



# Community-based natural resource management in Roatan: Strengths and challenges

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**Abstract** This study explored the transformative journey of community-based natural resource management (CBNRM) in the Bay Islands National Marine Park, Honduras, revealing the interplay of cooperation, funding, and communication in fostering successful conservation initiatives. Using a mixed-method approach, we investigated the historical and legislative process and enabling conditions that led to the transition to CBNRM, based on Gruber's 12 key principles. In regards to the present CBNRM system, we looked at its strengths, its challenges, and whether its functioning is seen as satisfying by local resource-users. Findings showed that key CBNRM principles—including an enabling environment, conflict resolution, research-based decision-making, public trust, and monitoring—fostered the transition. Furthermore, satisfaction with reef management and perceived patrol effectiveness, which are pivotal aspects in CBNRM, exceeded 70% in Roatan. Challenges such as strengthening local institutions and enhancing compliance were identified. Nonetheless, co-managers are actively working to resolve these challenges by focusing on enforcement, diverse funding acquisition mechanisms and community participation. The study underscores the pivotal role of local NGOs and collaborative committees in facilitating successful CBNRM. By providing evidence-based insights, we highlight the efficacy of multilevel, co-management models in resource management and

emphasize the value of adaptable strategies. These findings contribute to a deeper understanding of CBNRM dynamics in Latin America and the Caribbean, which may ultimately foster successful conservation initiatives in the Global South.

**Keywords** Caribbean · Community-based management · Governance · Honduras · Marine protected area

## INTRODUCTION

Community-Based natural resource management (CBNRM) has been heralded as a transformative governance model to counter the Tragedy of the Commons (Brosius et al. 1998; Kellert et al. 2000; Gruber 2010; Van Assche et al. 2016). CBNRM appears to be particularly effective in countries or regions, where national government agencies grapple with financial and technical constraints in devising, implementing and enforcing a regulatory framework for natural resource management over vast territories and sometimes heterogeneous populations (Brown 2010), which are often found in the Global South (Elliott et al. 2018). In such scenarios, CBNRM is often seen as a promising alternative to centralized approaches that often result in adverse outcomes (Ayoo 2007). CBNRM promotes a participatory governance style by transferring authority to local groups and institutions that are better equipped to design, implement, and enforce management strategies tailored to local needs and characteristics (Lauber 2008).

This paradigm's appeal also stems from its potential to simultaneously address both social justice and environmental protection (Brosius et al. 1998; Twyman 2000; Brown 2010). By re-assigning the rights to manage, utilize,

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and benefit from natural resources to local communities and marginalized groups, CBNRM empowers them with responsibility, authority, and accountability for equitable and collective resource management (Taylor 2009). Additionally, this approach may be uniquely positioned to collaboratively and quickly incorporate the novel research targeted at understanding conditions that enhance the adaptive capacity of natural ecosystems in response to climate change (i.e., Walsworth et al. 2019; McManus et al. 2021).

CBNRM is also considered a way to bring more stability to natural resource management, which counters the often fleeting and inconsistent governance styles dictated by transient political mandates (Ayoo 2007; Norris et al. 2018). This approach has been applied globally across a myriad of socioecological systems, ranging from terrestrial wildlife and woodland management in Africa (Hulme and Murphree 2001; Rechlin et al. 2008; Taylor 2009), to forests in India (Ormsby and Bhagwat 2010), coastal artisanal fisheries in South-East Asia (Maliao et al. 2009), the Caribbean (Rivera et al. 2021), the Pacific Islands (Techera 2010), marine protected areas worldwide (Pollnac et al. 2001; Christie et al. 2002; Twichell et al. 2018), and aquaculture in Canada (Bradford et al. 2020).

While, in some regions community-based management has been the de facto governance model for centuries (Colding and Folke 1999), others have transitioned from a centralized, top-down approach to a more inclusive co-management model. This is the case of Latin America and the Caribbean (LAC), where the transition to CBNRM has had diverse outcomes (del Mar Delgado-Serrano et al. 2017) and faced a series of challenges, such as conflicts of interests (Vugt 2002; Eyvindson et al. 2019), trade-offs between conservation and development (del Mar Delgado-Serrano 2017; Hajjar et al. 2020) and inability to scale-up solutions (Mendez et al. 2007; Ozment et al. 2021). This shift is typically considered successful when it results in an efficient and effective natural resource management (Measham and Lumbasi 2013; Mountjoy et al. 2016), while sustaining local communities economically, socially, and culturally (Gruber 2010). Documenting these transitions is essential to scale up CBNRM and implement it in socioecological systems that currently do not manage their resources sustainably or fail to empower local communities to benefit from their natural resources.

The Bay Islands National Marine Park (BINMP) offers a case study of a growing global issue, where a fragile island ecosystem, threatened by rapid tourism-driven development, relies on declining natural resources in the face of climate change and local anthropogenic threats. Here, the coral reefs—a crucial food source and economic lifeline for a significant portion of the island’s population—are under threat (McField et al. 2022). They are a vital tourist attraction, contributing significantly to both the regional

and national economies (Carrasco et al. 2013). However, the central government lacks technical and financial capacity to exclusively support the design and implementation of effective marine conservation strategies (Luttinger 1997; Brondo and Bown 2011). This dilemma propelled communities to seek alternative management styles, leading to a transition toward co-management.

In this study, we utilize an array of qualitative and semi-quantitative tools to evaluate the historical trajectory and enabling conditions that fostered the adoption of CBNRM in the BINMP of Honduras, with a particular focus on the island of Roatan. First, we interviewed local stakeholders and collected information from both scientific and gray literature to unpack the historical evolution of co-management in the area. Subsequently, we assess the main drivers of the transition based on Gruber’s 12 Key organizational principles for CBNRM. Finally, through close-ended questionnaires and follow-up interviews, we investigated stakeholders’ perceptions—defined as ‘a belief or opinion, often held by many people and based on how things seem (Gelcich and O’Keefe 2016)—regarding their satisfaction, and the strengths and challenges of the existing CBNRM system. This approach not only illuminates the specific context of the BINMP but also offers valuable insights for other regions in LAC struggling with similar transitions to CBNRM.

## METHODS

### Conceptual framework

The study utilized Gruber’s 12 Key Organizational Principles for Community-Based Natural Resource Management (CBNRM) to analyze data collected through focus group discussions, interviews, and structured questionnaires. Gruber’s principles, which he distilled from 23 papers published between 1969 and 2006, and validated against 24 case studies, embody 12 characteristics or principles associated with successful community-based environmental initiatives.

Gruber’s 12 organizational principles are: (1) Public Participation and Mobilization, (2) Social Capital and Collaborative Partnerships, (3) Resources and Equity, (4) Communication and Information Dissemination, (5) Research and Information Development, (6) Devolution and Empowerment, (7) Public Trust and Legitimacy, (8) Monitoring, Feedback, and Accountability, (9) Adaptive Leadership and Co-Management, (10) Participatory Decision Making, (11) Enabling Environment: Optimal Pre or Early Conditions, and (12) Conflict Resolution and Cooperation. The principles and their corresponding characteristics are detailed in Supplementary information Table S1.

## Study site

Roatan is the largest and most populated of the Bay Islands (Roatan, Utila, and Guanaja), located 65 km off the north coast of Honduras in the western Caribbean Sea. The island is divided into two municipalities: Roatan and José Santos Guardiola. Together with the municipalities of Guanaja and Utila, they form the Bay Islands Department. Roatan is a long thin island, 200 km<sup>2</sup> in area, oriented from east to west (Fig. 1). It is also part of the largest barrier reef in the Caribbean, the Mesoamerican Reef (MAR). It is primarily surrounded by fringing and barrier reefs with extensive mangrove wetlands on its eastern end. The fringing reef provides a wide spectrum of habitats, including lagoons with turtle grass, patch reef, and aggregate sloping reef (Bouchon Navarro et al. 2001).

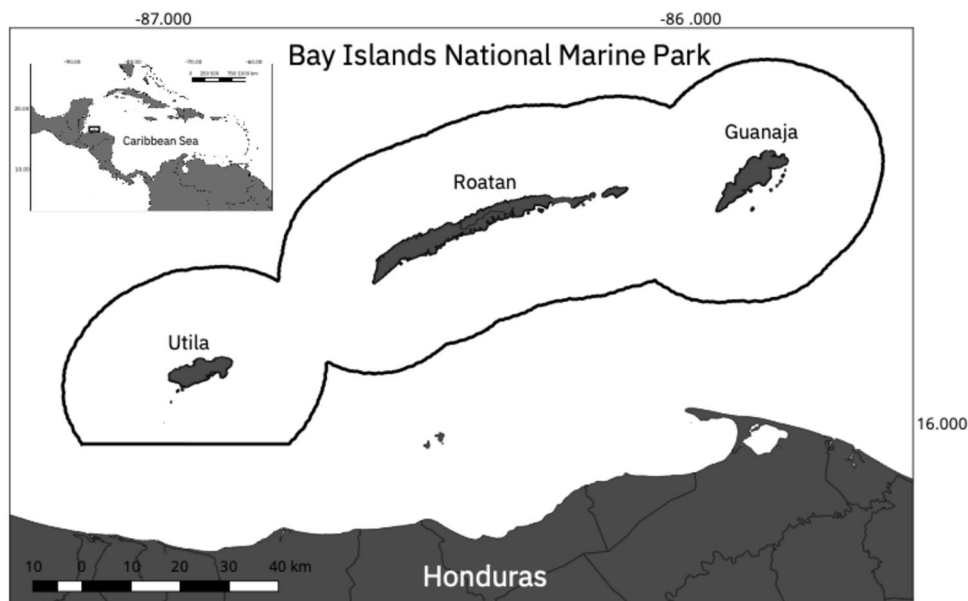
The majority of Roatan's population lives on the western half of the island due to economic and tourism development (Carrasco et al. 2013). Tourism is Roatan's most important economic sector, though fishing is also an important source of income for islanders (EPYPSA 2012). Roatan's population consists of five ethnically diverse groups, including European descendants from English-speaking settlers arrived in the early nineteenth century, English speaking British-Afro-Caribbean descendants from the early nineteenth century settlers, Spanish speaking Afro-Caribbean descendants referred to as Garifunas, Hondurans from the mainland referred to as Ladinos, and European and American foreigners referred to as expats. English is Roatan's primary language, however Spanish is increasingly spoken due to the steady influx of people from mainland Honduras seeking work opportunities.

## Context

Historically, the marine resources of the Bay Islands received no systematic protection until the 1980s, a change catalyzed by the growing influx of tourists drawn to Roatan and the Bay Islands for diving and fishing (Luttinger 1997; Forest 1998). This shift was notably documented in the “Environmental Control Plan of the Island of Roatan”, also known as the “Halcrow Report”, developed by Sir William Halcrow & Partners Limited and Consultecnia Honduras in 1982. As tourism surged, the deterioration of the reefs became evident (Forest 1998). In 1988 the Sandy Bay Marine Reserve was established through a municipal ordinance to protect the western side of Roatan, an effort primarily driven by local resort owners and dive shop operators in response to the degraded reefs. Despite municipal recognition, the funding for the reserve came from these private stakeholders (Personal communication I. Brady and S. Medina).

Following the reserve's initial success, the neighboring West End community founded the West End Marine Reserve in 1993, which soon merged with Sandy Bay Marine Reserve, forming the Sandy Bay-West End Marine Reserve, officially recognized by local government legislation (Acta # 25, Folio 262; Table 1).

By 1994, the Bay Islands Conservation Association (BICA) joined the management efforts, enhancing funding and organizing patrols. The broader appeal of Roatan and the Bay Islands as a tourist destination attracted significant investment which secured funds from the International Development Bank (IDB) in partnership with the Honduran government. This led to the Bay Islands Management



**Fig. 1** Map of the Bay Island National Marine Park, displaying the three main Islands Utila, Roatan and Guanaja

Project (PMAIB) initiated in 1997, aiming to protect critical areas through environmental assessments and zoning. Despite efforts to enhance protection in the Bay Islands, local community involvement in decision-making remained minimal until 2006.

The establishment of the Bay Islands National Marine Park (BINMP) by executive decree in 1997 marked a significant expansion of protected areas, encompassing all three islands—Utila, Roatan, and Guanaja. The increased involvement of local organizations like BICA, particularly

from 2006 onwards, helped drive this initiative, integrating local insights into broader conservation strategies despite ongoing challenges.

### Literature review

An exhaustive review of published and gray literature was developed to dissect the legal and governance structures shaping reef resources management in Roatan and the BINMP. Specifically, searches were conducted using

**Table 1** Main events that shaped the development of the Bay Island National Marine Park, associated legal documents, management and governance system and funding sources

Date	Event	Official document	Management/governance	Funding
Before 1980s	No specific management strategy for marine resources around the Bay Islands			
1980s	First reported observations of fish decline	Sir William Halcrow and Partners & Consultecnia. 1982. Bay Islands Environmental Control Plan		
1988	Establishment by local fishers and resort owner of the Sandy Bay Marine Reserve	Municipal Ordinance (Acta # 17, Folio 249)	Managing body composed of members of the local community exclusively	Resort-owner and voluntary donations
1993	Establishment of the joint Sandy Bay-West End Marine Reserve	Municipal Ordinance (Acta # 25, Folio 262)	Local community members (mostly resort-owners) with assistance from the Bay Island Conservation Association (BICA)	Resort owners and other local businesses, donating on a voluntary basis
1997	Despite the decrease in management cohesion and funding, the Sandy Bay-West End reserve and reserves in other islands are extended to include all three Bay Islands: the Bay Island National Marine Park is established. Initiation of the International Development Bank's Bay Island Management Project	National Decree: Acuerdo 055-97	Management body is comprised of a dozen of representatives from the national government, local municipalities, civil society and NGOs	
2010	The co-management system for the BINMP is officialized through national decree. It involves national government representatives, local municipalities, private companies, ethnic groups and other civil society groups and NGOs	National Decree: Decreto 75-2010	Management body is comprised of a dozen of representatives from the national government, local municipalities, civil society and NGOs	Budgets for programs and activities are fundraised by each organization according to their respective roles and tasks. The co-managers are not required to pay fixed membership fee
2014	Signature of the co-management agreement between 13 co-managers	Convenio para el Co-manejo del PNMBI, 2014–2019	Management committee comprised of 13 co-managers	Budgets for programs and activities are fundraised by each organization according to their respective roles and tasks. The co-managers are not required to pay fixed membership fee

Google and Google Scholar, employing keywords such as “Bay Islands National Marine Park,” “Sandy Bay Marine Reserve,” and “Sandy Bay—West End Marine Reserve” to ensure a wide capture of relevant data. In addition to these digital searches, direct contact was made with local co-managers (Roatan Marine Park, Bay Islands Conservation Association, Roatan Municipality, and the Bay Islands Free Tourism Zone Administrative Commission) and supporting organizations (Coral Reef Alliance and Healthy Reefs Initiative), requesting them to share their unpublished gray literature concerning the establishment and management of the marine protected area (MPA). This approach was supplemented by a visit to, and a thorough review of, the paper archives held by the Roatan Municipality and the Bay Islands Conservation Association Roatan chapter. Together, these efforts yielded insights from a range of documents, including local laws, regulations, and agreements (locally known as *decretos* and *acuerdos*), as well as the Roatan Marine Park’s newsletters (2007–2020) and official annual reports (2012–2022).

### Focus group discussion

Focus groups were held in April 2019 and December 2022, to determine which topics were explored through the one-on-one semi-structured interviews and the structured questionnaire. The discussion also allowed the collection of additional information on the governance system of natural resource management in Roatan. The focus groups were composed by three organizations: two spokespersons from Coral Reef Alliance, one from Healthy Reefs Initiative, and three from the Roatan Marine Park. Participants provided insights on the processes enabling information generation and dissemination within the local community, enforcement efficiency and the development and dynamics of collaboration and trust among stakeholders in Roatan. Information collected through the focus group discussions were also used to contextualize the questions for the subsequent structured questionnaires and semi-structured interviews.

### Structured questionnaire

The structured (close-ended) questionnaire used in this study was designed to assess the level of satisfaction of stakeholder, whose activities depend on reef resources, with the management system in Roatan and the how they perceive the transition to CBNRM through the lens of Gruber’s 12 key principles for CBNRM (Gruber 2010). Consistency between question formulation and Gruber’s framework typology was verified by the co-authors. The questionnaire featured 23 questions. The first four questions collected data on age, sex, sector of activity and basic

knowledge on the management system of Roatan’s reefs. The following 19 questions captured participants’ response on a 5-points Likert scale (anchoring points were, depending on the items: strongly disagree and strongly agree; very dissatisfied and very satisfied; very ineffective and very effective). Out of these 19 questions, 12 were statements reflecting one of Gruber’s 12 key principles for CBNRM. The other seven questions captured additional perception data on the following themes: Satisfaction with the management of the reefs (between 2010 and 2019), efficacy of patrols in Roatan (between 2010 and 2019) and general understanding of the BINMP’s status and functioning. The questionnaire was piloted on two occasions prior to its implementation to ensure all potential participants would understand it. The internal consistency and reliability of data collected through the structured questionnaires was checked using Cronbach’s coefficient, for which a minimum value of 0.7 was considered acceptable. Questions were divided into three clusters: Governance, Efficacy of patrols and Satisfaction with management, for which Cronbach’s coefficients were 0.88, 0.92 and 0.94, respectively. The questionnaire was built and shared online via the tool Google Form; it was available to participants (in English and in Spanish) between April and June 2020.

To ensure broad and representative participation, the questionnaire was distributed through snowball sampling, initiated with a list of potential participants provided by local organizations involved in reef management, such as Roatan Marine Park and Bay Islands Conservation Association. Each participant was asked to further recruit relevant acquaintances, facilitating diverse stakeholder involvement from the tourism sector, local government, NGOs, and businesses directly dependent on reef resources, such as dive shops, hotels, and restaurants. This method allowed us to gather insights from a spectrum of stakeholders: tourism sector ( $n = 4$ ), dive shops ( $n = 5$ ), other private companies ( $n = 4$ ), local government ( $n = 5$ ), local NGOs ( $n = 4$ ), hotels and restaurants ( $n = 5$ ), hotels ( $n = 4$ ), and restaurants ( $n = 4$ ). The questionnaire was administered online via Google Form in both English and Spanish from April to June 2020, accommodating the broadest range of participants despite local restrictions due to the COVID-19 pandemic. At total of 35 questionnaires were collected between April and June.

All statistical analyses were performed using the *psych* (Revelle 2022) and *tidyverse* (Wickham 2017) libraries in R computing software (R Core Team 2018).

### One-on-one semi-structured interviews

Semi-structured interviews with employees of local NGOs were initially conducted between January and October 2020 with follow ups in November 2022 and April 2024.

The primary topics guiding the interviews encompassed: (1) the present governance of natural resource management within Roatan and the BINMP, (2) the historical development and key milestones of the BINMP, (3) the nature of current relationships between local policymakers and stakeholders, (4) the evolution and efficacy of patrol operations in Roatan, and (5) the defining attributes of the prevailing co-management system. Interview participants included two spokespersons from the Coral Reef Alliance, one from the Healthy Reefs Initiatives, four from the Roatan Marine Park (RMP), two from Polos Waterboard, one from the Bay Islands Conservation Association (BICA), and one from Bay Islands Free Tourism Zone Administrative Commission (ZOLITUR). The interviews lasted between 45 min and one hour. Prior to conducting the interviews, a pre-test of the semi-structured interview was carried out with two local stakeholders to verify that all questions were clear and understandable for all participants. To ensure thorough understanding and obtain detailed insights, follow-up interviews were conducted as needed to clarify initial responses or further explore specific topics, such as the funding mechanisms supporting the current management system.

Supplementary information Table S2 provides a description of the methods.

## RESULTS

### Establishment of CBNRM in Roatan

Interviews with co-managers helped elucidate the transition to CBNRM. According to interviewees, the first formal co-management system was established by 1996, comprising BICA, resort owners, dive shop owners, and representatives from the National Institute of Forest Conservation and Development, Protected Areas and Wildlife (ICF, Instituto Nacional de Conservación y Desarrollo Forestal). However, according to local stakeholders in its early years, the BINMP was a 'paper park', lacking a legal framework for proper protection. Consequently, the coastal area around and within the reserve experienced substantial urbanization in the late 1990s.

Only later, in 2008, did an inclusive management approach for the BINMP materialize, when BICA, the central offices of ICF, and the Bay Islands' municipalities signed their second co-management agreement (Table 1). The Special Law for Protected Areas of the Bay Islands (decree 75-2010) issued by the Honduran congress in 2010, clearly defined the zoning of the BINMP and its protected status. It also detailed how co-management was to be organized, incorporating representatives from the national government, local municipalities, private companies, civil

society groups, and NGOs. A more detailed co-management agreement was signed by 13 co-managers in 2014 (Convenio Comanejo, 18.12.2014), outlining each co-manager's roles. Every co-management agreement has a validity of five years beyond which it can be automatically renewed for five years; a new agreement has been drafted and is awaiting signature, while the older version is still enforced.

The co-management agreement aims to promote the conservation and sustainable management of the BINMP, implement a co-management system legally and technically, protect existing ecosystems, lead scientific research, improve the lives of communities living around the protected area, and involve local groups, the private sector, and other civil society groups in these efforts (BINMP 2014–2019 Co-management Agreement). Furthermore, the 2014 Co-management Agreement created the Bay Islands Technical Committee. Each co-managing organization and additional supporting institutions designate a representative who joins the Technical Committee, which is responsible for the management of the protected area, particularly producing and implementing the protected area management, financial and operational plans. Currently, the Technical Committee meets regularly, at least six times a year.

ICF possesses the legal authority to draft and enforce technical standards and legislation that support national policies for forest and protected area development. In collaboration with ICF, the General Directorate of Fisheries and Aquaculture under the Secretariat of Agriculture and Livestock (DIGIPESCA-SAG, Dirección General de Pesca y Acuicultura—Secretaría de Agricultura y Ganadería) and the Merchant Marine (Dirección General de la Marina Mercante) ensure that all legal, technical, and infrastructural requirements are met to facilitate scientific research within the park. This partnership also promotes the involvement of local artisanal fishers and ensures that fishing and aquaculture activities comply with local laws and policies. The Honduran Tourism Institute (IHT, Instituto Hondureño de Turismo), and the Bay Islands Free Tourism Zone Administrative Commission (ZOLITUR, Commission Administrator Zona Libre Turística de Islas de la Bahía), a decentralized national agency, is responsible for the adequate regulation of tourism activities within the park. At a local level the municipalities act as regional authorities responsible for environmental protection.

Nonprofit organizations such as the BICA, RMP, the Bay Islands Foundation (FIB, Fundación Islas de la Bahía), and the Center for Marine Sciences (CEM, Centro de Estudios Marinos) conduct research and implement conservation measures to fulfill the objectives of the management plan. These organizations act as vital links between local stakeholders and the BINMP managing authorities. Specifically, in Roatan, both RMP and the Roatan chapter of BICA engage in research and

community outreach, with RMP leading patrols and enforcement efforts in collaboration with the Honduran Navy. Further information on the co-management agreement signatories is shown in SI Table S3.

### Transition to CBNRM in Roatan through Gruber's framework

Participants ( $n = 35$ ) to the structured questionnaire rated their agreement with 12 statements, representing Gruber's key principles for CBNRM (Gruber 2010). Figure 2 displays the levels of agreement across these principles, highlighting that five out of the twelve principles are notably influential in the transition to CBNRM in Roatan. These principles are: (1) Public trust and legitimacy; (2) Research and information development; (3) Monitoring, feedback and accountability; (4) Enabling environment and; (5) Conflict resolution and cooperation, these are highlighted below. Perceptions of the other seven principles had a 37–49% level of agreement. Detailed responses are shown in Supplementary information Table S4.

#### Research and information development

According to 82% of participants, Roatan's reef management decisions are well-informed by local and scientific knowledge. Focus group participants corroborated that the BINMP technical committee's decisions are informed by tools such as the Green et al. (2017) Resilience Principles

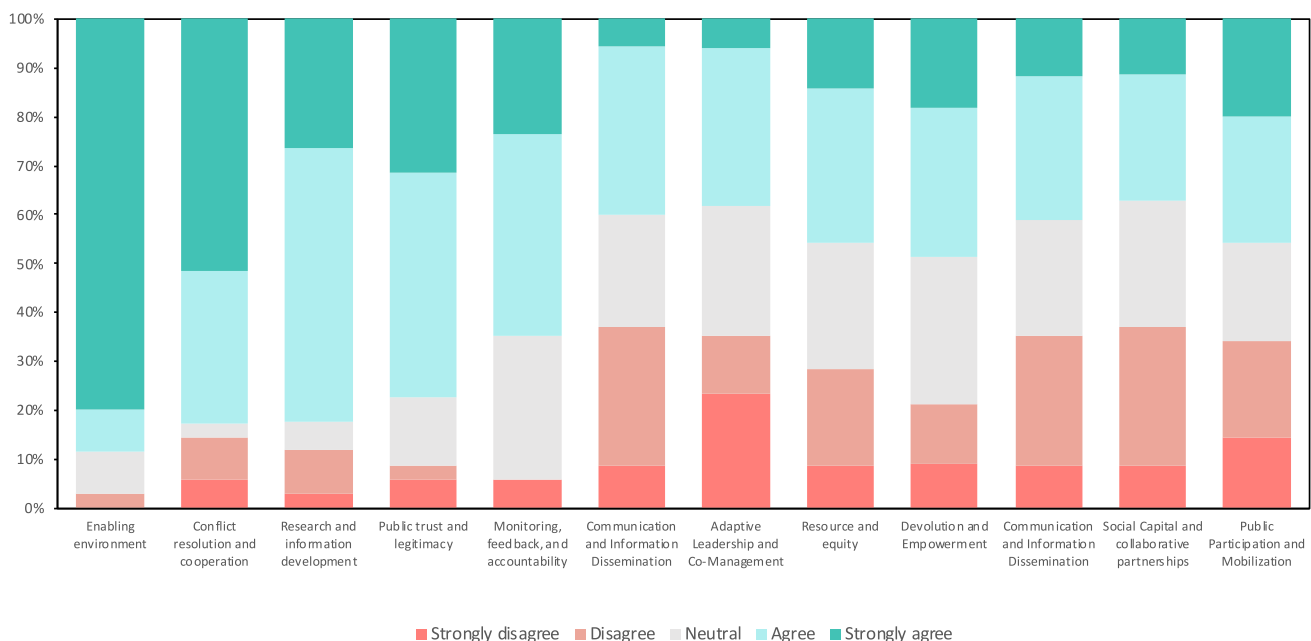
and the biennial Healthy Reef Initiative's Mesoamerican Reef Report Card (McField et al. 2022), published, since 2005. Highlighting the role of evidence-based strategies in the transition.

#### Public trust and legitimacy

77.14% of participants felt that management was effective (31% strongly agreed and 46% agreed), indicating that managers are perceived as performing well which is critical for gaining community trust. Focus group participants cited the BINMP Technical Committee's effective communication regarding the Park's zoning, management, and projected outcomes as instrumental in earning community respect and support. The RMP Newsletter played a significant role in maintaining transparency and keeping the community informed especially during the transition to CBNRM.

#### Monitoring, feedback, and accountability

65% of participants agreed that Roatan's reef management includes both active monitoring and systematic evaluation (24% strongly agreed and 41% agreed), underscoring their importance in refining the CBNRM approach. Discussions and interviews pointed to patrolling as the primary monitoring tool in Roatan, with the BINMP technical committee, particularly RMP, being recognized for its open communication about patrolling activities and adjustments to enforcement efforts based on the results.



**Fig. 2** Extent of agreement among the surveyed participants ( $n = 35$ ) concerning statements associated with Gruber's 12 key principles for Community-Based Natural Resource Management

### *Enabling environment*

Questionnaire data indicated that 80% of participants strongly agree, and an additional 9% agree, that Roatan's economy, heavily reliant on the reef's health, encourages community participation in reef management. This finding is supported by a review of gray literature, identifying tourism centered on marine biodiversity as the primary economic driver in the region (Roatan Tourism Bureau 2022).

### *Conflict resolution and cooperation*

A significant 51% of participants strongly agreed and 31% agreed that they know whom to contact regarding reef management issues. Focus group discussions revealed the importance of socialization processes in legitimizing regulations for the Technical Committee responsible for managing the BINMP. Examples of this approach are the RMP Newsletter ( $n = 77$ ) published between 2007 and 2019 and the biannual meetings of the technical committee, since 2014, which underscores the collective efforts and collaboration of local organizations, facilitating smoother transitions and community cohesiveness.

### **Satisfaction with CBNRM in Roatan**

The structured questionnaire was designed to discern how stakeholders perceive the current management system to evaluate the success of the transition. The results are shown in Fig. 3.

The majority of participants were aware that marine biodiversity protection measures are in place and that the island is part of a marine protected area (MPA) (74% agreement; 34% strongly agreed, 40% agreed). Furthermore, 71% of participants acknowledged their understanding of the rules enforced to manage the coral reefs within the MPA (34% strongly agreed, 37% agreed). The questionnaire results indicated a considerable satisfaction level with the reef's management, where 70% were either satisfied or very satisfied. Additionally, 77% of participants indicated that patrols were effective or very effective (Fig. 4).

However, fewer participants were certain about who holds the responsibility for the management (34% strongly agreed, 26% agreed). Moreover, an even smaller proportion agreed that those individuals are adequately equipped to manage the reef effectively. According to approximately half of the participants (51%), the current managers lack the necessary resources. The questionnaires also shed light on another critical aspect: despite widespread acknowledgment that the reefs are protected and a general understanding of the existing rules, compliance may not be as

high. In fact, 74% of participants disagreed with the statement that everyone in Roatan adheres to the regulations put forth for reef management (23% strongly disagreed; 51% disagreed).

### **Strengths and challenges of CBNRM in Roatan**

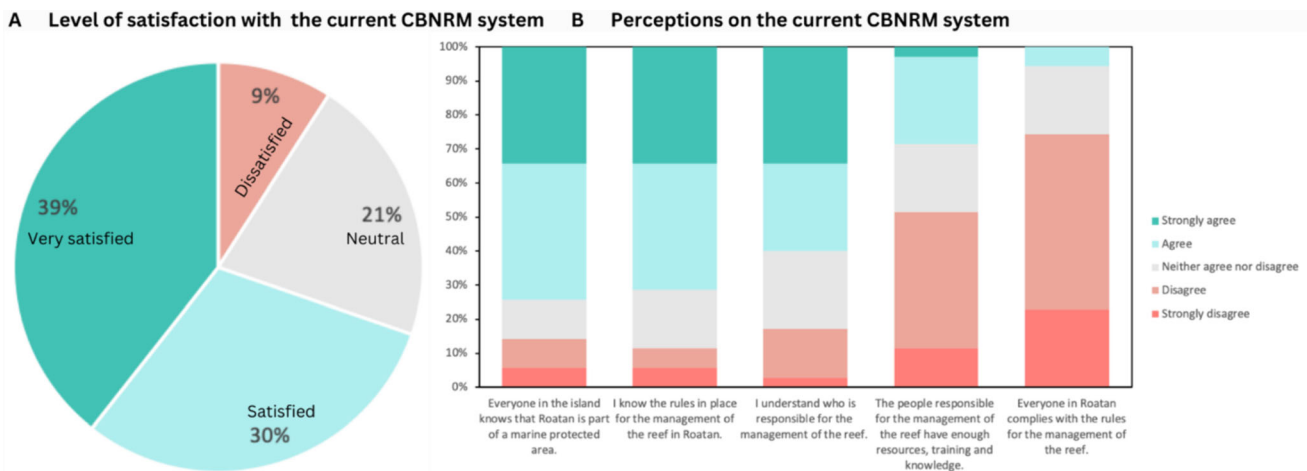
According to questionnaire responses the CBNRM in Roatan faces two key challenges: (1) Strengthening local organizations and, (2) Enhancing compliance. However, based on one on one interviews and gray literature information the co-managers are actively trying to overcome these challenges through three key strengths: (1) Focus on patrols and enforcement, (2) Diverse funding acquisition mechanisms and, (3) Community participation.

#### *Strengthening local organizations*

Half of the questionnaire participants either disagreed or strongly disagreed that the people responsible for managing the reef have sufficient resources, training, and knowledge. The newsletters highlight this issue, with the December 2009 edition reporting a loss of nearly \$30 K for RMP due to the financial crisis in Honduras which severely impacted the tourism sector. In February 2013, RMP participated in a socioeconomic monitoring workshop aimed at fostering community engagement and strengthening organizational ties, as noted in the newsletters. In 2014 co-managers bolstered collaboration with the national police, firemen and navy to “enable the development of a more strategic and efficient patrol and also ensure the safety of all marine protected area users”, according to official statements. Interviews further underscored the strain on personnel, with statements reflecting the challenges of limited staff: “we have the best intentions, but there's only so much a few people can do.” This prompted RMP to initiate a process in 2018 aimed at refining internal operations and the organization's administrative structure to better meet these demands.

#### *Enhancing compliance*

According to the questionnaires, 74% of participants believed that people do not adhere to rules, underpinned by persistent issues like illegal fishing and unauthorized developments mentioned throughout the newsletter editions. Efforts to boost compliance include a range of strategies from international trainings for RMP staff to community meetings with national authorities, with the February 2012 newsletter stating the importance of persuading the fishing sector to comply with regulations. In 2008 they developed a moorings project aimed at reducing anchor damage and fostering compliance. Additionally, newsletters have frequently highlighted illegal fishing of



**Fig. 3** Questionnaire participants ( $n = 35$ ) perceptions on the current status of the Community-Based Natural Resource Management (CBNRM) system in Roatan. Level of satisfaction (A) and breakdown of participants' perceptions regarding various statements related to the management (B), highlighting key areas of agreement and concern

commercially important species and the illegal wildlife trade. The February 2013 newsletter detailed a workshop with key government entities like DIGEPESCA, which clarified roles and designated RMP responsible for handling cases directly affecting the reef, especially illegal poaching. The February 2018 edition mentioned efforts involving livelihood diversification projects aimed at alleviating fishing pressure on the reef and curbing illegal fishing practices.

#### *Focus on patrols and enforcement*

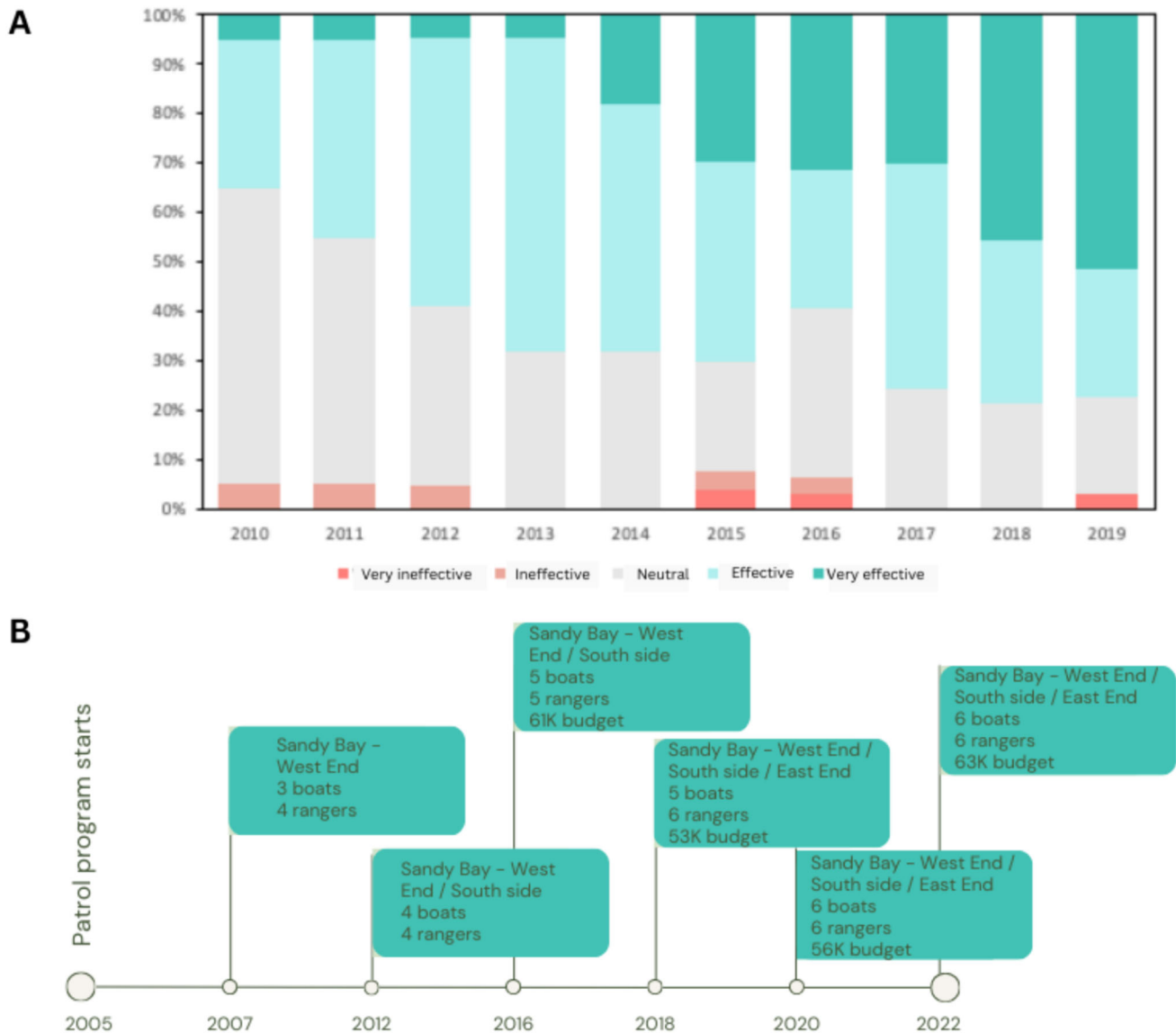
Questionnaire results showed a rise in perceived patrol effectiveness (Fig. 4a) that aligns with a progressive increase in the budget allocated to communication, marketing, and rangers' salaries over the years (Fig. 4b) according to semi-structured interviews and annual reports. This increase resulted in the enhanced visibility of patrols (with more rangers in the water and an increased number of confiscations or fines distributed for violations of park rules) and the organization in general. Additionally, the investment in marketing and communications raised the profile of other RMP programs, enabling more unrestricted funding to be allocated to the patrol program.

Since its establishment in 2005, RMP's patrol program has been significantly strengthened by a formal alliance with the Honduran Navy in 2016, prior to that they worked in collaboration with the national police department. Furthermore, the patrol coordinator role transitioned from part-time to a full-time position. By 2016, the patrol program's budget stabilized between \$50 K and \$60 K, leading to increases in the number of boats, expansion of patrol routes, and capacity building in areas like self-defense, national legislation, and equipment maintenance. Since

2019, the organization has improved patrol evaluation with a transition to an online monitoring and reporting system called SMART (Spatial Monitoring and Reporting Tool), enhancing the efficiency of the patrols. Through the use of the SMART application, they have been able to quantify their fuel consumption, time spent in the water and number of illegal activities. Based on the data recorded through SMART, RMP patrolled over 59,000 km and reported 148 illegal activities in 2022. Such fine detail resolution was not possible prior to the use of SMART.

#### *Diverse funding acquisition mechanisms*

RMP has developed various innovative funding strategies to support its conservation efforts. Tourists contribute to the NGO's budget through a voluntary user fee, initially offered in exchange for a token in 2005 and later a bracelet in 2006, accounting for 49% of the budget by 2006. The eco-store whose proceeds all go to RMP's unrestricted funds opened in West End in 2006, expanding to West Bay, Mahogany Bay and Port of Roatan by 2019. Currently, they have on-going partnerships with national and international brands to further bolster funding. In 2009, during the financial downturn, RMP initiated a sponsorship program for local businesses who in turn receive publicity in RMP's newsletters, webpage, and reports. Additionally, in 2015, RMP established its US branch, Roatan Marine Park International Inc (RMPI), which is registered as a 501(c)(3) nonprofit organization. RMPI generated over \$110 K in 2019. According to the interviews in 2018, an increased focus on boosting the research component attracted significant grants from international aid agencies, including the Swiss Development Cooperation (COSUDE) and the Mesoamerican Reef Fund (MARFund).



**Fig. 4** Questionnaire participant’s ( $n = 35$ ) satisfaction levels with patrol effectiveness from 2010–2019 (A) and key metrics for the Roatan patrol program from 2005 to 2022 according to key stakeholder interviews, newsletters and annual reports (B)

*Community participation*

Community engagement is integral to RMP’s strategy. The environmental education program has been pivotal in training several schools, resorts and businesses, the water taxi association, and the cruise ship ports to be environmentally responsible. Additionally, the park’s co-managers have provided a series of trainings in sustainable tourism, fishing and diving for community members from different sectors through programs like the *Coral Reef Leadership Network* and *Protect Our Pride*. From 2007 to 2020 over 18,900 students and 2513 adults were part of environmental education activities in Roatan (Supplementary information, Table S5). Regular public fundraisers,

highlighted in multiple newsletter issues, demonstrate close relationships with local businesses, crucial during economic downturns like in 2009. In fact, the 2017 newsletters indicate that the patrol program was expanded thanks to donations from local businesses.

In 2012 with a KfW Bankengruppe grant and funds from the national government they began working on livelihood diversification projects focused on beekeeping, creating a visitor’s center in the community of Punta Gorda and training community members in diving through two editions of the *Protect Our Pride* program, which gives local community members the opportunity to diversify their livelihoods by helping them earn their diving certification.

## DISCUSSION

Our findings in Roatan provide compelling evidence for the critical role that local organizations play in successful natural resource management. The gradual transition to co-management of the Bay Islands National Marine Park (BINMP) exemplifies the impact of cooperative efforts. The transition to CBNRM in Roatan can be attributed to strong alignment with five key principles of CBNRM: an enabling environment, conflict resolution and cooperation, research and information development, public trust and legitimacy, and monitoring, feedback, and accountability. Notably, satisfaction rates for reef management were high (75%), and satisfaction with patrols surged to 77% following the 2014 co-management agreement, increased funding and additional personnel. These outcomes reflect the success of consistent enforcement and increased visibility, which have boosted community engagement. Additionally, more than 70% of stakeholders are now aware of the protection measures and regulations, underscoring the broad understanding and support for these efforts. However, the low compliance rate at 6% remains a significant concern. The crucial role of local NGOs, as recognized by stakeholders, has been instrumental in advancing CBNRM in Roatan. Further investment in these organizations is essential to address current system challenges.

Beyond their role in securing funding, the BINMP technical committee has served as a bridging organization facilitating effective communication, cooperation, and conflict resolution.

Such collaborative dynamics have been instrumental in fostering cooperation and maintaining positive relationships among diverse stakeholders, an approach that mirrors successful conservation efforts observed in other regions of Honduras (Rivera et al. 2021). This concerted effort towards a common goal—preserving the health of the coral reefs—is crucial not only for environmental sustainability but also for the socioeconomic stability of the local communities (Lange et al. 2012). This strategy aligns with previous findings that emphasize the value of fostering cooperation and maintaining positive relationships to improve community involvement in natural resource management (Acedo and Gomila 2013; Pauwelussen 2015; Berdej and Armitage 2016). Furthermore, the success of such initiatives often hinges on the initial dissatisfaction among local communities with the existing management of their crucial natural resources. This discontent drives the push for more inclusive and effective management structures (Luttinger 1997; Pollnac et al. 2001; Pomeroy et al. 2004), such as co-management (Pomeroy and Rivera-Guieb 2006). Additionally, adaptive co-management frameworks, highlight the necessity of multilevel co-management characterized by flexible governance structures, polycentricity, learning by doing and

cooperative partnerships that allow for shared management responsibilities and ultimately foster resilience in community-based conservation efforts (Berkes 2007; Armitage et al. 2010; Finkbeiner and Basurto 2015). These characteristics were prevalent in the BINMP, where power has been decentralized to the communities and local government agencies, allowing direct communication with national authorities through multilevel governance structures coordinated by the technical committee. Such systems have demonstrated their effectiveness in managing protected areas in the Global South, ensuring sustainable resource management (Christie et al. 2002; White et al. 2002).

Significant challenges persist in enhancing compliance and strengthening local institutions. Despite high awareness and satisfaction rates, perceived compliance remains disappointingly low at 6% (Fig. 3b). Historical and ongoing issues, such as illegal fishing and unauthorized developments, continue to undermine conservation efforts, reflecting systemic shortcomings in local governance capabilities and enforcement mechanisms (Milliman 1986; Österblom et al. 2010; Kaye 2014), which are a common issue in low income countries (Agnew et al. 2009). Moreover, the lack of sufficient regulatory oversight and the occasional absence of clear legal framework and competencies of each organization contribute to these compliance challenges, necessitating a deeper examination of institutional frameworks and governance models (Rudd 2004; Symes 2007). Strengthening these areas is crucial for the sustained success of CBNRM (Fabricius and Collins 2007). Increased efforts in policy-making and local capacity building will be crucial to enhance the efficacy of governance structures (Downs et al. 1996). Furthermore, fostering stronger community involvement and enhancing local enforcement capabilities are essential steps towards improving compliance rates (Schreiber 2001; Gezelius and Hauck 2011). Integrating local knowledge systems with formal regulatory frameworks can provide more tailored and effective management solutions, potentially increasing compliance and engagement (Wilson et al. 2006; Linke et al. 2011). Addressing these challenges also involves acknowledging and mitigating the socioeconomic drivers of non-compliance, such as economic dependency on overexploited resources, which requires a multifaceted approach including livelihood diversification and improved socioeconomic benefits from conservation initiatives (Ha and Dijk 2013; Claassen et al. 2017), strategies which have started to be implemented in the BINMP. By understanding and integrating these complex factors, CBNRM initiatives can achieve more sustainable outcomes, leading to more resilient socioecological systems in the Global South.

In the context of funding, a gradual increase in funds was observed, mobilized by local and international NGOs for

enforcement and monitoring, which significantly contributed to the successful management of resources. Funding is a determining factor to the success of an MPA, as it dictates the amount of enforcement and personnel available to manage an MPA (Bos et al. 2015; Gill et al. 2017; Bohorquez et al. 2022). Funding challenges are particularly predominant in the Global South, where financial resources are often limited and irregular, affecting the consistency and sustainability of conservation initiatives (Bruner et al. 2004; Steger et al. 2017). Securing diversified funding streams as is the case in Roatan, including public, private, and philanthropic sources, can reduce dependency on a single financial channel and buffer against economic fluctuations, thereby enhancing the resilience of conservation funding (Carroll and Stater 2009; Whitelaw et al. 2014). Effective financial planning and management, combined with transparent reporting and accountability, as has been the case in Roatan and in other areas of Honduras (Estrada and Bastida 2020), are essential to maintain the trust of funders and stakeholders, further stabilizing funding for long-term conservation goals (Lander and Auger 2008; Kaufmann and Weber 2010). The role of science-based information has also proven invaluable for policy-making, a lesson that was learned when the initial response from the local community was triggered by their concern for the rapidly receding coral reefs due to growing tourism, and the noticeable depletion of marine life. In the face of local authorities' lack of conservation efforts, community members – primarily resort, hotel, and restaurant owners who relied on a healthy marine ecosystem for their livelihoods – began to pool private funds to support the initial managing committee. The role of science-based information in enhancing trust among stakeholders has been observed across MPAs worldwide, emphasizing the need for continuous investment in research and development to support effective CBNRM strategies (Cvitanovic et al. 2015, 2018; Arbieu et al. 2019).

It is important to note several limitations in this study that might affect the interpretation of its findings. First, a significant portion of the research was conducted prior to the global pandemic, which has had profound impacts on Roatan's economy, particularly its tourism sector, and a key livelihood source. This external shock may have altered stakeholders' perceptions, and in turn the relevance of our findings, underscoring the need for future research to assess these changes. Additionally, the data collection methods, particularly the questionnaires, were implemented in 2020, which might not fully capture the current dynamics of stakeholder perceptions. We recommend regular biannual monitoring and evaluation, considering the dynamic nature of socioecological systems (Ostrom 1990). Another consideration is the anonymity maintained during the questionnaire distribution to enhance response rates and candor, which, while beneficial for data integrity,

limits our ability to follow up on specific responses or to ensure a fully representative sample across all stakeholder groups. Thus, the results presented here should be considered as indicative rather than definitive, highlighting the need for ongoing engagement and detailed stakeholder analysis in future studies.

## CONCLUSION

The Roatan case study underlines the importance of bolstering local organizations and fostering trust among stakeholders for successful CBNRM. Continued place-based research on CBNRM systems in the Caribbean, like the Roatan case study, is necessary to draw basic lessons that can facilitate successful CBNRM implementation in the Global South, particularly in LAC. This region shares similar socioeconomic and ecological characteristics, making the insights from Roatan particularly relevant. The study highlights the effectiveness of diverse funding strategies and consistent enforcement as key factors in the success of CBNRM. Future efforts to transition to CBNRM in LAC should aim to formalize multilevel, adaptive co-management frameworks, through cooperation with local communities and NGOs to provide legitimacy and enhance stakeholder confidence.

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## Declarations

**Competing interests** Furthermore, the authors have no competing interests to declare that are relevant to the content of this article.

**Informed consent for human participants** All participants involved in the questionnaires, focus groups, and interviews were provided with a clear explanation of the research objectives. They voluntarily gave their informed consent before participating in any questionnaires, focus groups, or interviews. Furthermore, all personal identifiers, such as the names of focus group and interview participants, were securely stored and utilized exclusively for data collection purposes. These identifiers will not be disclosed widely or publicly released. In the case of questionnaires, no personal identifiers were recorded to ensure anonymity.

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