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# A deeper dive into the blue economy: the role of the diving sector in conservation and sustainable development goals

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Attaining an equitable Blue Economy requires reconsidering historical extractive usages of natural ocean capital in favor of more sustainable activities. Scuba diving is an expanding industry, and several examples illustrate how the diving sector has assisted with transitions to sustainable economic activities. In certain countries diving tourism generates revenues comparable with fishing industries, yet the sector remains underrepresented within marine conservation efforts. Therefore, we present five actions tailored to enhance the diving sector's participation in the Blue Economy: i) Organize the fragmented sector via international associations and federations; ii) Recognize usage rights for natural capital equal to extractive activities; iii) Modernize the sector using technology to improve connectivity and data sharing; iv) Invest in the sector by engaging private and public funding and subsidizing critical infrastructure to enable equitable access; v) Foster a sense of community by training and supporting local leaders, thereby ensuring more equitable participation by including women, indigenous people, and the youth. Diving represents one of the only endeavors that enables citizens to actively support the Blue Economy and help to achieve the United Nations Sustainable Development Goal 14, "Life Below Water"; therefore, the diving sector is uniquely poised to help address conservation goals and sustainable development.

## KEYWORDS

SCUBA, diving sector, conservation, sustainable development goals, blue economy, marine protected areas, 30x30

## 1 Introduction

The ocean, a vital livelihood source for over three billion people, faces grave threats such as climate change, pollution, ocean acidification, overfishing, biodiversity loss and habitat destruction (Georgian et al., 2022). Global consumption trends and market dynamics exacerbate these issues, promoting activities with detrimental environmental side effects including fossil fuel extraction, unsustainable fishing, aquaculture, and harmful

shipping methods (Lee and Nam, 2017). Additionally, economic incentives such as subsidies predominantly favor large industrial entities, further marginalizing small businesses and local communities relying on healthy oceans (Schuhbauer and Sumaila, 2016; Schuhbauer et al., 2017; Österblom et al., 2019; Harper et al., 2020). A sustainable and equitable ocean economy, or Blue Economy, aims to reconcile human needs with planetary health by fostering sustainable utilization of ocean resources that enhances marine ecosystems' resilience and improves livelihoods (Winther et al., 2020; Bennett et al., 2021; Sumaila et al., 2021).

The 2030 UN Agenda for Sustainable Development framework aids in harmonizing development with ocean and climate agendas through the principles of the Blue Economy (Nisa et al., 2022; Nisa, 2023). Sustainable Development Goal 14 (SDG 14), "Life Below Water" mandates the conservation and sustainable use of marine resources (Assembly UN G, 2015). To accomplish this, governance, economic development, environmental protection, and international communication must align and facilitate concerted action between marine ecosystems and economic systems (Wenhai et al., 2019). Despite the availability of necessary capital, a dearth of high-quality projects impedes Blue Economy financing (PEMSEA, 2015; UN OHRLLS, 2015; Fritsch, 2020 as cited in Sumaila et al., 2021), demanding solutions to the policy-level obstacles. While long-established stakeholders exploiting marine resources for extraction often overshadow small-scale sustainable endeavors, smaller, locally owned businesses adopting sustainable practices struggle to influence political discourse due to lack of organization, recognition and inclusion (Sumaila et al., 2021).

The tourism sector, particularly eco-tourism, is an underutilized facet of the Blue Economy and SDG 14, despite its potential to enhance conservation and sustainable development in local communities (Spalding et al., 2017; Mayén-Cañavate et al., 2019; Arcos-Aguilar et al., 2021). "Blue Tourism" emphasizes balancing environmental, social, and economic needs supported by marine ecosystem services, thereby presenting a sustainable solution (Bennett et al., 2019; Mayén-Cañavate et al., 2019; Cisneros-Montemayor et al., 2021). Despite studies underscoring the diving sector's significant economic contributions in many locations (Vianna et al., 2012; Spalding et al., 2017; Arcos-Aguilar et al., 2021), it still lacks the recognition and international organization necessary to play a pivotal role in the Blue Economy (Nisa et al., 2022).

## 2 Why SCUBA diving?

The diving sector—comprising tourism, scientific research, instruction, and the dive workforce—is integral to the United Nations Sustainable Development Goals, particularly SDG 14: Life Below Water (Lucrezi et al., 2017; Nisa, 2022; Nisa et al., 2022; Nisa, 2023). Deriving from military and exploration activities, SCUBA diving and snorkeling have become multi-billion-dollar industries, drawing millions to interact with underwater ecosystems (Wongthong and Harvey, 2014; Lucrezi et al., 2017; Nisa et al., 2022). The sector primarily contributes to the Blue Economy via diving tourism, which is both motivated and challenged by the

quest for sustainable development and conservation (Grafeld et al., 2016; Spalding et al., 2017; Eider et al., 2023). While diving tourism contributes significantly to local economies worldwide, it must be well-regulated because diving activities can detrimentally affect sensitive marine life (Giglio et al., 2020), and can also exacerbate social sustainability problems such as increased demand for locally-caught seafood (Lopes et al., 2017) and the climate impacts of dive tourism—particularly the ecological footprints of international air travel (Mancini et al., 2022). Moreover, the development of coastal areas requires adequate investments in waste disposal systems and sewage treatment and sanitation systems (Leposa, 2020), necessitating effective management to balance its impacts (Townsend, 2007; Wongthong and Harvey, 2014; Lucrezi et al., 2017; Giglio et al., 2020).

Diving tourism fuels the Blue Economies of many island states, contributing significantly to GDP and employment (UNCTAD, 2014; Nisa et al., 2022) and generating substantial revenue in various regions—particularly where unique marine life attracts visitors (Vianna et al., 2012; Spalding et al., 2017; Mustika et al., 2020; Arcos-Aguilar et al., 2021). Diving tourism has also demonstrated the potential to encourage conservation, attract tourism, enhance local quality of life, and cultivate community pride (Townsend, 2007; Wongthong and Harvey, 2014; Lucrezi et al., 2017). Examples such as the Cabo Pulmo National Park (CPNP) in Baja California Sur, México illustrate how the diving sector can foster a sense of pride in local resource protection and promote a sense of community, cohesion and leadership (Aburto-Oropeza et al., 2011; Ramírez-Ortiz et al., 2022). The Cabo Pulmo community fought for the protection of their coral reef ecosystem, which had been decimated by overfishing and destructive practices, and in 1995, the reefs offshore from Cabo Pulmo were designated as a National Marine Park by the Mexican government. Since that time, fish biomass within the CPNP has increased by more than 460% (Aburto-Oropeza et al., 2011; Ramírez-Ortiz et al., 2022), and the additional influx from dive ecotourism in the CPNP has generated an estimated (2017) USD 3.73 million in direct benefits for Cabo Pulmo inhabitants (CONANP-GIZ, 2017). The success of the CPNP should encourage local communities to form strong partnerships between the diving sector and governments worldwide to protect their invaluable marine resources sustainably and equitably.

Current research highlights the diving sector's role in promoting sustainable Blue Tourism and positive synergies with the SDGs (Arcos-Aguilar et al., 2021; Nisa et al., 2022). SDG14 aims for larger Marine Protected Area (MPA) networks worldwide, and the Convention on Biological Diversity has called for MPAs to increase to 30% of marine areas by 2030, in a plan called 30X30 (Roberts et al., 2020; Grorud-Colvert et al., 2021). However, conservation efforts must be carefully planned to avoid protecting areas that may be lower priority from a biodiversity perspective because they do not create conflicts with extractive industries (Dinerstein et al., 2019), and to prevent establishing ineffective "paper parks" (Grorud-Colvert et al., 2021; Albers and Ashworth, 2022). We suggest a framework to promote wider engagement by the diving sector in conservation and sustainable development efforts, thereby supporting SDGs and the Blue Economy. This

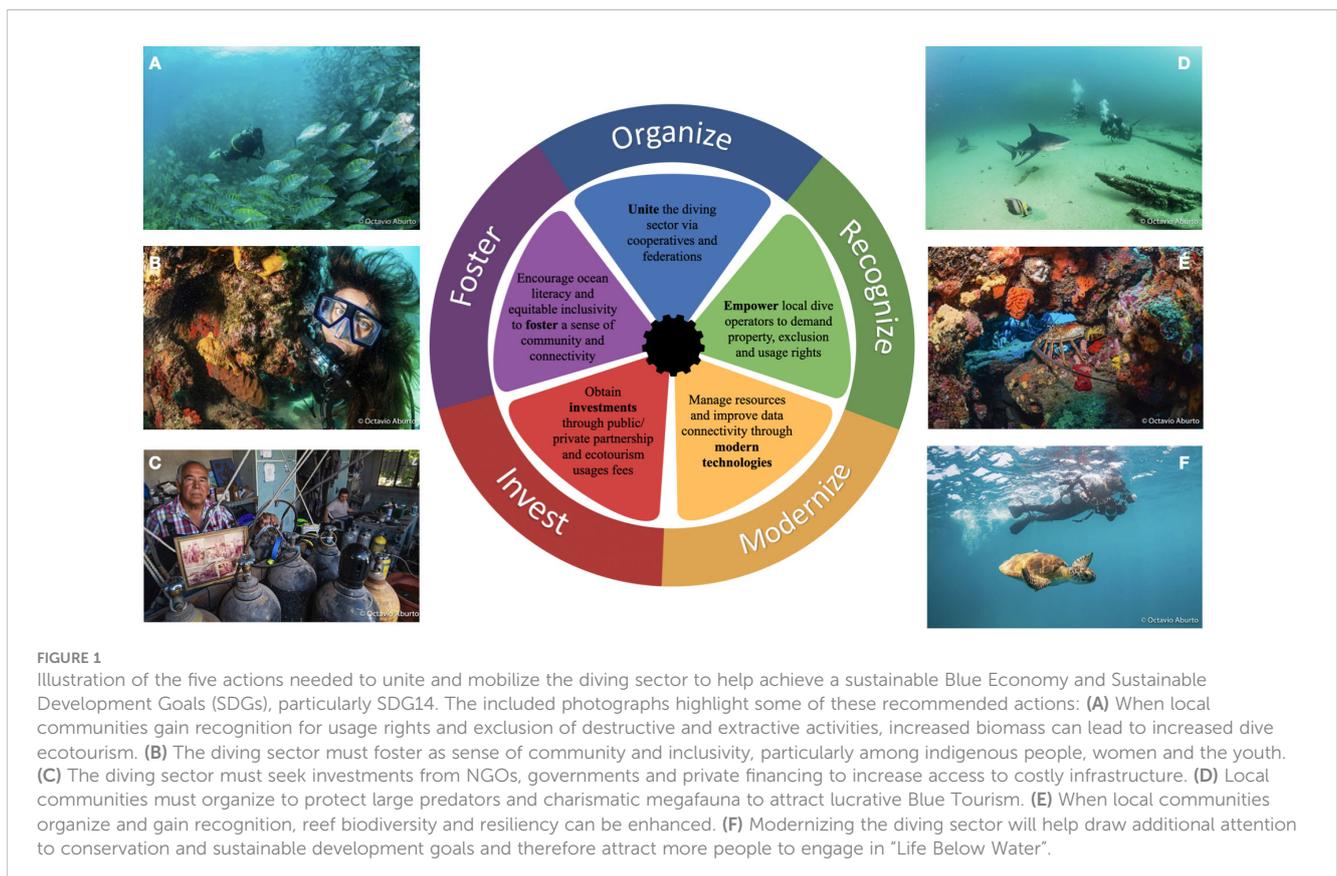
paper guides local-level stakeholders, identifies five actions to enhance the diving sector's participation in ocean conservation, and showcases examples where the diving sector has fostered inclusivity and sustainable development through partnerships and the involvement of local communities, NGOs, scientists and governments (Figure 1; Table S1).

## 2.1 Action 1: organize

The primary barriers currently hindering the diving sector from playing a more integral role in the establishment of the Blue Economy are the lack of strong local, regional, and international organization, cooperation, and coordination. As an industry, scuba diving lacks cohesion, thereby failing to be properly represented as a societal entity, and consequently cannot be adequately heard and served (Lucrezi et al., 2017). In order to bridge these divisions, the diving sector should strive for inclusivity in the strategic development of the Blue Economy and SDGs at both local and international levels (Nisa, 2022; Nisa et al., 2022). There is an urgent need for local diving operators to build national and international partnerships in tandem with local governments and gain recognition within the political and policy arenas. Such recognition would allow the diving sector to assist governments in modernizing their blue economy sectors, integrating scientific data, attracting investments, and fostering civic responsibilities among divers and people working in the industry (Nisa, 2022). For instance, on the island of Elba in Italy, local dive operators

formed an alliance with government and tourism entities to foster sustainable diving practices (See Table S1). This initiative, the Elba Diving Consortium (or Consorzio Elbano Diving in Italian), spurred by a common vision and shared objectives, established a model of effective organization and cooperation, offering a scalable blueprint for other regions.

Involving the local community in scuba diving, through sponsored training and school campaigns is also crucial. Such involvement brings positive impacts to local economies and engenders a sense of ownership towards the marine environment, helping to counteract the negative consequences of development and tourism-related economic growth such as littering, pollution, and resource overexploitation (Lucrezi et al., 2017). This community involvement is key to creating more congenial environments for tourists and locals alike and provides locals with valuable skills such as dive training and certifications, and learning English and other languages (Naja et al., 2021). Self-organized efforts and cooperative strategies among industry actors can enhance water safety protocols and increase access to collective conservation investments (Dimmock and Musa, 2015; Partelow and Nelson, 2020). Moreover, integrating indigenous knowledge and traditional forms of marine resource management can promote active local community participation in marine ecotourism development. This collaboration yields added benefits such as conserving biodiversity, cultural landscapes, and local traditions. A case in point is the integration of “sasi”, a traditional form of marine resource management, in marine ecotourism in the Raja Ampat islands of West Papua, Indonesia, facilitated through



concession agreements between marine ecotourism operators and the local indigenous community (Prasetyo et al., 2023).

The establishment of SCUBA diving unions would bolster the diving sector's abilities to organize and protect the interests of diving businesses, facilitating the search for national funding easing the burdens of stakeholders on various levels, from legislative to taxation, contributions, and health and safety insurance (Lucrezi et al., 2017). However, this requires the diving sector to form partnerships and associations that can advocate collectively for equitable rights and access. Although some diving associations, such as the Association of Utila Dive Shop Operators (AUDSO) in Honduras, have failed due to intense competition, these failures can be attributed to the absence of meaningful enforcement and incentives, indicating that such structures could succeed under the right conditions (Cronk et al., 2002).

Numerous local, national, and regional diving organizations and cooperatives illustrate various strategies for promoting cooperation over competition. The Gili Eco Trust in Indonesia has self-organized local diving businesses to pursue conservation and sustainability goals (Partelow and Nelson, 2020; Eider et al., 2023), while the NOAA Lionfish Invitational in the tropical western Atlantic organizes volunteer divers and marine scientists to assess the impacts of invasive lionfish (Clements et al., 2021). Furthermore, the Green Fins initiative by the UNEP and PADI promotes standards for sustainable diving tourism activities in South East Asia, while the Reef Life Survey and Reef Check initiatives organize global citizen-science efforts to collect biodiversity data (Hunt et al., 2013; Stuart-Smith et al., 2018; Turicchia et al., 2021; <https://www.reefcheck.org>). However, these efforts are primarily based on volunteer contributions and lack coordinated international economic and conservation strategies. As a result, local diving centers remain fragmented and lack the unifying power of collective organizations.

Cooperatives and federations can provide several benefits, from enhanced access to financing to decreased competition and improved collaboration. Drawing on lessons from the fishing sector, where cooperatives have a significant investment in local production and governments have incentivized cooperative formation (Pettersen, 1980; McCay et al., 2014; Bennett, 2017; García Lozano et al., 2019), the diving sector should establish federations, cooperatives, and advisory boards within the international diving community which, in turn, can foster robust private and public partnerships. In the era of SDGs, there are new opportunities for the diving sector to modernize and unite to support conservation, fight against invasive species, and promote the marketing of locally and sustainably caught seafood (Lucrezi et al., 2017; Nisa et al., 2022). Hence, using these lessons learned from the fishing sector, the diving sector can explore novel ways to organize and unite by establishing associations, federations, cooperatives, and advisory boards, all of which should be maintained and supported through joint efforts under SDGs (refer to Table S1 for additional examples).

## 2.2 Action 2: recognize

Recognizing and enforcing the rights of local diving operators and ecotourism enterprises to manage designated areas for Blue

Tourism activities is essential because economic benefits tend to be inequitably distributed due to centralized control and ownership of resources (Bennett et al., 2021). The implementation of rights-based fisheries and ecosystem service accounting practices can rectify this imbalance and create an environment where conservation aligns with economic benefits (Lubchenco et al., 2016). However, one significant challenge lies in the classification of many tourist destinations as common pool resources (CPRs), areas from which exclusion is costly, and use by one party reduces resource availability for others (Moore and Rodger, 2010). These circumstances often lead to issues such as overcrowding and resource depletion. Moreover, the high costs of monitoring and implementing user fees in remote areas can further discourage investments necessary for achieving sustainability (Vail and Hultkrantz, 2000). This dilemma can be resolved by granting and enforcing property rights for local communities, thereby avoiding what is known as "Diving Colonialism", where foreign investors dominate the SCUBA industry in developing nations, often to the detriment of local interests (Wongthong and Harvey, 2014; Lucrezi et al., 2017; Partelow and Nelson, 2020).

Effectively leveraging the diving sector's potential to contribute to the Blue Economy and SDGs requires equipping local dive operators with the means to claim and exercise usage rights. Integrating indigenous knowledge and customs into ecotourism development strategies can pave the way for a holistic, sustainable approach to marine resource management. In turn, this can ensure that scuba diving tourism development is built on a strong foundation of sustainable relationships between local communities and their marine environments (Prasetyo et al., 2023). Building upon this approach, local dive operations should serve as the focal point of innovation and ocean literacy promotion, becoming repositories of local knowledge by amplifying the voices of indigenous and local populations to ensure that the ocean is well-represented by diverse narratives and initiatives (García and Cater, 2022).

An example of this practice is the Shark Reef Marine Reserve (SRMR) in Viti Levu, Fiji, where dive operators recognized the traditional rights of local villages to their offshore coral reefs and reached agreements to gain exclusive access and restrict fishing, in return for marine park levies from visitors (Brunnschweiler, 2010). Similarly, the Cabo Pulmo National Park (CPNP) in Baja California Sur, Mexico, showcases how the government's recognition of the importance of coral reefs and the designation of CPNP as a National Marine Park resulted in both substantial increases in fish biomass and significant economic benefits for local inhabitants through dive ecotourism (Aburto-Oropeza et al., 2011; CONANP-GIZ, 2017; Ramírez-Ortiz et al., 2022). Integrating the diving sector within local communities can pave the way for the sector to gain greater recognition and acquire the necessary rights to champion and achieve conservation and sustainable development goals (refer to Table S1 for additional examples).

## 2.3 Action 3: modernize

In order to facilitate the diving sector's increased participation in conservation and Sustainable Development Goals (SDGs), it is essential

to harness the power of technology. Just as platforms such as eBird and iNaturalist have leveraged field observations from “bioblitz” events organized by museums (Sullivan et al., 2009; Cheung et al., 2022), diving-centric apps and websites could be established to encourage Ocean Citizenship. Such platforms would enable the sharing of information and promote widespread engagement. A promising technological framework for enhancing conservation efforts is the Internet of Underwater Things (IoUT), a global network of interconnected underwater devices capable of sensing, interpreting, and reacting to their environment (Domingo, 2012; Cardia et al., 2019). The IoUT employs powerful tracking technologies and embedded sensors, all connected via the internet and smartphones, offering an innovative approach for the Blue Economy sector.

Particularly pertinent to the diving community is the use of technology to passively collect vital data from dive computers and other inexpensive sensors worn by divers (Bube et al., 2022), a practice that has been successful in the surfing industry (Bresnahan et al., 2022). Recreational dive computers, which routinely record temperature and depth, are powerful tools that can supplement existing monitoring systems worldwide, particularly in under-sampled or highly variable coastal environments (Wright et al., 2016). Moreover, many divers are already equipped with consumer-grade action video cameras such as GoPros (GoPro™, California, US). These devices have proven effective in marine science for surveys, behavioral observations, and monitoring, thereby paving the way for modernizing citizen science endeavors (Henderson et al., 2017; Florisson et al., 2018; Lefcheck et al., 2019; Chapuis et al., 2021).

Currently, the inability of GPS technology to function underwater poses challenges for precise tracking of divers; however, the innovative use of underwater Quick Read (QR) Codes and handheld waterproof QR scanners could offer solutions. These technologies enable divers to pinpoint their location, navigate, and gather geolocated data, whilst providing real-time monitoring of their position and depth to operators at the sea surface (Bruno et al., 2019). In addition to divers’ safety and navigational enhancements, QR codes could also serve to track the activities and locations of dive vessels when placed on the boats. Furthermore, QR codes could offer divers additional information about a dive site, akin to terrestrial tour maps and location markers (Zhang et al., 2022). From a business perspective, QR codes could enhance customer interaction, allowing them to rate and review diving operators, book additional services, and enable agencies to monitor locations and durations of diving visits (e.g., Yanis et al., 2023).

Some additional innovations to consider are usage of autonomous underwater vehicles (AUVs) and Remotely Operated Vehicles (ROVs) to augment data collection and monitoring by divers. The use of AUVs and ROVs in marine science and conservation has increased due to their ability to reach areas that are difficult for divers to access, and to collect large amounts of data efficiently (McGeady et al., 2023). Harnessing modern technology to educate and unite the international diving community is a crucial component of the Blue Economy. By promoting technological innovation, we can effectively engage the diving sector in efforts to achieve SDGs and cultivate a sustainable approach to Blue Tourism (refer to Table S1 for additional examples).

## 2.4 Action 4: invest

In order to ensure recognition by governments, NGOs, and private donors, the diving sector needs to become more organized, unified, equitable, and sustainable (Bennett et al., 2019; Mayén-Cañavate et al., 2019; Cisneros-Montemayor et al., 2021). However, setting up a diving business can be a costly venture, and in many cases the costs from ocean-based economic activities are borne by women, youth and marginalized communities (Sumaila et al., 2021). Therefore, targeted subsidies, particularly for local communities starting organized structures such as cooperatives, can reduce costs and combat “tourism colonialism” (Prasetyo et al., 2023). Economic incentives can foster sustainability and encourage personal motivation for responsible resource use (Lubchenco et al., 2016). Programs certifying sustainable tourism standards should evolve from rewarding excellence to becoming essential requirements for dive operators (Bendell and Font, 2004). Subsidizing diving infrastructure could encourage participation in diving activities, thus raising awareness about marine conservation and promoting ocean literacy.

Johansen and Vestvik (2020) estimated that to achieve SDG 14 by 2030, an annual resource allocation of US\$174.52 billion is required. Currently, only US\$25.5 billion is spent, highlighting the need for “blue finance”—investments dedicated to ocean conservation (Shiiba et al., 2022). As Blue Tourism depends on high-paying customers’ continuous high occupancy, multiple sectors, including diving and surfing, must collaborate (Buckley, 2002a; Buckley2002b). Marine conservation organizations need to support equity through their policies and investments, addressing both human and social dimensions (Bennett et al., 2021). Limited access to credit or loans often precludes local ownership of dive businesses (Mograb and Rogerson, 2007; Townsend, 2007; Daldeniz and Hampton, 2013). Hence, international dive training and certification associations like PADI should invest in training local staff and promote supportive business practices (Townsend, 2007). Collaborations between NGOs and the private sector, as seen in the Green Fins code of conduct, hold significant potential (Hunt et al., 2013).

Examples of successful investment in local marine conservation include Raja Ampat, where marine park entry fees fund local conservation management, employing locals as park rangers and managers (Atmodjo et al., 2017; Purwanto et al., 2021). Similarly, in Medes Islands Marine Reserve, ‘fish banks’ increased ecosystem service profits, showcasing the potential of public/private investments (Sala et al., 2016). In Malaysia, shark-diving tourism has generated significant revenue, a part of which is reinvested in MPA management (Vianna et al., 2018). These cases demonstrate how tourism can lead to investments in conservation efforts, local communities, and the blue economy (Table S1).

## 2.5 Action 5: foster

The diving sector can act as a catalyst for conservation and sustainable development only if it cultivates a sense of civic responsibility. Instead of viewing diving primarily as a recreational

tourist activity, we need to inspire the upcoming generation of leaders to engage actively in the diving sector's pursuit of SDG14 and Blue Economy goals. This will require instilling a sense of culture in the diving community, as has been successfully achieved by societies like fishers, birders, and surfers. International surfing organizations such as the Surfrider Foundation and Surfers Against Sewage have encouraged ocean literacy and legislative change through campaigns for nearshore habitat protection (Worm et al., 2021). This circular approach could motivate young leaders from local communities to transform diving into a conservation and sustainable development force (Lucrezi et al., 2017). Promoting social networks within the diving community can drive collective actions and foster adaptive environmental governance, as shown by the collaboration between SCUBA businesses on Gili Trawangan, Indonesia, addressing marine conservation amidst tourism industry growth (Partelow and Nelson, 2020). The diving sector can promote a network of blue stakeholders by involving governments, science, private sector, NGOs, and society (Garcia and Cater, 2022).

Enhancing inclusivity and social equity in marine conservation demands respect for diverse perspectives, coupled with efforts to overcome structural and institutional barriers to conservation (Bennett et al., 2021). Many conservation practices have favored Western perspectives and neglected local needs, leading to ineffective top-down initiatives (Dowie, 2009; Muhl and Sowman, 2020). Balanced decisions ensuring ecosystem integrity and service sustainability are needed for effective ecosystem management (Trialfhianty and Suadi, 2017). "Leader-full" consensus, with each stakeholder contributing uniquely, promotes resilience and success (Manring and Pearsall, 2005). For example, in Viti Levu, Fiji, the local community took ownership of shark diving tourism operations by creating a community-based shark reef marine reserve, fostering local stewardship and enhancing conservation of marine species (Brunnschweiler, 2010), and shark diving tourism development in South Africa has increased the local community's awareness of the value of marine conservation, resulting in greater protection of marine flora and fauna (Dimmock and Musa, 2015).

Diverse leadership is key to conservation success, engaging different genders, races, ethnicities, and cultures to reflect a variety of values and viewpoints (Tallis and Lubchenco, 2014). Involving local women in conservation has improved protected area and fisheries management outcomes (Allendorf and Allendorf, 2012; Leisher et al., 2016). The diving sector should train a global network of young ambassadors to drive conservation and address knowledge gaps. A successful instance is Kimbe Bay, Papua New Guinea, where school children's participation in education programs led to the establishment of locally managed no-take marine areas (Cater, 2014, as cited in Prasetyo et al., 2023; Table S1). The diving sector must subsidize and advocate for initiatives enabling equitable involvement, empowering local communities to not only engage in, but also initiate and lead, conservation and sustainable development efforts.

### 3 Conclusions

The international diving sector has the potential to be instrumental in achieving the United Nations Sustainable

Development Goals (SDGs) and significantly contribute to an equitable Blue Economy, provided it undergoes the necessary transformations as outlined in our five actions (Figure 1). SCUBA diving and snorkeling, along with their associated industries, generate billions of dollars annually, engaging millions of individuals in direct interactions with the underwater world. Given that these industries rely heavily on healthy, biodiverse habitats, the diving sector's intrinsic motivation towards sustainable development and conservation is self-evident.

While the diving sector is already integral to the Blue Economies of many island nations, its potential is not fully realized due to a lack of international organization and a cohesive sense of community, something that other sectors have managed to successfully establish. In some countries, revenue from diving tourism surpasses even that of the fishing industries, underscoring the sector's importance. Yet, the diving sector remains significantly underrepresented within international marine conservation efforts.

Due to its unique role as one of the only human activities that allows direct interaction with "Life Below Water" (Sustainable Development Goal 14), the diving sector is uniquely positioned to address conservation goals and sustainable development and contribute to a more sustainable, equitable, and inclusive Blue Economy. However, to realize this potential, it is crucial to outline and follow clear metrics for success, anticipate and mitigate potential challenges, leverage technological advancements, and acknowledge the role of policies and regulations. Furthermore, the diving sector must make concerted efforts to integrate and systematically uphold indigenous knowledge, a rich resource that can significantly contribute to marine conservation and sustainable development goals.

### Author contributions

OA-O, FF and MF: conceived review. MF, FF, OA-O and ZN: wrote the paper. All authors contributed to the article and approved the submitted version.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmars.2023.1212790/full#supplementary-material>

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