

## ORIGINAL RESEARCH ARTICLE

# Key OECM policies for Taiwan's marine conservation

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**Abstract:** The Other Effective Area-Based Conservation Measures (OECMs) represent a transformative shift in global conservation by recognizing diverse governance systems and conservation outcomes beyond traditional protected areas (PAs). They are crucial for achieving the 30 by 30 target under the Kunming-Montreal Global Biodiversity Framework, which aims to conserve 30% of the of the world's land, inland water, and coastal and marine areas by 2030. As such, understanding and implementing effective OECMs is a global priority. This study presents a preliminary assessment of existing policies and key considerations in Taiwan's OECMs, offering insights for developing more effective environmental policies. Using a mixed-methods approach, we combine analysis of protected area data from the World Database on PAs with a systematic review of relevant literature. Our findings reveal that Taiwan currently has 92 designated PAs and OECMs, with national parks accounting for 99.9% of the total marine protected area. To date, due to the fact that the regulations regarding OECM in the Ocean Conservation Act passed in 2024 were only announced and implemented on 1<sup>st</sup> of July this year, the Marine Conservation Administration has not yet announced any OECM sites in Taiwan. Therefore, we analyzed and researched external public databases for reference. The qualitative analysis identifies three primary policy themes: marine spatial planning, environmental impact assessment, and marine scientific research. While Taiwan's recent Marine Conservation Act (2024) demonstrates progress in aligning with global conservation frameworks, our analysis suggests that OECM implementation remains at an early stage. The study highlights the need for more integrated governance approaches and identifies gaps in current conservation strategies. These findings contribute to ongoing discussions about area-based conservation measures in high-density coastal regions and provide a foundation for future research on OECM effectiveness in Taiwan.

**Keywords:** Biodiversity; Protected areas; Marine spatial planning; *In situ* conservation; Other Effective area-based conservation measure

## 1. Introduction

The Strategic Plan 2011–2020 for Biodiversity developed by the International Union for Conservation of Nature (IUCN) and Convention on Biological Diversity (CBD) introduces a common approach for delineating protected areas (PAs) and Other Effective Area-Based Conservation Measures

(OECMs), providing coordinated data for the World Database on Protected Areas (WDPA) and addressing the global environmental goals. Implementing OECMs is gradually taking pace with most countries adopting policies and considerations that promote the objectives of the latest blueprint in environmental protection and marine conservation.<sup>1-5</sup> OECMs emerged as a global environmental protection policy in 2010.

The CBD, adopted at the 1992 Rio Earth Summit, is a global agreement to ensure the sustainable use of Earth's biological resources for development progresses. It was formally defined under the CBD Decision 14/8 as strategies and guidelines that define and outline the protective measures for geographically defined areas that are governed and managed to achieve positive and sustained long-term outcomes for the *in situ* conservation of biodiversity as well as the related and applicable ecosystem functions and services that align with the existing cultural, spiritual, socioeconomic, and other locally relevant values.<sup>6-8</sup>

As probably the latest environmental and marine conservation blueprints, OECMs have not yet been widely implemented. However, the international community has recognized it as OECM, giving it an additional "conservation label" and allowing it to be counted towards international conservation targets.<sup>4</sup> Therefore, most countries are increasingly aligning their existing policies with the strategies outlined in the OECMs policies to achieve large area-based conservation targets and reduce biodiversity loss.<sup>6,9</sup> However, it is further important to note that OECMs-designated geographical regions are not entirely similar to the policies applicable to PAs, considering that OECMs require that conservation does not necessarily have to be a primary objective.

As of March 2023, 856 marine OECMs cover an area of 403,639 km<sup>2</sup>. At the same time, the PA policies outline conservation as a primary objective. In Taiwan, PAs designated for nature conservation can be divided into several types according to different protection regulations: Nature Reserves, Wildlife Refuges, Important Wildlife Habitats, National Parks, and National Forest Nature Reserves. This indicates that OECMs are recognized for their biodiversity achievements due to effective management. The difference between them and Marine PAs (MPAs) is established for conservation purposes. At the same time, OECMs are recognized for their conservation effectiveness, especially their ability to make a sustained and long-term effective contribution to the *in situ* conservation of biodiversity.<sup>10</sup> Therefore, the OECM policies cover and incorporate the existing PA strategies for formulating an inclusive single blueprint that incorporates the existing policies with the newly formulated strategy for conserving the environmental and marine environment and biodiversity.

The status of implementation of the OECMs in Asia is presently considered a template for the global adoption of the blueprint, with nearly two-thirds of the countries in the region partially or fully legislating and

implementing the related frameworks. Sharma *et al.*<sup>6</sup> highlight the presence of notable Asian economies, including Japan, China, the Republic of Korea, Maldives, and Taiwan, in adopting the OECMs policies within their environmental governance structures. Considering its geographical position, Taiwan is still formulating independent marine conservation and environmental policies.

Most of these policies are consistent with the existing global blueprint, and some Asian countries are significant contributors.<sup>6,9</sup> In July 2024, Taiwan enacted the Marine Conservation Act, which regulates OECMs in its articles. However, portions or all of the articles of the Act have yet to come into effect. The Executive Yuan (Cabinet) will determine the effective date in the future.

The National PAs or PAs within Europe and the United States have established certain standards that enable them to develop best practices toward conservation and community incorporation. For instance, the European countries adopted the Natura 2000 network,<sup>11</sup> an EU network with a PA system that regulates compliant biodiversity with the sustainable land use factor incorporated.<sup>6,9</sup> This encompasses Boreal's management plans approach to support local participation in conservation activities with the aims set out.

In the United States, the system under which the National Park Service operates is based on a co-management model, interacting with indigenous people to ensure that the ecological knowledge used in parks' administration is also culturally appropriate.<sup>11-15</sup> Champion examples, including the rehabilitation of Yellowstone National Park, have proven that efficient wildlife utilization and recovery save both species and local economies.

In 2022, Fisheries and Oceans Canada (DFO) released the Government of Canada's 2022 Guidance for Recognizing the Marine OECMs.<sup>16-18</sup> The guidance will apply to both current and future federally designated marine OECMs. Furthermore, the European PAs commonly emphasize linking up landscapes so that ecological corridors are better, and thus, species can rebound to questions of climate change.<sup>19</sup> From these examples, the reader can see an efficient management integration of a system that undertakes ecological, social, and economic aspects in managing PAs.

Taiwan is an urban concentrated island with a population density of an average of 649 people/km<sup>2</sup> that is actively legislating and adopting marine diversity and environmental conservation policies as a means

of mitigating the emerging environmental dynamics attributed to the effects of the global climate change that is directly affecting weather patterns within the regions. In Taiwan, marine spatial planning (MSP) policies have been at the forefront of implementing OECMs and PAs conservational guidelines for marine biodiversity conservation. According to the study, Taiwan houses more than 10% of the global marine species in its coastal waters,<sup>20</sup> and managing the OECMs designated areas requires multi-sectoral approaches that incorporate different policies to provide a practical framework for protecting and strengthening the diversity of marine resources.

While the existing academic research has focused on addressing coastal environmental concerns, very few of them have investigated the implementation of OECMs within the Asian region, which has created a research gap on the topic, especially in Taiwan, which is increasingly becoming a policy benchmark for legislation and implementation of marine environment conservation. The Marine Conservation Act was just passed in 2024, and many supporting systems and mechanisms have yet to be established. Research on the status of OECMs has provided an opportunity for recognition and support of areas of high biodiversity importance that do not fall within the current formal environmental and marine conservation policies, as well as a reason for the conservation of more types of areas under diverse governance and management systems.<sup>20</sup> However, no present study has extensively researched key considerations and policies in Taiwan's OECMs, with the existing studies focused on advanced countries, respectively.<sup>6,20-23</sup>

In Asia, the status of OECMs report<sup>6</sup> is a pioneer research that has provided insightful information on implementing OECMs across the region, focusing on major economies, including China, Japan, Indonesia, and the Republic of Korea.<sup>11-15</sup> While Taiwan is increasingly becoming a significant actor in marine environment conservation within the region, there has never been a conclusive research study or a technical report on the status of the implementation of OECMs within its boundaries, which has left a wide research gap in MSP in the country.

As ocean biodiversity faces unprecedented pressures from climate change and coastal development, the effective implementation of OECMs offers a vital tool for countries or regions like Taiwan to safeguard marine ecosystems while promoting sustainable ocean governance. This paper examines why these mechanisms are more crucial than ever for the planet's

ecological future. This study also adopts the qualitative research methodology and aims to provide a qualitative analytical perspective of the policies and considerations for implementing the OECMs-related strategies currently being legislated or adopted by Taiwan to meet the objectives set by the global environmental blueprint. Meanwhile, the study objectives are to achieve the study objectives, including the source and collection of statistical and systematic review data, data synthesis and analysis, and reporting of study findings. The present research study aims to provide a comprehensive and detailed analysis of the existing key policies and considerations in Taiwan OECMs, providing useful evidence-based insights for formulating new, effective, environmentally friendly policies and promoting the existing policies.

## 2. Materials and methods

To achieve the intended objectives, the present research study adopts a mixed research methodology that combines qualitative and quantitative research findings provide a detailed comprehension of the policies and considerations for implementing OECMs in Taiwan. The mixed research methodology effectively collects information associated with the variables of interest that inform the development of effective recommendations for promoting marine environment conservation in Taiwan. The primary objectives of the quantitative research methodology were to provide statistical information on the status of OECMs, including the number of regional areas protected under its statutes, the geographical area of the country under marine conservational management policies, the marine area in square kilometers, and the existing local statistical factors.

The qualitative research methodology aims to provide a qualitative analytical perspective of the policies and considerations for implementing the OECMs-related strategies currently being legislated or adopted by Taiwan. These are intended to meet the set objectives by the global environmental blueprint and to achieve the study objectives, including the source and collection of statistical and systematic review data, data synthesis and analysis, and reporting of study findings.

The qualitative methodological framework for the research adopted a technical systematic review approach based on the three-step framework<sup>24</sup> that involved planning, conducting, and reporting the review. Considering the topic of interest was a policy issue, the methodology analyzed existing perspectives

of policies associated with PAs and OECMs. The qualitative policy analytical research methodology entailed a detailed analysis of existing policies related to the topic using both primary and secondary sources involving bibliographic databases containing journals, government documents, think-tank statistics, patents, and sources of cited references to provide detailed information on the research topic.

Further, to ensure the validity and reliability of the research, the researcher supplemented the framework<sup>24</sup> with approaches for summarizing and disseminating research findings,<sup>25,26</sup> following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. The review included scientific materials focused on policies related to OECMs, which were identified with search terms and keywords relevant to the study. Articles were selected based on their quality and reliability. The final step in the methodological framework involved data extraction and reporting of findings.

The WDPA is the only existing global database that provides variable data on OECMs and a component of databases of the protected planet initiative (PPI) which is the joint product of United Nations Environment Programme (UNEP) and IUCN, managed by UNEP-WCMC and the IUCN working with governments, communities, and collaborating partners. The data used for the study can be directly accessed and/or downloaded from <http://www.protectedplanet.net/>, which effectively integrates timely information and data on OECMs based on monthly submissions from governments, non-governmental organizations, and associated environmental stakeholders. The data are directly sourced from the OECM database, which has been available on the PPI website since late 2019 and directly links to data on area-based conservation, as outlined in Figure 1. According to the WDPA database, there were 6463 OECMs and 303,312 PAs as of December 2024.

Considering the novelty of the concept of OECMs, the data, and records submitted to the WDPA and equally employed in the present research might not meet the IUCN or CBD definition of an OECM-protected area, and it cannot be guaranteed that data providers consistently follow the set definition standard. The data limitations can partly be attributed to different countries' definitions of PAs that might not completely align with the set IUCN or CBD definition. Therefore, the study does not necessarily assume that all the WDPA records and data meet the IUCN or CBD definition but assumes the accuracy of the data found within the

databases. However, the research considers the wide range of similarities between PAs and the OECMs, further validating the study findings. The description of the data variables of the research is outlined in Table 1.

### 3. Results

The qualitative methodology framework produced 83 related scientific research papers that focused on policies and key considerations for OECMs, including policy papers, white papers, government documents, and scientific academic literature associated with the topic. There were 25 duplicate papers, while 35 papers had irrelevant titles and focused on other regions apart from Taiwan. Furthermore, eight papers had abstracts that did not align with the research objectives and were considered editorials or commentaries, and only 25 papers were included for analysis.

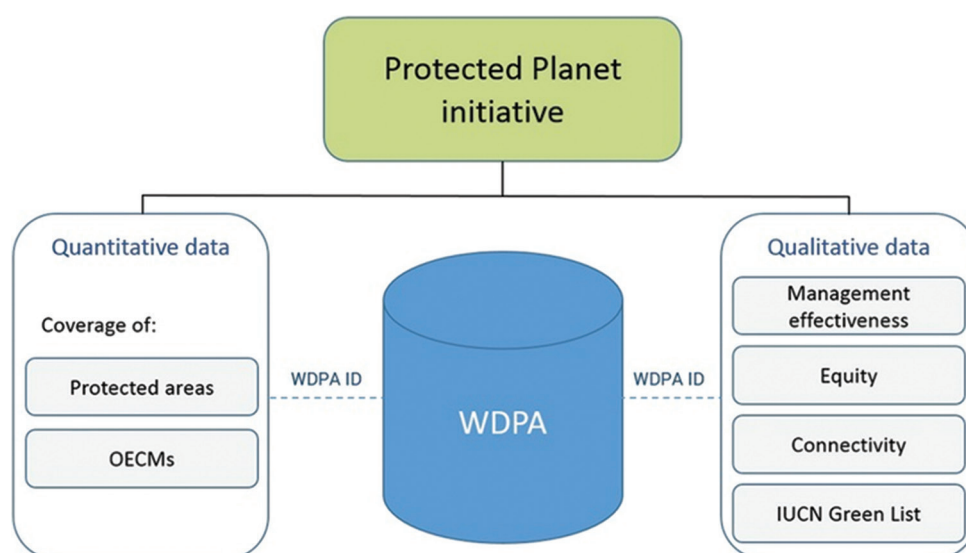
The qualitative findings were classified into primary themes and sub-themes that focused on the topic. The primary themes identified included PAs and OECMs, policies, and key considerations for OECMs. It is important to note that there is a slight difference between PAs and OECMs, but the two themes share many similarities and are, therefore, classified under a single theme. The sub-themes under the PAs and OECMs included biodiversity, PA consideration, geographically defined areas, coastal resources, and marine ecosystems.

On the other hand, the PAs and OECMs focus on conserving marine biodiversity and managing geographically defined areas, coastal resources, and marine ecosystems through policies such as MSP, environmental impact assessments (EIA), and marine scientific research.

The quantitative research methodology provided statistical information about Taiwan's OECMs. According to the findings, Taiwan has a total of 92 individual areas that are designated as national PAs and OECMs and formally recognized by the WDPA. Out of the 92 designated areas, only seven are managed by the Construction and Planning Agency, while the Forestry Bureau manages the remaining 85 areas. In terms of designation, 37 areas are designated as major wildlife habitats, 21 as nature reserves, 20 as wildlife refuges, eight as national parks, and six as forest reserves, as shown in Table 2.

The total area in square kilometers that are formally recognized as OECM is 11,524.596 km<sup>2</sup>, with the largest area being the Dongsha National Park with a total area of 3,600.31624 km<sup>2</sup> and the smallest area being the Hokutolite Nature Reserve with a





**Figure 1. Links between quantitative and qualitative information within the Protected Planet initiative. Individual protected areas and OECMs are identified across the databases by a unique identifier, the WDPA ID. Adapted from UNEP-WCMC<sup>27</sup>.**

Abbreviations: OECMs: Other Effective Area-Based Conservation Measures; WDPA: World Database on Protected Areas.

**Table 1. Description of key data fields**

Variable	Definition
Protected area status	Whether the site is a formally designated protected area or OECM
Name	The official name of the protected or conserved area
Original name	The name of the area in the local language
Designation type	Legal or administrative classification of the area
Designation (English)	English name of the designation type
IUCN category	IUCN management category assigned to the area (e.g., Ia–VI)
Marine classification	Whether the area is terrestrial, coastal, or marine
Reported marine area	Official reported size of the marine area (in km <sup>2</sup> )
GIS-derived area	Geospatially calculated area using GIS data (in km <sup>2</sup> )
Managing authority	Government or institutional body responsible for management

Abbreviations: GIS: Geographic Information Systems; IUCN: International Union for Conservation of Nature; OECMs: Other Effective Area-Based Conservation Measures.

total area of 0.002036 km<sup>2</sup>. The total area under the marine environment is 3,690.302 km<sup>2</sup>, with 60 areas

**Table 2. Number of protected areas by designation type**

Designation	Count of DESIG_ENG	Percentage
Forest reserve	6	6.5
Major wildlife habitat	37	40.2
National park	8	8.7
Nature reserve	21	22.8
Wildlife refuge	20	21.7
Grand total	92	100

Note: Percentages are based on the total number of designated protected areas ( $n=92$ ).

categorized as coastal, marine, and terrestrial, while 25 are categorized as predominantly or entirely terrestrial. Only seven areas are categorized as predominantly or entirely marine. National parks account for 99.9% of MPAs and OECMs total area while the remaining designations account for the remaining negligible areas, as shown in Table 3. In 2024, the proportion of global MPAs was 8.19%, covering an area of 29.67 million 3,535 km<sup>2</sup>, including about 7.32% of areas under national jurisdiction (national waters) and 0.87% of international waters (Areas Beyond National Jurisdiction, ABNJ). Within the national waters, which account for 39% of the global ocean area, the area of PAs is 26.508 million 3,588, accounting for 18. 76%; only 1.44% of international waters (ABNJ), which account

**Table 3. Marine protected area coverage by designation type in Taiwan**

Designation type	Marine area (km <sup>2</sup> )	Percentage of total marine area (%)
National park	3,687.050	99.912
Nature reserve	1.934	0.052
Wildlife refuge	1.088	0.030
Major wildlife habitat	0.229	0.006
Forest reserve	0	0
Total	3,690.302	100

for 61% of the world's ocean area, have been designated as PAs (<https://protectedplanet.net/marine>). Meanwhile, according to statistics from the Ocean Conservation Administration (OCA), Ocean Affairs Council (OAC), as of July 2025, there are 71 sites of MPAs, covering an area of about 5,407 square kilometers (excluding overlapping areas of about 3.88 km<sup>2</sup>), accounting for 8.39% of the 64,473 km<sup>2</sup> (provided by the Ministry of the Interior) within the territorial waters outside the boundaries of Taiwan restricted and prohibited waters around Jinmen, Matsu, and Taiping Island. The OCA will be more proactive in planning and identifying more sites with potential as OECMs.

As shown in Table 3, National Parks represent the vast majority (99.9%) of Taiwan's MPA coverage, indicating that other designation types have yet to be effectively incorporated into marine OECM planning. This reveals a potential policy gap in recognizing smaller-scale, community-led or coastal OECMs.

Taiwan's approach to OECM implementation, particularly its integration of MSP, EIA, and scientific research, offers relevant lessons for other densely populated coastal states. Similar to Japan's satoumi practices or Canada's marine OECM frameworks, Taiwan's emphasis on cross-ministerial coordination and biodiversity zoning could inform regional OECM strategies in the Asia-Pacific or Mediterranean regions.

#### 4. Discussion

UNEP-WCMC and IUCN<sup>28</sup> define OECMs as any geographically defined area not categorized under a PA but maintained for favorable, lasting impacts on *in situ* biodiversity, ecosystem functionality, and ecosystem services for local cultural, spiritual, social, economic, and other values based on Aichi Biodiversity Target 11.<sup>7,29</sup>

According to the 2024 report by UNEP-WCMC and IUCN,<sup>28</sup> the growth trend of MPAs has slowed

significantly over recent decades. During the Aichi Targets period (2010–2020), the total area of global MPAs increased by 18.14 million square kilometers over a decade. However, from 2020 to 2024, the increase was only 1.77 million square kilometers, less than one-tenth of the previous phase, indicating a slowing expansion rate, which highlights the challenges faced by MPAs globally in terms of planning and designation practices. In the future, timely and effective measures should be taken to protect marine areas through methods such as *in situ* conservation, and OECMs should be strengthened to complement MPAs and ensure the concept of marine sustainability. The comparative analysis of OECM-related studies is shown in Table 4.<sup>30–35</sup>

Further, UNEP-WCMC works with governments, NGOs, and other stakeholders to provide voluntary guidance to designate OECMs; they have an OECMs list. Taiwan currently states that the WDPA has recognized 92 national PAs. These OECMs are mainly owned by the government, including the Forestry and Nature Conservation Agency, Ministry of Agriculture, National Land and Management Agency, Ministry of the Interior and OCA, OAC, and encompass critical wildlife, nature reserves, wildlife refuges, national parks, MPAs, and forest reserves. Being coastal, marine, or terrestrial, most of these areas are within the marine environment, orienting the OECMs policies mostly to marine conservation. Meanwhile, government agencies also evaluate, select, and confirm PAs and OECMs. Therefore, in the future, multiple regulations and mechanisms formulated by various ministries must be coordinated and integrated to achieve consistency.

Taiwan's OECM policies focus on MSP, EIA mechanisms, and marine scientific research.<sup>36</sup> According to the UNESCO, MSP is mainly a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives. Similar to MPAs, MSP is a specially-based tool designed to support ecosystem-based and holistic management of ocean and coastal. While MPAs aim mainly at conservation on limited geographical scales, MSP more broadly seeks to integrate the ecological, social, economic, and political elements of human activities into the planning process.

In fact, MSP can be seen as a means to compensate for the weakness of MPAs. With Taiwan's recent efforts to highlight its ocean-oriented identity, it has introduced MSP policies in response to rising marine biodiversity.<sup>37</sup> To enhance biodiversity conservation and ecosystem balance, current OECMs and MSP policies in Taiwan

**Table 4. Comparative analysis of OECM-related studies**

Study perspective	Key challenges	Policy recommendations	Focus
Global	<ul style="list-style-type: none"> <li>• Lack of consensus on measuring effectiveness</li> <li>• Burden on local communities, limited resources</li> <li>• Misclassification risks, over-reporting, and conceptual confusion of OECMs versus PAs</li> </ul>	<ul style="list-style-type: none"> <li>• Develop shared guidelines, clarify roles, support indigenous/local stewardship</li> <li>• Improve definitional clarity, enhance reporting standards, and avoid inflating targets</li> </ul>	Conceptual and definitional clarifications
Indonesia	<ul style="list-style-type: none"> <li>• Lack of national monitoring outside MPAs</li> <li>• Threats from human pressures</li> <li>• Size disparity</li> </ul>	Recognize and support potential OECMs, improve integration with MPAs	Spatial analysis of potential marine OECMs
Australia	<ul style="list-style-type: none"> <li>• Limited alignment between proposed principles and global guidance</li> <li>• Risk of perverse incentives</li> <li>• Duplicated content</li> </ul>	<ul style="list-style-type: none"> <li>• Clarify principles, ensure consistency with IUCN guidance, avoid misclassification</li> <li>• Same as original</li> </ul>	<ul style="list-style-type: none"> <li>• Policy and implementation assessment</li> <li>• Duplicate of 2024 Conservation</li> </ul>
United States	<ul style="list-style-type: none"> <li>• Fragmented jurisdictional authority between federal and state levels</li> <li>• Lack of a formal OECM framework</li> <li>• Uncertainty in how multiple-use areas qualify under OECM criteria</li> <li>• Limited cross-agency data integration</li> </ul>	<ul style="list-style-type: none"> <li>• Adopt a unified national framework for recognizing OECMs</li> <li>• Increase transparency in MSP</li> <li>• Encourage data-sharing among agencies, and incorporate indigenous knowledge and co-management models</li> <li>• Local governance models in OECM recognition</li> </ul>	Cross-sectoral marine conservation strategies
Iceland	No national framework, ambiguous governance arrangements, lack of policy support	Include OECMs in national biodiversity strategies, adapt existing land-use categories	Governance system assessment for terrestrial OECMs
Taiwan	<ul style="list-style-type: none"> <li>• Early-stage implementation, lack of recognized OECMs under Marine Conservation Act</li> <li>• Fragmented policy mechanisms</li> <li>• Need for integration of MSP and EIA systems</li> </ul>	<ul style="list-style-type: none"> <li>• Strengthen inter-agency coordination, prioritize MSP, EIA, and marine scientific research</li> <li>• Promote formal recognition of potential OECMs, enhance public engagement and education</li> </ul>	Marine governance and policy development

Abbreviations: EIA: Environmental impact assessments; MPA: Marine protected area; MSP: Marine spatial planning; PA: Protected area; OECMs: Other Effective Area-Based Conservation Measures.

must evolve beyond spatial designation and incorporate more robust ecological criteria. While quantitative assessments of biodiversity outcomes remain limited, preliminary qualitative observations suggest that OECMs situated within ecologically sensitive zones, such as seagrass beds and coral reef corridors, show potential for positive biodiversity impacts when supported by local stewardship and adaptive governance.

Moreover, to strengthen their contribution, we recommend that OECM frameworks integrate standardized biodiversity monitoring indicators, establish long-term ecological baselines, and adopt participatory co-management schemes that actively involve local communities and indigenous knowledge

systems. In terms of MSP, prioritizing ecologically significant areas through legally binding zoning regulations and enforcing ecosystem-based thresholds can ensure that spatial planning makes a meaningful contribution to conservation goals. These enhancements would allow OECMs and MSP not only to support biodiversity passively but also to become active instruments of ecological restoration and resilience.

At present, marine ecosystem activities in Taiwan that fall within the PAs and OECMs are tightly regulated by different laws and regulations that align with the MSP governance objectives and require the approval of governance agencies and authorities.<sup>38</sup> The MSP regulates sea use through a permit system that entails

laws and regulations from different ministries, local government, and other administrative authorities.<sup>39</sup> The OCA is currently assisting industries and local groups in applying for OECM certification. At the same time, OCA has established a more user-friendly platform for applications (available in Chinese at: <https://www.oca.gov.tw/ch/index.jsp>).

One of the essential policies of OECM adoption in Taiwan is the zoning policy, which includes sea and offshore areas in the regional planning zones built into the Land Law. This law's jurisdictional baselines, territorial seas, contiguous zones, exclusive economic zones, and continental shelves explain these.<sup>37-39</sup> Taiwan's MSP principles also apply suitable protective measures to avoid environmental impacts, especially offshore wind impacts affecting the biological connectivity of OECMs and related marine environments.<sup>40</sup>

The implementation of OECM and formulation are based on MSP and EIA mechanisms in Taiwan for marine settings. MSP policies are built on EIA frameworks to manage spatial competition between marine economic sectors and environmental conservation and necessarily impact OECM areas.<sup>41</sup> The primary aspect of Taiwan's OECM conservation is to address the human impact and pressures within the marine ecosystem. EIA mechanisms measure these pressures, presenting intensity and value maps to mitigate environmental impacts.<sup>42</sup> On the same note, marine scientific research and environmental educational activities have played a crucial role in the adoption of environmentally friendly policies that are important in understanding the significance of the role of personal behavior in the creation and resolution of related issues and the promotion of pro-environmental behavioral choices.<sup>43</sup> Integrating marine research and related academia can involve a wide range of activities, including environmental assessments, monitoring programs, and formulation of environmental indicators that are directly used by government authorities and stakeholders to develop laws and regulations for PAs and OECMs.<sup>19</sup> Moreover, shallow marine scientific research and environmental education are thus critical for effectively implementing ecologically friendly policies for sustainable environmental management within the framework of Taiwan's OECM strategy.

## 5. Conclusion

Studies on OECMs have highlighted the potential of formally recognizing and supporting biological hotspots that have not yet been incorporated into the PA networks. This recognition approves the involvement of other

ecosystems under different governance systems and increases conservation prospects. In Taiwan, two major policy systems are involved in adopting and implementing OECMs together with PAs, namely, the MSP system, which has an essential role in marine biodiversity conservation. Taiwan's OECM policies are constantly aligned with the regulation mechanisms through MSP: the governing bodies regulate and inspect the marine ecosystem operations to achieve biodiversity goals. The conservation strategy in OECMs in Taiwan is based on reducing human activities affecting the marine environment. This approach mainly consists of MSP, EIA, and marine scientific research, which cover spatial rivalry between economic sectors and the conservation of surroundings. These mechanisms support sustainable marine management and help attain national and international biodiversity goals/targets regarding the utilization and conservation of biodiversity in specific zones of seas/oceans. OECMs demonstrate that environmental stewardship can be flexible, inclusive, and adaptive to socio-political realities—making them a leading example of modern environmental management rather than an isolated phenomenon. Their success can catalyze innovation in conservation governance, especially in areas where formal protection is not feasible due to legal, economic, or cultural barriers.

Our findings highlight Taiwan's emerging approach to protecting marine biodiversity. By focusing on MSP, EIAs, and scientific research, Taiwan offers a replicable framework for high-density coastal nations. Future studies should critically examine how these conservation strategies can adapt to climate change, incorporate community perspectives, and utilize new technologies to track ecological outcomes. These steps are essential to ensure that conservation measures remain effective, equitable, and aligned with international biodiversity goals. For future research, it is recommended that studies expand on several areas:

- (i) Evaluation of OECM effectiveness: Future research directions should examine the mechanism of the current OECMs and MSP policies from actual operative scopes in biodiversity conservation and the extent of ecosystem balance that has been preserved by these policies
- (ii) Stakeholder engagement: Additional studies to understand the relations and cooperation of local communities, industries, and the environment within the OECM model could help identify the best conservation and sustainable development methods
- (iii) Integration of new technologies: More research could investigate the increased use of other technologies, including geographic information



systems and remote sensing, in evaluating and managing Taiwan's OECMs

- (iv) Impact assessments and adaptability: It would be beneficial to conduct an in-depth study of lessons learned from long-term environmental impact evaluations and OECM policies and frameworks, considering their adaptability to new environmental shocks, including climate change
- (v) Educational initiatives: An evaluation of the effectiveness of interventions targeting changes in people's behavior due to educational programs could prove valuable in creating and endorsing mandatory pro-environmental actions, as well as the long-term success of OECM policies.

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## Conflict of interest

The authors declare no conflicts of interest.

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## Availability of data

The data that support the findings of this study are available from the corresponding author on reasonable request.

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