainable fisheries, outdoor recreation, and more. Regular assessments of the number of invertebrates, algae, seagrass, fish, marine birds, mammals, and reptiles species (count) can inform diversity indices. Monitoring every 2–3 years can provide meaningful trend data (Cardoso-Andrade etal, 2022).
KPI38	Cost control: Customer acquisition	Customer acquisition costs (CAC) affect the financial sustainability and competitiveness of maritime businesses by showing how efficiently resources are converted into new customers. Identifying efficient sales and marketing channels, improving resource allocation, and supporting decisions about customer segments and growth strategies can lower costs, supporting profitability, investment, employment, and long-term market growth. Annual sales and marketing acquisition costs (US$), divided by new customers each year (by customer segment) can be compared with estimates of lifetime customer value (re: retention) to assess whether acquisition spending generates sustainable returns.
KPI61	Cost control: Regulatory costs	Regulatory non-compliance can harm both ecosystems and coastal communities, while also creating financial, reputational, and operational risks for maritime businesses. Strong compliance supports regulatory certainty and stakeholder confidence. Annual compliance costs (US$), including fines, penalties, environmental taxes (where applicable), emissions-trading costs, and required mitigation investments, can be reported alongside the number and severity of compliance failures that resulted in enforcement. These can be supplemented descriptions of root causes, corrective actions, and repeat violations to determine whether environmental performance is improving (Kantor etal, 2019).
KPI5	Cost control: Transportation	Transport costs affect maritime competitiveness, supply-chain resilience, customer prices, and the environmental footprint of moving goods and people. Efficient freight movement can reduce both operating costs and associated emissions. Annual transport costs (US$) for clearly defined freight and passenger movements (origin, destination, mode) can be normalized by ton ($/ton/mile), passenger ($/passenger/mile), or TEU ($/TEU/mile, or similar), with clear indication as to whether capital and/or operational costs have been included. Also relevant are the total number of units transported and overall fuel use to help distinguish financial efficiency from environmental performance (Kantor etal, 2019).
KPI59	Efficiency: Energy from renewable resources	The use of renewable energy can reduce greenhouse-gas emissions and local air pollution, supporting climate resilience and public health. Renewable shore-side energy and other clean-energy infrastructure can also reduce dependence on fossil fuel imports, improving energy resilience and potentially lowering long-term energy costs. The annual percentage of port energy from renewable resources (%) can be complemented with total renewable energy consumption (MWh), fuel type, and associated GHG emissions (Molavi etal, 2020).

KPI	Name	Description
KPI6	Efficiency: Energy lifecycle costs	Energy lifecycle costs influence long-term affordability, and the resilience and environmental performance of maritime assets. Focusing on both capital and lifetime operating costs can help to avoid higher maintenance, energy, or replacement costs over an asset's life. Costs (US$) should be evaluated throughout acquisition through operation, maintenance, and disposal at the end of the expected service life of each asset.
KPI49	Efficiency: Fueling time	The time required to refueling vessels affects turnaround, port capacity, operating costs, and emissions. Faster, well-coordinated bunkering can improve berth utilization, vessel productivity, reduce idle time, and generally support more predictable port calls. Improved coordination and simultaneous operations provide opportunities to optimize port stays, reducing fuel consumption and GHG emissions. Bunkering time (hours) from start to completion should be tracked for each vessel call, reported as annual averages. Trends by vessel, fuel type, terminal, or bunkering method can be complemented by descriptions of delays, safety issues, or other operational constraints.
KPI58	Efficiency: Total energy consumption	Energy use by ports affects operating costs, greenhouse-gas emissions, and local air quality, while improving efficiency can strengthen competitiveness. Energy efficiency and maritime decarbonization are critical for reducing shipping-related emissions. Total annual energy consumption can be normalized by terminal area (kWh/m^2), or by operational metrics such as shipping volume or TEUs-handled. These can be supplemented with qualitative reviews of conservation efforts to identify further savings(Molavi etal, 2020).
KPI41	Entrepreneurship: Innovation funding	Maritime innovation can strengthen economic resilience, provide jobs, and improve environmental performance—as such, it is critical for reconciling economic growth with the protection of marine and coastal ecosystems. Financial support demonstrates the strength of the maritime startup ecosystem, and the availability of capital for emerging solutions. Report as funding raised each year (US$) across venture capital, grants, crowdfunding, and other relevant sources, by sector, company stage, and funding type. Complementary data include the number of funded ventures, total follow-on funding (US$), and descriptions of commercialization, and environmental or social outcomes.
KPI36	Entrepreneurship: Number of businesses per sector	A diverse maritime sector supports regional economic resilience, employment, innovation, and working-waterfront vitality. Washington's maritime industry spans interconnected activities from shipping and fishing to vessel construction and passenger transport, generating substantial statewide economic impacts. The number of active maritime businesses annually (by subsector and geography) can be identified from business registration datasets. These can be complemented with counts of new businesses, business closures or mergers (potentially reported as survival rates), total employment and revenues, as well as descriptions of emerging sectors and barriers to business formation (McKinley Research Group, 2023).
KPI37	Entrepreneurship: Number of digital economy enterprises	Digitalization can improve productivity, competitiveness, environmental monitoring, and resource efficiency while creating new technology-enabled jobs and services. NOAA has highlighted data-driven innovation as foundational to the "New Blue Economy." Key data points include the number of active digital-economy enterprises each year (by sector), total employment, total revenues, startup/closure (survival) rates, new patents, and financing (Jiang etal, 2024).
KPI39	Entrepreneurship: Number of qualified start-ups engaged	Maritime start-ups can drive innovation, skilled employment, competitiveness, and solutions to improve marine sustainability and operational efficiency. The strength of the maritime innovation pipeline and the effectiveness of industry partnerships and accelerators can be reflected in the number of qualified start-ups engaged each year (by sector), as well as their focus, stage, financing, jobs created, and survival or commercialization rates.
KPI46	Entrepreneurship: Vessel ownership	Fishing-vessel fleets support seafood production, coastal employment, food security, and maritime services, but excessive capacity can drive overfishing, ecological degradation, and economic inefficiency. It is therefore important to align fleet capacity with sustainable fishery resources. This can be tracked as the number of active vessels each year, gross tonnage, engine power (kW), and vessel type (mobile, pelagic, auxiliary), drawn from standardized registries. These data can be combined with trends with fishing effort, landings, stock status, and capacity utilization to distinguish productive capacity from overcapacity (Jiang etal, 2024).
KPI4	Innovation: Number of technologies piloted	Pilot projects can accelerate maritime productivity, safety, decarbonization, and ecosystem protection while reducing the risks of adopting unproven solutions. This allows benefits (and limitations) to be demonstrated under operational conditions, validating performance, and accelerating commercialization and adoption. This can be tracked as the number of distinct technologies piloted each year, by sector, and supplemented with data on performance, adoption/commercialization, and environmental outcomes, as well as descriptions of lessons-learned and barriers to deployment or adoption (Jiang etal, 2024).

KPI	Name	Description
KPI57	Management: Reducing overhead for sustainable management	Funding that matches project needs is essential for support sustainable resource use, with staff and budget capacity strongly predictive of conservation outcomes. Improved resource allocation can ensure that resources are available. This can be tracked as annual management costs (US$), combined with staffing and equipment needs, as well as the reliability of funding. Semi-regular assessments (once every 3 years) of management-effectiveness (recording inputs, processes, outputs, and ecological/social outcomes), are considered best practice (Cardoso-Andrade etal, 2022).
KPI33	Productivity: Business revenue	Revenues from fisheries and other maritime industries are a measure of the economic health of coastal communities, including employment, household income, and public revenues. Sustainable management is critical, as resource depletion or degradation can drive economic losses and damage community resilience. Understanding the economic value supported by maritime industries helps decision-makers to balance economic and environmental goals. Annual revenues (US$) can be paired with complementary indicators such as employment, fishing effort and associated costs, resource condition, and biodiversity to determine whether economic benefits are being sustained without degrading the underlying ecosystems (FAO, 1999; McKinley Research Group, 2023).
KPI52	Productivity: Cargo handling efficiency	Port productivity affects regional and global trade, supply-chain reliability, economic activity, and the efficient use of industrial land. Efficient container handling can move goods with less-congestion and infrastructure pressure. TEU (twenty-foot equivalent unit) is the standard measure for containerized cargo volume. Annual port throughput, normalized by total terminal area (TEUs/area), can inform comparison across ports and over time. Such data can be supplemented with descriptions of congestion (or unusual disruptions), operational changes, and infrastructure investments that could affect annual throughput (Molavi etal, 2020).
KPI47	Productivity: Ferries	Ferries are major factors in regional mobility and economic access throughout Puget Sound; improving passenger mobility while reducing reliance on higher-emission vessels and making more-efficient use of ferry capacity can reduce emissions per passenger. Full- or partial electrification (vessels or terminals) can reduce fuel use and greenhouse-gas emissions, as well as local air pollution. Effectiveness can be tracked as annual passenger-nautical miles (passenger-nm/year), annual passenger trips, total vessel capacity vs usage (%), annual fuel or energy consumption, and annual GHG emissions per passenger-nm. Such data can be complemented with descriptions of service reliability and accessibility (McKinley Research Group, 2023). This is related to KPI F5 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI48	Productivity: Ferry passengers	Passenger ferry services support regional mobility, access to jobs and services, tourism, and maritime economic activity. By connecting communities, ferries support household and visitor mobility, and generate economic activity through passenger spending. Total annual ferry passenger trips (disaggregated by route) can be complemented with service frequency, capacity usage, passenger spending, and resident/visitor status and demographics. Pairing such data with measures of accessibility and affordability can support equity assessments (McKinley Research Group, 2023).
KPI53	Productivity: Fishery exports	Fishery exports generate income, jobs, trade value, and food-system benefits, but excessive export pressures can incentivize unsustainable harvesting and damage local fisheries. Tracking the annual economic contribution of fisheries (US$) and identifying high-value species (or segments) can inform decisions to balance export earnings with domestic fisheries and ecosystem health. These data can be disaggregate by species group and fishery segment, compared with total exports, and paired with data on harvest volume, stock status, domestic consumption, and sustainability indicators to assess whether economic gains are maintained over time (FAO, 1999).
KPI42	Productivity: Industry Output	Fishery output reflects the economic vitality of coastal industries, including livelihoods, and community resilience. Trends in fishery and processing production can inform investment and management decisions. Reported annually using inflation-adjusted sales/output value and capture/landing value (US$) by fishery, total processing and final outputs (tons), supplemented with employment and value-added estimates where feasible. These data can be compared with fishery stocks to assess long-term sustainability (Jiang etal, 2024; Puget Sound Partnership, 2024).
KPI44	Productivity: Maricultural/aquacultural extent	While shellfish are known to provide water quality improvements, poor water quality can lead to localized closures of commercial and recreational harvests. The State Department of Health recognizes changes in harvestable acreage as evidence of improving or declining water quality and associated pollution conditions. Some forms of aquaculture may also become sources of contamination. This indicator should be reported as the total annual harvestable acres (by classification—Approved, Conditionally Approved, Restricted, Prohibited), and tracked for trends. Such data can be supplemented with fecal-coliform data qualitative pollution-source assessments (Puget Sound Partnership, 2024; Jiang etal, 2024).

KPI	Name	Description
KPI45	Productivity: Ocean-based seaweed and bivalves production	Seaweed and bivalve aquaculture can support food security, and coastal jobs, improving water-quality and habitat while requiring relatively few external inputs. Annual production can be reported as total annual production (tons), with wet weight reported for seaweed, and shell-on weight for bivalves, species, site, and production method, where feasible. These data can be complemented with descriptions of water quality, habitat benefits, and other environmental impacts. This is KPI A4 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI43	Productivity: Pelagic fishery production	Sustainable pelagic fisheries underpin food security, coastal livelihoods, and the maritime economy, but unsustainable harvest rates can impact stock abundance, biodiversity, and long-term productivity. Track annual landings (tons), by species, fishery, and location, where feasible. These can be combined with data on catch-per-unit-effort, stock biomass, and fishing mortality to assess stock sustainability status. Electronic monitoring and logbooks can improve data quality (Jiang etal, 2024).
KPI51	Productivity: Port import and exports	Access to global markets supports employment, supply-chain resilience, and economic growth, though port operations also carry environmental impacts that make efficient, lower-emission freight movement especially important. Annual cargo value (US$) and volume (TEUs) by port and terminal can be combined with data on non-containerized cargo (tons), by commodity and trading partner, with imports and exports reported separately. Trend data on total annual port calls, dwell time, capacity, and emissions intensity (tons emitted per ton shipped) can help to assess both economic performance and sustainability (McKinley Research Group, 2023).
KPI35	Productivity: State taxes	Maritime industries generate public revenues that support infrastructure, public services, and coastal communities, reflecting the broad economic contribution of aquaculture, fishing, conservation, and recreation and tourism. Record annual state tax revenue from maritime activities (US$/year) by subsector, where feasible. These can be used as inputs into economic-impact modeling to estimate direct, indirect, and induced tax revenues, including sales, business, and payroll taxes for relevant sectors (McKinley Research Group, 2023).
KPI56	Recreation: Personal harvest of target species	Shellfish and crab harvesting by individuals supports food security, recreation, and coastal economies, while providing tangible connections to cultural traditions and identities associated with healthy marine resources. Public access and participation rates, harvest demand, and pressure on target species can be assessed by measuring annual participants, fishing/harvesting days, and pounds harvested for Dungeness crab, bivalves, and salmon. WDFW catch-record cards and electronic reporting can be supplemented by creel surveys to estimate effort and unreported catch. Cultural and access benefits can be recorded qualitatively (Puget Sound Partnership, 2024).
KPI54	Recreation: Sportfishing intensity	Recreational fishing supports coastal economies, community well-being, and connections to marine resources, but fishing pressure must remain compatible with sustainable fish populations. This can be tracked as angler trips and catch per trip (kg/trip) by species, area, and season. WDFW provides catch and creel-survey data, which can be paired with catch rates to estimate total effort, participation, and catch-and-release rates, which may help to interpret trends in stock status (McKinley Research Group, 2023).
KPI55	Recreation: Sportfishing spending	Recreational fishers spend money on equipment, boats, and related goods, supporting coastal businesses, jobs, and the regional economy. Following NOAA methodology (2022), this is recorded as annual spending on durable sportfishing goods (US$) by equipment category, where possible. These data can be complemented with multi-year trends with angler participation (total annual fishing trips), employment, sales, and value-added in related sectors through periodic surveys designed to capture patterns of participation and consumer behavior.
KPI68	Education: Partnerships with trade schools, colleges, universities	The U.S. Maritime Administration recognizes educational partnerships as critical to developing a skilled maritime workforce (MARAD, 2026). Partnerships between maritime businesses and trade schools, colleges, and universities strengthen workforce capacity, support economic resilience, and help address skills gaps as marine technologies and industry requirements evolve. These collaborations create practical pathways into maritime careers, upskill existing employees, and align training with employer needs, benefiting both workers and employers. Record the number of active education partnerships each year, as well as the number of employees (and other participants) completing trainings. Where possible, assess subsequent employment outcomes. This is related to KPI F2 in the Ocean Impact Navigator framework (Vincent etal, 2022).

KPI	Name	Description
KPI69	Education: Training programs	Workforce education and training strengthens skills, employability, safety, innovation, and equitable access to maritime careers, all of which support long-term resilience of the sector. By building workforce capacity, closing skills gaps, and supporting career progression, organizational capabilities are improved. Record the number of training programs and annual participants, by topic and workforce group, providing participant characteristics where appropriate. These can be supplemented with completion rates, total number of certifications, skills gained, job placement and retention, and participant feedback to assess effectiveness and equity of access (Österblom etal, 2020). This is KPI F2 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI67	Inclusion: Diverse business ownership	Maritime business ownership patterns can reflect economic inclusion, the equitability of wealth-building opportunities, and economic and social resilience of coastal communities. Supporting entrepreneurs from historically underrepresented racial and ethnic groups—as well as women—can broaden participation in maritime supply chains, expand local economic benefits, and reduce disparities. Compare business ownership rates of individual demographic groups to regional and statewide averages. Where possible, also monitor procurement awards, contract values, and business survival rates by ownership group. These data can be supplemented with business-owner feedback on access to financing, contracting opportunities, technology, and support programs to identify barriers and guide action (City of Oakland, 2018).
KPI7	Inclusion: Local ownership	Local ownership of maritime businesses helps to keep economic benefits and decision-making within coastal communities, strengthening economic resilience and promoting equitable access to opportunities. Local entrepreneurs and investors, including fishers, marine service providers, suppliers, and small maritime businesses, can expand participation through accessible technologies, entrepreneurship programs, and affordable credit. The proportion of locally owned maritime businesses each year can be supplemented with descriptions of local procurement and spending, business creation and survival rates, as well as access to financing and technology. These can be complemented with interviews or surveys to assess barriers, perceptions of fairness, and benefits for underrepresented groups (Österblom etal, 2020).
KPI64	Inclusion: Participation of Indigenous Peoples in decision-making	Meaningful Indigenous participation in maritime decision-making supports equitable governance, protects cultural values and traditional relationships with marine resources, and strengthens the legitimacy and effectiveness of conservation and economic planning. Early, transparent engagement enables Indigenous Peoples to shape priorities, safeguard rights and interests, and share in the benefits of sustainable ocean industries. Track performance through the percentage of decision-making bodies and planning processes that include Indigenous representatives, alongside qualitative assessments of whether participation is timely, culturally appropriate, influential, and supported by Indigenous leadership. This is aligned with Target 20 of the post-2020 Global Biodiversity Framework and Tier I Sustainable Development Goal Indicators 5.5.1 and 5.5.2 (Hanson etal, 2021).
KPI72	Public safety: Condition of swimming beaches	Clean water protects public health, supports recreation and tourism, and strengthens the social and economic value of coastal areas. Poor water quality can expose swimmers to gastrointestinal, respiratory, and skin illnesses. The percentage of monitored swimming beaches meeting water-quality standards and the frequency of exceedances are tracked by Washington's BEACH Program. These can be complemented with data on bacteria indicators, beach advisories and closures, exceedance trends, and TMDLs, as well as descriptions of pollution sources, remediation actions, and recurring local conditions (Puget Sound Partnership, 2024).
KPI75	Public safety: Fires, explosions, or leaks	Marine fires, explosions, and pollution incidents can cause fatalities, injuries, environmental harm, vessel and infrastructure losses, and costly operational disruptions. Effective prevention protects people, ecosystems, and maritime continuity by identifying recurring hazards, strengthening emergency preparedness, and targeting investments in vessel, port, and industrial safety. Record the annual numbers of fires, explosions, leaks, or spills (ton released per vessel call/stop, number of persons affected). Fires and explosions should be disaggregate by facility or vessel type, location, severity, and cause. Spills should also report the substance that was leaked or spilled. These can be supplemented with statistics of near-misses, root-cause analyses, response times, and corrective-action completion to identify emerging risks (Molavi etal, 2020).

KPI	Name	Description
KPI71	Public safety: Illegal dumping	Clean maritime and coastal environments support public health, environmental quality, community well-being, and equitable access to safe public spaces. Effective waste management and pollution prevention can also reduce debris entering waterways and protect coastal ecosystems. Tracking illegal dumping helps identify disparities in environmental burdens and prioritize interventions. Record illegal-dumping service requests per 1,000 residents in majority minority Census tracts (excluding canceled requests). An alternative would be the number of NPDES permits for such tracts. These figures can be compared with regional averages, and combined demographic data to evaluate whether enforcement, waste services, and community-led prevention efforts are equitable (City of Oakland, 2018).
KPI73	Recreation: Nature-based recreation	Nature-based recreation supports physical and mental well-being, strengthens social and cultural identities, connects communities to coastal ecosystems, and sustains economic activity across maritime recreation, tourism, and boating. Opportunities for wildlife viewing, fishing and foraging, swimming, diving, and boating reinforce the public value of healthy Puget Sound waters and shorelines. Participation can be tracked seasonally, using the Puget Sound Partnership's Human Wellbeing Vital Signs Survey, and by measuring the proportion of state residents engaging in coastal activities, as well as their frequency of participation. Such data can be supplemented with surveys at key recreational sites to assess trends, accessibility, and demand for marine recreation infrastructure (Puget Sound Partnership, 2024).
KPI62	Working conditions: Average worker earnings	Competitive earnings support household financial security, workforce retention, skills development, and the maritime sector's ability to attract skilled labor. Workplace fairness also contributes to sustainable economic growth and social well-being. Record average annual earnings per full-time equivalent (US$/FTE/year), including benefits, with consistent treatment of seasonal workers and subsectors. These should be reported by subsector, occupation, and geography where possible, and compared with average regional wages and cost-of-living metrics. These can be complimented with data on retention, job vacancies, and worker-satisfaction indicators to assess job quality (McKinley Research Group, 2023).
KPI32	Working conditions: Employment	Maritime industry jobs support household incomes, community resilience, economic opportunity, and the workforce needed to sustain ocean industries and services. Record annual full-time-equivalent (FTE) employment in aquaculture, fishing, recreation/tourism, conservation, or other defined maritime subsectors. These can be complimented with data on wages, job quality, retention, vacancies, and workforce demographics to assess employment stability, equity, and changing labor needs (McKinley Research Group, 2023). This is KPI F1 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI63	Working conditions: Entry-level wages	Fair entry-level wages promote social equity, reduce financial insecurity, and help to build a stable, skilled maritime workforce. Competitive starting pay enables maritime employers to attract and retain workers, expand access to industry careers, and support economic resilience in coastal communities. The ratio of entry-level wages to applicable minimum or prevailing wages for similar local occupations are appropriate benchmarks. Track wages across roles and employment types (including benefits, where relevant), by job category and worker demographics to assess pay equity. This is KPI F4 in the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI65	Working conditions: Gender equity	Gender equity in maritime industries strengthens social inclusion, broadens the talent pool, and supports a more resilient, sustainable blue economy. Increasing the representation of women can help employers to address workforce shortages, diversify expertise, and expand equitable access to maritime career opportunities. Record the percentage of female employees each year, by occupation, seniority, department, and employment type. Identify participation gaps, especially in seafaring, technical, and leadership roles. These data can be complemented with surveys on women's experiences with recruitment, retention, workplace culture, and barriers to advancement This is KPI F3 of the Ocean Impact Navigator framework (Vincent etal, 2022).
KPI66	Working conditions: Income equity	Equitable earnings strengthen household financial security, workforce retention, social cohesion, and access to maritime careers, while reducing economic disparities. Wage disparities and workforce equity can inform recruitment, compensation, and advancement strategies. Wage equity can be reported as the proportion of workers below living-wage thresholds in comparison to those in high-wage occupations, by demographic group, occupation, and employment status. These can be complemented with data on median earnings, pay-gap ratios, benefits, promotion, and retention rates. Employee feedback can also help to identify barriers to equitable pay and advancement (City of Oakland, 2018).

KPI	Name	Description
KPI34	Working conditions: Labor income	Employment in Washington's maritime industry strengthens coastal communities, supporting households, whose purchases go on to support additional jobs and wages. Shipping and logistics, shipbuilding and repair, fishing and seafood, recreational boating, passenger transport and more all provide substantial employment opportunities and high incomes. Total annual wages by maritime subsector can be combined with input-output analysis to estimate additional indirect and induced jobs and wages (McKinley Research Group, 2023).

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