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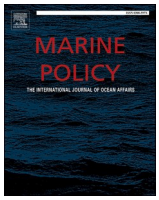

The bumpy road to conservation: Challenges and opportunities in updating the Galapagos zoning system

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ABSTRACT

In 2014, the Galapagos National Park Directorate, sponsored by various international non-governmental organizations, initiated a comprehensive marine and terrestrial spatial planning process to improve the management effectiveness of Galapagos' protected areas. This effort aimed to reconfigure management areas by expanding or redistributing no-take zones to protect Key Biodiversity Areas and ensure the conservation of at least 30% of terrestrial and marine ecosystems in the Galapagos. However, this process encountered significant challenges, notably the erosion of fishers' trust following the implementation of a "Marine Sanctuary". This top-down decision resulted in socio-political tension, compelling the Ecuadorian government to delay the implementation of the new marine zoning until there was conclusive scientific data on its socio-economic impact on local small-scale fishers' livelihoods. This paper examines the achievements and shortcomings of the Galapagos zoning update process, highlighting the successful integration of scientific zoning criteria and the enhanced protection of critical biodiversity areas, together with the reduced support from fishers and legal disputes. To move forward, we recommended a bottom-up approach centered on rebuilding trust among the fishing community via innovative engagement strategies and the introduction of market incentives to promote sustainable practices. Assessing the long-term impact of no-take zones is essential for refining management approaches. Additionally, the application of cutting-edge technology within an adaptive co-management model is recommended to improve fisheries and ecological data gathering and analysis, facilitating proactive and well-informed management decisions. Our suggestions aim to reconcile conservation objectives with the needs and aspirations of the local communities in this iconic archipelago.

1. Introduction

Ecosystem-based spatial management (EBSM) represents a well-established strategy for the integrated and planned approach to the governance of a wide range of human activities in spatially demarcated coastal and marine areas [1]. A cornerstone for implementing an EBSM approach is the use of Marine Protected Areas (MPAs), which can be divided into two primary categories [2,3]: (1) no-take zones or marine reserves, where all extractive activities are forbidden within a specified area, and (2) multiple-use MPAs, which permit regulated activities typically under marine zoning schemes and may incorporate no-take zones. In this regard, marine zoning, also termed ocean zoning, is defined as a spatially explicit tool involving regulatory measures to enact marine spatial plans [2]. These plans determine different uses or levels of use for various zones across all management areas of the target ecosystems.

The effectiveness of MPAs, particularly when integrated with co-management regimes, is increasingly recognized for its potential to recover depleted marine populations and safeguard areas of ecological significance [4–7]. However, it is also acknowledged that MPAs are not a one-size-fits-all solution for marine conservation challenges, as their effectiveness varies according to their design [5,8], and across different environmental and social contexts [9,10]. For MPAs to be successful, a holistic approach that integrates ecological and socio-economic considerations is critical [11,12]. Success hinges on active stakeholder engagement, effective enforcement mechanisms, applying scientific research for strategic planning and decision-making, and adopting adaptive co-management practices to address unforeseen ecological and

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socio-economic challenges [5,13,14]. Moreover, creating a proper set of incentives for communities affected by MPA regulations [15], and promoting education and public awareness is required for building public support [16]. Integrating MPAs within larger marine spatial planning efforts is also critical, enabling a comprehensive strategy that not only aims to protect biodiversity but also enhances the livelihoods and well-being of communities reliant on marine ecosystem services [12,13]. This ecosystem-based approach highlights the importance of a holistic and adaptive strategy in marine conservation, reflecting the complex interdependencies between marine biodiversity and human societies.

The Galapagos Marine Reserve (GMR) represents a global beacon for marine conservation. Established in March 1998, the GMR is notable for its unique biodiversity and as a key area for studying climate change impacts [17–19]. This makes it an exceptional case study for understanding the challenges and social-ecological impacts of implementing Marine Protected Areas (MPAs), particularly in the context of Latin America and the Caribbean.

In 2014, the Galapagos National Park Directorate (GNPD), sponsored by international non-governmental organizations (NGOs), officially initiated a participatory marine and terrestrial spatial planning process to improve the management effectiveness of Galapagos protected areas. A set of goals, objectives, and indicators were established based on scientific literature and international marine spatial planning experts' advice to adapt the marine zoning design [20]. After ten years, this participatory process is close to providing an updated reconfiguration of management areas, including the creation, expansion, or redistribution of no-take zones to protect new Key Biodiversity Areas (KBAs) and to ensure the conservation of at least 30% of all terrestrial and marine ecosystems of Galapagos (e.g., mangroves, corals, etc.), defined by the GNPD as "environmental units" [20]. KBAs represent globally significant sites for conserving biodiversity, identified through standardized criteria focusing on species and habitats critical for conservation [21].

However, the top-down implementation of a "Marine Sanctuary" in the Far Northern bioregion of the archipelago has affected fishers' trust and buy-in on the new Galapagos zoning system [22], particularly given inconclusive scientific evidence about the social-ecological impact of no-take zones [23]. The resulting socio-political pressure forced the Minister of Environment to postpone implementation of the new marine zoning until GNPD provides scientific evidence about the potential impact of the new network of no-take zones on local small-scale fishers' livelihoods.

This study assesses the progress and challenges in updating the Galapagos marine zoning. It aims to highlight key barriers that have delayed the effective implementation of the revised zoning system in the Galapagos. Drawing from these insights, the study offers strategic recommendations to expedite and complete the update process, emphasizing the necessity for it to be participatory, inclusive, and transparent. Implementing such a management approach is expected to strengthen the acceptance, credibility, and compliance with the new zoning plan, thereby improving its overall management effectiveness. This critical review draws on the previous insights and recommendations of Castrejón and Charles [23]. They examined the effectiveness of the former Galapagos marine zoning against a set of five foundational evaluation criteria (effective planning, monitoring, execution, evaluation, and adaptation), deemed crucial for the successful application of an EBSM approach [24].

This paper applies the Ehler and Douvere [24] marine spatial planning framework to examine the Galapagos zoning updating process. By offering a detailed case study on the practical application of marine spatial planning, this paper enriches discussions on marine spatial strategies by illustrating the integration challenges of applying an EBSM approach into the Galapagos' socio-ecological system. It details the update process of the Galapagos zoning system, analyzes its participatory approach and outcomes, offers forward-looking recommendations, and provides insights for the adaptive co-management of protected areas.

2. The Galapagos marine zoning

The GMR represents a 138,872 km^2 multiple-use MPA, located approximately 1200 km west of mainland Ecuador [20]. Between 2000 and 2006, marine zoning was implemented within its boundaries (Fig. 1). This initiative was integrated with a co-management system that granted exclusive fishing rights to local small-scale fishers, aiming to protect biodiversity and support sustainable fisheries [23,25]. However, the effectiveness of this zoning was undermined by the biased location of no-take zones in areas lacking key fishery resources [26], such as sea cucumbers and spiny lobsters, combined with poor enforcement and high non-compliance [27]. Furthermore, while coastal management subzones were established, their offshore extents were not defined [28], leading to overlaps in areas designated for conservation, tourism, and fishing due to the complex geography of the Galapagos [40]. This resulted in enforcement and compliance challenges within the marine zoning framework [20].

In 2014, the GNPD launched a marine and terrestrial spatial planning process with assistance from international NGOs. Initially targeted for completion by 2016, this initiative has faced delays due to socio-political and institutional challenges, leaving the new Galapagos zoning system unimplemented as of February 2023. The goal is to integrate the protected areas under a unified zoning system, applying social-ecological system (SES) and EBSM approaches. The SES approach acknowledges the complex, bidirectional interaction between human and ecological systems [29], where human actions impact ecosystems and vice versa, thus promoting a holistic approach to environmental management and sustainability [12].

Subsequent subsections examine the Galapagos zoning updating process, guided by Ehler and Douvere's [24] methodological framework, which breaks down marine spatial planning into ten stages. This examination draws on information from GNPD [20], Burbano et al. [22], and firsthand observations, presenting an in-depth case study on marine spatial planning's practical application. [28]

3. Updating the Galapagos zoning system

3.1. Identifying needs and responsibilities

The initial stage of the Galapagos zoning updating process focused on unifying the archipelago's marine and terrestrial protected areas under a single zoning system and clarifying the roles of government and NGOs during the planning. In 2005, the GNPD introduced a management plan incorporating a SES approach for terrestrial protection [30]. By 2013, this approach extended to integrating the Galapagos National Park and the GMR under the "Management Plan for Galapagos Protected Areas for Good Living" [31].

Despite plans for early revision [28], the marine zoning adaptation occurred gradually through an iterative "learning by doing" process, influenced by management effectiveness assessments [32]. These assessments highlighted the need for the integration of terrestrial and marine protected areas to improve their management effectiveness.

Operationally, the zoning system aimed to simplify the marine and terrestrial zoning design for better cost-efficiency in monitoring and surveillance, and to standardize management area names for clarity among stakeholders [20]. Conceptually, the GNPD aimed to integrate protected and inhabited areas under an SES approach, viewing the Galapagos as a complex interplay of social and ecological subsystems [20]. This approach helped policymakers and stakeholders to realize they are part of, dependent on, and have an impact on the terrestrial and marine ecosystems in which they live, work, and play, making clear the need to manage Galapagos as a complex SES [12,30].

Structurally, the revision of the zoning system prioritized expanding no-take zones to protect a greater number of KBAs and to conserve at

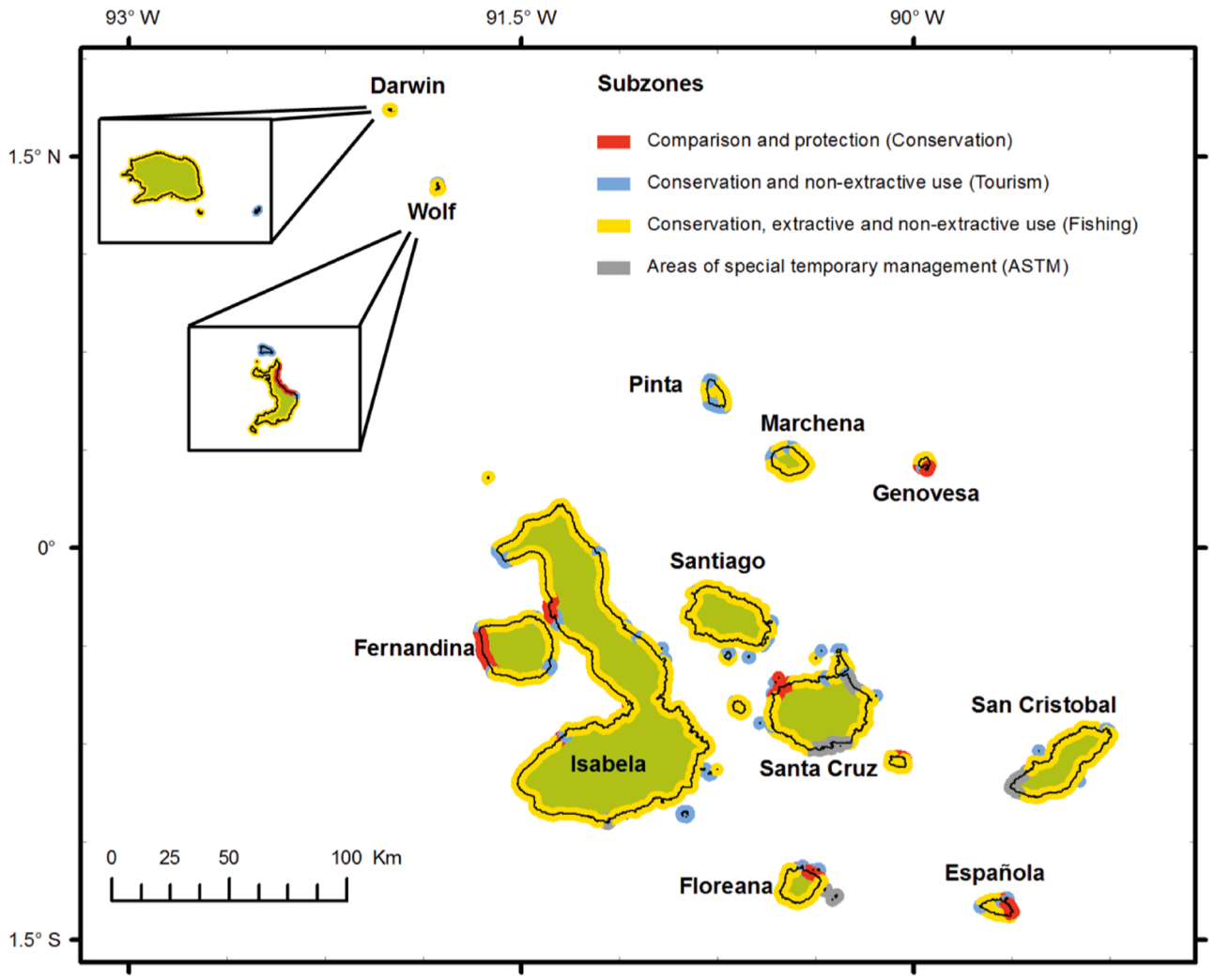

Fig. 1. Marine zoning of the Galapagos Marine Reserve, established between 2000 and 2006. Source: Castrejón and Charles [23].

least 30% of environmental units (e.g., corals, mangroves) across all five bioregions of the GMR as identified by Edgar et al. [33]. Special attention was given to critical habitats like seamounts and hydrothermal vents [20]. This was part of a broader effort to align the location of conservation zones across the Galapagos National Park and Marine Reserve, emphasizing a precautionary approach to biodiversity conservation.

3.2. Obtaining technical and financial support

The second stage focused on securing financial support for the Galapagos zoning updating process. Due to budgetary limitations, the GNPD struggled to fully fund the zoning system revision. In response, the World Wildlife Foundation (WWF) and Conservation International (CI) provided essential technical and financial support, covering facilitation, communication, data analysis, and compilation. Additionally, the Charles Darwin Foundation (CDF) performed spatial analyses to identify areas of high biodiversity [34]. Most of these activities were financed by the Leona M. and Harry B. Helmsley Charitable Trust.

3.3. Pre-planning of the process

During the "pre-planning" stage of the Galapagos zoning system update, the GNPD adopted an objective-based approach as foundation for the subsequent spatial planning steps. This stage started with the formation of a multidisciplinary team comprising biologists, ecologists, geographers, economists, and planners from government and NGOs. This team was responsible for crafting a work plan. While a year was allocated for the work plan's execution, the timeline encountered shifts, largely prompted by institutional and socio-political disruptions. These included the Galapagos Special Law revision spanning from 2009 to 2015, the prelude to Ecuador's 2017 presidential elections commencing in late 2015, and institutional instability evidenced by the appointment of five Environment Ministers and six GNPD's directors from November 2012 to December 2018 [22].

The planning process was guided by goals, objectives, and indicators aimed at prioritizing ecosystem and biodiversity preservation to support sustainable community welfare (Table 1), drawing on insights from academic research and expert consultations [20,35]. The final step of

Table 1
Objectives and indicators set up to guide the updating process of the Galapagos zoning system. Source: DPNG [20].

Objective	Indicator
• Guaranteeing representative protection of Galapagos environmental units. • Maximize the protection of endemic and/or endangered species. • Ensuring conservation zones are adequately sized to conserve biodiversity.	• 30% of all environmental units are included in conservation zones. • Maximize protection of KBAs. • All conservation zones must have an area of at least 100 km^2.

this stage was the redefinition of the Galapagos terrestrial and marine zoning system into Transition, Sustainable use, Conservation, and Intangible zones (Table 2), designed to balance environmental conservation with sustainable human activity [20].

3.4. Organizing stakeholder participation

The GNPD executed a stakeholder engagement strategy, consisting of three distinct phases: involvement, participation, and socialization [20]. During the involvement phase, the GNPD organized informative workshops in Santa Cruz, San Cristobal, and Isabela Islands, attracting approximately 38% of the invited 285 individuals [20]. These workshops aimed to educate various stakeholders—park rangers, fishers, naturalist guides, and others—on the integration of Galapagos protected areas into a unified zoning system and to collect their feedback. Given the differing protection statuses between the GMR (multiple uses) and the GNP (fully protected), discussions primarily revolved around marine zoning. Insights from this phase informed the drafting of a preliminary Galapagos zoning proposal [22].

The participation phase involved creating a "core group" of officials from key governmental bodies to review and approve the spatial planning team's technical inputs. Additionally, a participatory mapping initiative was launched with stakeholders, notably fishers, utilizing SeaSketch — a web-mapping tool used in marine spatial planning for data collection and collaborative design of science-based marine zoning scenarios [36]. Through SeaSketch, the team collated spatial data on the most important fishing grounds for the Galapagos small-scale fishing sector, aiding in the evaluation of present and prospective conditions (Stage 5). This phase included 20 multi-stakeholder workshops across the three islands, attended by 307 individuals (41% of those invited) [29].

3.5. Defining and analysing existing and future conditions

After establishing the goals, objectives, and indicators, the spatial planning team developed a preliminary zoning proposal, known as the GNPD zoning proposal, to integrate the terrestrial and marine protected areas into a unified system. This initial proposal focused on ensuring the distribution and representativeness of significant habitats and the protection of KBAs across the Galapagos. In addition to these primary considerations, the proposal also considered several supplementary criteria: the long-term preservation of established no-take zones, the protection of contiguous habitats crucial for species with multi-habitat life cycles, the coverage of all environmental units/habitats, the size and coverage percentage of conservation zones, and the socio-economic impacts and surveillance costs of different zoning scenarios [37]. This comprehensive approach was designed to maintain a balance between conserving vulnerable ecosystems and species and accommodating the socio-economic needs and practices of the local communities [37].

The GNPD zoning proposal underwent scrutiny through participatory mapping exercises (Stage 4), with stakeholder inputs processed via the SeaSketch tool. This facilitated the refinement of the proposal and the development of alternative zoning scenarios (Fig. 2a). The evaluation of these alternatives involved a trade-off analysis, examining if they satisfied the established criteria and aligned with the overarching goals of the updated zoning initiative, aiming for ecological sustainability and socio-economic viability [37].

Table 2
Objectives and indicators set up to guide the updating process of the Galapagos zoning system. Source: DPNG [20].

Management zone	Definition
Transition zones	Buffer zones that connect the protected and inhabited areas of the Galapagos. In these zones, all human activities permitted by the Galapagos management plan can be undertaken, under regulations established by the corresponding authorities.
Sustainable use zones	Multiple-use management areas are located within Galapagos' marine and terrestrial protected areas. Both extractive and non-extractive activities can proceed, but they must follow the regulations outlined in the Galapagos management plan, ensuring the sustainable utilization of ecosystem services.
Conservation zones	No-take zones that allow only non-extractive activities. Exceptions are carved out for initiatives targeting the elimination of invasive and non-native species. Notable instances include hunting goats and harvesting timber from the Spanish cedar (*Cedrela odorata*).
Intangible zones	Holding the strictest conservation guidelines, these no-take zones prohibit both extractive and non-extractive operations. The single exception is scientific research, which is subject to stringent regulations as set by the Galapagos management plan.

3.6. Preparing and approving the new Galapagos zoning system

In January 2016, the GNPD, in partnership with NGOs, began the process of socializing the fine-tuned zoning proposal with the fishing sector of Santa Cruz, San Cristobal, and Isabela. This proposal comprised both multiple-use management areas (transition and sustainable use zones) and an array of no-take zones across the archipelago (conservation and intangible zones). Notably, the proposal featured a unique no-take zone surrounding Darwin and Wolf Islands (Fig. 2a).

4. External shocks and repercussions

4.1. From a bottom-up to a top-down governance approach

The participatory zoning process in the Galapagos took an unexpected disruption due to the intervention of National Geographic's Pristine Seas Project and a notable Spanish singer and conservation advocate. They met privately with the President of Ecuador to advocate for the creation of a large "Marine Sanctuary" around Darwin and Wolf Islands and nearby seamounts, aiming to safeguard the area's dense shark populations [22]. This advocacy was backed by a 21-day marine expedition by the project in December 2015, which highlighted the archipelago's unique marine biodiversity through a documentary, supported by the Charles Darwin Foundation [22]. The urgency for protection was underscored by research highlighting the threats of illegal fishing to the shark populations and their vital role in the tourism economy [38,39]

In March 2016, the President of Ecuador responded by unexpectedly declaring a "Marine Sanctuary" in the Far Northern archipelago, bypassing the established criteria for zoning selection which focused on cost-effectiveness, efficiency, and fairness [24,37]. This decision marked a significant shift in the Galapagos zoning process, transitioning from a bottom-up to a top-down governance approach, fundamentally altering the trajectory of the subsequent stages of the Galapagos zoning updating process.

4.2. Negotiation process and promised compensation

On March 5th, 2016, a crucial meeting took place involving authorities from the Ministry of Environment, the Ministry of Tourism, the Ministry of Agriculture, Livestock and Fisheries (MAGAP), and the Governing Council of the Special Regime from Galapagos (CGREG), along with representatives from the small-scale fishing sector. The goal was to negotiate the establishment of the proposed Marine Sanctuary, with an agreement eventually reached that included compensation for the small-scale fishers to mitigate the sanctuary's impact on their livelihoods.

Following these discussions, the Marine Sanctuary was officially established by Presidential Decree No. 968 on March 21st, 2016. The decree assigned the Minister of Environment the task of defining the sanctuary's regulations, integrating it as a no-take zone within the

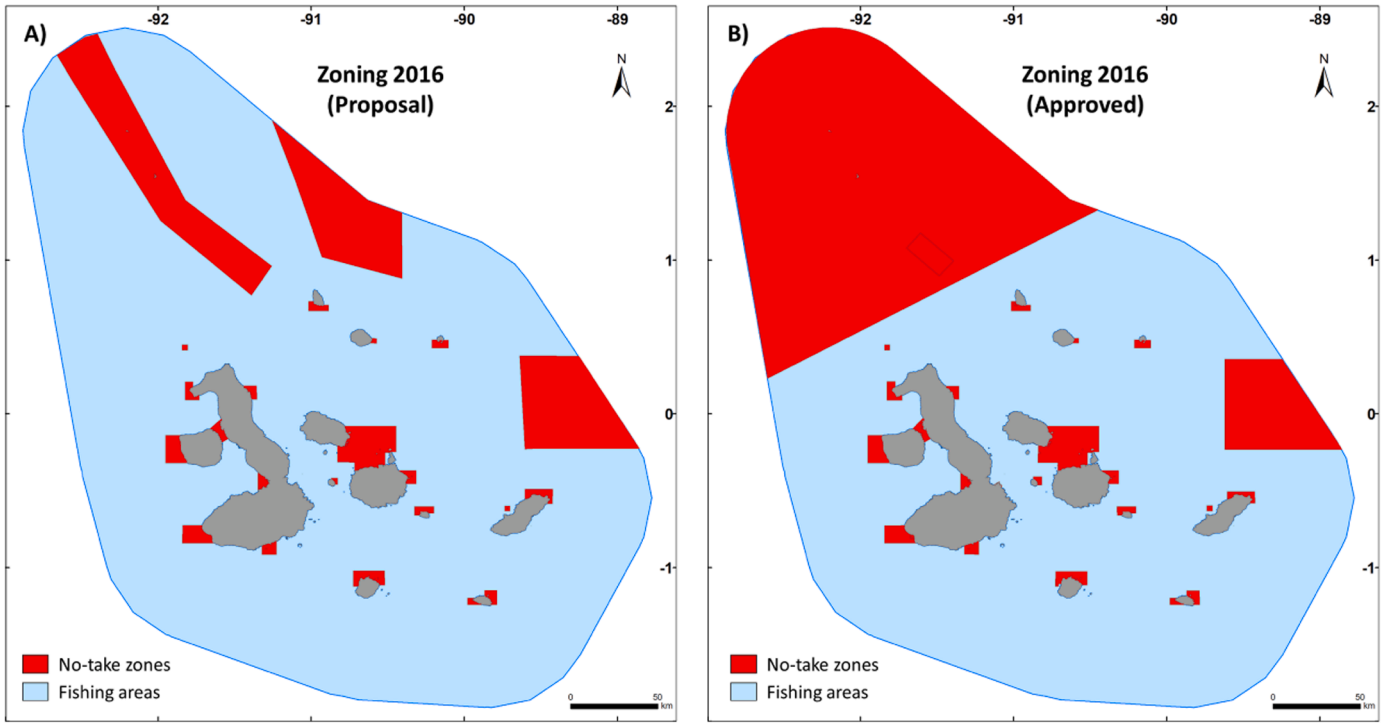

Fig. 2. The most relevant scenarios of no-take zones proposed for the new Galapagos zoning: A) zoning proposal developed by the GNPD with SeaSketch [37], and B) the official zoning plan enacted by the Minister of Environment on March 23rd, 2016 (Ministerial Agreement 026-A). For comparative purposes, this figure exclusively illustrates the location of no-take zones located in Conservation zones and Intangible zones. The blue area represents the Sustainable use zones (open fishing areas).

Galapagos' revised zoning plan (Fig. 2b). Despite initial resistance from the GNPD due to the top-down nature of the sanctuary's establishment, they were legally compelled to adjust the zoning plan accordingly.

By March 23rd, 2016, the Minister of Environment ratified the new zoning system through Ministerial Agreement 026-A, delineating 35 Conservation zones and 18 Intangible zones. This agreement also outlined the implementation of 14 compensation measures within 90 days. To oversee these measures, an inter-institutional team named the "Secretary of the 90 days" was formed, involving the GNPD, Ministry of Tourism, MAGAP, and CGREG.

The compensation measures aimed to support the tuna fishery development, including the installation of Fish Aggregating Devices (FADs) and a fisheries research plan. They also sought to improve fishery product commercialization through eco-labeling and certification of origin initiatives, reform the Special Fishing Regulation, introduce a new fisheries management plan ("Five-year Fishing Calendar"), authorize tuna fishing outside GMR's boundaries, implement Automatic Information Systems (AIS) for tracking fishing vessel activities, the allocation of associative tourist operation permits and mandated the local consumption of certified fish by the tourism sector. Furthermore, it outlined support for the small-scale fishing sector through credit lines, training and organizational support for fishing cooperatives, live lobster market development, and the establishment of a "Compensation and Transition Fund."

4.3. Opposition to the zoning process and responses

In April 2016, the GNPD launched the "Island per Island" communication strategy to introduce residents of each inhabited island to the new Galapagos zoning system [20]. However, the final zoning system, approved by the Minister of Environment, diverged from the GNPD's initial proposal, sparking confusion and opposition among grassroots fishers who felt the system was imposed on them [22]. This led to socio-political tensions, prompting the Minister of Environment to declare a one-year moratorium starting September 1st, 2016, for consultation and renegotiation, excluding the Marine Sanctuary which could only be modified by presidential decree. Mistrust towards the GNPD and NGOs, combined with leadership instability, further hindered the implementation of the updated Galapagos zoning system [22].

The controversy escalated when a National Assembly member for Galapagos challenged the constitutionality of the zoning system in November 2016, arguing it exceeded the Minister's authority and infringed on fishers' rights. However, the Constitutional Court upheld the zoning system in December 2021. Following the Court's decision, the fishing community organized a peaceful protest, leading to the establishment of a roadmap in June 2022 for reevaluating no-take zones, especially in crucial fishing grounds. The fishing sector called for scientific justifications for the closure of these zones and proposed modifications, including a reassessment of the Marine Sanctuary's designation and the potential for temporary no-take zones.

In response to these suggestions, the GNPD committed to providing the ecological and biological rationale for establishing no-take zones and assessing their potential economic impact on fishers' livelihoods. Despite efforts to finalize key activities such as impact reports and multi-stakeholder workshops by July 2023, the process remains incomplete as of March 2024. The new Galapagos zoning system's effective implementation is still pending, reflecting ongoing discussions and the need for consensus among stakeholders.

5. Assessing the new zoning system

This section examines the achievements and shortcomings intrinsic to the marine and terrestrial spatial planning process, from a perspective of how adaptive co-management could support "learning by doing" for the Galapagos' protected and inhabited areas.

5.1. Achievements

5.1.1. Strategic and integrated approach

One of the most relevant achievements of the process of developing the new Galapagos zoning system is the pioneering adoption of SES and EBSM approaches. The GNPD, in collaboration with other governmental bodies and NGOs, crafted a strategic, holistic, and foresighted plan to oversee both marine and terrestrial protected spaces, inclusive of inhabited territories, as a singular, multifaceted SES. This sought to achieve the mission of ensuring the conservation of Galapagos' distinctive ecosystems, preserving their vitality, productivity, and adaptability, and safeguarding their environmental services that underpin the well-being and sustainable growth of local communities [20]. When implemented with efficacy, this managerial approach promises to harmonize potential conflicting interests, mitigate the overarching influence of human activities, augment sustainable socio-economic expansion, and fortify biologically and ecologically vulnerable marine and terrestrial ecosystems.

5.1.2. Science-based management of zones

A significant shortcoming of the former Galapagos marine zoning was its lack of reliance on scientific criteria for establishing conservation areas [26]. No-take zones were demarcated in areas either sparse in high-value commercial species, like sea cucumbers and spiny lobsters, or abundant in tourism-centric species like sharks – often to mitigate concerns held by fishers, tourism entrepreneurs, and recreational divers regarding potential impacts of no-take zones on their livelihoods [26]. On the other hand, the new Galapagos zoning' design was guided by a comprehensive suite of aims, targets, and benchmarks, built in the scientific literature and international marine spatial planning experts' advice, and linked to the vision and principles of the current Galapagos management plan. In addition, eight scientific criteria were defined by the GNPD to guide the definition of management zones within the new Galapagos zoning (Table 3). These criteria have replaced the previous approach that earmarked zones based on economic interests, marking a significant shift towards a science-based management strategy.

5.1.3. Better representativity and connectivity

Guided by the science-based criteria described in Table 4, approximately 30% of each Galapagos marine and terrestrial environmental unit has been designated either as a conservation or an intangible zone, i.e., no-take zones [20]. Two exceptions to this broad categorization are the oceanic seamounts and rocky bottoms, which have been demarcated as no-take zones only over 14.3% and 25.6% of their total areas, respectively [20]. In contrast, an overwhelming 75% of the coastal lagoons were allocated as conservation zones, emphasizing their indispensable roles as breeding, nursery, and feeding grounds for a diverse array of marine species, including juvenile stages of blacktip (*Carcharhinus limbatus*) and hammerhead (*Sphyrna lewini*) sharks, commercial finfish species like sailfin grouper (*Mycteroperca olfax*) and snappers (*Lutjanus novemfasciatus*), and flamingos (*Phoenicopterus ruber*) [40–43]. Another significant improvement is the protection of a substantial fraction of seamounts, especially those located in the Galapagos coastal zone. This signifies a crucial move in enhancing the representability and connectivity of critical habitats and the abundant biodiversity they support [20].

5.1.4. Increased protection for threatened species and critical habitats

The former marine zoning protected 27 of the 38 inshore KBAs identified by Edgar et al. [33] across the Galapagos. Following these authors' call to safeguard all KBAs by allocating 1.9% of fishing grounds as no-take zones, the new Galapagos zoning system offers protection to 32 of the 38 inshore KBAs [20].

In terms of metrics, the former marine zoning encompassed 0.96% of the GMR as no-take zones (Fig. 3), equivalent to 1323 km^2 [44]. In contrast, the new Galapagos zoning system established 32.7% of the total marine protected area as a network of no-take zones (Fig. 2), designated as Conservation and Intangible zones (Table 4). This percentage is equivalent to 45,380.02 km^2 (Table 4), wherein 84.9% (38,546.49 km^2) corresponds to the Marine Sanctuary in the north. Concurrently, 58.2% of the total terrestrial protected area was declared as Conservation and Intangible zones (Table 4). This is a marked increase from the limited 10.8% of the total terrestrial protected area dedicated to conservation and restoration in the former terrestrial zoning system. Consequently, the revised Galapagos zoning model promises enhanced protection for numerous vulnerable species and critical habitats. These vital ecosystems, previously overlooked by the former zoning systems, are now encompassed within no-take zones, accounting for an estimated 34% of the entire terrestrial and marine areas of the archipelago (Table 4).

Table 3
Scientific criteria to define management zones within the Galapagos zoning system. Source: DPNG [20].

Criteria	Definition
Development of extractive activities	Extractive activities like fishing, hunting, mining, and logging are allowed in transition and sustainable use zones. However, hunting and logging are permitted in the conservation zone of the Galapagos National Park because both contribute to controlling the expansion of invasive species.
Fragility	Environmental units with low resilience and high vulnerability to perturbations caused by anthropogenic activities. The identification of these areas was based on the number and conservation status of endemic species and the location of Key Biodiversity Areas.
Representativity	A network of terrestrial and marine areas representing the different environmental units that reasonably reflect the full range of ecosystems existing in the Galapagos.
Connectivity	A network of terrestrial and marine areas linked by exchanges of larvae and migration of juveniles and adults, according to their life cycles. To keep the connectivity between conservation zones, a maximum lineal distance of 100 km between no-take zones was established as an attribute for this criterion.
Size and form of no-take zones	Guidelines for the definition of no-take zones were established to protect most of the distribution range and life cycle of marine and terrestrial biodiversity and reduce the vulnerability of Key Biodiversity Areas. In the marine area, it was established that conservation zones should not have an area lower than 50 km^2. In contrast, conservation zones should not have an area lower than 5 km^2 in the terrestrial area. In terms of form, the geometry of conservation areas should be the simplest possible, following latitude and longitude lines.
Development of public use	This criterion refers to the spatial location of visiting sites.
Presence of infrastructure and equipment for public service	This criterion spatially identifies the sites where there are infrastructure and facilities for the management of protected areas and public service, including the administrative and logistical infrastructure of the GNPD and Charles Darwin Foundation, breeding and interpretation centres, roads, shipping routes, electricity, and drinking water networks, sanitation and treatment plants, recycling centre, landfills, and telecommunication infrastructure.

Table 4
Total estimated area (in km^2) within the management zones of the new Galapagos zoning system. Source: DPNG [20].

Management zones	Land area	%	Marine area	%	Total	%
Transition	469.73	6.08	28.43	0.02	498.16	0.3
Sustainable use	2757.91	35.69	93463.63	67.30	96221.55	65.6
Conservation	4059.61	52.54	44892.60	32.33	48952.22	33.4
Intangible	439.53	5.69	487.42	0.35	926.95	0.6
Total	7726.78	100.00	138872.08	100.00	146598.86	100.0

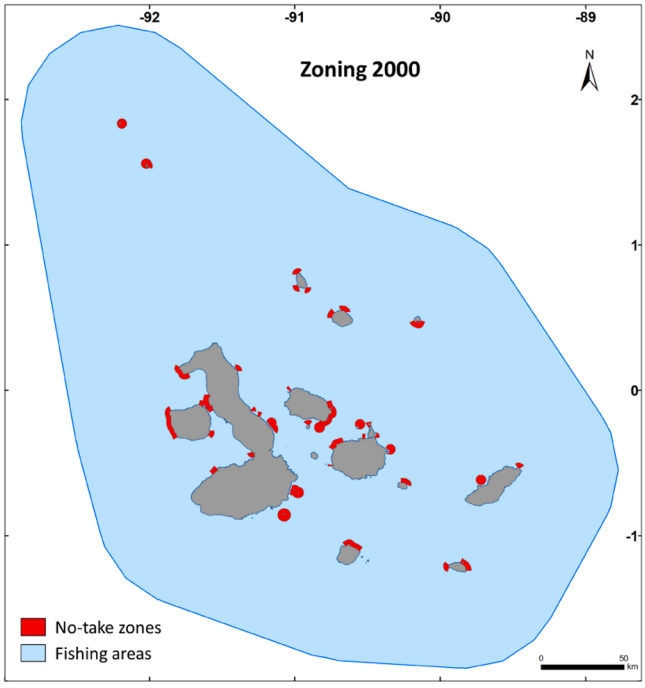

Fig. 3. Network of no-take zones of the former marine zoning of the Galapagos Marine Reserve, established between 2000 and 2006.

5.2. Shortcomings

5.2.1. Poor compliance and missing incentives

Despite advancements in surveillance and legal mechanisms to enforce Galapagos marine zoning, illegal fishing activities persist around and within GMR boundaries [45–49]. Efforts have been made to improve enforcement through technological advancements, such as satellite monitoring [23,50], and by fostering regional and international collaborations [51]. Between 2015 and 2020, the GNPD recorded 591 seizures, mainly consisting of natural items (e.g., sand, rocks, pieces of white coral, shells, soil, seeds, and sea urchin spines), often transported by tourists as souvenirs, as well as commercial (sea cucumbers and spiny lobsters) and endemic species (marine and terrestrial iguanas, and Galapagos tortoises) [46]. The GNPD also reported 100 unauthorized entries into the GMR by 66 vessels, with the majority (90%) originating from mainland Ecuador, followed by vessels from Nicaragua, the United States, and Vanuatu [46]. The most common infractions inside the GMR include fishing without a license, fishing trips without a functional Automatic Identification System (AIS), using expired fishing licenses, and illegal fishing gear, particularly longlines [46,52,53].

The absence of official annual reports on illegal fishing activities complicates efforts to assess trends and the effectiveness of enforcement measures [53]. Challenges in regulating fishing within the GMR include the lack of a fishery observer program or electronic monitoring system and a traceability system [54]. This creates opportunities for poaching and trading of illegal catch. Additionally, there is a disconnect between collective agreements and individual fisher behaviours. Despite efforts to engage community leaders in decision-making, these agreements often fail to achieve broad compliance, leading to continued illegal fishing activities due to perceived low detection risks [27,46,55]. The root of this issue partly lies in the lack of trust between grassroots fishers and their leaders, undermining the legitimacy of decisions made by co-management bodies [23,56]. Moreover, the challenge of encouraging adherence to regulations, such as the longlining ban, is exacerbated by the absence of economic incentives [57]. The Galapagos lacks premium markets for tuna caught without longline, discouraging more selective fishing methods [53,55]. Efforts by management authorities and NGOs to enhance the organizational capacity of fishing cooperatives have been short-term and fragmented, lacking the necessary financial and institutional support to change operational and market dynamics to discourage illegal longlining [46]. As initiatives aimed at promoting sustainable fishing practices have not been aligned with fishers' real needs and interests, there is a disconnect between conservation goals and the socio-economic realities of the fishing community [46]. This gap in incentives and alignment hampers voluntary compliance, perpetuating illegal fishing as an attractive and low-risk alternative, and undermining conservation efforts within the GMR.

5.2.2. Unclear decision-making process

From 1998–2009, governance over the GMR fell under the joint purview of the Participatory Management Board (PMB) and the Institutional Management Authority (IMA). Concurrently, the management of the province of Galapagos, which encompasses inhabited areas, was overseen by the National Galapagos Institute (INGALA) [25]. This meant that two distinct governance structures managed the protected and inhabited zones independently.

The PMB and IMA represented a cooperative co-management model for the marine area [58]. It permitted local stakeholders—including fishers, tourism operators, naturalist guides, scientists, and conservationists—to share the decision-making table with the GNPD and the Minister of Environment, the entities tasked with GMR management. In the PMB, consensus was the foundation of decision-making, while the IMA operated on a majority vote basis [56]. However, a significant governance system overhaul took place on June 11th, 2015, with reforms to the LOREG. Article 4 of the amended LOREG establishes that the province of Galapagos must be governed by the Governing Council of the Special Regime of the Galapagos Province (CGREG). This body assumes the responsibility of planning, managing resources, organizing provincial activities, and ensuring inter-institutional coordination with other state institutions. The CGREG observes representation from the Ecuadorian presidency, various ministerial bodies, the Secretary of National Planning (SENPLADES), and local municipal and parish administrations. Notably, local stakeholders, who were once vital players in the GMR's governance system, no longer have a seat in the CGREG.

The amended LOREG shifted the co-management system from a cooperative to a consultative model (with less sharing of decision-making). This change led to the dissolution of the PMB and, in its place, the establishment of the Consultative Board of Participatory Management (CBPM). Designed as a forum for citizen participation, the CBPM provides non-binding administrative and management advice for the GMR. At the time of writing this article, the CBPM remains non-operational.

The dissolution of the PMB and IMA led to the exclusion of local

stakeholders, particularly the fishing community, from management decision processes. This marginalization has discouraged and delegitimized the participation of fishers and other stakeholders in the re-zoning process. As a result, local management bodies and stakeholders face a loss of decision-making autonomy. This leaves the Galapagos vulnerable to top-down directives from mainland Ecuador, evident in initiatives like the inception and imposition of the Marine Sanctuary [22].

The shift in the governance structure of the GMR may have affected conservation and socio-economic outcomes, including reduced compliance with regulations, erosion of trust, and economic impacts on local livelihoods due to potentially overlooked socio-economic needs [22,46,59]. Among these challenges, a notable consequence has been the prolonged delay in implementing the updated Galapagos zoning, critically affecting the safeguarding of a greater number of KBAs, and thus endangering the conservation of critical habitats and diverse species' survival. Furthermore, the reduction in stakeholder engagement poses challenges to the adaptability of management practices in addressing pressing governance issues. For instance, a participatory process to amend fishing regulations has experienced a delay exceeding nine years, highlighting a gap in follow-up and accountability mechanisms formerly facilitated by the PMB and IMA [25], thereby postponing essential processes aimed at enhancing GMR's fisheries management. While establishing correlations between these governance changes and specific conservation or economic impacts demands further investigation, these overarching concerns reveal the critical need for inclusive stakeholder participation in the governance of the GMR to secure the best possible conservation and economic outcomes.

5.2.3. Top-down implementation of the Marine Sanctuary

The proclamation of the Marine Sanctuary via a Presidential Decree disrupted the participatory process established by the GNPD for the new Galapagos zoning. This unexpected management action sparked significant sociopolitical tensions, with calls to delay the implementation of the new regulations intensifying. The way the sanctuary was unilaterally established, bypassing consultations with the small-scale fishing sector, instilled feelings of betrayal and disappointment toward the GNPD and associated NGOs. This sense of exclusion undermined the general acceptance and support for the entire zoning initiative [22].

Efforts to replicate the participatory and consensus-oriented approach from the earlier Galapagos marine zoning were made to gain support for the updated zoning system. In 2000, the PMB approved a compensatory action plan aimed at offering alternative livelihoods to the small-scale fishing sector to mitigate the immediate economic repercussions generated by marine zoning [23]. Proposed alternatives included issuing commercial diving and sport fishing licenses to those transitioning away from traditional fishing to tourism. However, the delay in implementing these alternatives led to growing disillusionment and a sense of betrayal within the fishing community, likely eroding trust in the zoning system, its governing entities, and supporting NGOs [23]. Research by Barber and Ospina [60] showed that public trust in institutional performance, including credibility and honesty, was high in 1999 but declined after 2001. Despite an improvement in the credibility of the Charles Darwin Foundation (CDF) and the GNPD in 2006, this trend may have been reversed by the top-down approach to establishing the Marine Sanctuary, as suggested by Burbano et al. [22] and Burbano and Meredith [59].

History seems to repeat itself 24 years later with the introduction of the updated Galapagos zoning system. Out of the 14 promised compensatory measures outlined by Ministerial Agreement 026-A, only three have been realized [23]. These comprised the installation of FADs, which are currently non-operational, the endorsement of a new fisheries management plan, and the installation of AIS devices. Most of the agreed-upon compensation measures have proven unfeasible, and others remain stagnant due to insufficient political support. Consequently, eight years after the enactment of the updated Galapagos zoning, the participatory process is marked by skepticism and distrust [22,59]. This prevailing sentiment suggests that the costs of establishing the Marine Sanctuary may have outweighed its expected benefits.

The enduring conflicts and diminished trust in government agencies and NGOs by the fishing community have fostered a pervasive sentiment against conservation efforts among fishers. This distrust has intensified conflicts between the tourism and small-scale fishing sectors. Fishers perceive marine zoning as predominantly supportive of conservation and tourism activities, favoring the interests of NGOs and tourism entrepreneurs, at the expense of the fishers' needs, and to the detriment of their livelihoods. This situation highlights a growing divide and lack of mutual understanding and trust between the most relevant stakeholders of the GMR. This discord hampers the development of integrated management strategies that could benefit all sectors and the overall health of marine ecosystems. Without a shared vision and mutual respect among these critical stakeholders, efforts to balance conservation with sustainable economic activities face significant challenges, potentially compromising the long-term sustainability of the GMR.

5.2.4. Inconclusive scientific evidence about the impact of marine zoning

Concrete scientific evidence regarding the effects of the former Galapagos marine zoning on fisheries, marine biodiversity, and the livelihoods of fishers remains inconclusive. This absence of proof has fostered skepticism and hesitance from the local fishing community towards the Galapagos zoning system. An attempt to assess the effectiveness of no-take zones on Galapagos red spiny lobster populations was made by Buglass et al. [61]. Utilizing only three years of data (2012–2014), the study aimed to discern whether no-take zones had higher lobster populations or sizes than fishing areas. The results showed no significant differences. However, these findings require cautious interpretation due to limitations like a small sample size and potential locational bias of no-take zones. In this sense, Edgar et al. [26] observed that spiny lobsters were 2.7 times more abundant in fishing areas than in no-take zones. This implies a pronounced locational bias within the GMR, raising concerns that investigations without prior data could yield skewed findings when comparing no-take and fished areas. In addition, Buglass et al. [61] assumed that changes in red spiny lobster size and population were exclusively due to no-take zone implementation, overlooking the combined effects of climatic and anthropogenic drivers of change.

The updated Galapagos zoning system has declared several traditional fishing grounds as no-take zones, prompting fishers to seek the scientific rationale behind these closures. Thus, a comprehensive analysis of the social-ecological impact of former marine zoning, acknowledging the enforcement challenges and locational biases of no-take zones, is critical. Despite the availability of spatial long-term fishery (1997-present) and subtidal ecological (1994-present) monitoring data for the GMR, integration of these datasets to assess the long-term social-ecological effects of marine zoning has not occurred. The Galapagos subtidal ecological monitoring program, institutionalized in 2004, was created to evaluate the human and environmental impacts of marine zoning on marine biodiversity [62]. However, it has faced financial and institutional limitations, hindering the effective use of crucial ecological information for informed and timely decision-making. Consequently, despite extensive fisheries and ecological data, specific evidence to support the modification, redistribution, or creation of no-take zones and understanding their economic impact on fishers' livelihoods remains unavailable. This situation highlights a significant missed opportunity in applying existing data towards making well-informed adjustments to marine zoning.

5.2.5. Excessive focus on no-take zones

The Galapagos zoning system operates under the misconception that no-take zones are the most effective spatially explicit management tool for marine biodiversity conservation and stock rebuilding. This misunderstanding of the EBSM approach, particularly in its marine application, has hampered efforts in the Galapagos to achieve a balance

between marine biodiversity conservation and fisheries management [23].

There is growing evidence that no take-zones are useful tools to increase the biomass and size of overexploited species and biodiversity of marine ecosystems [5,63]. However, it is crucial to recognize that no-take zones are merely one tool among many in the EBSM toolkit. Other spatial management strategies, such as Territorial User Rights for Fisheries (TURFs), temporal restrictions, rotational fishing areas, and spatial gear limitations, also play essential roles in promoting an EBSM approach. Yet, these alternative and complementary fisheries management tools remain unexplored in the GMR, limiting opportunities for ecosystem-based marine conservation and the rebuilding of overexploited fish stocks.

6. Toward effective Galapagos zoning system

6.1. Bottom-up approach and suitable incentives

To ensure the successful implementation of the new marine zoning, re-establishing the trust and validation of the small-scale fishing community within the rezoning process remains paramount. This necessitates a comprehensive and inclusive engagement of all interested parties. To this end, political support, technical guidance, and essential funding should be provided to the CGREG and GNPD to put in place the CBPM. The new consultative co-management system should be built on the insights and lessons learned from the previous collaborative co-management regime implemented between 1998 and 2015.

A prominent challenge rests in the re-engagement of grassroots fishers, particularly considering the prevailing weaknesses in social cohesion, leadership, and organization within most fishing cooperatives [23]. To address this challenge, it becomes imperative to deploy state-of-the-art participatory methodologies to re-engage fishers and a broader stakeholder group, including tour operators, naturalist guides, environmental conservationists, scientific experts, local administrative representatives, and the community at large, into the rezoning process. Furthermore, management authorities and stakeholders must achieve a shared understanding and endorsement of the methodological framework required to evaluate the socio-ecological impacts of the former and current Galapagos marine zoning systems. This should encompass assessments related to the conservation status of fishery resources and marine biodiversity, as well as the broader implications for fishers' livelihoods.

Simultaneously, the creation of appropriate incentives is fundamental to motivate stakeholder engagement and compliance with the updated zoning regulations. Economic incentives could include the establishment of social enterprises and a voluntary eco-labeling program, or certification of origin scheme aimed at encouraging fishers to implement advanced monitoring, control, and traceability technologies [53,57]. The goal is to reward sustainable fishing practices by securing access to markets that offer a premium for seafood products that are sustainable, ethically sourced, and environmentally friendly. For example, leveraging the tourism industry to pay higher prices for high-quality, longline-free tuna presents an opportunity to generate market-based incentives for fishers to switch to more selective fishing gear or to implement bycatch mitigation methods [53]. This approach is viable given the demonstrated willingness of tourists to pay a premium for certified Galapagos yellowfin tuna that satisfies criteria such as food safety, freshness, minimal bycatch, and direct sourcing from local fishers [64].

Implementing this comprehensive adaptive co-management model, supported by suitable market incentives, could enhance the legitimacy and acceptance of the updated Galapagos zoning system, ensuring that it fairly represents all stakeholder groups. This strategy aims to amplify the voice of local coastal communities within the decision-making framework, thereby aligning GMR management with conservation objectives and the socio-economic needs of the community [23]. Furthermore, it has the potential to foster gradual and adaptive improvements in fishing practices, contributing to the reduction of illegal, unreported, and unregulated (IUU) fishing and bycatch within the GMR.

6.2. Long-term assessment of the effectiveness of no-take zones

An in-depth comprehension of how various drivers of change – including ENSO, overfishing, IUU fishing, and others – influence fishery resources and marine biodiversity is crucial to ascertain how the former network of no-take zones affects the sustainability of commercial stocks and marine biodiversity conservation [65]. To fully grasp the impact of marine zoning, it is necessary to consider the influence of other significant natural and human-induced drivers [18]. For instance, Castrejón and Charles [65] found that the boom-and-bust exploitation of the sea cucumber fishery and the 2007–09 global financial crisis, rather than the implementation of no-take zones, were the most important drivers influencing the distribution of fishing effort in the GMR between 1997 and 2011. These drivers catalysed macro-scale shifts in fishing dynamics, which in turn, reshaped micro-scale fishing patterns. Understanding how fishery stocks, marine biodiversity, and fishing communities have coped and adapted to these complex drivers of change is crucial for the effective assessment and adaptation of multi-use MPAs.

However, a comprehensive assessment of the long-term ecological effects of no-take zones, along with other drivers of change, is often unfeasible in Latin America due to the data-poor reality of many fisheries. The GMR emerges as a notable exception, due to the availability of long-standing spatially explicit programs to monitor fisheries, as well as subtidal ecological monitoring programs. We suggest merging these two invaluable data sources to facilitate a deeper understanding of the repercussions of drivers of change, including the implementation of the former marine zoning. These insights can be used to guide the development of ecosystem-based adaptation measures, aiming for sustainable fisheries, marine conservation, and the welfare of fishing communities.

6.3. Reconciling conservation and fishery management objectives

The new Galapagos marine zoning aims to bolster the protection of KBAs and enhance ecological connectivity through an enhanced no-take zones network. For an effective reconciliation of conservation and fishery management objectives, no-take zones should be strategically allocated across the archipelago [23,26], considering the distribution and population dynamics of key fishery resources [66]. No-take zones, to be effective, should be implemented in areas that ensure the protection of a proportion of the breeding stock and critical habitats. As the location of these critical areas across the Galapagos archipelago remains uncertain, it is essential to integrate fishery data and participatory research to identify key breeding and nursery grounds. Additionally, identifying fishing hotspots and assessing the small-scale fishing sector's opportunity costs will better inform the creation, expansion, or redistribution of no-take zones [65].

The allocation of no-take areas should incorporate the findings of Escobar-Camacho et al. [18], who identified 13 high-ecological value areas (HEVA) covering roughly 23% (14 715 km^2) of both marine and terrestrial habitats in the Galapagos. These HEVA represent the area most vulnerable to climate change, unsustainable tourism, local population growth, IUU fishing, and invasive species. The conservation of HEVA is of paramount importance due to their role in the distribution and life cycle of native, endemic, and endangered species, as well as their status as remnants of primal ecosystems [18].

Furthermore, we reiterate the recommendation of exploring the usefulness of alternative spatially explicit management tools [23]. For instance, Pons et al. [67] found that closing 30% of the fishing grounds across 15 global fisheries areas reduced bycatch by an average of 57% when dynamic time and area closures were implemented, with minimal or no loss of target catch. These authors concluded that spatial dynamic

ocean management can be almost four times more effective than a static approach for bycatch mitigation. Thus, we propose investigating the effectiveness of the static network of no-take areas in preventing the incidental catch of endangered, threatened, and protected species, particularly for large migratory pelagic species. The findings should be used to modify the design of Galapagos marine zoning to reconcile conservation and fishery management objectives, e.g., through the spatial dynamic approach suggested by Pons et al. [67].

Another complementary spatial management approach could be a combination of a coastal network of no-take zones with co-managed harvested areas that allocate exclusive spatial fishing rights to local communities. This management approach has been suggested by several studies as a more robust approach to address the roots of fisheries management failures that led to overexploitation of shellfish fisheries in the Galapagos Marine Reserve and elsewhere in the world [4,65,68,69]. In this sense, Castrejón and Charles [65] advocate for the experimental allocation of TURFs in strategic areas of Isabela, Santa Cruz, and San Cristobal Islands, based on the distribution of fishing fleets and fishing effort hotspots across the archipelago. These sites were selected for the exclusive usage of certain fishing grounds by each local fishing fleet, minimizing potential conflicts among fishers from different islands and bolstering ease of surveillance due to proximity to homeports. The adoption of such TURFs could generate a sense of stewardship among fishers, encouraging self-enforcement mechanisms to achieve conservation and fisheries management objectives [70,71]. To increase the legitimacy of Galapagos marine zoning, and minimize potential conflicts, Castrejón and Charles [65] also propose defining co-management areas, based on the distribution of fishing fleets across Galapagos. For each of these areas, they suggest creating specific co-management councils, comprised of those fishers, and other relevant stakeholders, directly impacted by the allocation of no-take zones within the distribution area of their fishing fleets or tourism operations. This area-based co-management, in combination with a coastal network of no-take zones and TURFs, would promote inclusive decision-making through strategic distribution of no-take zones, minimizing adverse effects on fishing communities' livelihoods and enhancing the new Galapagos zoning's acceptance, legitimacy, and compliance [65].

6.4. *Innovative technology for adaptive co-management*

The adaptive co-management approach for the Galapagos' marine zoning necessitates a robust and dynamic data collection framework. This should be structured to provide relevant indicators, rapid reporting, streamlined processing and analysis, and effective dissemination mechanisms to facilitate near real-time adaptive interventions.

While there are many technological advancements capable of enhancing the subtidal ecological monitoring program, its integration has been hindered by budgetary constraints and institutional deficiencies. Thus, we recommend the development of a data system tailored to enhance precision, expedite reporting, bolster analysis, and facilitate prompt dissemination of subtidal ecological insights. Implementing such a system promises not only cost savings but also agile and adaptive decision-making avenues, for efficient management of marine zoning. This entails the development of a user-friendly mobile app for seamless data collection, a secure data repository for long-term storage, and an intuitive dashboard for real-time analysis and visualization. Envisioned as the "Subtidal Ecological Monitoring" module, its creation could be informed by the transdisciplinary approach suggested by Bradley et al. [72]. Integration with Ecuador's "Sistema Único de Información Ambiental (SUIA)" is advisable for its application, ensuring streamlined data sharing and accessibility. This integration will not only simplify data management but also support the ongoing enhancement of decision-making processes within the Galapagos marine zoning framework, leading to more effective and timely management interventions.

7. Conclusions and lessons learned

The updating process of the new Galapagos zoning system represents the most relevant effort since the creation of the Galapagos National Park in 1959 aiming to cohesively manage the protected and inhabited areas as a complex social-ecological system while advancing the adoption of an EBSM approach.

Remarkable actions have been taken by the Ecuadorian government and strategic partners to build a new zoning scheme that addresses the failures of the former marine and terrestrial zoning systems. This initiative has adopted a strategic, long-term vision that harmonizes conservation objectives with the sustainable development needs of local communities. A key improvement has been the science-driven delineation of management zones, transitioning from economically driven to science-based criteria, thus bolstering biodiversity protection, habitat connectivity, and the expansion of no-take zones to safeguard critical habitats and threatened species more effectively.

However, challenges such as poor compliance with zoning regulations, missing economic incentives for sustainable practices, and an unclear and exclusionary decision-making process have complicated the updated Galapagos zoning system's implementation. In particular, the top-down implementation of the Marine Sanctuary, coupled with persistent institutional instability and inconclusive scientific evidence on the social-ecological impact of no-take zones, has eroded fishers' trust and buy-in to the updated zoning system.

To fully realize the ambitions of conserving marine biodiversity, rebuilding depleted fisheries, and enhancing coastal community livelihoods, local stakeholders must genuinely support the Galapagos zoning system. This commitment should not be merely based on promised compensations, but deeply rooted in belief in the zoning system's benefits. This requires a more inclusive, adaptive co-management model that rebuilds trust with the fishing community, based on stakeholder engagement and the integration of cutting-edge participatory methodologies. Such an approach should be bolstered by honouring the agreements established and the introduction of appropriate incentives that encourage responsible fishing practices and stakeholder compliance. In addition, the strategic and science-based allocation of no-take zones and TURFs within an area-based co-management context represents a potential solution for reconciling conservation efforts with fisheries management objectives. This EBSM approach, rooted in inclusivity, adaptability, innovation, and scientific integrity, could pave the way to safeguard the Galapagos' unique biodiversity, while supporting the livelihoods of its inhabitants, potentially serving as a model for conservation efforts globally.

Author statement

The authors of the manuscript numbered JMPO-D-23–01257, titled "The bumpy road to conservation: challenges and opportunities in updating the Galapagos zoning system," with Mauricio Castrejón as the corresponding author, together with Nicolas Moity and Anthony Charles, declare that this manuscript, in whole or in part, has neither been submitted nor published elsewhere. The authors also state that there are no conflicts of interest.

CRediT authorship contribution statement

Mauricio Castrejón: Writing – original draft, Investigation, Funding acquisition, Conceptualization. **Nicolas Moity:** Writing – review & editing, Visualization. **Anthony Charles:** Writing – review & editing.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the corresponding author used ChatGPT-4 to improve the readability and language of the manuscript.

After using this tool/service, the authors reviewed and edited the content as needed and took full responsibility for the content of the publication.

Conflict of Interest

The authors declare no competing interests.

Data availability

No data was used for the research described in the article.

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