Approach to Existing Management Perspectives in Scuba Diving

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There are a considerable number of studies reporting the negative impacts of recreational diving and their causes, yet there is a gap in the information regarding the aspects of activity management. A large part of the measures identified address stakeholders' awareness, data on the activity, and implementing adapted management measures. Stakeholders need to be integrated into the entire process of managing the activity because they are the target for correcting actions.

scuba diving management | environmental impacts | management actions | sustainability

1. Introduction

Each year, a considerable number of new divers complete a diving certification, making recreational diving one of the fastest growing coastal tourist activities [1][2][3]. The diver training organisation, the Professional Association of Diving Instructors (PADI), has more than 100,000 certified professionals, who in turn have certified more than 28 million divers since 1967, spread over more than 200 countries and territories [4][5]. This recreational activity is economically viable and can raise environmental awareness by allowing direct observation of the marine ecosystem [6][7]. It is also accepted in multiple-use marine protected areas (MPAs) as a source of income [7][8][9]. However, carrying out this activity also brings negative impacts on the marine environment, particularly through physical disturbance of species and habitats. Moreover, non-indigenous species (NIS) can be transported by diving boats from marinas and introduced into sensitive marine areas such as MPAs [10].

2. Awareness, Training, and Briefings

The development and use of training and interpretation programmes on marine habitats and marine life can be the key to greater awareness and engagement of divers underwater [11]. Skilled diving behaviour is strongly related to safety practices that reinforce relationships with diving buddies, diving masters, and diving friends but are less effective as behaviours that preserve the marine environment. Changing attitudes and behaviours involves both an awareness of the consequences and the knowledge of specific issues that can be addressed through public education programmes (e.g., incorporation of marine conservation awareness programmes in public schools). Interesting to note is that the best-known training organisations started to offer environmental awareness programmes for divers and, in collaboration with the diving industry, have developed a package for training eco-diving instructors (e.g., Scuba Schools International (SSI)), thus demonstrating concern in this regard. Diver

education and buoyancy training have been a key feature in the reduction in the environmental impact of the scuba diving industry [12]. Thus, improvement of these two qualities has been shown to have a positive effect in reducing contacts made by divers in the ecosystem [13][14][15]. These are the two prerequisites for this industry, which encompasses international and national autonomous agencies (e.g., the British Sub Aqua Club (BSAC), La Confédération Mondiale Des Activités Subaquatiques (CMAS), and the Professional Association of Diving Instructors (PADI)). It is known that education is a successful tool for increasing divers' awareness, and another indirect form of intervention that can minimise the level of diver impacts is diving guides. The intervention of dive guides seems to be successful, as it seems to contribute to a reduction in diver contact with the ecosystem in the range of 20% to 80% [13]. The intervention of a dive guide reduces the likelihood of a diver contacting benthic organisms in the first 10 min of each dive. In general, the level of impact can be minor when there is continuous monitoring/intervention by the guide, thus achieving a more sustainable dive. An example is what happens in Santa Lucia (Lesser Antilles, Caribbean), where only the dive guide's intervention methods work in reducing coral damage by divers [16]. Along with novice divers, underwater photographers may cause great destruction on the seabed, particularly on sessile organisms such as corals [17][18][19]. To photograph different scenarios and species, they often position themselves close to the substrate/bottom, leading to direct contact with marine organisms, and this is when they do not hold onto them to steady themselves [17]. Surprisingly, in [18] it was found that specialist photographers are the worst when it comes to causing impact, which reinforces the need for transversal education. Another source of impact with negative repercussions on the marine ecosystem is conflicts between divers. This is common in areas where diving becomes popular or overcrowding occurs [20]. In Molokini, minimum distances are required between participants of the same activity groups, maintaining security to avoid conflicts [20]. In certain destinations, there are reports from dive guides of disputes between divers during the dive when trying to see small emblematic species such as seahorses, which have resulted in the destruction of the seabed [21]. Therefore, for better management of the activity, codes of conduct have emerged in some regions and for some of the diving offerings (e.g., shark diving) with the aim of protecting marine species [22][23]. In developing a specific code of conduct, it is essential to integrate all stakeholders in the process [24] and to consider the reality and specificities of the site/region where it will be implemented. Moreover, this measure allows diving guides to take underwater measures if necessary.

These examples illustrate that improving the awareness of divers and dive operators through education can contribute to more divers using a particular site without causing degradation. Since 1996, the importance of education has been emphasised as having an extreme relevance in raising environmental awareness and reducing the damage caused by divers in renowned diving destinations. However, although the industry has already evolved in this sense, it still shows some resistance to investing in education as a vehicle for more sustainable management of diving activities. Still, more dive operators are improving their tools to offer a more sustainable operation with less impact on nature, such as their diving briefings. This tool, if well done with all the information about the diver's behaviour and the environmental menaces of the diving activity, can improve divers' awareness of actual and potential threats, and is a beneficial management tool for awareness and conservation of marine habitats. A dive briefing can take different forms, such as conservation education dive briefings, video briefings, or predive ecological briefings, which, based on several studies, significantly decrease the frequency of contacts

made by divers [25][26][27][28]. It can also contain different content, like the ecological aspects of corals [28] and other emblematic species [28], specific alerts for scuba divers with cameras and gloves [29], basic aspects of coral biology with visual materials [30], and alerts for divers to maintain neutral buoyancy [30]. In the Florida Keys National Marine Sanctuary, a dive operator has implemented a “conservation-centred briefing” that has been shown to significantly reduce the number of touches by divers per minute compared with the results obtained by the other dive companies (0.16 ± 0.08 (mean ± SE) and 0.37 ± 0.06 (mean ± SE), respectively) [27].

3. Research/Monitoring the Marine Environment

Through scientific research, in various places in the world the intensive use of dive spots may have led to differences in the distribution of benthic species abundance [13][31][32][33]. Also, it has made it possible to identify some of the behavioural sources causing the environmental impacts [17][25][34][35][36]. Evidence since 2006 indicates that for effective management and protection of the marine environment from anthropogenic activities, it is essential to have a characterisation of it, together with a delineation of its thresholds within a consistent classification [34]. Therefore, the first step in recreational diving management is to characterise the benthic community of dive sites, as benthic species are the ones that receive mechanical damage such as breakage. Monitoring of the activity and of critical indicators of vulnerability is essential to identifying mitigating management actions before setting about calculating the “carrying capacity” of the area and limiting the number of divers [19][37][38]. All this highlights the importance of scientific research to acquire greater knowledge about the management of recreational diving activity. Through research, it was possible to ascertain that the intensive use of diving places by the diving industry may lead to several negative impacts on the marine environment. That is why long-term monitoring of this activity is crucial. In general, there has been a growing evolution in scientific research and monitoring of diving activity over the last three decades; however, there is still a lack of information and management of the activity in many of the diving destinations analysed. Thus, more information needs to be generated (e.g., recent studies with new data, studies involving monitoring and evaluation) to adapt management measures to current circumstances.

4. Carrying Capacity Approaches

In the analysis conducted, under the umbrella of the carrying capacity management action group, all management actions that focus on controlling the number of divers in a particular dive spot. Demand for a diving site is dependent on several factors, such as the marine biodiversity and the geological features of the site, but also on the wilderness experience. The benefits of the wilderness experience usually decline with the number of visitors, which generates a phenomenon of congestion or overcrowding. The overcrowding effect is also magnified by the agglomeration of diving activity in the most accessible and renowned destinations. There is a generalised consensus that limiting the number of visitors to diving sites is one of the simplest management actions and can contribute to alleviating the environmentally negative impacts of divers on the ecosystem [39][40]. Primarily, the concept of carrying capacity is developed for terrestrial sites and is the “maximum number of visitors” that a particular geographical place can carry. It was developed as a management instrument to ensure that the number

of recreational visits to a wilderness area would not degrade the quality of the recreation experience and would maintain its biological and ecological functions [41]. One of the main problems of applying the concept to marine sites and scuba diving is the feasibility of excluding divers from a particular site [42]. The second problem arises from pursuing two main objectives: preserving the quality of the recreational experience and maintaining biodiversity and ecological functions. The first empirical application of the carrying capacity concept to a marine environment was used for the Bonaire Marine Park and reached the conclusion that diving had no significative effects on fish communities, but even low diving levels had an impact on coral colonies [31][43]. The majority of subsequent studies focused on the effects of divers' behaviour on coral communities and identified both short-term and cumulative effects [1]. A second group of empirical studies on non-tropical rocky reefs addressed the identification of the bio-indicators of diving impacts [14][33][44].

5. Adaptation of the Diving Industry

The management action group analysed, diving industry adaptation, encompasses measures whose main objective is to improve the operation of the activity and minimise its impact on the marine environment. Measures are associated with stakeholders that are part of the SDTS, such as divers, dive operators, and diving schools [45]. Interaction with other stakeholders such as local communities, recreational fishing operators, local authorities, and policymakers has been suggested [9]. All these stakeholders interact in managing the activity, adopting management measures, mitigating impacts, addressing conflicts in multi-use sea spaces, and supporting an environment that ensures economic sustainability and the wider sustainability of the industry [45][46]. These multiple stakeholders share a heterogeneity of interests, but it has been argued that scuba dive operators have a personal stake in the conservation of diverse marine life and in the conservation of small coral areas [47][48]. Borrowing from ICM methodology, it has been argued that a management strategy that takes multiple stakeholders into account must invest in proper communication and participation in the management processes [46].

A range of ad hoc measures deal with the impact of the activity on the marine environment and the preservation of quality dive sites. One example of a specific measure resulting from industry adaptation is the use of buoys so that the descent and ascent of divers have a reference in shore dives, consequently preventing the destruction of marine habitats common in this type of diving, which has a greater impact than diving from a boat. This is related to the fact that divers start and end their dive in a sand zone [16]. On the southern Caribbean island of Bonaire, only vessels over four metres are allowed to anchor, and in the case of fishers, only those using "stone anchors" are allowed [13]. Thus, a mooring system for dive operators and other boats has been installed for this purpose. Also, when divers arrive on the island, they need to take part in a briefing on the marine park, as well as participate in an orientation dive, both of which are provided by the host operator.

As mentioned above, one of the measures that has been implemented by dive operators is entry points over sandy areas, away from coral reef areas [29][49]. This measure may have other associated measures as suggested by different authors, such as definition of the distances between entry points (e.g., 30 m apart, 12 m apart), maximum limit on the number of divers that can descend at each point at a time (e.g., 9 divers, 10 divers) [50][51], and minimum distances between those participating in the same activity groups [20]. There are other measures whose

implementation could provide added value, like the planning of dive routes by operators so that sensitive habitats and species are not disturbed [52]. An example of the success of this measure is the Algarve (Portugal), where the underwater routes pleased those who visited them [53], promoting environmental awareness in situ. All the above examples show that the diving industry has been adapting and should continue to adapt to provide better and safer diving experiences with less negative impact on marine ecosystems. Only then can there be more sustainable diving activity.

6. Economic Values/Mechanisms

The management action group studied, economic values/mechanisms, comprises measures related to the economic value of the activity and, consequently, the local economy of diving destinations. User-pay fees for divers have been studied either for access to marine parks [54] to finance conservation [55] or simply as an instrument to manage specialist activities such as diving with sharks [42][50][56]. Access fees are suggested as an instrument to manage demand while generating revenue for park management and conservation. Most access fees are set below what divers are willing to pay [57], and in most cases, the revenue generated is not used to fund marine conservation or enforce activities. Willingness to pay for fish diversity, pristine coral, and the presence of megafauna such as sea turtles, mantas, and whale sharks is well above the values set for the majority of diving access fees [58]. The design of new fee structures, which take the value of heterogeneity into account, in studies on the willingness to pay has led to a new discussion about the use of other pricing techniques such as discriminatory pricing [59]. The potential of privately managed marine reserves and co-managed marine reserves is another example of the use of economic mechanisms at the local level in the Philippines and Malaysia [60].

While scuba diving is a market service and divers pay a competitive market price, it can be argued that this market price does not consider the use of marine public goods such as fish diversity, coral quality, and the uniqueness of the diving experience. Divers pay a price for a diversity of services provided by operators, such as accessibility to spots and equipment use, but the perceived value of a dive is greater than the price. In accordance with the research of Schoeman et al. (2016) [61], the value of tourism products can be calculated by taking tangible (e.g., marine biodiversity) and intangible (e.g., diving experience) elements into consideration. The diving tourism product is intangible; however, through the diving experience a value (e.g., emotional, functional, social, epistemic) is created that influences the satisfaction of those who practice it. Therefore, the diving industry should not underestimate the relevance of the intangible aspects of the diving experience and should focus on them in its marketing, product development, and day-to-day diving activities. In addition, they cannot neglect the aesthetic value of the dive sites because they are one of the most crucial factors in convincing visitors to come to the destination, so their maintenance should be considered a priority [62]. The diving industry can use the theme of newness in marketing strategies and keep the market up to date with product changes and new opportunities through social media, e.g., Facebook, Twitter, and Instagram [61]. Besides that, they should motivate tourists to share their positive experiences and stories with others using the same communication platforms, because satisfaction significantly influences storytelling intention [63].

The case studies analysed deal with a “very rigid economic system”. In the Portofino MPA, the resident population recognises the relevance of the marine environment to their livelihoods but, antagonistically, does not want the tourism sector to be regulated. There are few employment opportunities, mainly because they do not invest in innovation and because the local population mostly serves only high-income tourists. Moreover, the facilities of the tour operators are located outside the area in which they operate, which excludes the participation of the population in the operations and, consequently, has resulted in a decrease in the number of residents in Liguria [3] [64]. But the economic benefits of recreational diving (when professionally managed) for the coastal tourism sector can translate into multiple gains for the local population. This is more significant in the case of poorly diversified, small island economies.

7. Stakeholder Engagement

Another, no less important management action, stakeholder engagement, includes the measures related to the involvement of all stakeholders related to the SDTS, stakeholders contributing with social and cultural resources, and government (e.g., policymakers and managers). Since 2014, the focus on the importance of effective stakeholder engagement in more sustainable management of diving activity has increased [48]. The measures analysed suggest that the work of stakeholders needs integration (e.g., managers with dive operators, scientists with policymakers) to identify the desired ecological and social states for a given region and/or dive site. This is in line with what is suggested by Augustine et al. (2016) [65]. Stakeholders like scientists and policymakers need to be open to the use of different approaches, such as empirical knowledge from stakeholders, expert judgement, policies in place, habitat and/or species mapping, and spatially explicit modelling, to demonstrate how the integrity of the marine environment is interlinked with human well-being. With the knowledge acquired, the gaps can be filled with balanced management measures at all levels, ecological, social, and economic, as suggested by [66]. In decision-making processes, with respect to marine spatial planning, dive operators should be consulted [67]. It is essential that there are effective communication channels between all stakeholders [3] and that all, especially local ones, are included through consultation and public participation during the entire planning process, as argued by Tsilimigkas and Rempis (2021) [68]. Furthermore, management rules need to be transparent, and the form of communication should be as clear as possible, as stakeholders are often concerned about corruption and mismanagement of the activity. An example of an important stakeholder contribution is when developing a code of conduct (e.g., region-specific, site-specific) [69]. In conclusion, different authors agree that there is a need for a conversation between all stakeholders in dive tourism about the steps to take to obtain a more sustainable dive industry.

8. Zoning

Management measures could have another field of action besides that presented above. In the research performed, the authors find that spatial zoning strategies and spatial planning tools like temporal zoning are used in diving activity management. For example, managers can rearrange the diving district/zone for each dive through spatial zoning strategies to permit divers to be visible at one time. This measure reduces the number of diver

encounters without reducing the number of permitted divers in each dive site [50]. Also, it can be applied to separate divers through spatial zoning for interpersonal conflict resolution, as mentioned above and according to [70][71][72]. Zoning can also be used to identify dive sites that are sensitive to divers' impacts and where diving should not occur, such as shallow-water, coral-rich zones [73]. It can still contribute in another way to the activity for [74]; an appropriate zoning scheme with established criteria for the use of local ecosystem services (considering the specific environmental and socioeconomic conditions) could be a good measure for small islands with fragile ecosystems.

Temporal zoning, in conjunction with increased fees, could be implemented to decrease usage and maintain the profitability of dive sites and access for dive operators [72][75]. This measure and the staggering of visiting times are solutions that have also proved effective in resolving interpersonal conflicts at dive sites [20]. For Ha et al. (2020) [76], diving tourism destinations should implement zoning systems based on the perspective of spatial behaviour. In conclusion, the measures analysed show that it is possible to implement zoning strategies in diving destinations and simultaneously make a profit from their implementation, for example, through the implementation of temporal zoning alongside fees. Also, zoning can be an efficient way of organising dive operations at dive sites, avoiding interpersonal conflicts between divers.

9. Governance and Public Policy

Under the umbrella of the management action group, governance, and public policy tools, the measures analysed have a focus on developing and redesigning appropriate policy instruments, such as policies/rules and legislation/regulation of diving activity, as well as measures that suggest surveillance of the compliance of these instruments after their implementation. Scuba diving tourism is mostly a self-regulated, market-oriented activity, with operators accepting common standards for the training and safety of participants [70]. Evidence of the negative environmental impacts of scuba diving led training organisations to develop guidelines for best practices and the Green Fins code of conduct, with the main purpose of mitigating the effects on coral reefs [77]. Enforcing marine park regulations and promoting site substitution policies was suggested by Abidin and Mohamed (2014) [39].

In a case study of the Azores scuba diving industry, the first step to manage shark diving activity is designing appropriate legal frameworks, according to Bentz et al. (2013) [22]. For these authors, laws/rules can lead to mandatory controls on the number, qualifications, and operations of shark diving businesses, but only if compliance with the law and the rules developed and implemented is subsequently monitored.

Another avenue for public policy is a regime that licenses scuba operators, considering the environmental state and the diving pressure in a particular spot [78]. Compliance with regulations and surveillance of the industry activity is another proposed avenue [79]. Conservation of marine life through the creation of MPAs and their effective management is becoming more relevant in the Caribbean Sea and the Indian and Pacific Oceans, either using regulatory public instruments, community initiatives, or private third parties. In summary, as argued by Lucrezi and Saayman (2017) [78], there is an ongoing debate on different approaches for governance, such as the self-regulatory framework [80], third-party control of the industry [47][80], and a meta-governance framework as suggested

by Hunt et al. (2013) [77]. The high growth of scuba diving tourism in both protected and unprotected areas creates an urgent need for policies that address the impacts of divers and diving operations on marine biodiversity and habitats to allow preservation of diving sites. Yet caution is need when designing or reformulating policies so that they do not undermine the different key elements of the SDTS.

10. Adaptive Management Approaches and Economic Values/Mechanisms

The literature review also showed that there is a greater focus on adaptive management measures for diving activity. Adaptive management is an iterative process of change in management actions/measures based on continuous monitoring and new practices centred on social learning. Adaptive management benefits from stakeholder participation and addresses environmental, social, and economic concerns. That is why an increasing demand for management frameworks in the context of scuba diving and empirical studies to develop synthetic indicators [81] provides a more structured approach to assist managers and stakeholders in developing mitigating and adaptive actions. The following managing frameworks have been identified in previous studies: (i) a carrying capacity approach [8][43][82] (ii) a limits of acceptable change management framework [81][83], (iii) a percentile-based management framework [84], (iv) a discriminatory pricing framework [42], (v) a systems approach to collaborative management [45], and (vi) an adaptive management framework [85]. Also, adaptive dive management must be based on the characteristics/particularities of each dive site because each dive site has its own identity. Furthermore, it should be evaluated through scientific monitoring [86].

Integrated coastal management (ICM) plans and dive plans for diving sites are also listed in the literature as good management strategies [87][88][89]. This type of plan can have different contents and should take into consideration certain aspects, such as the importance of beginner and occasional diving tourism [90]; the marine conditions to which divers are exposed and whether they correspond to their level of certification (e.g., training of divers and introductory dives should occur in places with no coral cover) [87][90]; and the damage of marine ecosystems by divers, which can be avoided through educational interpretative tools [89]. The implementation of artificial coral reefs is another strategy often referred to in the literature. These artificial structures can mitigate the negative impacts caused by divers on nature [25][39] and, consequently, reduce stress levels [87]. They are sometimes present at or close to dive sites (e.g., shipwrecks, anchors); however, their construction is allowed if they do not occur spontaneously. It is quite possible that in the near future it will be necessary to implement artificial reefs in MPAs to give the dive hotspots time to recover [70]. This action involves diverting divers from overloaded reef zones to artificial areas, as recommended by the authors of [91]. The list of management approaches does not end here. An adequate system of discriminatory fees and prices to attract divers could be a strategic tool to control the number of visitors, thus mitigating possible damage to the ecosystem [57][75][92][93]. It constitutes a feasible management response to decrease encounters between divers without leading to a reduction in the total number of divers simultaneously at the same dive site [50]. Fees collected from the activity can be used for the preservation and maintenance of coral reefs, including proper monitoring and awareness-raising campaigns targeting the industry for developing more sustainable activity, as is suggested by the literature [25]. Another solution to achieve better

management of sensitive ecosystems is “no-take marine reserves”, where fishing and diving activities are totally banned [17][94].

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