



On the development of criteria for determining the effectiveness of technical working groups: A case study about information processes in marine conservation and fisheries management in Belize

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ABSTRACT

Use of scientific information in evidence-based decision-making is critically important in addressing coastal and ocean management concerns. In an ecosystem-based management context, ensuring that the “right” information (reliable) is available can be particularly challenging as the information often resides in different organizations with different management mandates. Many governmental and intergovernmental organizations have used a range of approaches, including technical advisory committees and working groups, to facilitate multidisciplinary input into the development of appropriate policies and management practices. This study examined the roles of multiple stakeholders participating in technical working groups that assist in decision-making for marine fisheries management in Belize, a coastal country in Central America. Through interviews with members of three working groups – the Spawning Aggregation Working Group, the Managed Access Working Group, and the National Hicatee Conservation and Monitoring Network – and decision-makers in the Belize Fisheries Department, information production processes and pathways for information uptake into policy were investigated. Major characteristics of communication at the science-policy interface associated with each working group were revealed. Important communication enablers and barriers were identified related to the operation of the working groups, such as membership commitment and resource availability, which influenced knowledge exchange within and outside the groups. Based on the results, a set of requirements for the creation and operation of effective working groups was formulated with regard to requisite inputs, the operational processes, and the types and uses of the information outputs of the groups. These requirements serve as a foundation for development of indicators of the effectiveness of working groups in environmental management contexts that support communication and decision-making at science-policy interfaces.

1. Introduction

Decision-making and policy development in fisheries management and resource conservation encompass a range of actors and information sources that span ecological, economic, social, and governance realms. Governmental organizations operating at various jurisdictional scales with the authority for decision-making for fisheries management and conservation are prolific producers of scientific information to support decisions (Fuller et al., 2023). Besides the wide responsibility of government bodies, substantial additional relevant scientific information often resides in other organizations with different management mandates (Cvitanovic et al., 2014). While scientific information has been the

primary input in evidence-based decision-making, other sources of information, such as local knowledge and Indigenous knowledge, offer important perspectives to inform decision-making for natural resource public policy (Malmer et al., 2020; Poto et al., 2022; Renck et al., 2023).

Science-policy interfaces are complex, dynamic crossroads where information flow and pathways between researchers and policy makers are influenced by a wide diversity of decision- and policy-making contexts (MacDonald et al., 2016a). Working groups can play an important role in facilitating communication at these interfaces by providing a common forum for stakeholders which generally operate under various institutional arrangements for the production and communication of information to support decision-making (Bandola-Gill and Lyall, 2017;

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Forbes, 2011; Roux et al., 2006; Soomai 2017a; Suhay and Druckman, 2015). Many fisheries governmental organizations have created technical advisory committees and working groups to promote communication of relevant information among scientists, policy-makers, and other stakeholders (Berdej and Armitage, 2016; Brunbauer et al., 2023; Fuller et al., 2023; Kowalski and Jenkins, 2015; Roy, 2012). Including diverse views obtained through the engagement of multi-sectoral groups can result in co-production of information, and the development of comprehensive recommendations and solutions for coastal and ocean management (Crowston et al., 2015; Howlett and Mukherjee, 2017; Pascoe and Dichmont, 2017; Young et al., 2014).

Considerable human and financial resources are needed to establish multi-sectoral working groups. Determination of the effectiveness of a working group in fulfilling its mandate is an important step that can influence continuing operational support. Measuring the effectiveness of a working group in fisheries management from an information perspective can be a challenge as indicators of the use of advice produced by such groups are often difficult to identify. Use of fisheries information in management and conservation contexts can vary widely along a spectrum between increased awareness of issues (conceptual use) to changes in practice and policy (instrumental use) (Nutley et al., 2007; Weiss, 1979). Where use of information occurs on this spectrum is affected by the multifaceted socio-cultural, economic, and political considerations and values that influence policy-making (Bogensneider and Corbett, 2021; Cairney, 2016). Gluckman noted that policy-making is often “confused and complicated,” with arrangements between science and policy governed by institutional and social culture (Gluckman, 2018, p. 94). The wide range of different actors operating at science-policy interfaces also characterizes the diverse communication practices that influence how information is used (Pielke, 2007). Thus, increasing understanding of the effectiveness of working groups relevant to use of information within the context of this spectrum warrants further investigation. Such understanding can be achieved through a multi-step research process that builds on the foundation provided in this study.

This paper presents results of a study that examined the role of three technical working groups in producing and communicating scientific information to policy- and decision-makers with regard to conservation and fisheries management in Belize. Preservation of the marine environment is a national priority in Belize and has been driven by the designation of the Belize Barrier Reef System as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site in 1996. The Reef System sustains an array of activities in tourism and fishing that support many marine industries and fosters local economic development (Coastal Zone Management Authority & Institute, 2016). Beginning in 2001, the Belize Fisheries Department adopted a technical working group approach and set up several multidisciplinary groups, with members from different sectors, to assist with addressing a wide range of marine and freshwater fisheries management and conservation challenges.

The overall intent of this paper is to present the results of an informative case study to illustrate key factors in the function and operation of working groups as such groups are common among governmental resource management practices. This study was guided by three research questions: (1) What are the mandates and composition of each working group? (2) How is information produced in each working group and communicated? and (3) How do policy- and decision-makers use the output of the working groups? Important enablers and barriers in the production, communication, and use of information were identified through interviews with members of the working groups. Identifying characteristics of working groups that enable information transfer at the science-policy interface can support effective fisheries management. Based on the results, operational requirements related to information pathways and conservation and fisheries management mandates were formulated as a set of questions that can be used as the basis for developing criteria and indicators to determine effectiveness of working

groups in information transfer at science-policy interfaces.

2. Background

2.1. Characteristics of multidisciplinary working groups

Working groups are commonly used in many countries and numerous international bodies to support evidence-based decision-making and policy development on a breadth of environmental issues. Working groups facilitate access to subject matter experts from different countries and organizations who work without bias and contribute the latest understanding on a topic. A working group may be classified as a team of two or more members with different educational or professional backgrounds who meet or interact regularly, according to particular organizational expectations and individual roles and responsibilities, to perform tasks to achieve a shared goal (Crowston et al., 2015; Kozłowski and Ilgen, 2006). Administrative aspects and the dynamic interactions among actors, for example, meeting frequency and length, physical location of members, and organizational cultures, influence the operations and achievement of team goals (Crowston et al., 2015; Fouilleux et al., 2005; Mann and Hardisty, 2014).

Multidisciplinary working groups fulfill an important function in facilitating collaboration among individuals from multiple stakeholder groups. This collaboration can result in efficient gathering and improved access to information needed for evidence-based decision-making (Richards, 2017). Involving informed multidisciplinary stakeholders may increase the credibility, legitimacy, and saliency of information as well as trust among the actors, thereby increasing the likelihood of the use of that information and the success of policies (Cash et al., 2002; Jacobson et al., 2013; Massaua et al., 2016; Sarkki et al., 2014). Collaboration occurs at different stages, including communication, consultation, and participation where the level of involvement and communication type differs (Massaua et al., 2016). Collaboration within working groups is directly related to the operational outcomes resulting from pooling of individual resources, increased capacity, and increased interaction among participants (Berdej and Armitage, 2016; Klenk and Wyatt, 2015; Richards, 2017).

Previous studies of working groups at different governance levels highlighted the importance of context in affecting the characteristics of information production within the groups (Kowalski and Jenkins, 2015; Young et al., 2014). Working groups can be used in a variety of management contexts among different disciplines. Research in the health sector has shown that working groups can provide unbiased assessments to previous controversial studies in health cases (Mann and Hardisty, 2014). Studies of working groups within the European Union (EU) show that they are designed to act as communication channels for technical and political players in negotiating policy formulations for EU legislation where members are often bound by their national interests (Fouilleux et al., 2005). These groups are built directly into the EU institutions and their rules and procedures are shaped by the EU to the extent that framing and politicisation of technical and scientific information to support policies and legislation can be as, or more, important than the specific policy objectives of member countries. Working groups in marine protection, conservation, and fisheries management exhibit similar characteristics to research processes that combine knowledge from different disciplines, co-production of knowledge, and framing of scientific information for decision-making (e.g., Wells et al., 1999, 2002).

Developing institutional arrangements for collaboration among actors is key to ensuring co-production of information, thereby facilitating the use of multiple information sources for successful management and conservation of natural resources (Klenk and Wyatt, 2015). The creation of bridging roles and boundary organizations to broker knowledge and facilitate communication at science-policy interfaces has been known to enable information uptake in decision-making (Bandola-Gill and Lyall, 2017; Gustafsson and Lidskog, 2018; Jensen-Ryan and German, 2019;

Wilson and MacDonald, 2018). Knowledge brokering is often essential for addressing problems with social and political complexity such as climate change, as demonstrated by the work of the Intergovernmental Panel on Climate Change, a prominent global boundary organization in the field of climate studies. In the field of marine management, organizations such as the Food and Agriculture Organization of the United Nations (FAO), the International Council for the Exploration of the Sea (ICES), and the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) play important roles as knowledge brokers or boundary organizations (ICES, 2023; Soomai, 2017b; Wells et al., 1999, 2002). Studies of knowledge brokering in governmental decision processes have identified pathways in which research may be incorporated into decision-making (Cvitanovic, 2017). Usually, no one institutional arrangement for boundary work or a single method will fully bridge the interface. Knowledge brokers, whether individuals or organizations playing boundary or bridging roles, are often part of a network of researchers and decision-makers who mediate or link groups in support of co-production of information and relationship building for evidence-based decision-making (Bandola-Gill and Lyall, 2017; Gustafsson and Lidskog, 2018). The type of knowledge brokering depends on the level of involvement of different actors; for instance, actors can function as coordinators, connectors, or information mediators (Wilson and MacDonald, 2018). Through knowledge brokering, scientists are encouraged to pursue research relevant for use in decision-making and policy-makers are presented with advice generated from the best available data and information (Bandola-Gill and Lyall, 2017; Cvitanovic, 2017; Klenk and Wyatt, 2015; Strydom et al., 2010).

2.2. Working groups in fisheries management in Belize

Established in 1977, the Belize Fisheries Department (BFD) is the legal authority for fisheries management in the country. The BFD's Capture Fisheries Unit collects data on economically viable fisheries and conducts analyses to provide scientific information for government decision-making for fisheries management (Alves, 2021). The BFD utilizes technical working groups, each with a specific fisheries-oriented mandate and comprised of multiple actors and stakeholders in national fisheries management to assist with resource management (Alves, 2021). Members of each working group are either assigned or volunteer to be the designated representative of their respective organization. By 2016, 11 working groups had been established, many with similar membership and mandate, and operational practices. This study focused on the work of three groups: the Spawning Aggregation Working Group (SPAWG), the Managed Access Working Group (MAWG), and the National Hicatee Conservation and Monitoring Network (NHCMN). These three groups were selected as they exhibit differences in sectoral membership and represent the range of management and conservation mandates across the 11 working groups.

The Spawning Aggregation Working Group was established in 2001 with an initial mandate to inform policy development for designating and protecting spawning aggregation sites. Membership included scientists, representatives of environmental Non-Governmental Organizations (eNGOs), and policy-makers. At times, fishers were consulted to provide advice on the designation of spawning aggregation sites. The mandate of the group was later extended to advise on research and management of the Nassau Grouper (*Epinephelus striatus*) in response to a significant decline of the species in SPAWG sites due to heavy fishing pressure. The objectives of the group include completion of economic assessments, establishment of a monitoring program for spawning aggregations, and exploration of co-management options for information management (Cho-Ricketts, 2015; Gibson et al., 2007; Heyman et al., 2005). Advice from the group guides development of regulations for established protected areas and open and closed seasons for fishing Nassau Grouper (e.g., Statutory Instrument No. 49 of, 2009, 2009). The group has published biological information and species identification protocols (Belize National Spawning Aggregation Working Group, n.d.;

Heyman and Requena, 2002). Monitoring and status of aggregations receives regional support through the Caribbean Fishery Management Council (CFMC) / Western Central Atlantic Fishery Commission (WECAFC) / Central American Organization of the Fisheries and Aquaculture Sector (OSPESCA) / Caribbean Regional Fisheries Mechanism (CRFM) Working Group on Spawning Aggregations, a joint working group established by WECAFC in 2012.

The Managed Access Working Group was created in 2009 from an existing taskforce formed to oversee two Territorial Use Rights in Fisheries (TURFs) pilot projects in Belize. The TURF projects were designed to address management problems related to limited data availability and illegal, unreported, and unregulated fishing. This group is comprised of senior managers and decision-makers from government and non-government organizations. Following continuous review and collaboration with fishers, the group was tasked with developing the overall design of a national TURF program. This group was selected for the study because it had a particular and measurable purpose rather than a continuous conservation goal. Alves (2021) provides a detailed description on the outcome of the managed access rollout, the MAWG, and its position within the institutional framework of Belize's marine governance.

The National Hicatee Conservation and Monitoring Network was created by the BFD and eNGOs in 2012. The objectives of the network are to develop and coordinate activities related to scientific research, education and outreach, and legislation and enforcement regarding the critical status of the Central American river turtle (*Dermatemys mawii*), commonly known as the "hicatee." The turtle is hunted for its meat as it is an important source of protein in rural communities (Vogt et al., 2006). In 2017, the species was listed by the International Union for the Conservation of Nature (IUCN) as critically endangered as assessments showed a significant population decrease (Polisar and Horwich, 1994; Rainwater et al., 2012). Although the turtle is not fully protected, it is hunted in accordance with the current fisheries regulation (Belize Fisheries Department, 2023). The NHCMN has a unique membership structure: some members are categorised as "core members" while others belong to a "wider network" to indicate their level of involvement. Core members are engaged in all activities of the group while the wider network members are not directly involved and only receive information to be kept updated about activities. This study focused on the smaller "core group" of members of the NHCMN that operates as a working group.

This study of three working groups is an important foundational step in determining the effectiveness of working groups in Belize. Through interviews and documentary analysis key characteristics of the working groups were identified that informed the articulation of a suite of questions about operational requirements for effective working groups. Recently, the launch of the marine spatial planning process for the Belize Sustainable Ocean Plan gave rise to seven new technical working groups to facilitate sector planning (CZMAI, 2023). The results of this study can inform establishment of working groups in Belize as the multi-sectoral approach to collaboration in integrated coastal and ocean management remains a popular advisory method of the governing agencies, similar to other resource management jurisdictions.

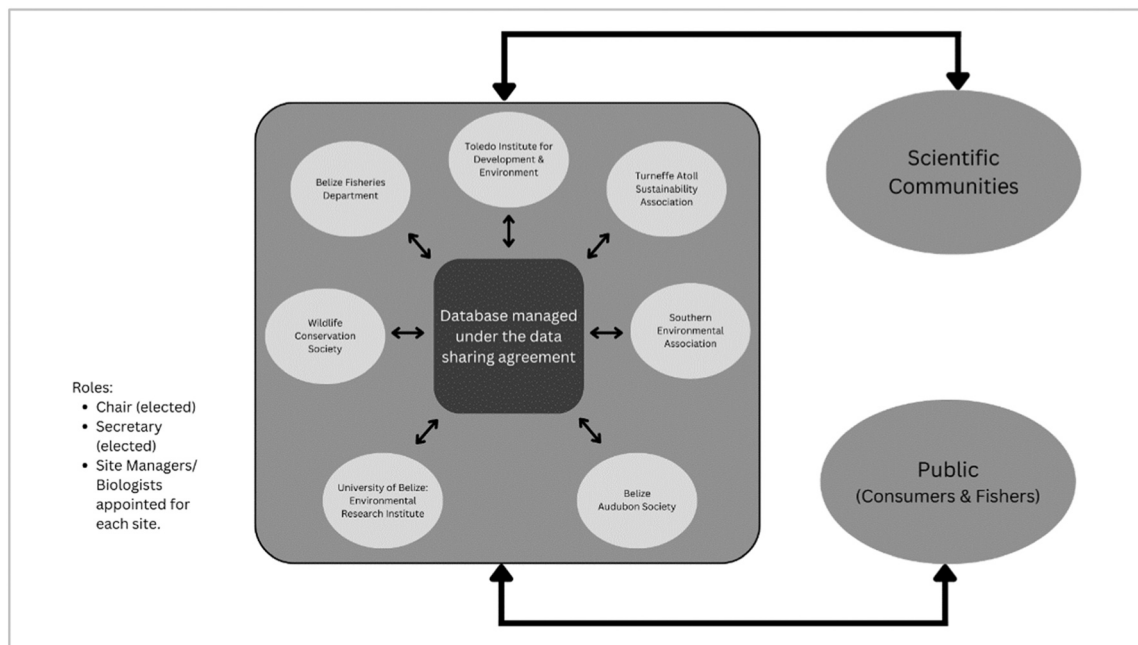
3. Methods

Information production, communication, and use in decision-making were examined in the three working groups: the Spawning Aggregation Working Group, the Managed Access Working Group, and the National Hicatee Conservation and Monitoring Network. The three groups were selected to include the oldest (SPAWG), the least degree of overlap in membership in the groups among all the groups in the Belize government, and the different mandates of the groups. Provision of information for policy-making was studied through semi-structured interviews consisting of mostly open-ended questions with members of each group and with decision-makers in the Belize Fisheries Department. Each group

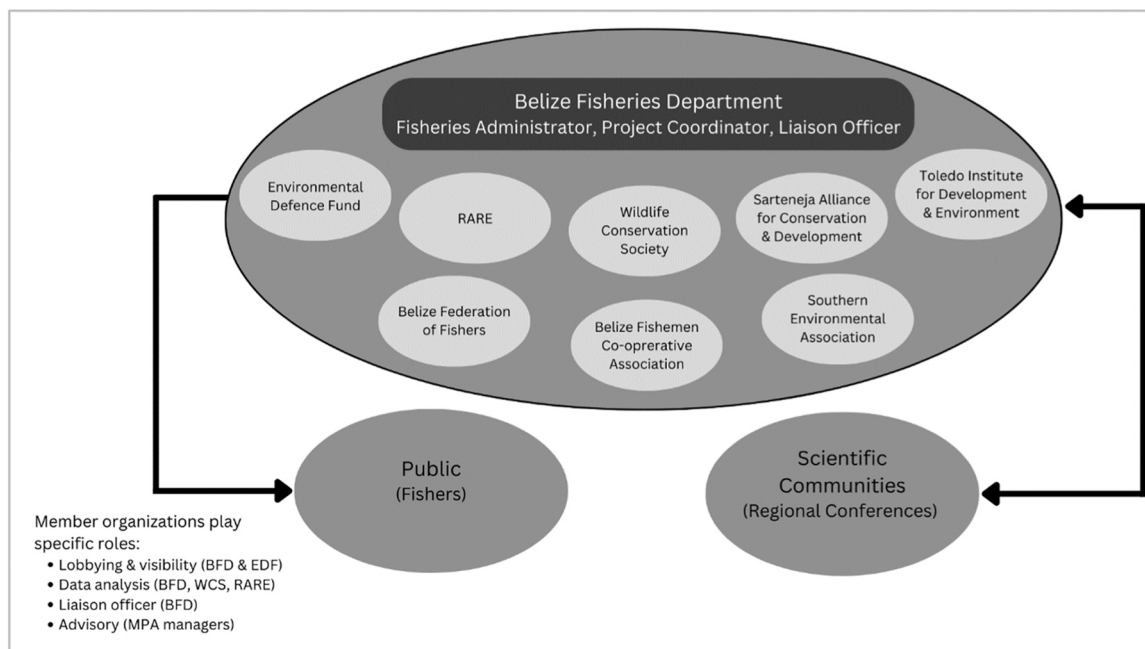
consists of six to eight members. Five policymakers are employed in the Policy and Planning Unit of the Belize Fisheries Department to advise the fisheries administrator on policy issues, budgets, and annual planning, and to liaise and coordinate with other fisheries technical units within the department. Additionally, documents produced by each group, e.g., terms of reference, meeting minutes, agendas, research papers, and pamphlets, were examined in combination with the analysis of the interviews.

The interviews, designed to develop an understanding of information pathways from production to use, included questions about the professional backgrounds of the working group members, their roles in their

respective organizations, and the operation of the groups regarding information production and dissemination and the types of output from the groups and their use. The interviews with decision-makers obtained their perspectives on the mandates and expected outcomes of each group, and their views about the direct and indirect use and influence of the information generated by the working groups in decision-making contexts. Ethics approval for the study was obtained at Dalhousie University. Invitations to participate in the research were sent by e-mail and 17 interviews were conducted. The response rate was 65 % for the working groups (SPAWG (n=6), MAWG (n=5), NHCMN (n=4)) and 40 % for the Policy and Planning Unit (n=2).

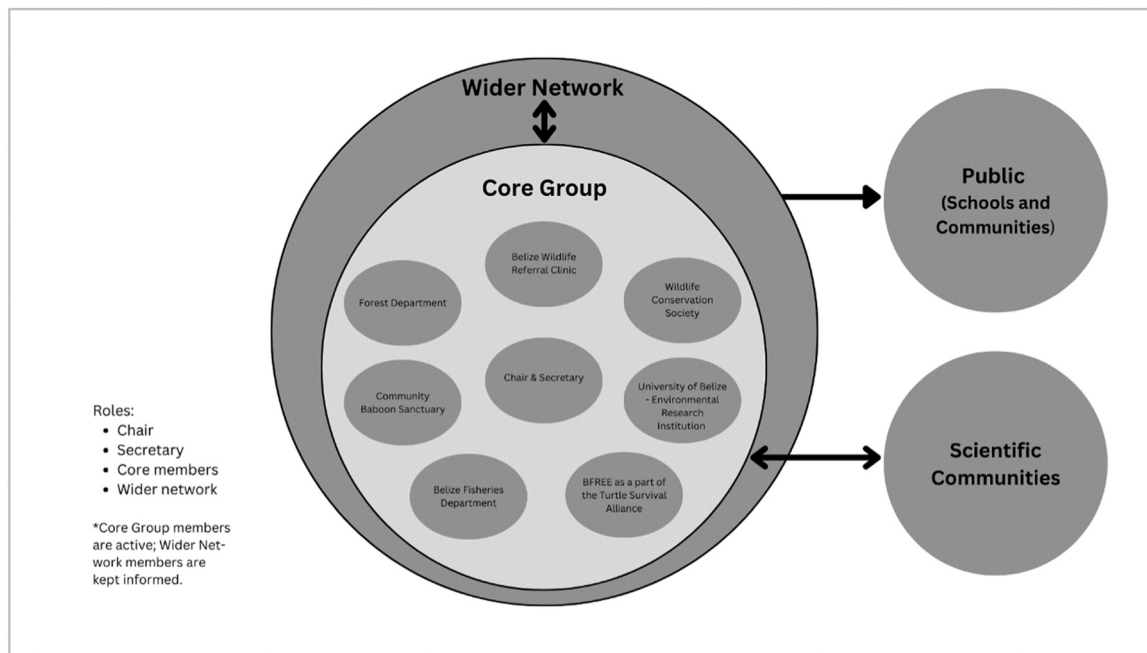


a) Spawning Aggregation Working Group



b) Managed Access Working Group

Fig. 1. Flow of information relevant to the working groups (Solid arrow lines represent formal communication pathways).



c) National Hicatee Conservation and Monitoring Network

Fig. 1. (continued).

The interviews, conducted in person (or by phone or online) in Belize, were audio recorded and transcribed, and detailed field notes were made. To ensure the anonymity of individual responses, each participant was assigned a unique alpha-numeric code: PM[#] for policy-makers and SPAWG[#], MAWG[#], and NHCMN[#] for working group members. Only core members of the NHCMN were interviewed. Participants from each working group included representatives of government, eNGOs, and academia. Policy-makers were members of the government department.

The interview responses were analysed using qualitative content analysis where text was coded to identify themes that describe information production, communication, and use in each working group. The policy-maker responses were coded and analyzed to provide additional context, confirm use of information, and compare its use across groups. The open-ended questions provided a substantive volume of qualitative data. Using an inductive approach, the responses were first coded manually to identify broad themes and then imported into NVivo 11 for further coding and analysis (Bloomberg and Volpe, 2012; Coffey and Atkinson, 1996; Holton and Walsh, 2017; QSR International, 2017). An independent researcher validated the coding of the interview data and ensured absence of biases in the coding process. Themes that emerged from the data were used to describe the characteristics of working group membership and collaboration among organizations.

4. Results

4.1. Working group composition and information pathways

Fig. 1(a, b, and c) shows the composition, output, and flow of information from the working groups to different audiences. Generally, the composition of the groups is similar (see Table 1); for instance, members from governmental organizations, academia, eNGOs, and other stakeholder groups, such as the fishing industry; research and governmental organizations are in the majority. Members of the working groups are chosen generally based on their expertise. Proposals for new members to join a group are tabled for discussion and new members are added based on a majority vote of a group. Each group includes the required administrative roles of a chair and secretary, and data

collectors who provide biological and socio-economic information to support discussions in the group meetings. A facilitator serves as a liaison between the Belize Fisheries Department and the working group. Though not an explicitly identified role, the facilitator is a conduit for information flow between each working group and policy-makers. The various roles are not mutually exclusive as the chair could also be the facilitator, as was observed in the MAWG.

The meeting agendas vary among the working groups. For example, the SPAWG contributes data for discussion and analysis, the MAWG actively formulates plans for policy and operations, and the NHCMN provides updates on individual activities. Operational differences were noted for each group. For instance, the chair of the SPAWG and NHCMN is rotated whereas the MAWG has a fixed chair position with the Belize Fisheries Department. The role of the Belize Fisheries Department as a fixed chair of the MAWG can be attributed to the mandate of the group which necessitates a government regulator taking the lead. Information is produced by individual organizations or through collaborative efforts within each group. In the individual approach, organizations collect data and produce in-house publications that are shared primarily within the group. In collaboration, organizations from different sectors, including eNGOs, academia, and government, collect and share data with the working group to produce an output that includes multiple sources and types of information.

4.2. Output of the groups and information use

Multiple communication methods and information types targeting different audiences allow the working groups to be successful communicators. The groups produced five types of information output: administrative, informal, policy, public, and scientific. Administrative documents were the most commonly mentioned (e.g., meeting agendas, minutes, reports, updates, and workplans), followed by information designed for public education campaigns (e.g., newsletters, website information, signage, and media (visual or audio)). Informal information refers to email correspondence by which questions or clarifications, and updates on activities are communicated. Each group used a combination of individual and collective methods depending on the type of information output. The participants described all administrative and

Table 1
Composition, characteristics, and roles of the working groups.

		Spawning Aggregation Working Group (SPAWG)	Managed Access Working Group (MAWG)	National Hicatee Conservation and Monitoring Network (NHCMN)
Composition and Operation	Mandate	Initially, the working group was created to inform policy on declaring and protecting spawning sites. Currently, the working group has a species-specific focus (<i>Epinephelus striatus</i>) for collecting data, communicating with resource managers, and coordinating monitoring activities around spawning seasons.	Evolved from a taskforce to a working group to guide the Fisheries Administrator on implementation of the Managed Access Program, and transition from an open access fisheries regime to a Territorial Use Rights in Fisheries (TURF) system. Governance focus (data, management, legal, and social aspects).	This working group has a species-specific focus (<i>Dermatemys mawii</i>) and develops and coordinates activities related to science and research, education and outreach, and related enforcement and legislative aspects.
	Stakeholder types	Government, research institutions, co-managers	Government, research institutions, co-managers, international NGOs, funding organizations, fishing organizations	Government, research institutions, NGOs
	Member organizations	Belize Fisheries Department (BFD), Wildlife Conservation Society (WCS), University of Belize Environmental Research Institution (UB-ERI), Belize Audubon Society, Southern Environmental Association, Turneffe Atoll Sustainable Association, Toledo Institute for Development & Environment	Belize Fisheries Department (BFD), Glover's Reef Marine Reserve, Port Honduras Marine Reserve, Wildlife Conservation Society (WCS), RARE, Environmental Defence Fund (EDF), Southern Environmental Association, Sarteneja Alliance for Conservation & Development, Belize Fishermen Cooperative Association (BFCA), Belize Federation of Fishers (BFF)	Belize Fisheries Department (BFD), Wildlife Conservation Society (WCS), Community Baboon Sanctuary, University of Belize Environmental Research Institution (UB-ERI), Belize Wildlife Referral Clinic, Belize Foundation for Research and Environmental Education (BFREE) as a part of the Turtle Survival Alliance (TSA) in Belize
	Membership selection	Based on organizations conducting monitoring and data collection at SPAWG sites	Selected by the BFD and the funding agencies	Based on expertise and regulatory responsibility for hicatee
Leadership	Number of members	7	8	Core members (6) Wider network (15–20)
	Meeting frequency	Quarterly (50 % attendance required for quorum)	Quarterly, or regularly until overall goal is achieved	Scheduled quarterly meetings; average one meeting per year
	Decision process	Decisions made by majority vote	Decisions made by the BFD	Decisions made by majority vote
	Terms of reference	Yes	Yes	Yes
	Lead organization	UB-ERI (at the time of data collection)	BFD	BFD (at the time of data collection)
	Roles	Defined roles: chair, secretary, and site managers for each SPAWG site. Roles are determined by democratic process.	Organizations have unique roles: lobbying with politicians (BFD & EDF), data analysis (WCS); liaison officer (BFD) as secretary to coordinate and advise the Fisheries Administrator directly.	Defined roles: chair, secretary, core members, and wider network. Core members are active; wider members are kept informed.
	Role determination	Rotation of leadership roles among member organizations supported by endorsement from members of the group	Leadership role remains with the BFD	Rotation of leadership roles among core members

informal communications as a form of “co-production” of information due to its collaborative nature, which serve the internal communications associated with each group. Communication was described as information sharing within a group whereas information dissemination referred to distribution of information to external bodies through outreach activities. Outreach activities include meetings with high-level decision-makers, such as government ministers, and participation in large public events.

The outputs of the working groups are used for awareness building, planning, and application in policy. A range of stakeholders, e.g., subscribers, managers, and donors, use the information for education and awareness, to guide further research, and to verify spending and funding processes. The policy-makers spoke about direct use of working group information products, e.g., their use of annual reports, to provide general information and to guide their decisions about management measures, future planning, and development of legislation and regulations. Both policy-makers who participated in this study noted that the MAWG was regarded as a credible advisory body, which assisted in the national rollout of the TURF system through pilot testing that generated scientific advice for development of a framework and legislation to support the government policies (PM1; PM2).

4.3. Important enablers and barriers in the information pathways

The working group members identified numerous enablers and

barriers in the information production processes. Fig. 2 lists the six most common in each category related to availability of financial resources, membership commitment, and the organization of the working groups.

4.3.1. Enablers

According to 65 % of the respondents, membership commitment was a major enabler for completing working group activities. Membership in the groups is often voluntary and duties and issues within the representative organizations take precedence. Nonetheless, strategies to sustain interest were highlighted. For example, in SPAWG, a 50 % quorum in attendance is required and members are encouraged to attend virtually if meeting in person is not possible (SPAWG1). As a government participant stressed: “there was compromise, I think everybody involved had a stake in the management of our fisheries resources and wanted to see an overarching management intervention that would address most of the issues that fisheries face: illegal fishing, increase in effort [of] all those things. So it was a vested interest that every partner had, and ... [are] guided by the TOR [terms of reference]” (MAWG3).

Other important enablers related to availability of resources and information production. Financial resources were identified by 35 % where, given the appropriate resources, the group could sustain its annual activities and objectives could be accomplished. Collaboration in information production was identified by 35 % of working group members and policy-makers as an enabler, but for different reasons. Working group members view their collaboration as a means of resource

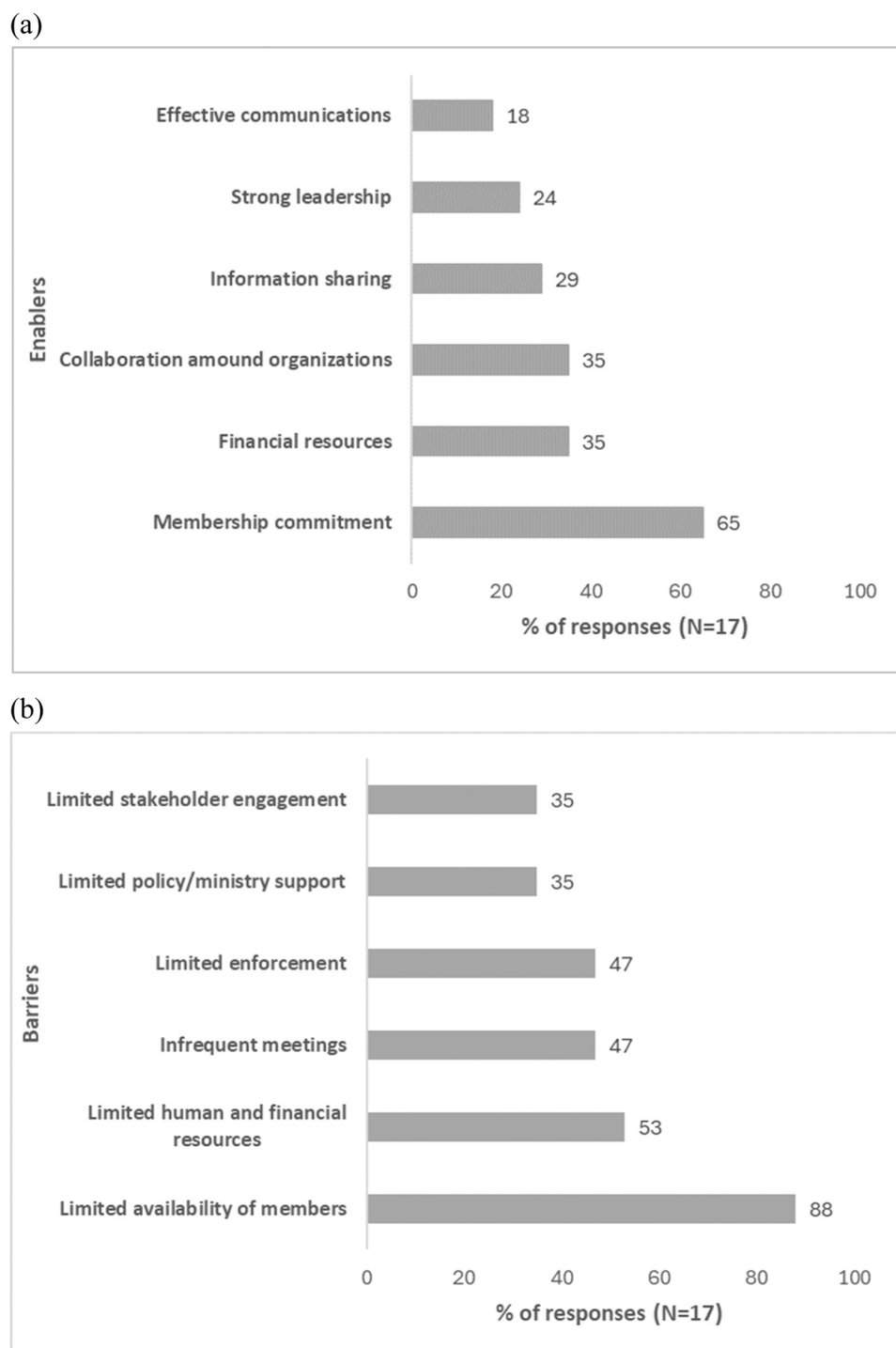


Fig. 2. Enablers (a) and barriers (b) in the information pathways identified by the working group members.

pooling and conducting group activities. A government participant stated: “as individual members, we try to see how each organization can ‘piggy-back off each other’ to try to get some kind of information” (NHCMN1). Policy-makers see the groups as a driver for policy action, e. g., a policy-maker noted that “these groups play a very important role for the successful implementation of any regime, any management strategy, and policy, merely because the regulatory agencies are very much constrained when it comes to human and financial resources” (PM2).

Information sharing among the agencies participating in the working groups was highlighted by 29 % of the respondents as another important

enabler for providing and receiving insights into different problems, and for filling information gaps that exist. Collection and analysis of data and the production of related information are completed as a collective, rather than an individual activity, thereby addressing information gaps and avoiding duplication of activities. For example, members gathered data for spawning aggregation sites, which were shared with other members to develop a national “picture” (SPAWG6). Formal data sharing agreements addressed concerns about intellectual property rights and ensured that the organizations collecting data were credited for their contribution to national databases. As an academic researcher noted: “what the data agreement does is to ensure clear guidelines on the

use, accreditation of that data and I guess in a sense protection of it ... but more importantly than that is we have a clear understanding and structure on how we can utilize our data and other people's data ... but if you wanted to produce any publications using data from other members, then their permission is required and you need to credit them in your publication" (SPAWG6).

Inclusion of local knowledge through the involvement of the fishing industry was viewed as an asset to promote use of information produced by the working groups. An academic interviewee pointed out that the success of the SPAWG was due to the participation of fishers and fishing cooperative members in the working group in a consultative role: "we want the monitoring to be at a certain level and the group is working together to get their members at that level so that our data is more legitimate, consistent, and credible. So when we do produce our reports, whether it's as individual organizations or as a working group, it is sound" (SPAWG1). Members of the fishing industry view their participation as contributing to the work of the group as well as learning about the policy process. An industry member stated: "In terms of the management of the reserve ... a high percent of them are fishers because they are the ones we are trying to convince in changing their behaviour but we engage in the policy level as well because having an understanding of all of this information and understanding what the fish profiles look like ..., it helps us to drive more need to the fisheries bill, the need for other policy level actions" (SPAWG4).

Leadership, directly relating to the role of chair in each group, was identified as an enabler by 24 % of the respondents. Responses about this role related to a chair encouraging group members to contribute to work or keeping a group's progress on track in the production of results. Operational aspects, such as communication that fosters stakeholder engagement and improvement of group activities, were also identified as an enabler. The cycle of information production and access to funds propels a group to produce more information (NHCMN3). Public-facing information produced for community audiences (specifically schools and children) was important to NHCMN, which recognized that targeting younger generations will stimulate cultural and behavioural change (NHCMN1). Sustaining working groups in meeting their mandates was mentioned by a government participant: it "allows us to guide the fisheries department in management and rollout of the program. And I know that while the fishers lose faith, they have to understand that this working group and the managed access committees gives them a space at the table" (SPAWG4).

4.3.2. Barriers

Limited human and financial resources to facilitate operations were reported as the leading barriers to effective functioning of the working groups. Eighty-eight percent of respondents highlighted limited human resources as inhibiting the ability to produce information and the capacity of decision-makers to respond and implement recommendations. As noted earlier, membership in the working groups is often voluntary and individual responsibilities within the host organizations take precedence over the working group activities, thereby affecting availability and commitment (NHCMN1). Furthermore, 55 % noted that limited financial resources negatively influenced the availability of members to participate in meetings and working group activities. For instance, lack of funds to travel to meetings slows the progress of a group's work. An academic researcher summarized the impact of this barrier:

I have sat on many of them [working groups] over the years including some right now and I tend to find an inconsistency in the effectiveness of working groups which often has to do with funding and follow through. So many organizations are so busy and it's hard to find time to pursue activities especially if they are not funded or if you don't know exactly what you're supposed to do or could do without any kind of plan. (NHCMN4)

Aspects related to the organization of meetings present challenges in the information pathways; 47 % of respondents across all working

groups stated that infrequent meetings were a barrier for effective working group operation. Meeting frequency has at times ranged from mostly dormant (NHCMN), to ad hoc and unstructured (MAWG). The lack of leadership to ensure the operation of a group can be critically important. As an academic stated:

It's more powerful when you come as a group and share that information and move together as a group you know, even if you each do your individual things, but at least you're informed as a group. But for that to function, you need a champion, you need someone who would be the glue, who would convene the meetings and try to make sure that even if you don't meet in person, that something is needed, and they are following a work plan and follow up with contributions to efforts. Even if it's through an email or other means but there always needs to be a leader, there needs to be a champion and so that's where I think we kind of lost our way. (NHCMN3)

The functioning of the Belize Fisheries Department itself impacts the working groups. Across the three groups, 47 % of respondents mentioned challenges with operationalizing enforcement within the BFD that negatively affect its ability to act upon information revealing illegal activities in protected areas and in communities. While this issue illustrates the lack of uptake of working group information output by the department, it also highlights limited resources to conduct enforcement activities. A government participant stressed:

The legal framework is a big challenge because we, as the direct manager of the reserves, we are the ones who are always communicating with the fishers and most of the time it's getting complaints from them about how "we don't have this in place" and "what are we going to do about this," "how are we going to chase this fisher who is still fishing illegally," so it's a big challenge for us to try to bring them to an understanding that we don't have the legal backing to do it and what is in our reach is very limited because we don't have that legal document to back us up. (MAWG4)

Limited policy support for recommendations arising from working groups was identified as another important barrier by 35 % of the respondents. Communication barriers related to gaining support by policy- and decision-makers were highlighted. Although information produced by working groups includes recommendations for consideration and use in policy and legislation, their adoption may not be apparent. Several members described the lack of support at the ministerial level: "the department cannot proceed without the cabinet's approval. So, although it is a priority, we have to wait until they decide to approve it" (NHCMN2). Another member described this barrier as a "lack of recognition that we are a natural resource-based economy and to make natural resource management decisions we do need the science ... but if you don't recognize that this information from these groups is important ... then you are not supporting [evidence-based decision-making] as a part of management" (SPAWG5). A SPAWG member described the difficulties of communication between scientific research and policy-makers: "there is no use showing [policy-makers] the fish counts, that doesn't affect them ... It's all bar graphs, pie charts and every time I see a science presentation, it's not conclusive enough" (SPAWG5). Limited policy support for the information outputs of working groups generally results in limited financial resources allocated to these groups.

Lack of collaboration among group members and stakeholders was mentioned as a barrier to information production. While stakeholder engagement is recognized as a primary activity among the working groups members, 35 % stated that the anticipated outcome (cultural/behavioral change and compliance) is not seen. Policy-makers and members of the SPAWG attribute this expectation to a lack of informative effective communication and interface with fishers (PM1; SPAWG5). The NHCMN and SPAWG apply an individualistic approach to data collection and information production. Coupled with communication barriers, when collaboration is limited, the groups do not

become aware of current activities, thus decreasing the usefulness of their efforts (NHCMN3). Although the SPAWG follows the most integrated monitoring approach with common protocols and a database for the storage and analysis of data, inconsistencies in annual monitoring of sites still exist depending on the availability of funds.

4.4. Recommendations from working group members

The working group respondents provided several recommendations to improve the functions of the groups, related to membership, resources, organization of the groups, and information outputs.

4.4.1. Membership

Member availability and meeting frequency can be addressed if the organizations formally assign representatives to attend group meetings. Members of NHCMN and MAWG believe that if individuals and member organizations were held accountable for attendance, participation of the organizations will be ensured. Members indicated that scheduling more regular meetings, e.g., every quarter, could strengthen the momentum of working group activity. Recognising that membership is often voluntary and priority is frequently placed on organizational mandates, a dedicated representative from each organization can ensure commitment to achieve the goals of the working groups.

A facilitator contracted to follow up with members on action items could increase accountability and momentum of working group activities. Additional benefits include strengthening the accountability of the leadership roles and increasing the level of outputs for each group. This approach could also provide an additional incentive to take on further responsibility for roles that fall outside the scope of current work within the individual organizations. If the allocation of a budget to a facilitator was prioritized, disadvantages related to limited resources could be overcome. Hiring a facilitator might mean, though, that a single organization or specific members would bear the cost of funding the role, potentially reducing the organizational flexibility of the working groups.

4.4.2. Resources

Working group members suggested creative ways to address barriers related to limited resources, primarily financial support. For instance, resource pooling currently sustains annual group activities and enables the realization of working group objectives. Members of NHCMN and SPAWG described how such pooling helps in the production of information for public outreach. Multiple organizations can provide a range of contributions to the information produced and facilitate information dissemination through different pathways. Creating a dedicated position with responsibility to prepare proposals for additional funding for the working group activities was commonly recommended to address limited financial resources. Policy-makers also supported exploring new opportunities for funding and noted that creation of an office to support the working groups could be beneficial. Developing large funding proposals as a “network” or joint venture among the member organizations could be particularly beneficial (NHCMN2). Working group members also believe that collaboration among the working group organizations increases the likelihood of receiving additional resources for activities from donor organizations and the members need to be adaptive and strategic in their activities to maximize these funding opportunities.

4.4.3. Organization of the groups

Improved leadership was recommended to mitigate the barriers related to limited support from senior decision-makers, restricted funding, and inadequate participation in the working groups. Members stated that meetings should be regularly conducted quarterly. A strong and focused leadership presence could steer the activities of the working groups. For instance, although the MAWG has a fixed chair/leadership role, members indicated that a greater sense of ownership of the group’s mandate needs to be recognized. Some members of the working groups, e.g., SPAWG, refer to themselves as “co-managers” as they are

representatives of eNGOs with formal agreements with the government to ensure that legislation and regulations are enforced in specific sites while safeguarding community welfare and sustainable resource use. Such co-management models are commonly used in management of protected areas in Belize through formalized public-private partnerships that aim to address gaps in financial accountability, transparency, reporting, and research (Belize Fisheries Department, 2020). These eNGO members who co-manage specific fishing areas feel their organizations could be more integrated into the work of the governmental bodies by participating in the working groups to maximise efforts to meet the particular fisheries management or conservation objectives.

Promoting a stronger focus on conservation or management issues versus the longevity of a working group was highlighted as a way to ensure that human and financial resources were available. As a government participant in the NHCMN noted: “the project does not have to focus [only] on the network maintenance and to ensure that they have activities that they can carry out but it can focus on the wider picture of hicatee conservation and management in Belize ... or ... a subcomponent focusing on the network and ensuring that there is effective participation and involvement on that level” (NHCMN2). In the case of the NHCMN, the participants recommended adopting a structure involving core members only rather than including members of the wider hicatee network. This restructuring would see the voluntary participation replaced by members or organizations obligated to contribute to required activities or actions of the working group.

4.4.4. Output

The participants offered several recommendations about use of the information produced by the working groups for three audiences: policy-makers, scientific communities, and members of each working group. The policy-makers suggested improvements could be made by complementing scientific information with recommendations for action or management decisions. The policy-makers noted scientific information needs to be written for audiences typically not familiar with research subjects and be framed as “scenarios” to aid understanding (PM2). This communication approach can increase information uptake into decision-making in resource management. Thus, additional analysis and development of scenarios could contribute to better adaptive management. Tailoring the reports of the working groups for the executive branches of government could also increase understanding by decision-makers and strengthen their appreciation of the value of the work the groups complete.

Working group members carry out research and data analysis for publication in scientific journals that advances knowledge on the topics considered within the mandates of the groups. For example, NHCMN members conduct studies pertaining to species population monitoring, captive breeding of hicatee turtles, and physiology, which the members regularly publish in research journals. Although the results are shared with group members and policy-makers, access difficulties occur when the journals reside behind subscription paywalls. While open access publishing is increasing, the interviewees suggested that disseminating copies of forthcoming articles among working group members prior to publication would overcome the access hurdle. They also recommended engaging the working groups as review panels for potential research permits, thereby providing input at initial stages of research projects.

In addition to information for management and scientific communities, the working groups prepare information for internal use, e.g., meeting minutes and workplans, which supports the objectives of the groups. Regular review of both workplans and terms of reference was recommended so that members are kept informed of activities and collaboration is strengthened.

5. Discussion

5.1. Knowledge brokering in fisheries management

The operations of the three working groups demonstrate how multiple organizations work together to provide technical support to the Belize Fisheries Department (BFD), provide guidance for decision-making on fisheries policy, and engage in public outreach to increase awareness of issues in fisheries management in the country. The numerous collaborative strategies pursued in producing information and promoting its use illustrate knowledge brokering and information mediating activities as described in recent literature on boundary organizations (e.g., Bandola-Gill and Lyall, 2017; Breckon and Boaz, 2023; Cvitanovic et al., 2024; MacKillop and Downe, 2023). As knowledge brokers, members of the groups communicate with one or more audiences (various publics, policy-makers, and scientists), to encourage use of the information outputs. Knowledge brokering by the working groups is enabled by their structure and mandates that bring information producers and user communities together through the information pathways described by the working group members.

The BFD and the working groups also act as information mediators as they fill liaising roles between individuals and organizations. The BFD serves as a focal point for two-way communication of information with the working groups to support the department in meeting its management objectives. Through the working groups, the BFD engages with other governmental organizations, NGOs, academia, and the public, to strengthen internal and external communication efforts about conservation and fisheries management issues. On an individual level, working group members participate according to their defined functions to assist in the movement of information between the groups and designated audiences. For instance, the facilitator in the fisheries department fills an important knowledge bridging role in each group to receive and disseminate information for use in decision-making.

The knowledge broker and mediator roles of a working group and individual members can span gaps that often exists between governmental departments and resource users in supporting co-management approaches to fisheries management. These approaches provide opportunities and the capacity for consultation of a range of experts on specific issues and the ability to provide a flexible forum to consider questions that a single organization may be unable to undertake on its own. Established partnerships facilitate ongoing collaboration among members of the groups to produce public outreach information. Many members interact systematically to develop broadly considered recommendations and informative messages that reflect the common positions of the individual organizations and reduce the likelihood of misunderstanding and misuse of the information produced. Standardized data collection through data sharing agreements among the organizations have resulted in the development of a comprehensive database covering a wide geographic range. The longevity of the groups, where members have interacted over an extended period of time, facilitated adoption of standardized approaches to data collection and management. Relationship-oriented strategies for collaboration in producing information by member organizations allow the working groups to actively seek and provide the “know-how” and “know-who” to inform policy and practice implementation.

Aware that communication of advice can encounter roadblocks or delays in transmission to policy- and decision-makers, the working groups have incorporated knowledge brokering into their activities, even though this function is not explicitly included in the Terms of Reference of the groups. In the view of several interviewees, a brokering role is particularly important when Ministerial support is lacking or when recommendations from the working groups do not receive cabinet level approval (see 4.3.2 above). While providing advice is a central responsibility, the MAWG recognized the insufficiency of relying entirely on a linear transmission pathway for advice that it provides to decision-makers and its uptake in policy. This group has assigned a

lobbying role to some of its member organizations to raise awareness and use of its information output (see Table 1). Research in recent decades has demonstrated that while the linear communication model persists, it inadequately explains policy- and decision-making processes (Maas et al., 2022; Tangney, 2022). The political dynamics of national policy-making present contexts where knowledge brokering and lobbying fulfill notable roles in the transmission and adoption of research advice (Bogensneider and Corbett, 2021; Cairney, 2016). Understanding these contexts contributes to the effectiveness of working group initiatives. The results of this study demonstrate how the mandates of working groups could direct which members play brokering and mediator roles. For instance, given the more politically relevant mandate of the MAWG, the Belize Fisheries Department, as a government regulator, held a fixed chair position and filled a facilitator role to ensure that biological, social, and economic considerations are brought to bear as the group meets its mandate related to policy development for access to marine resources.

5.2. Operational requirements for effective working groups

Several prominent factors emerged from the interviews and documentary analysis that can inform building a set of operational requirements for effective working groups in decision-making processes. Theoretical models of organizational effectiveness guide development of understanding about how the enablers and barriers identified in this study may be influencing the effectiveness of the groups. In particular, models, such as the Competing Values Framework, enumerate traits that can be used to design processes to improve performance within organizations by enhancing leadership and productivity of teams (Rojas, 2000). Other models, such as the Open Systems Model, are designed to assess an organization's response to specific challenges or issues faced by it through improving processes and practices and refocusing goals (Rojas, 2000). The Input-Process-Output (IPO) model, for example, describes the operational activities of teams and groups where effectiveness is defined as the achievement of desired results through assessment of the success at each of the three stages of the model (Kozłowski and Ilgen, 2006). Alternative IPO models, e.g., the Input-Mediator-Output-Input (IMOI) model, include a mediator stage that enables a cyclical approach to team work to facilitate accomplishments of complex and dynamic teams or social systems (Ilgen et al., 2005).

Characterising operational effectiveness is a complex undertaking and understanding an organization's functional and environmental focus is a prerequisite to assessing its effectiveness. Various models have been used to describe diverse contexts, including natural (biological processes), economic (manufacturing processes), and designed (machine computations) physical systems to demonstrate the general structure of systems (Ilgen et al., 2005). Studies comparing criteria for effectiveness across several models have shown that the design and implementation of existing frameworks are context specific and the IPO model framework generally forms the basis for many of the existing models on organizational effectiveness (e.g., Steers, 1975).

The enablers and barriers identified in this study of Belize working groups are similar to those found in other studies of information activities at science-policy interfaces in fisheries management (e.g., Knagård, 2015; Soomai et al., 2011; Soomai, 2017a). Members of the three working groups and the policy-makers believe that the groups play important roles in decision-making in spite of the identified barriers in the information pathways. While the Belize working groups share some similarities with the functions of the organizational effectiveness models, specific criteria for the operation of each group require they be relevant to the unique management contexts. The principles of the IPO and IMOI models provide a pertinent platform for understanding effectiveness requirements based on the characteristics of the flow and use of information identified in the three working groups. Using the key enablers and barriers in the information pathways of these groups, a

suite of operational requirements to evaluate the performance of working groups was formulated (Table 2). Based on the input-process-output (IPO) model of Kozlowski and Ilgen (2006), these requirements are categorized as input, process, and output factors and are presented as questions to assess working group effectiveness in communication in the pathways specified in Fig. 1. Consideration of these factors underpins understanding of the impact of the enablers and barriers related to resource availability, membership commitment, and organization of meetings.

The input requirements define organizational aspects needed for a working group to function and plan its membership and appropriate roles, and the data and financial resources needed to address issues the group considers. In meeting the input requirements, working groups can identify and attend to the common barriers of limited resources, meeting frequency, and member availability at the launch of a working group. In addition to addressing barriers, early recognition of leadership roles and responsibilities can enhance information production and communication processes. Though limited financial resources was the most cited barrier in this study, availability of such resources does not necessarily enable a working group to generate useful information. Even when the appropriate level of resources is available, other enablers may be needed for a working group to meet its objectives and sustain annual activities. The input requirements emphasize the roles of each working group member to strengthen membership commitment. Working groups can create terms of reference to specify roles for each member which then can be used to assess the performance of group members as a gauge of commitment.

The process requirements allow working groups to adopt best practices for information production and framing of results, and to ensure inclusion of evaluation processes to facilitate organizational learning. Meeting these requirements can assist members in identifying collaboration strategies and sharing of legitimate, credible, and relevant information. Increasingly, local and Indigenous knowledges are being incorporated into fisheries management decision-making processes in many contexts and are legally mandated in some jurisdictions. In

developing information to transmit to decision-makers, the Belize working groups collaborate with the fishing industry and seek local input. Thus, co-production in this setting entails use of both scientific and local knowledge. Appropriate framing of scientific information promotes its uptake by both the members of the working groups and their audiences, e.g., policy-makers. The level of technical detail and clear explanation are critical factors in the transfer of information in science-policy interfaces which influence how and whether information is used in decision-making (Druckman and Lupia, 2017; Hajdu and Simoneau, 2020; Jamieson et al., 2017; MacDonald et al., 2016b). As a policy-maker in this study noted, scientific information should be made available in suitable formats for different groups and less technical versions produced to promote understanding by policy- and decision-makers (PM2). When working group members prepare scientific evidence for different audiences, they can mitigate barriers in its use by such audiences. Communication challenges between scientists and policy-makers are common in conservation and fisheries management contexts (Cvitanovic et al., 2015; Karcher et al., 2022), which working groups operating as information brokers can alleviate (Breckon and Boaz, 2023).

The output requirements include questions to aid in determining whether information reaches relevant audiences and whether the desired outcomes are achieved. Information outputs are contingent on the context in which a group operates. For example, if a working group is tasked to provide advice to inform a specific government program, the request for information about the focus of the program should drive preparation of information to guide policy development and/or increase awareness of the issue(s) the program is designed to address. Thus, establishing a strong communication pathway with the policy-makers will support successful transfer of information. Determining the effectiveness of the working groups regarding the use and/or influence of their information outputs may be the most difficult aspect of the activities at science-policy interfaces to establish. The impact of information may not be obvious or easily measured in the short-term. The number of potential determinants of the impact of information can be extensive including biological/ecological (e.g., species abundance), socio-economic (e.g., compliance with regulations, employment options), and governance (e.g., legal instruments or regulations implemented) factors. Moreover, as noted above, use of information falls along a spectrum (Nutley et al., 2007), which can mean the time lag from transmission of information to its direct use may be lengthy and not easily detectable.

Operationalizing the requirements for effective working groups will allow members to examine their input, process, and output activities and strengthen enablers and mitigate barriers to their primary purpose, namely, production of information to advise policy- and decision-makers. Completing this exercise can assist in identifying communication difficulties in the science-policy interface in fisheries management both in Belize and similar contexts in other countries. For instance, initiatives to achieve the requirements could highlight where financial resources could be allocated to facilitate the transmission of information and its uptake into decision-making. Meeting the requirements may also expedite learning regarding the creation of effective working groups. For example, improving membership commitment may result by clearly articulating the mandate of a working group, the roles of members, and enhancing communication lines and trust between group members. The prolonged existence of a group may be important to its success and the efficient functioning of information production and transmission processes. This outcome was especially apparent with the SPAWG where its longevity positively influenced the commitment of members compared to the other groups.

6. Conclusion

In this study, interviews with key informants provided extensive qualitative data to develop understanding of the roles and activities of

Table 2
Operational requirements to evaluate the effectiveness of working groups.

Input	
Composition	Does the working group include all relevant stakeholders?
Roles	Are roles established for each working group member? Do members play an active role in the working group? Do members identify with specific roles?
Leadership	Are leadership roles defined in the working group?
Resources	Are resources available to support the working group operations? (Identified and committed funding resources)
Process	
Production method	Is information produced with multi-stakeholder input (i. e., collaboratively)? Is the information produced shared with all members?
Framing	Is information produced for different audiences? (various formats - technical and non-technical) Are information and recommendations relevant to management decisions?
Organizational/ group learning	Is there an evaluation of working group processes/ operation? Are findings incorporated into new operational methods of working groups?
Output	
Communication	Are there established pathways for communication outputs from the group?
Audience	Does information reach intended audiences?
Use & Outcome	Are measurable outcomes identified and implemented? Do the information outputs achieve the desired conservation or resource management outcome? Does the output influence future work within or outside the working group?

three working groups in the production, dissemination, and use of information for fisheries and conservation management in Belize. The research disclosed important features of the processes related to information communication at the science-policy interface. Working groups, primarily through their responsibilities to assemble and prepare data and information for evidence-informed decision-making, are an established advisory mechanism in fisheries management in Belize. This research provided empirical evidence of the role of multidisciplinary working groups as knowledge brokers to policy- and decision-makers. That the working groups enable strong inter-agency partnerships in fisheries management can inform future multi-sectoral collaboration in integrated coastal and ocean management in Belize. For example, Grimm et al. (2023) found marine conservation in Belize is stakeholder-driven, supported by information provided from multiple sources.

Barriers, such as limited resources, are a common concern for developing countries like Belize. Given widespread financial austerity measures – a global phenomenon – working groups are an important mechanism for collaboration and pooling of resources. In 2022, the government of Belize established the Belize Fund for a Sustainable Future as a transparent and inclusive mechanism to access grant funding for conservation and sustainable development of national marine and coastal resources (Belize Fund for a Sustainable Future, 2022). Designating a member of each working group to proposal writing could address the financial resource difficulty that Belizean working groups face.

Notwithstanding the financial challenges, collaborative efforts among multiple stakeholders can assist in conservation management by facilitating information production and dissemination to inform decision-making in fisheries. Multidisciplinary working groups fill knowledge brokering roles that are important in assembling and expediting the uptake of research in fisheries management. Similar barriers have been highlighted and mitigated in other jurisdictions, where formation of research partnerships between government organisations and the fishing industry are a common means of addressing constraints that negatively impact scientific research programs and information output and its use (Soomai, 2017a).

The development of operational requirements for working groups sets up a systematic framework for forming groups that will be effective in generating information for conservation and resource management decisions. This outcome is needed as governmental organizations frequently create groups, involving multisector membership, e.g., academic researchers and environmental non-governmental organizations, to achieve expectations for transparency in decision-making (MacDonald and Soomai, 2019). The requirements for working group effectiveness (Table 2) specifies pertinent questions to consider inputs, processes, and outputs applicable in many fields that involve multiple players contending with complex issues. These requirements enable the development of methods to evaluate information pathways implemented by working groups and they highlight the importance of defined memberships for the production and dissemination of advice. In addition, leadership capabilities and stakeholder and public engagement, which are key enablers in the uptake of information in policy and practice, are noted. Working groups that periodically review their operational processes can achieve organizational learning and ultimately can be effective in supporting the work of policy- and decision-makers.

Determination of the effectiveness of working groups is a multi-step research process that will lead to the establishment of relevant criteria and pertinent indicators. This study is an important step in setting a foundation for developing criteria and indicators of effectiveness. The interviews and documentary analysis identified key characteristics of working groups that informed the articulation of the suite of questions about operational requirements for effective working groups. As no single working group in this case study met all of the requirements, development of criteria and indicators of effectiveness will need to

account for variation in the mandates, memberships, and responsibilities of groups due to the contexts in which they operate.

The Belize Department of Fisheries, along with other government units, continues to pursue a commitment to achieve national conservation, sustainable fisheries, and coastal zone management goals (CZMAI, 2016). This study can inform future multi-sectoral collaboration in integrated coastal and ocean management in Belize and in the Caribbean region. In particular, understanding barriers and enablers related to information production, communication, and its use in decision-making can guide the operation of working groups. The government of Belize, like many others, continues to create working groups to support decision-making activities (e.g., the marine spatial planning working groups set up in 2023).

Collectively case studies contribute to understanding complex phenomena, which the investigation of the Belize working groups provides. This case study could prompt further research that will complement and build on the findings about the operational effectiveness of working groups. This research identified diverse membership profiles of working groups, e.g., scientists, representatives of NGOs, policy-makers, fishers. Studies of working groups in other settings can explore whether membership homogeneity/heterogeneity affects the performance of working groups and expected use of advice. While the current research focused on the operation of three working groups, further research could consider additional working groups in the Belize government and investigate the views of a larger sample of policy-makers about knowledge mobilization and information use by the intended audiences of working groups. Similar case studies of working groups in other governmental jurisdictions could determine the sufficiency of the effectiveness requirements formulated in this study and contribute to a framework for strengthening working group processes and formalizing their roles as knowledge brokers. For example, the robustness of information assembled by working groups and its policy relevance are among factors, outside the scope of this study, that may affect the effectiveness of such groups. While the IPO model is widely used, other models can be considered for assessing the effectiveness of working groups. As working groups are common in many governmental, intergovernmental, and non-governmental settings, further work that builds on the results of this study to establish and test criteria to verify the effectiveness of working groups for supporting environmental and conservation decision-making is warranted.

CRediT authorship contribution statement

Kalene Eck: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Suzette S. Soomai:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Bertrum H. MacDonald:** Writing – review & editing, Supervision, Methodology, Funding acquisition.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Bertrum H. MacDonald reports a research grant was provided by the Government of Canada Social Sciences and Humanities Research Council. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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