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Challenges and opportunities of local engagement in coral restoration at Laughing Bird Caye National Park

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ABSTRACT

Introduction: Numerous studies have revealed the importance of local support for successful restoration and conservation initiatives. Much less attention has been devoted to identifying the challenges and opportunities that influence community support.

Objectives: To identify the challenges and opportunities influencing community engagement in coral reef restoration at Laughing Bird Caye National Park, Belize and its buffer zone.

Methods: We interviewed restoration practitioners and key stakeholders, conducted a SWOT analysis with community members engaged in restoration efforts, and surveyed the broader public to evaluate local perceptions of the factors influencing community engagement in coral reef restoration.

Results: Participant responses revealed four systems shaping local engagement: management, social, educational, and environmental. Key challenges included limited participation in restoration decisions, social dysfunction, low awareness of coral ecosystems, and environmental threats. Opportunities focused on expanding educational programs, particularly for youth, supporting local economies and livelihoods, promoting environmental stewardship, and strengthening governance through collaboration and local leadership.

Conclusions: Our research revealed challenges that deter community engagement but also identified opportunities that may transform obstacles into actions to build trust, institutionalize collaborative participation, and empower local stewardship as a sustainable, community-driven process. Our results are specific to the community in Placencia, Belize but our methodology provides a potential roadmap for identifying stakeholder concerns and developing inclusive and effective programs to promote community engagement in restoration and conservation efforts elsewhere.

Key words: Participatory research methods; qualitative analysis; community engagement, Placencia, Belize, Caribbean, Laughing Bird Caye.

RESUMEN

Desafíos y oportunidades de la participación local en la restauración de corales en el Parque Nacional Laughing Bird Caye

Introducción: Numerosos estudios han revelado la importancia del apoyo local para el éxito de las iniciativas de restauración y conservación. Sin embargo, se ha prestado mucha menos atención a la identificación de los desafíos y oportunidades que influyen en el apoyo de la comunidad.

Objetivos: Identificar los desafíos y oportunidades que influyen en la participación comunitaria en la restauración de arrecifes de coral en el Parque Nacional Laughing Bird Caye, Belice y su zona de amortiguación.
Métodos: Entrevistamos a profesionales de la restauración y actores clave, realizamos un análisis FODA con miembros de la comunidad involucrados en los esfuerzos de restauración y encuestamos al público en general para evaluar las percepciones locales sobre los factores que afectan la participación comunitaria en la restauración de arrecifes de coral.
Resultados: Las respuestas de los participantes revelaron cuatro sistemas que configuran la participación local: gestión, social, educativo y ambiental. Los principales desafíos incluyeron la participación limitada en las decisiones de restauración, la disfunción social, el bajo conocimiento sobre los ecosistemas de coral y las amenazas ambientales. Las oportunidades se centraron en ampliar los programas educativos, especialmente para jóvenes, apoyar las economías y medios de vida locales, promover la responsabilidad ambiental y fortalecer la gobernanza mediante la colaboración y el liderazgo local.
Conclusiones: Nuestra investigación reveló desafíos que desincentivan la participación comunitaria, pero también identificó oportunidades que pueden transformar obstáculos en acciones para generar confianza, institucionalizar la participación colaborativa y fortalecer la gestión local como un proceso sostenible liderado por la comunidad. Nuestros resultados son específicos para la comunidad de Placencia, Belice, pero nuestra metodología ofrece una ruta potencial para identificar preocupaciones de los actores y desarrollar programas inclusivos y efectivos que promuevan la participación comunitaria en la restauración y conservación en otros contextos.

Palabras clave: Métodos de investigación participativa, Análisis cualitativo, Participación comunitaria, Placencia, Belice, Caribe, Laughing Bird Caye.

INTRODUCTION

Biodiversity researchers worldwide have emphasized the importance of involving local stakeholders and communities in biodiversity conservation (Cinner et al., 2016; Ison et al., 2021; Sterling et al., 2017). Community engagement has been identified as essential for driving conservation efforts, especially in addressing environmental challenges and promoting resource-conscious behaviors (Monroe, 2003, Stern, 2000). Dawson et al. (2021) contend positive conservation outcomes often depend on Indigenous peoples and local communities (IPLCs) taking a central role in conservation efforts, influencing decision-making processes or having local management institutions integrated within their recognized governance structures. As a result, many countries have adopted policies emphasizing community involvement in managing natural resources (Ojha et al., 2016). Sterling et al. (2017) concluded stakeholder engagement is associated with positive attitudinal shifts towards conservation and identified four key factors to stakeholder engagement: (1) integrating stakeholder knowledge and values into decision-making, (2) ongoing inclusion of stakeholder input, (3) transparent decision-making processes, and (4) enhanced trust between stakeholders and planners. Rozzi et al. (2018) emphasize the importance of promoting partnerships across various institutional and governmental levels and the importance of direct engagement through formal and informal education. The integration of communities in conservation efforts has been reported to prove successful when partnerships are formed and diverse knowledge systems are combined (Gavin et al., 2018), which require overcoming challenges associated with integrating traditional and western scientific knowledge and power imbalances (Burke, 2023; Huntington, 2011).

Whereas a good deal of attention has been devoted to recognizing the importance of community engagement for conservation efforts, less emphasis has been placed on evaluating community and local Indigenous perceptions of the motivations and challenges that either promote or hinder the community engagement process. To address this knowledge gap, our study examined stakeholders', restoration practitioners' and local community members' perspectives on the engagement process related

to coral reef restoration activities in Laughing Bird Caye National Park, Belize. Evaluating the perspectives of key stakeholders and local community members is important because the relationship between local communities and the marine environment is highly interdependent; local communities can either hinder conservation efforts and contribute to biodiversity loss or actively engage in efforts to protect the environment (Mace, 2014). Consequently, the success of conservation initiatives is influenced by the communities residing in these areas (Cinner et al., 2016; Ison et al., 2021). Ultimately, the overall goal of this research was to identify strategies to promote community and key stakeholder engagement in coral reef restoration and conservation efforts. To do so, we identified the following objectives: (1) identify key motivations that influenced community members, key stakeholders, and restoration practitioners to engage in coral reef restoration efforts; (2) identify challenges and barriers to active participation by key stakeholders and community members; and, (3) identify potential strategies to engage communities more effectively and address dysfunctionalities that impede coral reef restoration and conservation efforts.

MATERIALS AND METHODS

Study area: Laughing Bird Caye National Park (LBCNP) was established in 1991 under the National Parks System Act (Government of Belize, 1991). LCBNP is located on the shallow reef platform of the Mesoamerican Barrier Reef System, which is the largest barrier reef in the western hemisphere. The LCBNP is one of seven sites that comprise the Belize Barrier Reef System, designated a UNESCO World Heritage Site in 1996 (Government of Belize, 1996; Fig. 1). Its ecological and economic importance is significant, with tourism at the site valued at nearly USD 5 million annually (Nawaz et al.,

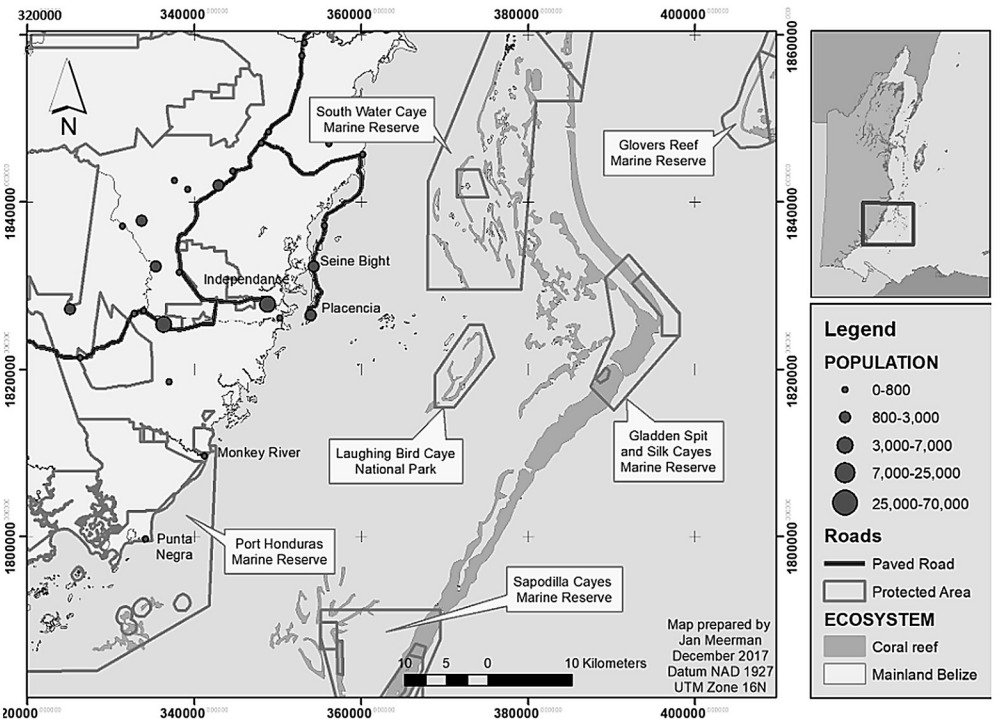

Fig. 1. Laughing Bird Caye National Park and surrounding buffer zones (Reproduced from Laughing Bird Caye National Park Management Plan 2018–2023, Volume One; SEA Belize, Southern Environmental Association (2018).

2017). Management of the park is coordinated by the Southern Environmental Association (SEA) through a participatory five-year plan that balances biodiversity conservation with sustainable tourism, including strategies to reduce the environmental impacts of visitors (Alicea, 2010). Since 2006, this management framework has been complemented by active coral reef restoration. Thousands of Acroporid coral fragments have been outplanted within the park and its buffer zone, with community participation proving essential for ensuring the long-term success of these initiatives (Vaughan, 2021).

LCBNP conservation efforts are deeply connected to the nearby communities of the Placencia Peninsula, whose livelihoods and identities are intertwined with the marine environment. Placencia Village, founded by European and Creole settlers, lies at the southern tip of the peninsula, while Seine Bight, about five miles north, is home to a Garifuna community descended from African, Carib, and Arawak peoples officially recognized as one of Belize's Indigenous groups (Palacio, 2007). For much of the twentieth century, local economies relied on fishing and agriculture; however, over the past three decades, the rapid expansion of coastal tourism has reshaped livelihoods (Key, 2002). During 2000–2010, the local population doubled (Webb, 2024). Today, approximately 6 000 residents, split almost evenly between Seine Bight and Placencia Village, depend directly and indirectly on marine resources and tourism, making their involvement in restoration and conservation efforts both a social and ecological necessity.

Methods: We employed a mixed methods approach to examine community engagement, combining qualitative and quantitative data using the exploratory sequential method (Fetters et al., 2013). The method explores qualitative data first and then uses this data to develop the quantitative instruments (Creswell, 2009). We collected data during two field seasons that totaled four months and included interviews; SWOT (strengths, weaknesses, opportunities, and threats) analysis; and surveys (Fig. 2). The precise dates of data collection are not provided to protect the anonymity of participants. A more detailed explanation of the instruments used is available in Uribe-Castañeda et al. (2014). Interviews conducted with restoration practitioners were used to gather information about their strategies for engaging communities in restoration programs, and with key stakeholders to obtain information on their perspectives of the engagement process. After preliminary analysis of the interview data, we developed a SWOT analysis for community members engaged in coral reef restoration efforts to identify perceptions of restoration engagement efforts. We also conducted surveys with the broader community by interviewing community members selected at random at a local food market to understand their perceptions and compare responses collected from restoration practitioners and key stakeholders.

Our research methods were based on the Ethical Community Engagement Framework (ECEF) developed by Carter et al. (2022; Table 1). The ECEF describes a structured approach to engage communities in ways that are participatory, inclusive, and transparent (Carter et al., 2019).

Sampling design: Two semi-structured interview instruments were developed to analyze community engagement strategies for restoration programs in the Laughing Bird Caye NP and buffer zone. We conducted interviews

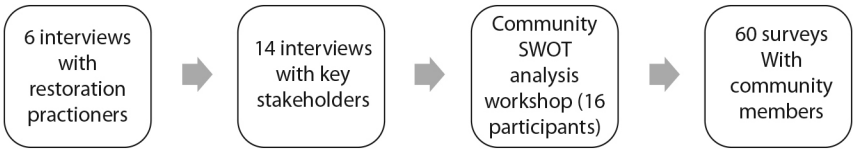

Fig. 2. Study design identifying participatory research methods and target audiences.

Table 1
Ethical community engagement framework (Carter et al., 2022).

Principle	Statement
1	A deep commitment to intrinsic values about people, their natural endowments and their agency is integral to inclusive (and effective) engagement
2	An empathetic attitude along with specific interpersonal skills are essential to the engagement process
3	Situational awareness is paramount to building trust and achieving inclusion
4	In a research context, qualitative methods can be a useful technique for inclusive engagement
5	Participatory monitoring, evaluation, and learning enhance facilitators and communities' ability to reflect, collaborate, co-create, and adapt to situations
6	Without sufficiently deep commitment and ownership of engagement processes, initiatives are less likely to sustain over time

in person, who were recruited through chain referral or "snowball" sampling (Kittinger et al., 2016), until reaching sample size saturation (Hennink & Kaiser, 2022). Snowball sampling involves selecting a few individuals among key stakeholders and asking them to refer to others who also meet the criteria to participate in the study (Etikan et al., 2016). The interviews lasted between 30 and 90 minutes each. The first set of interviews was with restoration practitioners. Interviews consisted of eight questions (Appendix 1) and identified activities carried out by them, the level of engagement with the local community, the target audiences, and the metrics used to evaluate their programs. The second set of interviews was with key stakeholders and consisted of 10 questions (Appendix 2) designed to determine the level of awareness about community-based restoration efforts, whether those interviewed participated in them, the inclusivity of the community engagement efforts, the barriers that could prevent community members from participating, and the motivations of key stakeholders to participate in the program activities.

We conducted a SWOT analysis workshop to assess the effectiveness of the local community-based restoration efforts and identify potential areas for improvement. The four elements of a SWOT analysis include internal factors such as strengths and weaknesses, as well as external factors like opportunities and threats (Benzaghta et al., 2021). Community members who participated in the workshop were divided into four groups, each assigned to one of the four categories of the SWOT analysis. At the end of the workshop, a representative from each group shared the ideas and insights collected with all the participants. Sample size was dictated by the number of community participants.

We used data collected during interviews with restoration practitioners and key stakeholders and the SWOT analysis to develop a survey for the broader community using the ECEF framework developed by Carter et al. (2022). The survey consisted of 14 close-ended questions designed to collect information about the community members' perceptions of coral reefs, their challenges, and their conservation status (Appendix 3). Some questions from the interviews were changed from open-ended to close-ended questions with multiple answers, the answers options were identified according to the data collected during the interviews and were designed to identify motivations of community members to participate in coral reef restoration activities, the barriers that could hinder their participation, and the activities in which they would like to contribute to restoring the coral reefs. We chose to collect a sample size double the recommended sample size based on the anticipated point of theoretical saturation (Thomson, 2011).

We transcribed the semi-structured interviews, translated transcriptions from Spanish to English, and coded the translated transcriptions

using MAXQDA 2022 qualitative analysis software following the guidelines proposed by Kuckartz & Rädiker, (2019). Coding involves organizing and interpreting qualitative data by assigning labels or codes to specific data segments that represent meaningful and categorical themes (Saldaña, 2013). We did three rounds of coding; a first round of open coding, a second round of category coding, and a third round of axial coding to ensure details were preserved in the translation. The codes were grouped into four themes (parent codes) aligned with research objectives. SWOT analyses and survey data are reported using descriptive statistics and correlations where appropriate following recommendations of De Winter et al. (2016).

Approval for the development of these methods was obtained from the University of Florida Institutional Review Board (IRB202100741) and the National Institute of Culture and History in Belize (ISCR/H/2/132).

RESULTS

We identified 609 information segments during analysis and coding of interviews of restoration practitioners and key stakeholders. Information segments were coded and categorized into engagement categories (parent codes) and subcategories (subcodes). We identified four main systems associated with the challenges and opportunities influencing community engagement in coral reef restoration at Laughing Bird Caye National Park and associated buffer zone. Based on information gathered from interviews with target audiences, the systems identified were (1) management, (2) social, (3) educational, and (4) environmental (Fig. 3, Fig. 4). Within each thematic group of categories, we identified subcategories of common factors and elements that promoted or hindered local engagement and grouped them as challenges and opportunities.

Challenges: Challenges associated with management and administrative systems were identified as the most significant factor hindering local engagement in coral reef restoration, accounting for 67 % of all responses across all challenges categories (Fig. 3). However, there were key differences identified between restoration practitioners/key stakeholders and the broader community, with key stakeholders and

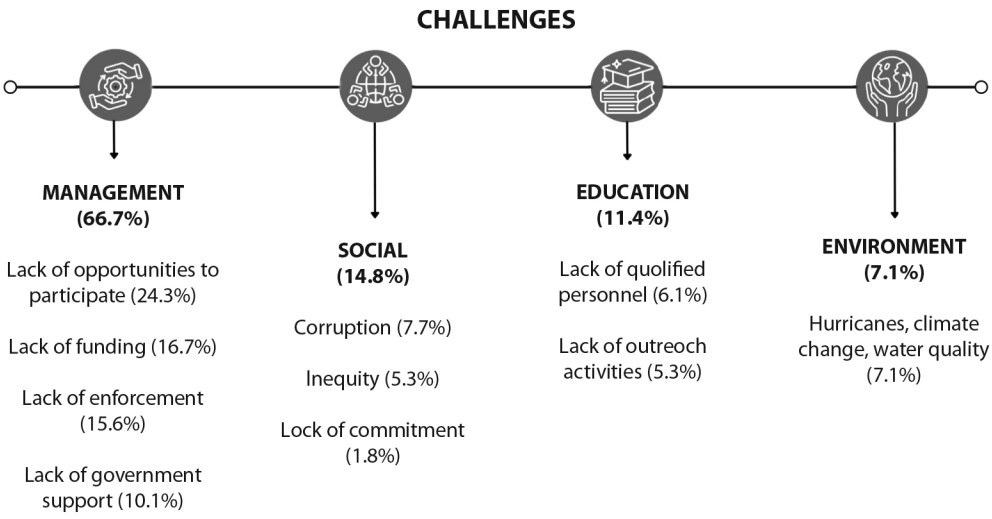

Fig. 3. Challenges to local engagement in coral reef restoration identified by restoration practitioners, key stakeholders and the broad community from Laughing Bird Caye National Park and its buffer zone. The percentages of all challenges total 100 %.

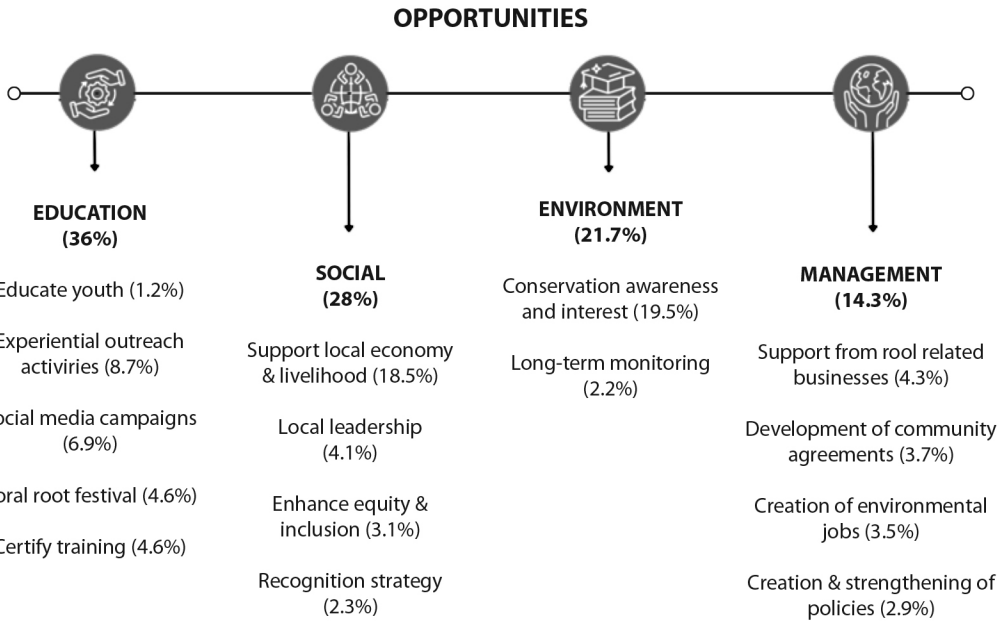

Fig. 4. Opportunities of local engagement in coral reef restoration identified by restoration practitioners, key stakeholders and broad community in the Laughing Bird Caye National Park and its buffer zone. The percentages of all opportunities total 100 %.

restoration practitioners contending that lack of enforcement and funding as the main challenges. SWOT analyses with key stakeholders also identified the lack of significant and consistent government funding as weaknesses influencing coral reef restoration efforts. Surveys among the broader community expressed different concerns, specifically that opportunities to engage in coral reef restoration are limited with 65 % of the respondents indicating they had very little or no participation in coral reef conservation efforts, especially regarding decisions affecting coral reef management. The lack of community engagement appears to be associated primarily with the lack of opportunities to engage because we found a significant positive correlation between sense of personal responsibility and acknowledgment of community responsibility for coral reef conservation (r_s [60] = 0.53, $p < 0.001$), and 83 % of individuals surveyed indicated they felt a personal responsibility for protecting the coral reef ecosystem.

Social challenges were identified as the next most important barrier to community engagement in coral reef restoration. This category constituted approximately 15 % of all interview responses with the most cited issues being corruption within government departments, social inequities associated with opportunities for community members to provide effective input on decision-making, and lack of commitment among the community due to loss of faith in participatory processes (Fig. 3). SWOT analyses had a slightly different view, reporting limited local awareness, lack of qualified office staff, and conflict with local tourism impediments. Community survey respondents identified two primary factors presenting social barriers to community involvement - time constraints (59 %) and a shortage of opportunities and invitations to participate (25 %). Financial concerns (10 %) were also identified as a potential barrier to participation in reef restoration.

The lack of education and awareness (11 %) emerged as a recurring challenge to community engagement in coral reef restoration (Fig. 3). The perspectives on educational needs are

noticed in different ways between groups. Restoration practitioners primarily viewed the lack of education as a problem in terms of the availability of qualified personnel to assist in restoration efforts, whereas community members viewed educational needs in terms of the lack of outreach activities designed to increase awareness and understanding of coral reef restoration efforts. SWOT analysis indicated that limited local awareness was a weakness and the lack of knowledge among boat captains posed a serious threat to the reef. Community surveys indicated the lack of community outreach and educational programs as a need specifically for youth (15 %), through social media campaigns (15 %), and for adults via community meetings (13 %).

The least often cited challenge (7 %) to coral reef restoration efforts from restoration practitioners and key stakeholders were extrinsic environmental threats such as climate-related stressors and poor water quality (Fig. 3). Responses from interviews and the SWOT analysis identified lack of enforcement of existing regulations and loss or damage to mangrove and seagrass habitats associated with tourism and coastal development as more important potential threats to the coral reef.

Opportunities: Despite being identified as a challenge, education was also the most frequently cited opportunity to strengthen community engagement in coral reef restoration, representing 36 % of responses from interviews (Fig. 4). Within this system, participants emphasized youth education as the greatest opportunity to increase awareness of the importance of the reef to the local community and develop knowledge and skills necessary to participate actively in coral reef restoration. Results also indicated the importance of experiential outreach activities, social media campaigns, and skills training as strategies to engage both youth and adults and foster long-term commitments to coral reef stewardship. Community initiatives, such as coral reef festivals, were also identified as opportunities to increase awareness and participation and provide economic opportunities to local businesses. SWOT analyses identified similar strategies as strengths and opportunities, emphasizing engagement of the local community in an array of potential educational programs and activities to strengthen community interest and engagement in reef restoration efforts. As noted in challenges, surveys of the local community revealed a desire for increased educational opportunities, with 68 % of responses associated with strategies to engage including some type of educational opportunity for the local community.

Social opportunities accounted for 28 % of responses from interviews, with the strongest emphasis placed on supporting local economies and livelihoods (Fig. 4). Respondents emphasized the importance of strengthening local leadership, advancing equity and inclusion efforts, and implementing recognition strategies for community volunteers to promote broad participation and ownership of conservation initiatives. SWOT analyses supported these ideas, identifying strategies such as active community involvement, awards and recognition for community engagement, and expanding social media to engage the community more effectively. As discussed in challenges, community surveys emphasized the desire for increased opportunities for community engagement, with 83 % of individuals surveyed indicating they felt a personal responsibility and 94 % acknowledging community-level responsibility for protecting the coral reef ecosystem. Of note is that 69 % of those surveyed indicated they were optimistic or strongly optimistic about the future of the reef and we identified a significant correlation among individuals whose primary motivation for reef restoration was to sustain local fisheries and individuals whose primary motivation was to enhance the local economy ($rs\ [60] = 0.70$, $p < 0.001$). Consequently, there is optimism and interest in supporting coral reef restoration among the broad community and specifically among two important community interest groups.

Environmental opportunities for promoting community engagement represented 22 % of interview responses and were primarily identified with evidence of increased interest in reef

conservation and restoration among community members through direct engagement and the need for and interest in technical assistance, such as long-term monitoring identified as necessary for guiding adaptive management and ensuring continuity of ecological protection (Fig. 4). SWOT analysis further indicated the importance of additional opportunities to enhance environmental awareness and action within the community through active community involvement. Community surveys identified opportunities for greater engagement with local businesses, such as strengthening links between restoration and sustainable tourism by promoting meaningful tourist involvement, such as volunteer programs engaging tourists who would also contribute financial support for conservation activities.

Management opportunities were the least often referred to category, comprising 14 % of responses (Fig. 4). However, opportunities associated with management strategies represented a smaller but significant proportion of responses, focused primarily on local partnerships associated with strategic planning, budgeting, and policy development including key governance and organizational needs. Opportunities to strengthen enforcement and policy frameworks by creating mechanisms for collaboration between fisheries, tourism, and conservation government agencies were also identified. Participants also identified opportunities to build community support by developing community agreements, creating environmental jobs, and strengthening policies designed to sustain conservation efforts. SWOT analyses identified community resources such as boats and knowledgeable captains and sources of funding such as local sponsorships as opportunities to support management activities. Community surveys indicated interest in new job opportunities to contribute to monitoring and other management activities.

DISCUSSION

Our study at Laughing Bird Caye National Park highlights the challenges associated with engaging local communities in coral reef restoration and how these are influenced by the interconnected nature of social, educational, environmental, and management systems. Our findings also illustrate how challenges in each of these areas offer opportunities to enhance community engagement in restoration and foster conservation and long-term resilience of coral reefs. The information we gathered using participatory research methods from restoration practitioners, key stakeholders (interviews), and community members engaged in restoration activities (SWOT analysis), and the broader public (surveys) were guided by ECEF principles developed by Carter et al. (2022). We addressed these principles in our interview, SWOT, and survey methods by demonstrating (1) respect for values and motivations that may influence attitudes, (2) inclusivity, (3) situational awareness to build trust, (4) effective use of qualitative methods to promote engagement, (5) participatory methods, and (6) respect for shared ownership and community responsibility for successful outcomes. This approach proved valuable for gaining trust and participation among study groups and for eliciting information that provided insights into local perceptions of barriers and potential pathways to increased community engagement in coral reef restoration and conservation.

Management systems - Governance barriers and institutional opportunities: Management-related challenges emerged as the most significant barrier to community engagement. Across groups, respondents stressed a lack of community inclusion in decision-making, insufficient funding, and weak enforcement of existing regulations as serious obstacles to restoring and protecting the reef ecosystem. However, there were differences in priorities between restoration practitioners/key stakeholders and the broader community. Whereas restoration practitioners/key stakeholders felt the biggest challenge was lack of sufficient and consistent funding, local community members identified the lack of participation in management decisions as the highest priority. Although

adequate and consistent funding for restoration efforts is clearly important (e.g., a politician admitted, *"funding is* inconsistent *and often tied to short-term projects"*), the lack of opportunities for community members to provide input on management decisions can discourage potential support (e.g., a fisher interviewed stated "*rules are written without us*"). Consequently, creating opportunities for greater community input may need to be prioritized to facilitate community input, which could potentially facilitate greater community engagement including local support for reef restoration activities. These findings echo Gill et al. (2017) and McClanahan et al. (2006), who posit that top-down governance models often exclude local voices, undermining legitimacy and compliance. Another management challenge identified by all groups was the lack of enforcement of existing regulations designed to protect reef resources. For example, fishers expressed disillusionment with governance, especially law enforcement - *"laws exist, but nobody enforces them*." These findings mirror concerns voiced by Luttinger (1997), who reported that inadequate enforcement undermines reef conservation in the Caribbean

However, many interviewees also recognized management restructuring as a key opportunity. By reallocating resources, enhancing enforcement, and creating participatory decision-making spaces, management modifications could unlock the full potential of community engagement, including generating new, local sources of financial aid and in-kind support. Various ideas were voiced, with politicians acknowledging the need for stronger legal frameworks and restoration practitioners emphasizing the potential for co-management models - "*if fishers and educators are at the table, the policies will be better and the restoration more effective.*" These insights align with Ostrom's (1990) framework on participatory governance and with Cramer & Kittinger (2021), who argue for integrating community voices into formal conservation strategies. Stakeholders emphasized that greater inclusivity in decision-making could bridge divides and promote local support, including co-management - *"sharing authority with local communities creates ownership and reduces dependence on external funding*." Cinner et al. (2012) reported that co-management improves ecological outcomes and Ostrom (1990) determined management of natural resources requires that rules be developed and enforced by local users themselves. Consequently, strategic management actions that integrate businesses, policies, and local leadership represent important opportunities to integrate local support and promote long-term community engagement in coral reef restoration.

Education systems - lack of knowledge and the role of environmental learning: A central challenge, as well as an important opportunity, identified was the lack of education and awareness about coral reef ecosystems and restoration processes. As with management challenges, perspectives on educational priorities differed between restoration practitioners/key stakeholders (i.e., the need for skilled personnel) and community members (i.e., the need for increased community awareness among youth and adults). As one schoolteacher remarked, *"many of my students do not understand what coral reefs are, so they don't see why they should care if they disappear"* and fishers emphasized "*people only see the ocean as a source of fish, not as a system that needs care*." Multiple studies have determined that limited environmental knowledge reduces participation in conservation initiatives, which is counterproductive to restoration goals (McClanahan et al., 2006; Trialfhianty & Suadi, 2017). Consequently, this knowledge gap and the lack of formal and informal education hinders the ability of communities to fully engage in restoration because they don't understand the importance and benefits of doing so.

Fortunately, education was widely recognized as the greatest opportunity for promoting local engagement in coral reef restoration. Participants in all stakeholder groups consistently suggested the need to integrate reef conservation into school curricula and adult education.

Educational programs that increase knowledge of the coral reef ecosystem and the benefits it provides, especially participatory learning experiences associated with reef restoration, can promote interest and support for reef restoration and conservation. As one environmental educator explained, "*if we can teach the children early, they will teach their parents, and we will build a culture that values the reef.*" Furthermore, the differences in educational priorities identified by restoration practitioners/key stakeholders and community members are not necessarily mutually exclusive because increased awareness and interest in reef restoration may encourage the pursuit of more advanced training to acquire skills needed by restoration practitioners. These ideas align with Carter et al. (2022), who reported that participatory learning enhances pro-environmental behaviors. By embedding restoration into formal and informal education, therefore, communities can bridge knowledge gaps and cultivate long-term engagement in restoration and conservation efforts, including more advanced training to develop needed skillsets.

Social systems – social dysfunctionality and the potential of social capital: Social dysfunction, particularly self-interest and distrust, was identified as a major factor that hinders community engagement and collective action in support of restoration efforts as evidenced by statements such as this - "*different groups don't talk to each other, they compete for resources instead of working together.*" In addition to self-interest and distrust within the community, some community members also reported mistrust toward government agencies. Such divisions are counterproductive, as reported by Bajracharya et al. (2005) and Cramer & Kittinger (2021), who emphasize that weak social cohesion undermines conservation effectiveness.

Opportunities for strengthening social capital by building partnerships and promoting collaboration were emphasized, such as developing "*joint projects between schools, dive centers, and NGOs* [which] *can multiply impact and reduce duplication.*" The need to build greater trust among community members was also identified, such as reviving traditional community gatherings - "*we used to meet to decide how to fish, why not meet to decide how to restore?*" Social engagement was also recognized as important for people to "*feel part of something bigger.*" Such approaches resonate with Ostrom's (1990) framework, which emphasizes collective-choice arrangements, and with Good & Bahr (2021), who found that collaborative restoration fosters trust and long-term stewardship. Greiner and Gregg (2011) found that collaborative engagement improves both social and ecological outcomes. By fostering collaboration among broad coalitions, reef restoration can become a platform for strengthening social dynamics and promoting community engagement and collective action.

Environmental systems - environmental threats and the motivation for action: Our research revealed that the community identified and was concerned about multiple environmental stressors affecting reef health. Extrinsic factors, such as rising sea temperatures, were identified as concerns but of lesser importance than local factors such as poor water quality, destruction of mangrove and seagrass habitat due to coastal development, and damage to the coral reef from tourism activities. Lack of enforcement of existing environmental regulations intended to protect the reef was also identified as a concern. As stated by a restoration practitioner, "*we restore corals, but the water quality keeps killing them.*" Statements from fishers emphasized declining catches as evidence of ecosystem degradation, which illustrates how declining reef health can negatively impact local livelihoods. As emphasized by Edgar et al. (2014) and Hein et al. (2019), restoration efforts cannot succeed without also addressing underlying environmental stressors. Paradoxically, these same threats were also seen as motivating opportunities. Dive center owners explained that "*tourists are shocked when they see bleached reefs, and that can push them to care*," and politicians noted that visible

reef decline "*creates urgency for policy change*." Good & Bahr (2021) and Carter et al. (2022) found that ecological crises can catalyze public engagement and policy innovation. In this sense, environmental threats, while daunting, can serve as catalysts for education, advocacy, and stronger management interventions.

Conclusions: Our findings identify challenges that deter community engagement in coral reef restoration and conservation efforts related to education, social dynamics, environmental threats, and management systems. Issues such as limited environmental awareness, fractured social dynamics, persistent ecological threats, and weak governance undermine engagement. However, our findings also demonstrate that there are opportunities to transform obstacles into strengths. Within each challenge lies a corresponding opportunity:

- education can empower stewardship,
- social collaboration can build trust,
- environmental threats can create a sense of urgency, and
- governance reforms can institutionalize participation.

By investing in education, fostering collaboration, addressing environmental drivers, and embracing inclusive governance, coral restoration can evolve from isolated interventions into a sustainable, community-driven process.

Our results revealed how different stakeholder groups viewed barriers and solutions to community engagement in restoration and conservation of the coral reef ecosystem in Laughing Bird Caye National Park. Although our research specifically reflects the perspectives of stakeholder groups from a coral reef-dependent community in Placencia, Belize, the methods we implemented provide a strategy for identifying stakeholder concerns and opportunities associated with marine protected areas elsewhere and potentially for conservation issues more broadly. By identifying stakeholder concerns and opportunities, the information obtained can be used as a roadmap to develop inclusive, effective, and lasting programs that promote community engagement in restoration and conservation efforts.

Author contribution statement: NU-C, MM, conceived, designed the research, and wrote and edited the manuscript; NU-C collected and analyzed the data.

Ethics statement: The authors declare that they all agree with this publication and that they have made contributions that justify their authorship; that there is no conflict of interest of any kind; and that they have complied with all relevant ethical and legal requirements and procedures. All sources of funding are fully and clearly detailed in the acknowledgements section. The respective signed legal document is in the journal's archives.

See supplementary material
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