Article

The Ocean Equity Index

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The ocean is essential for humanity[1–3]. Yet, inequity in ocean-based activities is widespread and accelerating[4–8]. Addressing this requires governance approaches that can systematically measure equity and track progress[9]. Here we present the Ocean Equity Index (OEI)—a framework for assessing and improving equity in ocean initiatives, projects and policies. We apply the index, which scores twelve criteria, to case studies at local, national and global scales. We show that the OEI can generate structured data to support evidence-based decision-making across ocean sectors and scales. As a theoretically robust and widely applicable tool, the OEI can guide the design of more equitable ocean initiatives, projects or policies, ensuring better outcomes for coastal people and marine ecosystems.

Ocean inequity is growing rapidly as countries and corporations increasingly look to the ocean to meet human demand for resources[4,6]. Benefits from the world's oceans are accrued by a handful of powerful actors[5,7,8], whereas the burdens of the surging ocean economy—which range from exposure to pollution and toxic waste to the impacts of climate change and biodiversity loss—are borne by the most vulnerable[10,11]. Many who constitute this group—including Indigenous Peoples, local communities, women and small-scale fishers—are not fully recognized, are excluded from ocean decision-making processes and do not gain a fair share of ocean benefits[12,13].

To improve ocean equity, governments have recently signed onto a variety of legal and voluntary instruments that include promises to improve equity, participation and human rights in ocean governance and management (Supplementary Table 1). For example, the pursuit of equity is reflected throughout the United Nations Food and Agriculture Organization's (FAO) Voluntary Guidelines for Securing Small-Scale Fisheries[14], the newly adopted United Nations agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ)[15], and the Kunming–Montreal Global Biodiversity Framework[16]. However, progress towards advancing ocean equity is hampered by a lack of clarity on how to define and measure equity[9,17], limited resources for time-intensive equity assessments[18] and a lack of actionable recommendations to effectively improve ocean

equity[19]. Past research has made important contributions by identifying preliminary processes and indicators to measure various aspects of ocean equity[17,20–22], yet there is no standardized assessment tool that integrates the multiple dimensions of equity in a systematic, comparable and rigorous manner.

Here we present the Ocean Equity Index (OEI): a framework comprising twelve criteria for assessing ocean equity across ocean sectors and scales. By synthesizing and building on existing indicators, the OEI provides a standardized and transparent approach for measuring ocean equity that can be used by Indigenous Peoples and local communities, researchers, managers and policymakers to better understand and monitor equity, and to design strategic actions to improve ocean equity. We demonstrate the application of the OEI through case studies at local, national and global scales and across various ocean sectors. We show that the index can generate structured data on status and progress toward equity to support evidence-based decision-making. Ultimately, the OEI aims to increase the integration of equity into ocean-based activities, improving outcomes for coastal communities and ocean ecosystems.

Ocean Equity

Ocean equity can be defined as the recognition, meaningful involvement and fair treatment of all people within ocean initiatives, projects

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Table 1 | The three interconnected domains of ocean equity

Domain	Definition
Recognitional equity	The respect and promotion of the rights and the diverse knowledge systems, values and institutions of all relevant actors[a][17,25,30,31]
Procedural equity	The opportunity for effective participation of all relevant actors in decisions about ocean initiatives that affect them, and accountability for fulfilling responsibilities[17,25,30,32]
Distributional equity	The fair distribution of harms and benefits associated with ocean initiatives between all relevant actors, including current and future generations[17,25,30,32]

[a]We use the term actor to refer to both rights-holders and stakeholders, while also acknowledging the distinction between rights-holders (those with customary and historical rights to determine the use of and access to nature in ways that are fundamental to their human rights) and stakeholders (individuals or groups claiming a stake in a decision-making process)[32].

and policies[13,17,19]. In this context, 'ocean initiatives, projects or policies' refers to any ocean-based activity or plan, including fisheries and aquaculture management, maritime transportation, offshore oil and gas, ocean energy, deep-sea mining and marine conservation, among others (referred to hereafter as ocean initiatives). Advancing ocean equity is essential owing to its intrinsic role in supporting just ocean economies[23] and its instrumental role in supporting the long-term health of marine environments and the well-being of people reliant on them[9,24]. Although it is difficult to offer a definition of ocean equity that fully represents its complexity, the literature tends to recognize three core and interrelated domains[9,25,26]: (1) recognitional, (2) procedural and (3) distributional equity (Table 1).

In the context of equitable ocean initiatives, 'all relevant actors' refers to the wide array of individuals, groups or organizations that have a role or interest in—or will be impacted by—the management and conservation of marine resources[27]. Key categories of relevant actors often include Indigenous Peoples, local communities, residents, migrant populations, community leaders, government officials or agencies, regulatory bodies, industry, employees and environmental or other non-governmental organizations, among others. The definition of relevant actors will vary according to the context and scope of the analysis. It is therefore important to understand which actors need to be involved, how they should be engaged, and at which level, before beginning an equity assessment. Stakeholder analysis[28] and actor network theory[29] can be effective methods to identify relevant actors, including both human and non-human actors, such as whales or the marine environment itself (refer to the section 'A protocol for applying the OEI' in the Supplementary Information).

Building on the three domains of equity, and based on our review of equity in environmental justice, conservation and ecosystem services literatures[17,24,25,30–34], we argue that equitable ocean initiatives should prioritize the following six principles of ocean equity: (1) promote and protect human and Indigenous rights and the right to a healthy ocean; (2) respect all relevant actors and their diverse knowledge systems, values and institutions; (3) support effective participation and transparency in decision-making; (4) promote accountability for (in) actions and access to effective dispute resolution processes; (5) promote effective mitigation of harms; and (6) promote equitable sharing of benefits among relevant actors (refer to the section 'Six principles of ocean equity' in the Supplementary Information). Each principle of ocean equity is further divided into two related operational criteria for a total of twelve criteria (see Fig. 1, Methods and Supplementary Table 3). Criteria here refer to standards or metrics by which ocean equity can be evaluated.

The Ocean Equity Index

The OEI is a standardized framework that guides users through a process to assess the equity of an ocean initiative and to identify actions

to improve equity. The index consists of twelve criteria nested within six principles and three domains of ocean equity (Fig. 2). The twelve criteria reflect the core characteristics of ocean equity, thus providing a framework for assessing ocean initiatives against foundational principles of equity.

The OEI can be applied to assess ocean initiatives from local to global scales. For example, the index might be used to assess the equity of a local project, a regional programme or a global policy document. The OEI is intended for use by Indigenous Peoples and local communities, researchers, managers, policymakers and others aiming to assess and enhance ocean equity in initiatives. It can be completed by individuals, teams or multiple actor groups in different ways (refer to the section 'A protocol for applying the OEI' in the Supplementary Information). To effectively complete the OEI, an individual or group requires familiarity with the OEI criteria, a rich understanding of the socio-economic conditions, cultural dynamics and environmental challenges specific to the ocean initiative, the ability to gather and interpret information about the ocean initiative from various sources, critical thinking skills to make informed judgements about scoring on the basis of the available evidence, and the ability to communicate assessment findings to diverse audiences.

Each criterion is scored between zero and three points on the basis of the scoring guide (Table 2). Scoring statements for each criterion range from the violation of a criterion to the full implementation of the criterion. Scores are assigned on the basis of data interpretation from a wide range of sources (for example, policy documents, management or marine spatial plans, focus group discussions, semi-structured interviews, desktop studies or field observations) and/or firsthand experience with an ocean initiative. Scores are recorded in the OEI Assessment and Visualization Form (Supplementary Information), along with comments that explain each score to allow assessors to describe nuances not allowed by the categorical scoring system and to aid interpretation. Once all twelve criteria have been scored, the scores are added out of a maximum of 36 points and the total is automatically converted to a percentage to facilitate comparison and effective communication. A figure is automatically generated for each case. The subsequent step involves identifying actions for improving equity within each criterion in the 'next steps' column. Whenever possible, equity assessments should be completed by different relevant actor groups. If actor groups hold divergent perspectives on equity, we recommend facilitating focus group discussions to explore the underlying reasons for these differences in opinion, generate actionable ideas to address them, and facilitate dialogue between the groups, thereby fostering improved collaboration and ultimately improving equity. The final step in the assessment is to communicate the assessment results to key actors and encourage actions to improve ocean equity (refer to the section 'A protocol for applying the OEI' in the Supplementary Information for further information on completing an OEI assessment).

Applying the OEI (six case studies)

To demonstrate the usability of the OEI, we applied it to six case studies, representing different ocean-based initiatives, policy realms and scales (Fig. 3). The average score for the six case studies (out of a maximum possible score of 100%) is 68%, highlighting substantial opportunities for enhancing ocean equity. Index scores varied considerably, ranging from 44% to 78%, with the United Nations Ocean Conference (UNOC3) declaration scoring relatively poorly and the Danish renewable energy company's environmental impact assessment (EIA) framework and rāhui governance in French Polynesia scoring highly (Fig. 3). On average, the 'inclusion and influence' criterion scored highest across cases (an average of 2.7 out of 3 possible points). In cases that received high scores for inclusion and influence, all relevant actors were afforded the opportunity to participate in decision-making and to have influence over decisions. For example, in French Polynesia, local communities and

Domain	Principle	Criteria	Definition	Example
Recognition	Rights	Human and Indigenous rights	Promotion and protection of human and Indigenous rights, including marine tenure rights, the rights of women and the right to just working conditions, through all ocean initiatives[38-40].	A marine planning process in the Northern Shelf Bioregion of Canada recognized Indigenous authority to govern the ocean by making them an equal co-governance partner to the provincial government[41].
		Right to a healthy ocean	Promotion and protection of the right to a clean, healthy and sustainable marine environment, including a safe climate, clean air, healthy ecosystems and biodiversity, safe and sufficient water, healthy and sustainable food, and a non-toxic environment through all ocean initiatives[42].	The requirement for offshore wind projects to carry out ecosystem restoration following construction and to undertake ongoing environmental assessments[43].
	Diversity	Knowledge and values	Respect and inclusion of the worldviews, knowledge systems, values and practices of all relevant actors, particularly of Indigenous Peoples, local communities and women, in all ocean initiatives[44].	Fisheries management that applies a 'two-eyed seeing' approach to learn from Indigenous knowledge and 'Western scientific' knowledge[45].
		Institutions	Respect and inclusion of the formal and informal rules of all relevant actors, particularly of Indigenous Peoples and local communities[46].	National fisheries legislation in the Solomon Islands recognizes and supports customary marine tenure systems[47].
Procedure	Participation	Inclusion and influence	The ability of all relevant actors to effectively participate in ocean decision-making and have influence over decisions[48].	In 2011, the Mauritian government passed the New Local Government Act, which required that one-third of all municipal and village councils be comprised of women—the act dramatically increased the participation of women in marine governance[49].
		Transparency	Visible decision-making processes, including access to timely information in accessible formats to all relevant actors[48].	Following culturally appropriate protocols, Mi'kmaq communities are engaged in meaningful consultations regarding marine protected area (MPA) governance in Atlantic Canada[50].
	Accountability	Responsibility	A clear, agreed-on definition of the responsibilities of different actors, and mechanisms for holding actors responsible for their (in)actions[32].	Bangladesh's National Shrimp Policy outlines the responsibilities of government and industry owners to protect mangrove forests and refrain from encroaching on community land[51].
		Dispute resolution	Presence of fair, effective, accessible and contextually appropriate dispute resolution mechanisms to address current and historical disputes, plus awareness of the processes and capacity to effectively use the processes[30].	A tribunal of members of the Permanent Court of Arbitration found that all countries that have traditionally fished islands and coral reefs in the South China Sea using artisanal methods must be permitted to continue to do so[52].
Distribution	Harms	Assessment of harms	Gathering of information on the potential or realized negative impacts of an ocean initiative on different actor groups, including Indigenous People, women and other priority populations[60].	The Kenyan Climate Change (Amendment) Act 2023 requires every carbon trading project to undergo an environmental and social impact assessment[53].
		Mitigation measures	Clear description of contextually appropriate mitigation measures to avoid, minimize or compensate for negative impacts of an ocean initiative on different actor groups[25].	In Fiji, Marine Conservation Agreements outline compensation mechanisms (including payment for ecosystem services or livelihood alternatives) for lost access to marine resources resulting from no-take MPAs[54].
	Benefits	Evaluation of benefits	Gathering of information on the potential or realized positive impacts of an ocean initiative across different actor groups, including Indigenous People, women and other priority populations[55].	In France, public consultation is required for all new aquaculture projects, allowing citizens to voice their expectations regarding the project's benefits[56].
		Benefit sharing	Mechanisms are in place to share benefits arising from an ocean sector or initiative. The arrangement defines the fair distribution of monetary and non-monetary benefits across actor groups[57].	In the UK, offshore wind farm developers contribute to community benefits funds for affected communities[58].

Fig. 1 | The three domains, six principles and twelve criteria of the OEI, including definitions and examples. Refer to Supplementary Table 2 for a list of human and Indigenous rights that are relevant for ocean initiatives. Information in the figure from refs. 25,30,32,38–60. MPA, marine protected area.

fishers led the creation of the rāhui governance system. The lowest average score was found for the transparency criteria (an average of 1.5 out of 3 possible points). In cases that received low scores for transparency, decision-making processes were not visible and/or information was not available in accessible formats to all relevant actors. In the fish-drying case in Tanzania, for example, the 'transparency' criteria garnered one out of three points because project information was available in English rather than in Swahili or other local languages, limiting access to information for non-English speakers. In the UNOC3 declaration case, transparency also received one out of three points because the declaration made no mention of information access or how decisions would be made. In such cases, immediate steps to improve transparency could be
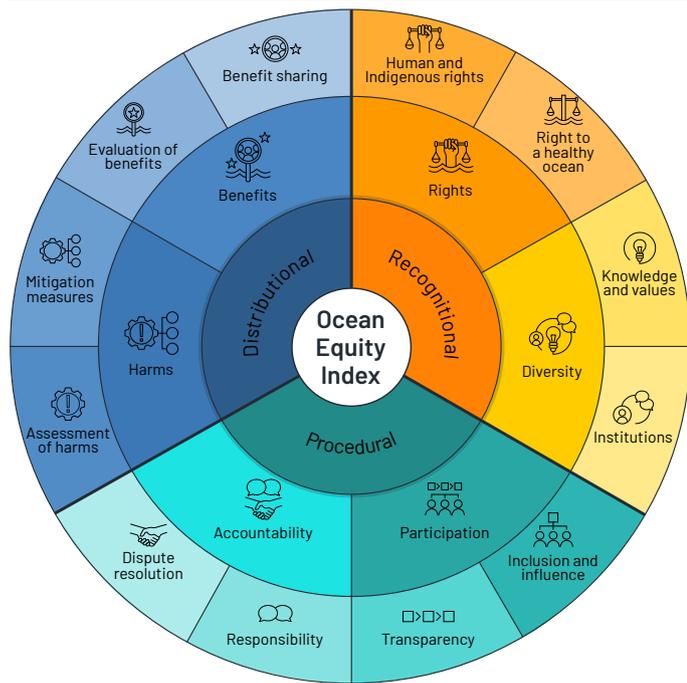
Fig. 2 | Conceptual framework for the OEI. The framework comprises the three domains (inner circle), six principles (middle circle; two per domain), and twelve criteria (outer circle; two per principle) for assessing ocean equity.

taken by ensuring that important documents, decisions and resources are available to everyone. This could include providing materials in multiple languages and formats (for example, large print, audio) and on different platforms (both digital and physical).

Cases with identical scores illustrate that the characteristics of equity can be highly variable, even among instances that share the same score. For example, the Danish renewable energy corporation's EIA framework and rāhui governance in French Polynesia both scored 78, but the scores arose from very different individual criteria scores (Fig. 3). The EIA framework scored higher for 'mitigation measures' because the company engages marine officers to work with local fisheries communities located close to offshore windfarms to detect and mitigate risks as early as possible. By contrast, rāhui governance in French Polynesia scored higher for 'human and Indigenous rights' because the rāhui system is grounded in the recognition and protection of local marine tenure rights (Fig. 3). These cases also illustrate that actions to improve ocean equity will be case-specific, even in cases with the same or similar scores.

To perform a sensitivity analysis and highlight how inter-personal variability can be accounted for in OEI evaluations, the case of Canada's Department of Fisheries and Oceans (DFO) Maritimes ecosystem-based management framework was assessed by three different

assessors. The Kendall's coefficient of concordance was high and significant ($W = 0.67$, $P = 0.02$), indicating strong agreement among the assessors. We used the majority score when all three assessors did not rate equally a given criterion.

Discussion

We propose the OEI—a rapid yet robust approach for assessing the extent to which ocean equity is addressed in the governance and management of initiatives across ocean sectors and scales — and illustrate the utility of the index through six case studies. The OEI offers a consistent and measurable definition of ocean equity. The criteria are based on foundational theories from the environmental justice, conservation governance and ecosystem services literatures. By clarifying critical elements of equity, the OEI creates a common set of variables and vocabulary for planning, monitoring, evaluation and research, applicable from local projects to global strategies. The index is the first standardized tool for evaluating ocean equity, providing numerical scores, qualitative comments and identifying next steps to help decision-makers with understanding equity gaps. In developing the index, we addressed three major challenges: (1) inconsistent understanding of social equity and how to assess it in ocean initiatives[9,17]; (2) limited capacity for time and resource-intensive equity assessment[18]; and (3) a lack of actionable recommendations to effectively advance ocean equity[19].

Going forward, we envisage the OEI as a practical, flexible tool that can be adapted and improved upon by a broad range of users at different scales. We are hopeful that Indigenous Peoples and local communities can tailor and use the OEI to assess (in)equity of initiatives that affect them, and, if necessary, hold implementers of ocean initiatives to account. To ensure robustness and boost learning, it would be useful for researchers to apply the framework in a wider range of case studies. Practitioners and funders could apply the OEI to gather baseline data: as criteria to screen funding applications, to promote best practices for equity in the design of new ocean initiatives, to design better social safeguards and to ensure that equity is monitored throughout the life of a project. Governments could use the OEI to report on national commitments to equity. At the international scale, there is a need for a few high-level ocean equity indicators to allow for reporting of national progress against pre-existing commitments, such as the UN sustainable development goals (SDGs), the new Kunming–Montreal Global Biodiversity Framework and the forthcoming benefit-sharing mechanism of the BBNJ agreement. The UN Department of Economic and Social Affairs—which acts as the secretariat for the SDGs—might adopt the OEI to help facilitate better engagement with notions of equity, as SDG 14 is limited in its focus to equity in the distribution of resource access and benefits.

As with any assessment framework or tool, the OEI has limitations that should be considered by those using the index and its data. First, scoring relies on human perceptions and judgement, introducing subjectivity and potential bias, especially if organizations self-monitor their ocean initiatives[35]. To reduce bias or power imbalances, assessments

Table 2 | Example scoring statements for three of the twelve criteria in the OEI (one criteria per domain is shown here; see Supplementary Information, OEI Assessment and Visualisation Form for the complete scoring guide)

|	Very poor (0)	Poor (1)	Good (2)	Very good (3)
Human and Indigenous rights	Human and Indigenous rights are violated by the ocean initiative	No recognized need for policies or processes to protect human and Indigenous rights	Recognized need for policies or processes to protect human and Indigenous rights	Policies or processes to protect human and Indigenous rights are identified and/or implemented
Transparency	Information about the ocean initiative is withheld from relevant actors	No recognized need for ensuring timely and accessible information to all relevant actors	Recognized need for ensuring timely and accessible information to all relevant actors	Timely and accessible information about the ocean initiatives is available to all relevant actors
Benefit sharing	Benefits from the ocean initiative flow to powerful actors and away from marginalized groups or communities	No recognized need for benefit-sharing mechanism(s)	Recognized need for benefit-sharing mechanism(s)	Benefit-sharing mechanism(s) are identified and/or implemented
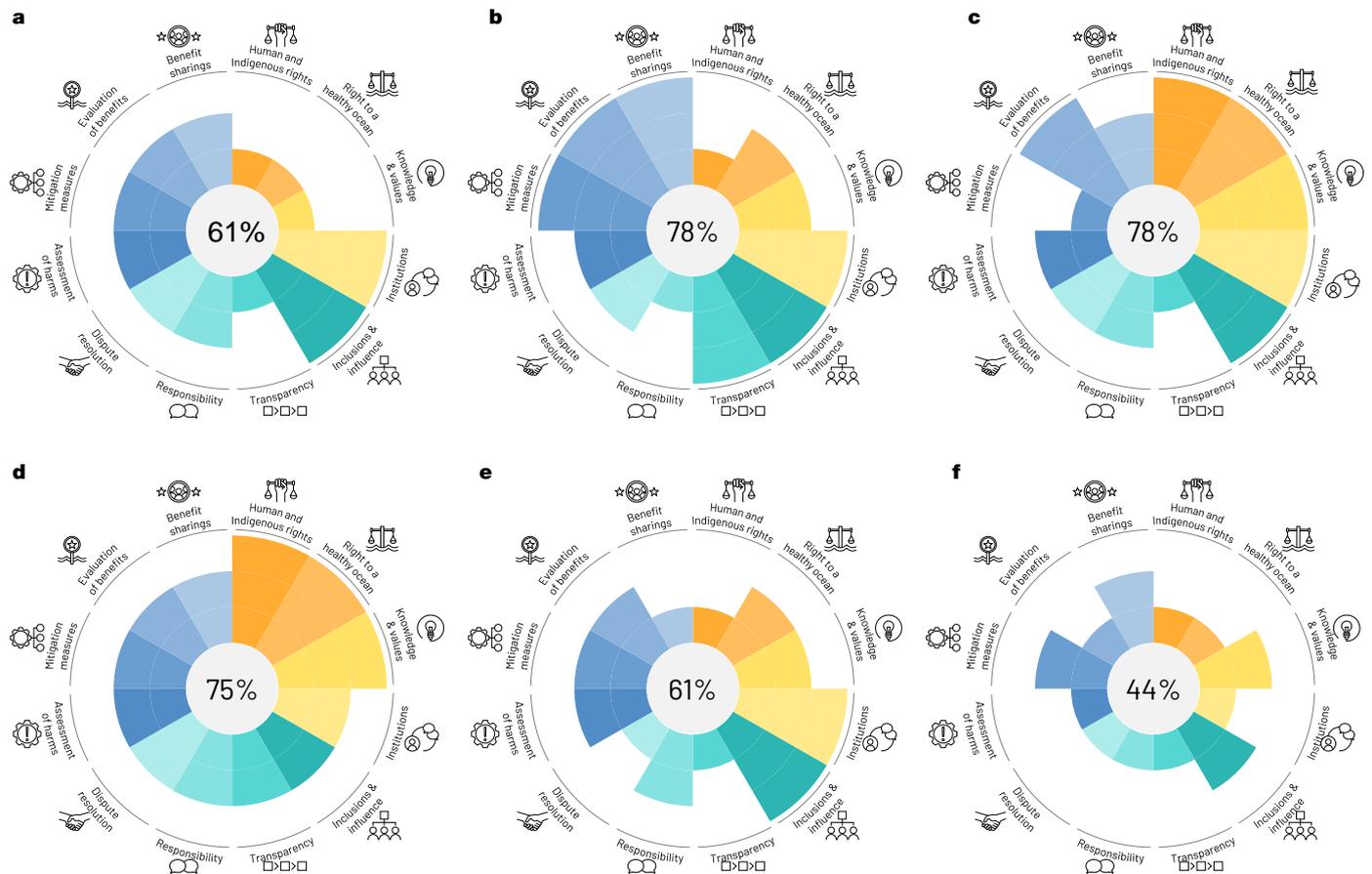
Fig. 3 | OEI case study scores. Overall (inner circle) and individual (coloured petals) criteria scores are included for six cases. **a**, A local fish-drying project in Tanzania, which aimed to reduce post-harvest loss and strengthen livelihoods through solar technology. **b**, A renewable energy company's EIA framework, designed to measure the impact of offshore wind farms on marine biodiversity in Denmark. **c**, Rāhui governance, which refers to the renewal of traditional coral reef management practices, in two coastal regions of Tahiti in French Polynesia. **d**, An ecosystems-based management framework from Fisheries and Oceans Canada's Maritimes region. **e**, The national policy context for blue carbon projects in Mexico. **f**, The third United Nations ocean conference (UNOC3) declaration, a report that is agreed upon by all members of the United Nations General Assembly and is designed to support the implementation of SDG 14 (life below water). Case data were collected through semi-structured interviews and desktop studies. The outer ring is the maximum possible score for each criterion.

should ideally be completed by independent third parties, multi-actor focus group discussions, or by those directly affected by the initiative (for example, Indigenous Peoples and local communities). When this is not possible, evaluations can stem from multiple assessors, and agreement among assessors can be evaluated with the Kendall's coefficient of concordance, as was done here for Canada's DFO Maritimes ecosystems-based management framework.

Second, creating an index condenses extensive information into a few categories. We limited the OEI to twelve criteria to balance complexity with ease of use; however, universal criteria may oversimplify the complexity of equity across diverse policy realms and contexts, as well as local perspectives on what constitutes equitable ocean initiatives[36]. To address this limitation, in-depth assessments of equity might be used as a complement to the OEI by providing richer descriptions of equity and contextualizing its findings[22].

Third, the OEI criteria are all input and process indicators, which makes it an appropriate tool for assessing equity in the governance and management of an ocean initiative. The OEI does not assess the outcomes of an initiative or the efficacy of particular criteria (for example, whether a mitigation mechanism is effective); however, we contend that when an OEI score is high, the likelihood of achieving positive outcomes for both people and nature increases.

Fourth, we recognize that different national contextual factors (for example, political factors, economic factors, environmental policies or socio-economic conditions) may condition or shape the ability of initiatives to enhance ocean equity—even when these initiatives embody the necessary ingredients to promote equitable processes and outcomes[37]. We therefore suggest that if one wants to assess an initiative that applies in two or more countries, one would need to do an assessment in each, and also encourage building on the ocean equity assessments through exploring whether and how national contexts enable or undermine the ability to promote equity within governance and management.

Finally, ocean equity can also be impacted by external factors. For instance, climate change can reinforce existing inequity, exacerbate vulnerability and undermine the success of coastal initiatives[11]. Using the OEI to advance equity at the nexus of joint policy goals can help to increase effective adaptation to climate change[19].

Outlook

Interest in using ocean resources is rising rapidly[4], and ocean inequity is accelerating[6,13]. In an effort to combat accelerating ocean inequity, many governments and organizations have made unprecedented commitments to advancing ocean equity across various marine policy realms. The OEI provides a robust framework and rapid approach to assess ocean equity and to identify actions to improve ocean equity. Actors seeking to fulfil these equity obligations can apply the OEI as a framework to measure status and progress, identify key strengths

and gaps, and develop strategies for more equitable design and implementation. Ultimately, the OEI aims to contribute to better integration of equity into ocean initiatives, ensuring better outcomes for coastal people and marine ecosystems now and into the future.

Online content

Any methods, additional references, Nature Portfolio reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at https://doi.org/10.1038/s41586-025-09976-y.

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Methods

We used a four-step methodology to develop the OEI. First, to identify criteria for assessing ocean equity, we reviewed peer-reviewed and grey literature on environmental justice, social equity, conservation and ecosystem services to produce a long list of existing equity criteria[61,62] (Supplementary Table 3). We identified potential indicators on the basis of the following evaluation criteria: (1) conceptual relevance (the indicator accurately represents key aspects of ocean equity; (2) measurability (the indicator is easy to measure, monitor and understand); (3) scalability (the indicator can be used at different spatial scales); and (4) actionability (it provides information that can guide management, policy decisions, or interventions)[63–65]. Second, we refined the initial list of criteria through two in-person workshops (December 2023 and May 2024), supported by the Centre for the Synthesis and Analysis of Biodiversity (CESAB) of the Foundation for Research on Biodiversity (FRB; www.fondationbiodiversite.fr). From a list of 150 initial criteria, we grouped criteria using qualitative conceptual clustering and consensus-building[63]. We revisited each criterion and evaluated similar criteria as to whether they added anything new to the discussion or were merely different articulations of the same concept. This prioritization process led to the six principles of ocean equity and the final set of twelve criteria. To finalize this step, we defined and provided an example for each criterion (Fig. 1). Third, we tested and refined the criteria through a series of presentations and workshops to government representatives; members of regional and international non-governmental organizations; not-for-profit organizations and private companies; members of the High-Level Panel for a Sustainable Ocean Economy and the Ocean and Climate Platform; and academics. Feedback from these presentations was used to clarify terminology and definitions for the criteria. Fourth, we trialed the tool through six case studies—each from a different ocean sector and scale. To perform a sensitivity analysis, we engaged multiple assessors for the same case study, evaluated and discussed the degree of agreement using Kendall's coefficient of concordance, and used the majority criterion for display of the OEI. Through these discussions, interactive workshops and pilot case studies, we were able to improve the clarity of the criteria and better ensure that all relevant aspects of ocean equity were sufficiently captured by the index.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

All data are available in Supplementary Table 4. Refer to http://www.oceanequityindex.org for further information.

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☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
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Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	n/a
Data analysis	The Kendall's coefficient of concordance test was done using R 4.5.1

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Research involving human participants, their data, or biological material

Policy information about studies with [human participants or human data](). See also policy information about [sex, gender (identity/presentation), and sexual orientation]() and [race, ethnicity and racism]().

Reporting on sex and gender	n/a
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Population characteristics	n/a
Recruitment	n/a
Ethics oversight	n/a

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Research sample	Knowledge holders on case studies
Sampling strategy	Knowledge holders on case studies
Data collection	Survey
Timing and spatial scale	n/a
Data exclusions	n/a
Reproducibility	We have tested for alignment among respondants
Randomization	n/a
Blinding	n/a

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Materials & experimental systems

n/a	Involved in the study
☐ ☐	Antibodies
☐ ☐	Eukaryotic cell lines
☐ ☐	Palaeontology and archaeology
☐ ☐	Animals and other organisms
☐ ☐	Clinical data
☐ ☐	Dual use research of concern
☐ ☐	Plants

Methods

n/a	Involved in the study
☐ ☐	ChIP-seq
☐ ☐	Flow cytometry
☐ ☐	MRI-based neuroimaging

Antibodies

Antibodies used	n/a
Validation	n/a

Eukaryotic cell lines

Policy information about cell lines and Sex and Gender in Research

Cell line source(s)	n/a
Authentication	n/a
Mycoplasma contamination	n/a
Commonly misidentified lines (See ICLAC register)	n/a

Palaeontology and Archaeology

Specimen provenance	n/a
Specimen deposition	n/a
Dating methods	n/a

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Ethics oversight	n/a

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Laboratory animals	n/a
Wild animals	n/a
Reporting on sex	n/a
Field-collected samples	n/a
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Study protocol	n/a
Data collection	n/a
Outcomes	n/a

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Policy information about dual use research of concern

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☒ ☐ Increase transmissibility of a pathogen

☒ ☐ Alter the host range of a pathogen

☒ ☐ Enable evasion of diagnostic/detection modalities

☒ ☐ Enable the weaponization of a biological agent or toxin

☒ ☐ Any other potentially harmful combination of experiments and agents

Plants

Seed stocks	n/a
Novel plant genotypes	n/a
Authentication	n/a

ChIP-seq

Data deposition

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Data access links
May remain private before publication. | n/a

Files in database submission | n/a

Genome browser session
(e.g. UCSC) | n/a

Methodology

Replicates | n/a

Sequencing depth | n/a

Antibodies | n/a

Peak calling parameters | n/a

Data quality | n/a

Software | n/a

Flow Cytometry

Plots

Confirm that:

☐ The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).

☐ The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).

☐ All plots are contour plots with outliers or pseudocolor plots.

☐ A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation | n/a

Instrument | n/a

Software | n/a

Cell population abundance | n/a

Gating strategy | n/a

☐ Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.

Magnetic resonance imaging

Experimental design

Design type | n/a

Design specifications | n/a

Behavioral performance measures | n/a

Acquisition

Imaging type(s)	n/a
Field strength	n/a
Sequence & imaging parameters	n/a
Area of acquisition	n/a

Diffusion MRI ☐ Used ☒ Not used

Preprocessing

Preprocessing software	n/a
Normalization	n/a
Normalization template	n/a
Noise and artifact removal	n/a
Volume censoring	n/a

Statistical modeling & inference

Model type and settings	n/a
Effect(s) tested	n/a

Specify type of analysis: ☐ Whole brain ☐ ROI-based ☐ Both

Statistic type for inference (See Eklund et al. 2016)	n/a
Correction	n/a

Models & analysis

n/a	Involved in the study
☒	☐ Functional and/or effective connectivity
☒	☐ Graph analysis
☒	☐ Multivariate modeling or predictive analysis