Lessons learned from marine-related learning networks

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1. Executive Summary

Current challenges involving the interaction between humans and their coastal and marine environments present complex and intractable, or wicked, problems that exist at the nexus of disciplines and cultures, thus demanding an approach that incorporates multiple dimensions. Marine-related learning networks aim to bring together multiple actors and perspectives in marine decision-making, management, or policymaking contexts to learn and share knowledge. The goal of this research is to contribute to the current understanding of marine-related learning networks through a broad overview of good practices for effective internal functionality and external impact of such networks. We collaborated with an emerging learning network in Brazil, PainelMar, to develop three primary questions that guided our research:

1. What are marine-related networks and why do they form?
2. What attributes contribute to the effectiveness of marine-related learning networks?
3. What are the outcomes of marine-related learning networks and how are they affecting marine resource management and governance?

After an initial literature review and expansive research into existing marine-related learning networks, we conducted semi-structured interviews with 40 expert informants from 16 marine-related learning networks around the world. Our informants are core staff, advisors, leaders, and coordinators, and represent professionals from 13 different countries across the full spectrum of career stages. Using a grounded theory approach to our data analysis, five themes emerged: network rationale, operations, participation, leadership, and outcomes.

Rationale: Marine-related learning networks cover a broad range of activities reflected in the diversity of their goals, but their overarching purpose is to increase knowledge and capacity of network members and the communities they serve. This primary purpose is reflected in the basic foundation of a learning network, which is to increase knowledge through sharing and collaborative knowledge development. Informants in this study used a variety of terms to define their networks, but they often noted that rather than focusing on the terminology, it was more important to focus on the outputs of the networks, all of which are designed to achieve a common goal: improving the health of the oceans and the livelihoods of those who depend on them.

Operations: Internal operations, including administration, funding, communication, and tracking metrics, provide the foundation for the implementation of the activities that learning networks conduct in order to achieve their goals. The network coordinator is a crucial role—they keep the network moving forward by engaging members and partners and organizing activities. Limiting the scope of the network

and growing intentionally and incrementally makes managing the network for the long-term possible. In-person communication is vital; face-to-face activities often lead to trust building between participants, which in turn facilitates meaningful learning and dialogue. However, measuring the impact of such learning is often a challenge, and in order to justify funding and investment, networks need to show that they are successful. Networks use various metrics to track both process and outcomes, but those with well-defined goals and a clearly outlined theory of change are better able to monitor their often intangible outcomes and impacts.

Leadership: Strong leaders are important components of effective networks. The leadership skills and qualities that support the most successful networks are communication and facilitation skills, the ability to build trust and forge relationships, as well as flexibility and adaptability. The importance of leaders and the role they play in network effectiveness underscores the need for networks to develop clear governance structures and continuity mechanisms that serve to ensure smooth leadership transitions. Networks should also work to formally and informally develop new leaders to support their long-term goals and operations. Leadership growth as a result of network influence reflects well on the network itself, and can be a metric for a network's success.

Participation: Participants form the heart of networks. Learning networks rely on members, volunteers, and leaders to plan, develop, and translate knowledge into impact. Individuals see networks as a way to leverage personal growth. This motivation for participation corresponds with engagement strategies seeking to inspire new members or volunteers to contribute their skills while developing crucial technical or professional capacities. By prioritizing participation, learning networks break down silo mentalities and connect across sectors through collaborative engagement, although some networks favor structured membership systems while others prefer flexible or unofficial ones. Network participants employ diverse forms of knowledge in addition to conservation science when engaging with networks, and by doing so can transcend institutional, academic, or technical knowledge hierarchies. However, formidable limitations to participation exist. For example, many learning networks seek global North-South and other cross-cultural partnerships, although this can be difficult to achieve given travel and language barriers.

Activities and outcomes: Marine-related learning networks generate on-the-ground improvements in marine management by conducting capacity building workshops, skill development sessions, and peer-to-peer learning exchanges. They also bring together diverse stakeholders at meetings and forums, engage with scientists, decision makers, and other actors at international conferences, and coordinate ongoing data collection initiatives in order to inform the development and

implementation of effective policies, including sustainable fisheries regulations and new marine protection measures. Furthermore, they assist in the creation of products with applied uses, such as protected area guidelines or coral restoration guidebooks, and contribute toward influential scientific publications and informational databases. Networks are able to achieve these outcomes in large part due to the long timescales over which they operate. This helps them build trust within the communities that they work with, an outcome in and of itself that is also a fundamental component of how networks achieve their successes.

Based on our research, marine-related learning networks play a critical role in ocean governance. They emerge in response to issues that arise where there is an information gap or disconnect, and they mobilize communities and share knowledge and resources to improve management and inform policy. Key elements of effective networks include developing trust over the long-term, having a dedicated coordinator, responding and adapting to changing conditions, and clearly defining goals and priorities. While these networks are not a panacea, they do help overcome some of the traditional problems of governance, such as a lack of dialogue between those with knowledge and those who need it. Marine-related learning networks bring people together, recognizing that collaboration is key for improving ocean governance.

2. Introduction

The decline in global ocean health poses a serious threat to all aspects of human well-being and livelihoods (Bindoff et al., 2019). In response, the United Nations declared 2021-2030 as the Decade of Ocean Science for Sustainable Development (UNESCO, 2019). The Decade aims to "encourage the science community, the policy-makers, the private sector and the civil society to think beyond business as usual and aspire for real change" by "addressing knowledge gaps, enabling action at all levels, and building capacities to act worldwide (UNESCO, 2019). Conventional, top-down, mono-disciplinary approaches where state or market leaders dictate action fall short in addressing complex, multi-scalar pressing ocean issues (Lemos & Argrawal, 2006). Achieving ambitious large-scale goals, like the UN Sustainable Development Goals (SDGs), will only be possible in the ocean realm if the status quo approach to governance and management is subverted to focus on equity, inclusion, and collaboration (Cisneros-Montemayor et al., 2019). Networks that connect people are at the frontlines of the demand for innovative approaches to addressing complex problems surrounding our oceans and communities (Keast et al. 2004).

Networks have diverse meanings across fields and disciplines, yet they are a ubiquitous concept. In its most simplistic form, a network is a set of actors or nodes that are linked through a specific tie (Bogartti & Halgin, 2011). In most disciplines, particularly in the social sciences, networks are not a new concept, but they all refer in some sense to complexity, and the ways in which purposeful exchange and interaction occur (Kenis & Schneider, 1991). It is generally understood that networks do not seek profit in their approach to sharing information and solving problems collaboratively (Kandziora et al., 2019). Since the United Nations Conference on Environmental Development (UNCED) in 1992, networks designed to address the challenges of social-ecological systems encompassing the oceans have become more common (Princen & Finger, 1994). Specifically, some of these networks offer opportunities for learning within the network (Bessant & Tsekouras, 2001), while others prioritize knowledge creation for wider external use (Clark, 1998). Rather than impose fixed solutions, such networks emphasize an iterative process of learning and knowledge exchange (Berkes, 2008).

Learning networks emphasize the processes of knowledge transmission and integration which are critical to address the fundamental challenges of ocean-related "wicked problems" (Weber & Khademian, 2008). Wicked problems, first conceptualized by Rittell and Webber (1973), are unique, relentless, indeterminate, and ever-evolving. They have multiple explanations, no single solution, and they cross-cut other problems, societal sectors, and policy domains (Ackoff, 1974; Clarke & Stewart 1997). Most efforts to address them aim to improve conditions, as entirely eradicating the problem can

be nearly impossible (Rittell & Webber, 1973; Weber & Khademian, 2008). Given that learning networks are adaptive, collaborative, and use an experiential knowledge-based approach, they are poised to provide efficient means of addressing certain problems of this nature (Matous & Todo, 2015; Tobey & Volk, 2002). In learning networks, this often occurs through capacity development, which we define as, "the ability to perform functions, solve problems, and set and achieve objectives" (Fukuda-Parr et al., 2002, p. 8). We examine learning and knowledge networks that focus on marine issues and the societies that depend on ocean resources, which we collectively refer to as marine-related learning networks throughout this report.

Empirical studies on the role of marine-related learning networks remain scarce, and even less research exists on the design and structure of these learning networks. This project undertakes a broad examination of lessons learned from marine-related learning networks around the world, drawing on 40 expert interviews with individuals from 16 distinct networks. Our research goals are two-fold: to contribute to the body of knowledge on learning networks through qualitative analysis informed by respected marine-related learning networks and to provide key findings for an emerging Brazilian learning network, PainelMar.

2.1 Our client: The Brazilian Future Ocean Panel (PainelMar)

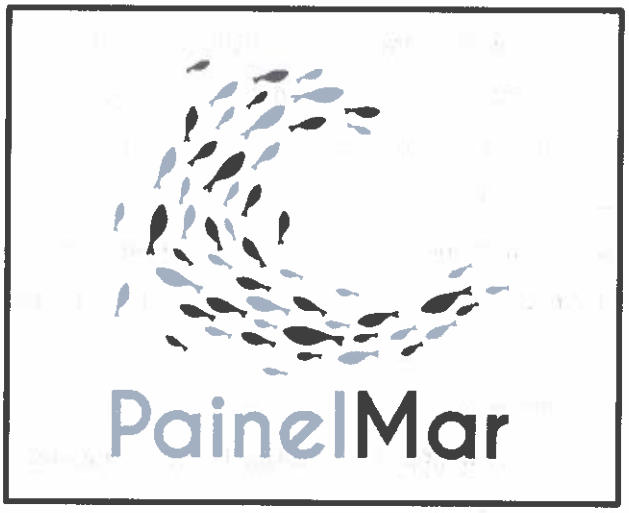

Figure 1. The PainelMar logo. Each component of the logo has meaning. The wave signifies ocean, seas, renewal, and movement; the school of fish means collectivity, equality, and balance; the color turquoise evokes new ideas, knowledge, and integrity; and the blue means boundless, water, creativity, and harmony.

PainelMar is a marine-related learning network in Brazil that formed in response to detrimental anthropogenic impacts on coastal and marine ecosystems and their dependent populations. PainelMar's

goal is to act as a "multi-sectoral, collaborative platform of individuals and organizations on the interface of knowledge and decision-making processes, aiming at qualifying policies for the sustainable use and health of the oceans" (PainelMar, 2017, p.1). To achieve this goal, PainelMar identifies eight objectives in its strategic document (PainelMar, 2017):

1. Promote connections among knowledge networks
2. Build strategies for assembly and joint action of different actors
3. Arrange the available knowledge and distribute in an accessible way to governmental agencies, civil society and interested parties
4. Develop and assemble capacities of different sectors of society (civil society, government, private sector, academy, etc.) that promotes the engagement in knowledge and interest dialogues
5. Mediate communication amongst multiple actors
6. Contribute to strengthening the Brazilian role in the international realm of ocean governance
7. Discuss and propose targets, guidelines and strategies for marine and coastal governance
8. Evaluate, develop, transfer and distribute innovative marine technologies

In Brazil, current systems of marine protected area (MPA) management that do not incorporate local perspectives have resulted in conflicts with governing agencies, with the small-scale fishers ending up charged with wrongdoing (Lopes et al., 2013). This science-driven approach limits the effectiveness of MPA management, as fishers also hold critical and useful knowledge (Gerhardinger, 2009). While top-down hierarchical systems of environmental governance are in place in Brazil, these efforts have been ineffective, and make clear the need for inclusive, participatory approaches, with relevant actors (Gerhardinger et al., 2019; S. Mattos, personal communication, February 29, 2020).

The diverse coastal and marine environments of Brazil provide vital services to the economy and are critical to the collective social identity of the country (Elfes et al., 2014). Dubbed the "Blue Amazon" by the Brazilian Intergovernmental Council for Marine Affairs (the nation's premier forum for ocean governance), this region supports an immense variety of vibrant and diverse marine environments and stretches along a coastline of 4,650 miles, which is 1,000 miles longer than the US east and west coasts combined (Central Intelligence Agency, 2020; Gerhardinger et al., 2018). Sharing knowledge, collaborating on policy, and coordinating action related to protecting these ocean environments and the communities that rely on them are complicated tasks, and Brazil's current political climate amplifies these challenges. The complex environment in which PainelMar operates provides the foundation for our research goals, which we co-developed with leaders of PainelMar.

2.2 Research goals

Marine-related learning networks have the potential to address a multitude of issues that inhibit effective marine management and governance. These networks are referred to by a multitude of names, including communities of practice (Wenger et al., 2002), social networks (Walton et al., 2014), learning networks (The Heinz Center, 2004), knowledge networks (Creech & Willard, 2001), and knowledge-action networks (Shrivastava et al., 2016). In these networks, information exchange, capacity building, and the sharing of good practices are often emphasized (Christie et al., 2016; FAO, 2017; Philibotte et al., 2019). The dynamic and continual flow of information and good practices between network members can help create the adaptive, proactive management necessary to address modern ocean management and governance issues complicated by challenges related to climate change, food security, and other transboundary problems (Cvitanovic et al., 2015). There may also be an emphasis on collaboration and communication, which can help overcome challenges produced by cultural barriers and regional or geographical differences (Cohen et al., 2012; Zhang & Dawes, 2006). Much of this collaboration occurs across disciplines, including between scientists and decision-makers, as a complex web of continuous interactions (Bidwell et al., 2013; Haythornthwaite, 2006). Networks offer an opportunity for peers to engage with and learn from each other, lend advice, and develop shared practices and approaches for tackling common challenges (Cummings & van Zee, 2005; Pietri et al., 2015). As such, we seek to determine how this is accomplished, because the inputs required to develop, implement, and operate these networks are uncertain and heavily context dependent (Cvitanovic et al., 2015; Fazey et al., 2007). We also aim to expand and enumerate upon the practical applications and outcomes of marine-related learning networks.

The goal of this research is to contribute to the current understanding of marine-related learning networks, examine which network components contribute toward their effectiveness, and identify areas for future research. We developed three primary questions that guided our research process:

1. **What are marine-related networks and why do they form?**
2. **What attributes contribute toward the effectiveness of marine-related learning networks?**
3. **What are the outcomes of marine-related learning networks and how are they affecting marine resource management and governance?**

3. Methods

This research seeks to understand and synthesize good practices for developing and implementing learning networks operating in the realm of ocean management and governance. We distinguish good practices from best practices, acknowledging that the concept of best practices tends to understate the importance of progress and learning from mistakes, and that there is no single approach nor one set of solutions that is applicable across the wide variety of contexts within which these networks engage (Rose, 2005). The broad nature of our research goals required an expansive review of literature related to learning network theory and practice, as well as an examination of studies focusing on the work of specific marine-related networks operating around the world.

3.1 Qualitative interview themes and questions

To ensure our research questions were actionable and reasonable within the timeframe of the study and deliver a research product that fulfills the needs of our client, PainelMar, we based our thematic focus on discussions with PainelMar leaders and their current challenges and needs as an emerging learning network in Brazil. Of particular interest to PainelMar is the integration of science, society, and maritime policy agendas, given the urgency required to address the rapid socio-environmental changes that have occurred over the past decade and that are particularly evident in Brazil's diverse geographic, societal, and political landscape (PainelMar, 2017).

Data for this research was collected by the report authors, Henry Bell, Dave Berndtson, Katy Dalton, Benjamin Kantner, and Marlena Skrobe, through qualitative, semi-structured interviews with key informants. All informants are experts who are working or have worked in leadership, advisory, or other core capacities with marine-related learning networks around the world. Our interview questions were based on both conceptual and general operational themes. Conceptual themes included participation, leadership and institutional capacity, social outcomes, policy change, and ecological outcomes. General themes included network background, administration, phases, and structure. These themes guided the development of our questions and evolved naturally throughout the interview process. We applied interview techniques situated in Dexter's elite interviewing methodology (1970). Interviews were semi-structured, such that we began each interview with a complete set of the same prepared questions, but allowed informants to guide the focus and questions that were asked based on emerging topics and ideas. However, certain core questions were asked of every informant. Each interview typically lasted between 45 - 60 minutes, and informants were asked approximately 10 - 15 questions. See Appendix A

for our complete set of interview questions. Throughout our interview process we revisited and revised this list of interview questions as new relevant themes emerged, although changes were minimal.

3.2 Informants and networks

Our sample includes 40 individuals from 16 networks. We interviewed between 1 and 7 informants from each of the 16 marine-related learning networks around the world. All interviews were conducted and transcribed between November 2019 and January 2020. Our key informants were located in 13 countries, and all had significant roles within the administrative structure of the network, either as a leader (8), coordinator (12), advisor (15), or core staff member (5). Of these individuals, approximately two-thirds were women. Informants ranged in experience from early career to retired professionals. The number of informants interviewed depended on the size of the network and the availability and responsiveness of those whom we contacted. Detailed information about each informant is not provided in order to preserve the confidentiality of the sources, although we have summarized certain informant information to provide context for the included networks. We originally contacted approximately 100 individuals from 20 networks in an attempt to represent networks that work at different geographic scales, are in different stages of development and operation, and that focus on different topics, such as fisheries or marine protected area (MPA) management, environmental resilience, knowledge generation, or policy action. Our research sample was dependent upon potential informants responding to our requests and subsequently agreeing to take part in confidential interviews. The 16 networks included in our study ranged in scale from local to global (Figure 2; Table 1).

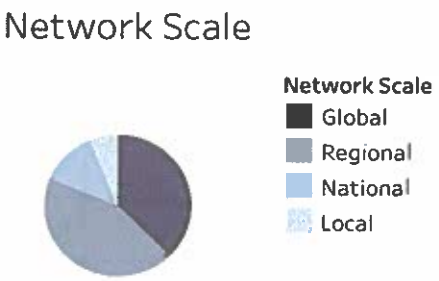

Figure 2. 16 networks were included in our study. One was locally focused, two were national, seven were regional, and six were global.

Although a number of our findings discuss themes of network member participation and engagement, it is important to note that our data come from the perspective of those involved at the management and administrative level of networks, such as leaders, core staff, or advisors, and does not include other members and participants. We gained important insight from our informants on these subjects, but we acknowledge that their perspectives do not represent all voices within marine-related

learning networks. We elected to focus our research on this key informant management subset primarily due to our time and resource constraints as researchers, as well as the expressed needs of our client, PainelMar leadership, and their role as leaders and administrators in an emerging network. A future area of research would be to expand on our interview questions and themes by engaging in qualitative interviews with marine-related network members and participants, rather than coordinators, leaders, and other core staff.

Table 1: The 16 networks included in our study, and the scales and locations in which they operate. See Appendix B for network websites as of March 14, 2020.

Network	Scale	Location
Big Ocean Network	Global	Global
Brazilian Future Ocean Panel (PainelMar)[1]	National	Brazil
Caribbean Marine Protected Area Management Network and Forum (CaMPAM)	Regional	Caribbean
Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF)	Regional	Western Pacific
Future Earth Earth Systems Governance Project (ESG)[2]	Global	Global
Future Earth Ocean Knowledge-Action Network (Future Earth Ocean KAN)[2]	Global	Global
Global Socioeconomic Monitoring Initiative for Coastal Management (SocMon)[3]	Global	Global
Madagascar Locally Managed Marine Area Network (MIHARI)[4]	National	Indian Ocean
Mediterranean Protected Area Network (MedPAN)	Regional	Mediterranean
Mesoamerican Reef Fund (MAR Fund)[5]	Regional	Caribbean
MPAConnect	Regional	Caribbean
Pacific Islands Marine Protected Area Community (PIMPAC)	Regional	Western Pacific
Pohnpei Teachers' Learning Community (PTLC) climate-related knowledge network	Local (regionally affiliated)	Micronesia
Reef Resilience Network (RRN)	Global	Global
SMART Seas Africa Programme (SMART Seas)	Regional	Indian Ocean
Too Big To Ignore (TBTI)	Global	Global

[1] We interviewed two key informants from our client, PainelMar, but did not include the resulting data in our findings to avoid undue influence on our results from those with whom we collaborated to determine our project scope and research questions.

[2] The Earth Systems Governance Project and Ocean KAN are two separate network initiatives operating within the larger Future Earth Network - Future Earth is often referred to as a "network of networks" (Informant interviews, 2019-2020).

[3] SocMon is a "globally networked, regionally adapted" socio-economic monitoring initiative and methodology for coastal management that also works in advisory and ancillary capacities with other networks (SocMon, 2020).

[4] MIHARI is an acronym for ***MI**tantana **HA**rena **R**anomasina avy eny **I**fotony*, which roughly translates to "marine resource management at the local level" (MIHARI, 2020).

[5] MAR Fund is a planning and coordinating body that provides funding, coordination and other support for numerous networks operating in the Caribbean region, among other activities.

3.3 Qualitative analysis

Our approach to coding and the qualitative analysis of our interview data was conducted based on principles from Strauss and Corbin's (1990) *Basics of Qualitative Research*. We coded our interviews using the principle of theoretical sensitivity and the processes of open and axial coding in order to produce our results. We used Atlas.ti version 8 and Atlas.ti Cloud.

25 code categories were created based on 6 interview question themes as well as patterns and new topics that emerged throughout the interviewing process (See Appendices C and D). Initial coding was conducted in two rounds. The first round followed the principles of open coding and was conducted by a member of the research team who had not participated in the interview, in order to apply a fresh perspective to the informant's answers. The second round of coding was conducted by a researcher who had participated in the interview in order to correct for any information within the answers that had been misinterpreted or missed. Based on these first two rounds of coding and our interactions with the data, we adjusted our code categories and their dimensions for the next step of our analysis.

Each researcher was then assigned to one of these code categories to conduct axial coding. During this process, we followed the approach of Strauss & Corbin (1990) to elucidate relationships between categories and concepts based upon inference and deductive reasoning, identifying and synthesizing the most salient portions of our data. Each researcher was responsible for reading through all the quotes highlighted during the open coding rounds and systematically organizing the data in response to emerging patterns, contradictions, and themes. This same person was also tasked with relating relevant theory and supporting literature for their category and writing up a comprehensive theoretical memo for each code that covers the main findings (Miles & Huberman, 1994).

Due to the allotted time frame for this project, we were unable to conduct comprehensive grounded theory, but we did adhere to the fundamental principle of a "constant comparative method of

analysis," an iterative process that involved continually comparing our data to previously collected and analyzed data throughout the data collection process (Glaser & Strauss, 1967). As such, we did not make any conclusions based on the literature before conducting interviews, though we did conduct a preliminary literature review to familiarize ourselves with the historical context and contemporary understanding of marine-related learning networks. Our ongoing conversations with Dr. Patrick Christie, Dr. Leopoldo Gerhardinger, and Dr. Leandra Gonçalves also contributed continuous dynamic input, and helped us prioritize our findings and guide our analysis. After conducting our analysis, we made comparisons between our interview themes and theories and research related to the development, functionality, and outcomes of marine-related learning networks as well as the roles of leadership and member participation in shared-learning and collaborative contexts.

4. Results

Our analysis is based on 1906 quotations from the 40 coded interviews. In the following sections we highlight the themes (network rationale, operations, leadership, participation, and outcomes) and findings that emerged and integrate them with existing learning network theory and previous studies that focused on marine-related learning networks.

4.1. Rationale Behind Networks

This section explores the motivation behind marine-related learning networks in our study, the definitions they use to describe themselves, and how they develop goals in response to their specific needs.

4.1.1 Why are networks needed?

Although the marine-related learning networks in our study exhibit a variety of histories and organizational structures, they develop based on the needs of the network participants and the communities they serve. The impetus behind the emergence of these marine-related learning networks springs from the nature of environmental challenges associated with the 21st century: these challenges are complex and constantly changing, they transcend governance boundaries, and those taking action to address them require urgent access to resources and information (Scarlett & McKinney, 2016).

Marine ecosystems are constantly changing and the lives of those depending on them can be thrown into flux as a result. Therefore, static information and set management prescriptions are not enough to address the problems associated with managing ocean resources (Berkes, 2009). There is a trend from curiosity-driven, mono-disciplinary modes of scientific knowledge production towards interdisciplinary, participatory, and solution-oriented approaches (Van der Hel, 2016). The concepts of networks and network structures, such as marine-related learning networks, are at the forefront of innovative solutions for the complex problems facing our oceans and the livelihoods of those who depend on them (Keast et al., 2004).

Marine-related learning networks include local perspectives through expanded participation over long periods of time, whereas rigid management structures often fail to adapt or consider the changing needs of local communities. As an advisor with a global network noted, *"You cannot impose something from outside. You have to work with people and it takes a lot of time, particularly with indigenous groups. Whether or not we're talking about indigenous or non-indigenous peoples, the key element is working with people."* This focus on inclusive participation is a core feature of marine-related

learning networks at all spatial scales. Informants emphasized the importance of working with those closest to the issues, because management structures are either too rigid to adapt, or the turnover and change in leadership does not provide long-term support that these communities need. One coordinator in a global network noted the turbulent political landscape as a particular challenge for communities in the Caribbean:

> *"I think the political landscape is one of the issues in particular. So here we have governments for a five-year term, so something may be collected under one government and the other government will come in and either not use what was collected or rubbish it. Then they want to do their own this and that. This is habitual in the region...we can have a government that develops a physical development plan and the next administration comes in and is like - 'yeah, we don't. Because we didn't do it, it's not good.' So, I think that is part of the issue."*

These fluctuations in government leadership and policies made it difficult for communities in the Caribbean to work on projects that demanded a long-term investment. Creating a network was one way to deal with these external fluctuations, as the network's resources and emphasis on sustained capacity development would build community resilience and support long term resource management projects.

Although many environmental impacts are local, an increasing number of environmental problems cross political boundaries or evoke concern among people in different countries facing similar problems that would benefit from shared learning (Mitchell, 2010). Many of the global and regional marine-related learning networks in our study connected individuals in order to tackle transboundary ocean challenges. For example, an advisor with a network situated in the Coral Triangle described the need for collaboration between countries in the region:

> *"To be effective in this region countries need to work together because there's a lot of cross-boundary issues. Fisheries are not limited to one country...There are pollution issues, lots of migrant fishermen, illegal activities going on, and all sorts of things that involve these countries. Not to mention that they are the center of marine biodiversity in the world. So, they have a lot of common interests."*

These networks provide a space where individuals and/or organizations from various nation states can collaborate and work towards tackling a shared challenge. Governing marine resources and ecosystems adaptively can be a knowledge intensive endeavor that requires a holistic approach to understanding social-ecological systems, especially complex ones that cross both temporal and spatial scales (Berkes et al., 2003; Berkes, 2009; Cvitanovic et al., 2015). In addition to coming together to tackle shared problems, networks provide a space where members can share lessons learned from one country to another:

> *"And in the Mesoamerican reef, which is really, it's the largest transboundary [coral reef] that exists and it's the largest reef in the Atlantic. It was just necessary, it's just a need for people to actually communicate and share experiences because what happens in one country or doesn't happen will definitely affect the others. It is so interconnected, right? As a region you really need to work together."* — Leader, regional network

Another shared reason for developing is the need to bring best-available science and knowledge into the hands of those closest to the issues. This need is a primary feature of learning networks, as the principle of shared learning is used to enable capacity development (Bessant & Tsekouras, 2001). An informant with the PTLC climate network elaborated on how teachers did not have the resources they needed to teach about how climate change was impacting their community:

> *"There was a disconnect between the resources that were available locally and the teachers that wanted that sort of information. We didn't go into this thinking it would be a knowledge network or a learning network. It just sort of evolved based on the needs that were there."*

In this particular case the knowledge needed was disconnected from teachers, and the network encouraged ongoing information exchange between community members, teachers, and scientists.

In many cases, the demand for information is urgent. Another advisor with a regional network emphasized that community members were facing immense challenges and being able to communicate with each other was necessary to share safety information throughout the region:

> *"A few fishermen had died in a boat sinking and so whoever was in charge of the beach management unit really took it upon herself to take action and make it their own thing as opposed to waiting for someone else to solve their problems."*

This need to increase information-sharing and build local capacity was commonly referenced by our informants. Many networks in our study, especially national and local networks, are set up to empower communities to tackle local and timely issues rather than relying on outside support structures, which are often expensive, inefficient, and do not incorporate local perspectives. A leader in a regional network stressed the importance of building capacity as a way to reduce costs:

> *"This is an area where there's very little resource. We have to be very careful with our resources. We can't be paying for these $800-a-day scientists to come and help every other individual site or community. By doing this learning network, we've cut down so much on those expenses, having members be able to help each other out...So we've reduced a lot of the costs to conservation in Micronesia by building the expertise within our own learning network. And then those members can help others in the different areas that are required."*

As knowledge creation and knowledge sharing are priorities of these marine-related learning networks, it is predictable that the need for knowledge was a common thread in all of our networks. Two themes emerged with regard to knowledge creation and sharing:

1. Nascent marine-related issues and areas of focus are providing an impetus for researchers, managers, and issue-related societal actors to come together to develop and share new knowledge.

   "It was established at a time when...the field of large scale MPAs was very nascent. It was just emerging." — Informant, Big Ocean

2. Although resources, including technical expertise and knowledge may exist, this information is not in the hands of practitioners and others who are closest to the issues.

   "ESG Task Force is really just connecting people and making sure that they have access to whatever resources are available." — Informant, ESG

   "[The network] acts as a bridge for them to connect with each other, to connect with technical experts, and to help them seek information, knowledge, best practices or whatever they might need" — Coordinator, regional network

Regardless of the types of information that networks mobilize, it is important for them to avoid overlap with other institutions, networks, or organizations that are trying to solve similar problems. An informant with the Future Earth Ocean KAN noted that, *"the large part of the success of these learning networks or knowledge-action networks is filling a gap and not duplicating something that's already existing."* Therefore, it is important for networks to recognize their inter-relatedness and the potential impacts they may have on NGOs or other networks that could be competing for resources and funding.

4.1.2 Definitions used

A network consists of a set of actors or nodes connected by a specified tie that links them (Bogartti & Halgin, 2011). There are many different terms used to describe networks comprised of individuals and/or organizations who come together to share and create knowledge (Pietri et al., 2015), including communities of practice (Wenger et al., 2002), social networks (Walton et al., 2014), learning networks (The Heinz Center, 2004), knowledge networks (Creech & Willard, 2001), epistemic communities (Alder & Haas, 1992), and knowledge-action networks (Shrivastava et al., 2016).

Our informants described their respective networks as learning networks, peer-to-peer learning networks, knowledge networks, knowledge-action networks, knowledge transfer fellowship, communities of practice, connectivity networks, network-of-networks, social networks, research

networks, advocacy networks, and as networks. These terms varied across and within networks, with informants often referring to their respective networks as one or more of the listed terms.

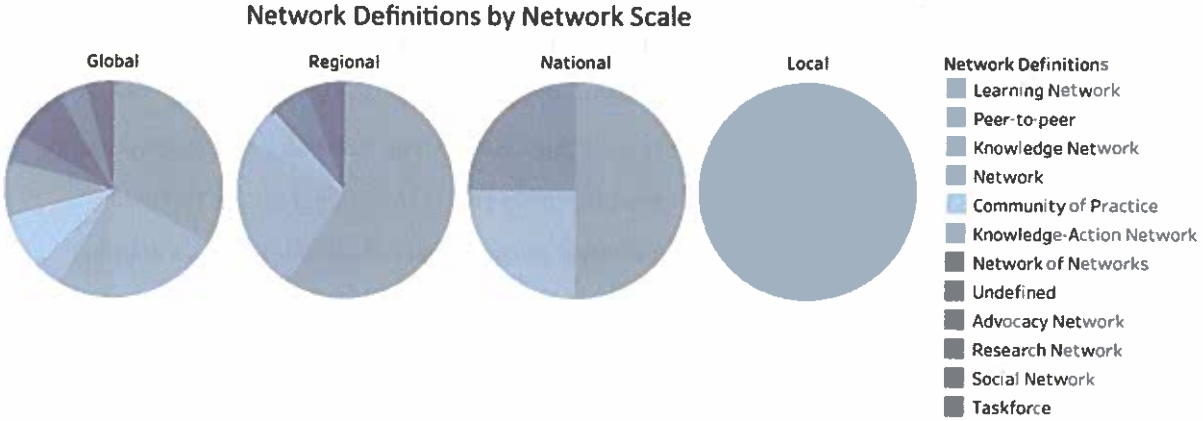

Figure 3. Network definitions that informants in the 16 different networks used. This figure represents the diversity in terminology within the various network scales and indicates that there was diversity in terminology within the networks themselves. Some informants used more than one term or definition to describe their network.

Our results indicate that there is no clear ontology or one set way to define these networks. The differences in terminology used often relates to their cultural and language context, the needs and organization of the network, and what the overall goals of the network are. Even within seminal works on communities of practice, there is ambiguity in the definitions given, but it has been argued that these ambiguities are a source of the concept's adaptability for different purposes, both academic and practical (Cox, 2005). The same can be said for learning networks, as flexibility within the network and to external influences was highlighted as an integral part of network definition adaptability by informants in our study.

As one advisor with a global network noted, *"I think in many cases because we're talking about multiple languages, one term is not the way to go."* As these networks vary in scale and regional location across the globe, the terms used to define the networks change given the cultural context. On a similar note, as network members often interact with individuals outside of their network, the language used can depend on the individual or organization with whom they are communicating. As marine-related learning networks are an emerging field of study, having flexible network definitions leads to an improved mutual understanding of what the network is trying to achieve, which is of greater importance than having a common vocabulary. In support of this, a leader of a global network said:

> *"I think the terminology just matters to whatever person you're trying to talk to. Somebody might have an understanding, because of the way they learned about a learning network. And so, if I say network, they're not making the connection that I am*

talking about a learning network, so I need to keep trying new words until I get that they understand what we're doing."

While the different terms used may be driven by cultural and linguistic contexts, there are subtle differences in the terms based on the organization and outputs of the network. For example, some networks exist for the purpose of supporting good decision making, like improving policy. As one leader of a global network emphasizes, *"learning networks are not about decision making. They are about advancing the knowledge base to support good decision making, transparent decision making, and equitable decision making."* While other networks focus on the role of learning as the main characteristic of their network definition. A coordinator of a regional network describes a learning network as a, *"loose organization of people all working towards similar goals that have opportunities to learn from each other."*

Learning networks often aim at innovation through knowledge sharing and/or collaborative knowledge development (de Kraker et al., 2013). Some learning networks connect peers of a similar background in order to increase similar shared knowledge, while other learning networks connect individuals and/or organizations from different sectors in order to share knowledge from various backgrounds. Poell et al. (2000) emphasize that learning networks can "take various shapes depending on both actor dynamics and work characteristics" (p.25). Similarly, knowledge networks "emphasize the constantly evolving flow of information between scientists and stakeholders to build relationships between members of a community to combine, create, and transfer collective knowledge" (Bolden et al., 2018, p. 2). These organizational differences often relate to the goals of the network. Some networks are created for the sole purpose of sharing knowledge, some are formed to create new knowledge, and others focus on translating information to benefit policy implementation. It is more valuable to focus on the outputs of the network versus coming up with a global collective definition. A leader in a global network emphasized this point, *"I think what you can really also ask is—what is the end game here? You know, what are we collectively trying to accomplish?"*

Although there are differences in the network definitions based on the context and purpose of these networks, there are also shared characteristics between the definitions. While not everyone mentioned these elements, some informants noted that trust, flexibility, and transparency are integral components of their respective networks.

Trust was considered a critical ingredient for learning and knowledge networks. A coordinator of a regional network said, *"I think one of the foundational elements for a learning network is to have trust."* In many of these networks the knowledge being created consists of various types of knowledge,

from academic knowledge, to local knowledge, to traditional ecological knowledge (TEK). Bringing together science and local knowledge is no easy feat, and for many participants trust is necessary in order to bridge these types of knowledge together (Berkes, 2008). Building trust, overcoming barriers and skepticism, and allowing people to come together to share a common vision are necessary for a network's success (Eglene et al., 2007).

Related to trust is the notion of transparency. Williams (2005) notes that by increasing levels of dyadic and group-level trust, organizations can further develop their ability to be transparent and provide relevant, timely, and reliable information. Many informants noted the importance of being transparent with regard to vision, goals, and organization of the network. Transparency is critical to ensuring goal clarity and promoting the usefulness of knowledge, as many of these networks are providing knowledge in a space that has been dependent on top-down approaches. A leader of a global network noted the importance of transparency as a tool to break hierarchical structures, *"They [networks] can provide that critical knowledge in an open and transparent fashion, which helps even the power"* (see Section 4.4.3).

Informants highlighted flexibility as another critical characteristic of their networks. Numerous informants indicated that flexibility was essential to a network's success, and to ensuring the network has the best-suited structure for tackling issues related to the marine environment. As the challenges are always changing, a coordinator of a global network noted that it also meant that the skills needed to tackle such challenges may also change:

> *"You always need to be very flexible because every day is different. You never know what is going to happen. And you have a week, weeks, months to plan and then it's a completely different thing so you have to be open to that. It just changes. It's very dynamic - change is inevitable and it's continuous - so it's continuous to acquire new skills."*

Flexibility within the network was also noted as important to a network's success. As leadership and membership changes over time, the needs and goals of the network shift as well. *"Everybody has something of value, and by recognizing that, sometimes a network shifts depending on the people involved. So flexibility, that's a big thing,"* said an informant with the PTLC climate network. Another informant with the same network noted that networks are, *"flexible enough to be both a conservation tool and a way that we can learn about what's actually going on locally so that we're able to offer something."* In the rapidly growing field of environmental governance, flexibility, including adaptability, is important throughout an effort's lifetime (Armitage et al., 2012; Tobey & Volk, 2002)

4.1.3 Goals of networks

Marine-related learning networks cover a broad range of activities reflected in the diversity of their goals, but their overarching purpose is to increase knowledge and capacity of network members, extending to the communities they serve. This overarching purpose unites them and is reflected in the basic foundation of a learning network, whose core purpose is to increase knowledge through knowledge sharing and collaborative knowledge development (Bessant & Tsekouras, 2001). Improving knowledge exchange among scientists and decision-makers is fundamental for supporting the adaptive governance of marine resources and for those who depend on them (Cvitanovic et al., 2015).

The marine-related learning networks in our study have a variety of goals including, but not limited to, improving social and ecological resilience, promoting climate change adaptation, strengthening the management of marine protected areas (MPAs), Locally Managed Marine Areas (LMMAs), and Large-Scale Marine Protected Areas (LSMPAs), exchanging perspectives among stakeholder groups, policy makers, and scientists, and empowering communities such as small-scale fisheries. The diversity of their goals is expected given the array of complex, wicked problems in our marine social-ecological systems. However, these networks share a common vision: to improve the health of the ocean and the livelihoods of those who depend on related marine environments:

> *"What we're trying to do is engage people in the plight for conserving the oceans."*
> — Informant, CTI-CFF

Marine-related learning networks work towards their common vision by connecting individuals who benefit from learning, working, and growing together rather than working individually. As noted by Keast et al. (2004), although participants in networks have their own individual perspectives, depending on the marine-related learning network in question, these perspectives are often joined together into a new overarching goal or set of goals. The networks included in our study fell into two categories with regard to how their membership influenced their goals and the knowledge exchange process:

1. Networks that connect peers or managers of a similar sector.

> *"The whole premise of MPAConnect is peer-to-peer learning. And so, the whole purpose of creating this network and facilitating the relationships is for managers to learn from their peers. To learn from each other, to learn from these experiences."* — Informant, MPAConnect

> *"For peer-to-peer learning and an engagement...it's not just a researcher coming in and doing comparative case studies, it's actually the practitioners being able to get together, virtually or otherwise, and talk to each other about the key shared experiences and differences across implementing any kind of management, but in this case, ocean management."* — Coordinator, global network

These particular networks focus on connecting peers in order to share lessons learned, challenges, and new insights. These networks do not focus on connecting people from different backgrounds. Instead, they focus on connecting individuals who can learn from one another. These individuals can be in the same region or in a different region.

2. Networks that connect individuals and organizations from different sectors, including science, policy, and civil society (inter and transdisciplinary).

> *"The whole purpose of ESG is to bring people together in theory and practice. And so, I think by having that focus, they've really attracted a lot more people from developing countries, but also people who are underrepresented more broadly."* — Informant, ESG

> *"The Future Earth leadership was kind of in the process of designing new networks of research and collaboration and can we connect people to each other better and get more transdisciplinary, interdisciplinary research happening."* — Informant, Future Earth Ocean KAN

These networks prioritize connecting individuals from different disciplines and sectors and seek to bridge the global north and global south divide (see Section 4.4.4). Fisher & Chen (2011) assert that interdisciplinary research brings together individuals with different skill sets and perspectives in order to create a more holistic understanding of complex problems. Furthermore, Cohen et al. (2012) note that networks of actors that cross both geographical and administrative scales can be important for strengthening management capacities.

While the membership and goals of networks may vary, goal setting is an important process that all networks share. As Biermann et al. (2019) state, "no network can survive and grow without a sense of purpose" (p. 18). This process was described by an advisor with a global network, *"first things first, take an inventory of what's what—define your universe."* This means determining why the network is needed, who is involved in the network, what the goals are and how the network plans to achieve them. While "defining your universe" is difficult to do, it is necessary for the development, formation, and survival of a network. As one advisor with a global network noted, *"if you're without a specific purpose, I think it's hard for people to self-organize and self-motivate."* Determining these goals and thus the organization and mechanisms of a network will determine who is involved in the network. As a coordinator of a global network emphasized, *"Defining your goals is both hard and important and it's taken us a while to do that."* Goal setting is often a collaborative process that evolves over time through meetings and continuous discussions. Our research indicates that it is a twofold process that involves the following considerations:

1. The needs of the participants in the network and the communities they are serving.

2. The skills, expertise, and knowledge that the network can provide.

> *"Take a very place-based approach to figuring out what the people in that place see as what they're lacking already. And if there's any way that we could help by bringing in our expertise, what do they need to know and can we actually help them solve that problem?...How do you leverage your expertise?"* — Informant, PTLC climate network

It is important to determine the needs of participants and to leverage the network's expertise, especially in situations of limited resources and time. One informant with MPAConnect emphasized this point, *"taking this sort of capacity needs approach has been really valuable in helping to allocate scarce resources, and also in helping to justify where and why you're targeting resources with the tools also being useful for tracking progress."* This requires efficient communication with members to make sure the network is representing them, and to determine the priorities and goals of the network. Otherwise, the network risks producing redundant or unnecessary information that could limit participation or the sustainability of the network:

> *"...we're fundamentally doing the same work in the sense of like the end of the day goals, but how we support managers and get there is always evolving. And if we aren't looking into those new things...what people need, then we're going to be left behind."* — Informant, RRN

However, it is critical that this process is not extractive, and respects the time of already over-committed individuals. Regardless of whether needs are determined formally through a mechanism such as a needs assessment, or simply through frequent and consistent check-ins with members, a common theme across networks was the need to be participant driven and flexible. Similarly, many informants discussed the importance of ground-truthing planned activities and goals to ensure that they align with those the network is trying to serve. For example, an informant with PIMPAC noted:

> *"If I develop a tool...it's always in collaboration with people on the ground...it's always filtered by our people on the ground who can be like, 'that's not going to work here...you need to change it.' So, it's a heavily collaborative thing."*

Regular, frequent communication with members is necessary to maintain engagement, clarify roles, and adjust as needed (Philbin & Linnell, 2013). This ongoing collaborative process also promotes culturally appropriate and relevant practices, and encourages local stewardship and resilience of social-ecological systems (Fazey et al., 2007; Friedlander, 2018).

4.2. Network Operations

In this section, we discuss the structures, strategies, and resources required for networks to operate. From how networks are communicating to the ways that they track and monitor outcomes and

impacts, the following operational and logistical insights on learning networks emerged as key foci among informants.

4.2.1 Administration

The management of learning networks, including the processes involved in running them, emerged as a key element of operational effectiveness in our analysis. The administrative burden of managing networks is huge, and requires dedicated staff time to organize, communicate, fundraise and coordinate. Our research indicates that people underestimate the amount of time, resources, and effort required to start and maintain learning networks. Informants consistently echoed this position, which is considered a main challenge because often funds are dedicated for activities and projects, not for maintaining the network itself. The coordinator, in particular, emerged as a major and important administrative role from the start, as pointed out by an informant from CTI-CFF:

> *"...we always come back to the principles of a learning network. You need a clear purpose and a dedicated coordinator, some key resources to take it off. Otherwise it's not going to really happen."*

The role of a coordinator may differ slightly between learning networks, but the position is generally one of planning, organizing, communicating, fundraising, and managing critical operational tasks. Coordinators were often likened to the "motor," "driver" or "champion" of the network. Their qualities, including their passion, energy, motivation and dedication to the work, allow them to persist despite often being overburdened and even working other jobs in addition to their role in the network. Our informants stressed how avoiding burnout in these positions is especially challenging in resource-limited contexts, and can compromise continuity in the absence of effective management. Because of their varied responsibilities, network coordinators wear many hats, and use diverse skills, such as the ability to mediate across sectors and in situations where people are outside of their comfort zones. This role is sometimes called a "broker" or a "weaver" and is described as someone who is able to both arrange and manage the various mechanisms of the network, while also facilitating and motivating learning, connection, and exchange (Bessant & Tsekouras, 2001; Keast et al., 2004; Philbin & Linnell, 2013). In the absence of a coordinator, a decentralized learning network can mainly expect to diffuse knowledge, rather than provide meaningful connection and exchange. Our findings echo these sentiments; regardless of the title, this role—which often goes far beyond administration—is crucial to fulfilling the needs outlined in Section 4.1.1.

We found that how the network is organized, coordinated, and led is also a major factor in why actors engage and how they participate in network activities. Effective coordination and organization

correlates to better and more frequent communication, which facilitates better participation and inclusion. In these cases, having different advisory bodies and/or dedicated staff helps mediate communication and alleviate pressure on the coordinator. Informants shared that simple practices, like maintaining good documentation and record keeping, can make a big difference for functionality. A larger, transboundary, or more complex network may require more structural diversity to function effectively.

> *"I think what we learned in addition to the process was the need to have flexibility in how you set up the structure, because it really depends on the members. Every network has its own culture, so you should be able to have that adaptive ability in applying "the manual" so to speak, in different contexts."* — Informant, CTI-CFF

The administrative process is a learning experience for networks, and as one informant from a global network noted, *"a lot of structural problems are because of institutions and processes."* There is no one-size-fits-all approach for managing networks, but investing in administrative capacity, as opposed to project-specific investments, is vital to navigating the dynamic process of figuring out how to best set up management.

Informants also advised starting small and not rushing, working incrementally, and setting the initial bar low to allow the network to manage growth and expectations, and to refine priorities and goals. Dealing with network growth can be challenging, particularly in the absence of financial support, clearly defined goals, or the ability to leverage collective action (see Section 4.2.2). Informants often talked about how many additional activities they *would* do if they had both the administrative capacity and funding, but also mentioned that it is wise to limit and define the universe to what is feasible given available resources. This approach is key in part because learning networks should be long-term investments (though some networks started out with an ending date), and their value is derived from developing lasting relationships and fostering trust, which facilitates meaningful exchange and learning (Chandler & Kennedy, 2015; Christie et al., 2016). Limiting the scope and growing incrementally makes managing the network for the long-term more feasible.

As learning networks are long-term investments, they may be more susceptible to external influences, such as changes in political administrations or shifting donor priorities. One way to deal with political pressures is to remain neutral. For example, one informant from a regional network said: *"the challenge is that you have to be careful that it's not politicized...it's key that the network remains neutral."* Conversely, this informant from the Future Earth Ocean KAN points out that the goal of remaining neutral is not always realistic, and that transparency is a way to approach contentious issues:

> *"I tend to think of neutrality as fiction. I think the goal is to be transparent. So, I absolutely think that you can have a policy preference and you can even have a partisan preference as long as you are transparent, you're honest about what your goals are and why they're your goals."* — Informant, Future Earth Ocean KAN

This variation amongst informants reflects the diversity of goals of the networks in our study. While some are trying to influence and advocate for certain policies, others are more focused on addressing knowledge and capacity gaps. Another external influence consistently referenced by informants was funding (see Section 4.2.2). In general, such external influences were often discussed as being outside of network control, particularly when government funding is involved, as illustrated by an informant from Big Ocean, "*...national budgets are highly political, that just comes along with it. So, that definitely makes surviving as a network in this landscape harder.*" For this reason, informants emphasized flexibility and resilience of network structure and administration.

Adaptively managing networks internally allows for changes in priorities and improved effectiveness as circumstances inevitably change over time. Such changes can include both administrative or funding changes, as well as the dynamic and constantly evolving nature of marine issues, as discussed in Section 4.1. Such adaptive structures promote flexibility, reflexivity, and learning, which are critical to the successful management and governance of marine resources and those who depend on them (Österblom & Folke, 2013). Partnerships emerged as an important flexible administrative tactic, as evidenced by this leader of a global network:

> *"I'm 2.5 people spread across the globe. So, in order to be grounded and relevant, working with a local network, or when there weren't local networks in existence, we at least had local key people that knew who was on the ground doing what. So, if there's a local network, it's critical, because they're going to have a better understanding of everything then you would as a global network."*

Networks partner and work with other networks as well as with organizations, people, and institutions on the ground in order to increase their reach and make activities most appropriate for the intended audience. Partnerships and working flexibly to take advantage of opportunities to increase the face-to-face interaction of the network are elements of how networks adapt and may change over time (Bodin & Crona, 2009).

Differences of opinion emerged when informants discussed whether networks should operate formally or informally. A formal network has agreements or structural arrangements that make member participation more official or subject to certain provisions, while an informal network has more fluid participation. Proponents of informal networks lauded their ability to react quickly to changing situations and priorities without dealing with bureaucracies, while others pointed out that excessive

informality can limit the ability to institutionalize critical knowledge and manage the network with internal and external legitimacy. This tension between stability and flexibility is a difficult line for networks to walk, and most fall somewhere in between based on context-dependent factors; networks need to be able to respond both rapidly and consistently over time (Provan & Kenis, 2008). As stated by an informant from MPAConnect, *"...there isn't a formal agreement. It's an informal network. And like a lot of international cooperation, the network runs on goodwill and generosity to take part."* Although MPAConnect does not refer to itself as being formal, this does not preclude them from using formalized operational procedures and mechanisms. Essentially, most of the networks we interviewed have formal internal operations, although they maintain informality and flexibility with their external activities and participants. Some informants shared that official agreements, MOUs, and other formal structures can be necessary when working internationally and dealing with political and international issues—the bigger the network, generally the more important it is to have such formal structures. Some informants also likened formal networks to having paying membership, which can help strengthen the sustainability of the network, but may limit and exclude members with limited financial resources.

4.2.2 Resources and funding

Funding is a major limiting factor for learning networks, as they are difficult to sustain over time. Enthusiasm and passion are important and can generate momentum, but financial resources are critical for network longevity (Philbin & Linnell, 2013). So, while funding does not guarantee a network's success, without financial support, no network can deliver sustained positive outcomes (Gill et al., 2017; Reis et al., 2002). Other resources mentioned by informants other than funding include: key individuals, leadership, information, technology, equipment, time, local knowledge, and connections.

Funding was almost always referred to as a challenge, and was often related to what the network *would* do if it had more funding. However, when informants discussed the positive aspects of funding, they referred to working with other networks and organizations and developing partnerships to secure new sources of funding and avoid stepping on each other's toes.

> *"...those [agreements to work together] are really valuable cause then that basically gives on the ground people like myself access to more funding."* — Informant, Big Ocean

> *"...it helps us to join forces [with other networks] to find new funding sources for us...We managed to reach new big donors together."* — Informant, MedPAN

This inter-network collaboration is particularly important in spaces where many actors may be competing for the same financial resources. For example, in certain regions, or when several networks

are all funded by the same institutions, they must maintain those relationships and avoid tensions that might prevent effective operations.

Often, funders have influence over network priorities, activities, and even participation. Donor designations dictate how money can be used, which may lead to a dearth of money for maintaining essential network activities, such as annual meetings, staff salaries, administrative needs, and fixed operating costs. Some informants indicated that they have turned down funding and certain donors because there was a misalignment of priorities, or because they did not want the donor to have too much control over the network. There is some tension between networks working to determine priorities based on member needs, and donors who often have their own priorities and needs that might not necessarily align with those of the network members.

> *"There was one funder, potential funder. He came back with a lot of questions, dates...but they were valid, he wanted to see more activities that would meet up to what was proposed. But it's like chicken and the egg, you need money for that. So, if you don't have the budget, how can you include the activities?"* — Advisor, global network

> *"[The funder] decided to make the guide that we're working on a requirement for the US Jurisdictions to be able to get the next round of funding, which we did not know about. And we were not done, we are still not done with this guide. We're still working on it...The jurisdictions' money is being held up by this guide that we are not yet done with...We had to have a lot of discussions with our partners to tell them that we didn't know that policy was going to be made based on our work. We had no clue. They were not happy with us.... I think at the end it's that authentic communication with people that you work with closely and just trying to keep those partnerships as best as you can and just be honest with each other."* — Informant, RRN

> *"But one of the, one of the mistakes was that in fact donors will not fund an international secretariat because they want to fund things that are more localized and more on the ground and they don't want to put money into, into bureaucracy basically."* — Informant, CTI-CFF

The challenges with funding are ubiquitous across networks, though the networks that are integrated within or have partnerships with well-funded NGOs experience more security in their finances, as this informant from a global network notes, *"we've been getting the money over the years because we have been delivering, but we're also set up that way...so we're able to get the funding because of the structure of how we work."* That said, who participates in network activities also depends on funding, in part because the funding source can attract participants, and because donors may have vested interests in particular geographies that allow certain people to participate in an activity.

As discussed previously, longevity is an important component of an effective learning network, but the fact that funding comes in short-term sequences makes long-term efforts difficult to execute.

The "chicken and egg" problem of funding manifests in that funders want to see evidence of successful activities, which requires investment both in the activities themselves and in the measuring or documenting of success (see Section 4.2.3). Of course, this also requires funding the administrative aspects of learning networks, rather than project or activity-based support as most funding is.

> *"I think that they [learning networks] should be permanent and that is the huge barrier there is funding. Funding structures just aren't made for that...it's just really hard to make that happen without aligning your research into what's already happening there."* — Informant, PTLC climate network

> *"... it's got to be a sustained effort, but nobody wants to think about that from a funding perspective."* — Advisor, regional network

Funders might view long-term investment in building relationships as occurring at the expense of outcomes, as the process of developing successful learning networks takes significant time (Keast et al., 2004). However, having stable funding enables networks to function long-term and develop trust and the relationships necessary to work toward network goals (Feldman & Ingram, 2009).

Dealing with scarcity of resources requires good information about the goals and priorities, and effective, frequent communication with members. Networks can only allocate scarce resources effectively and fairly if there is clarity about what the highest priority needs are (see Section 4.1.3). It is also important for networks to be transparent about finances, and to look at reporting and funding applications as opportunities to document success and share stories instead of as barriers.

> *"...you better have built their trust. You better have a very clear and transparent financial system because...if it's not being handled properly, that becomes a major issue."* — Advisor, regional network

> *"...whoever you're submitting your progress reports to, work really closely with them. To make sure that we're reporting how they [the funders] want us to...there is some leeway where we've worked with them to say, instead of a final report that no one will read, can we do a communication piece? And it's this 20-page document, we get someone to design it, it looks really good, and it's like accomplishments from all the places and like success stories."* — Coordinator, global network

Informants advised being carefully selective about grants and only accepting those that allow objectives to be aligned with local contexts (and not the other way around). Generally, networks have to be dynamic about their funding and manage uncertainty, because the funding outlook is rarely stable or sustainable.

4.2.3 Metrics and measurement

To justify funding and investment, marine-related learning networks must show that they are successful and are meeting the needs of their members and participants. This documentation can be particularly challenging for marine-related learning networks because the activities in which they engage are not always linked to specific indicators of success; in other words, the outcomes are often more intangible and difficult to connect with the work of the network in the absence of a concrete measurement framework (Bessant & Tsekouras, 2001). This is especially true for networks with ecological goals, where connecting management or governance activities to ecological outcomes is particularly challenging (Stafford et al., 2018). For example, one informant from RRN remarked, *"we cannot find a measure that is feasible to track that relates our trainings to reef health."* However, even before looking to measure explicit relationships between inputs and outcomes, our analysis suggests that networks need a well-defined theory of change and explicit goals (Section 4.1.3) so that they know what success would look like.

> *"Monitoring or measuring our impact is really difficult. We try to get statistics wherever we can, but how things are used and implemented on the ground by people really is hard to know. I'm not sure that we've really nailed that one yet."* — Core staff, global network

> *"If we were able to show more with what we're doing and through the monitoring evaluation, through communications, I think we'd be in a better place to be able to get more resources for this work."* — Informant, PIMPAC

Despite the inherent challenge of measuring outcomes and results, informants stressed that such efforts are essential. More specifically, informants noted the importance of checking in and taking stock before, during, and after network activities. Following up after, in particular, allows the network to understand how the training could be improved, and to facilitate future participation (see Section 4.4.2). Additionally, after collecting information about outcomes or results, networks must then analyze the collected information, and feed these results back into refining the network's activities. Some informants expressed regret that they had not built these mechanisms for monitoring and evaluating into the network's structure in its early stages, and were now lacking comprehensive information about the impact of the network throughout its life.

> *"...basically we know it's working because people keep participating. So, I guess we vote with our feet and we judge the quality of impact or effectiveness or even just basic utility by whether or not people participate in our network."* — Leader, global network

> *"...how to say that it is working... I would say the interest funders to fund the network, or interest of the different stakeholders involved in decision making"* — Informant, MIHARI

"We've thought through it as a team and brought in others to help us think, how can we show a connection, because that's what everybody wanted me to show initially—how is this training helping a reef? And I had to just think through it a lot and get more opinions and now I just tell people, I can't. I can't tell you that...the best way we've had to show we've had an impact is through the documentation of those stories" — Leader, global network

Our results indicate that marine-related learning networks typically measure either process-related metrics, outcome-related metrics, or both. The process, or output, metrics measure some of the more traditional, numeric indicators, such as the number of participants in an activity or meeting, while outcome metrics tend to be more focused on descriptive, qualitative metrics, such as stories, that illustrate the broader impact of the network (Table 2). It is important to monitor both process and outcome metrics in order to track progress and adjust, as focusing on just one method or the other may provide a limited or inadequate picture. Learning networks are process-oriented, and so metrics that indicate levels of engagement, participation, and feedback within learning networks are often just as important as the outcomes that said engagement produces (Christie et al., 2007; Philbin & Linnell, 2013). Our informants emphasized that since networks cannot often measure learning or capacity development itself, they have to measure outputs and use those as proxy indicators. Augmenting numeric measures with stories and other descriptive metrics helps balance assessments, both in terms of collecting well-rounded and useful information, and in terms of cost effective and sustainable efforts.

Table 2. The metrics and methods for measurement of process, outputs, and outcomes of learning networks used by the networks included in the study.

Metrics	Measurement methods
- Number of participants/attendees in a network activity or meeting - Number of active members - Sustained participation over time (momentum) - Interest of funders/financial support - Materials produced - Number of partnerships - Stories - Leadership development - Policy creation & influence - Management changes & influence - Collaboration	- Surveys & polls - Self-reporting - Audits - Communication, documentation with participants - Anecdotal evidence - Observation

A contradiction appears among informants on the topic of surveys, which networks frequently use to assess many of the metrics discussed above. Some informants expressed issues with using

surveys, such as their unreliability and low response rates, while others found them useful and cost-effective. The debate about the use of surveys is certainly not unique to learning networks, and the quality of the data collected and interpreted depends on survey design and data analysis methodology.

4.2.4 Communication and exchange methods

Communication is the core of learning network activity, and all of the networks interviewed used multiple methods to engage their participants and members (Table 3). However, not all of the methods are equally valued.

Table 3. The types of activities and platforms used by learning networks to communicate.

Types of activities	Platforms used
Trainings, workshops, peer-to-peer exchanges, knowledge exchanges, meetings, webinars, online courses, conferences, products, publications, lectures and tutorials, think tanks, symposiums, site visits, technical support, videos	Email, WhatsApp, listservs, newsletters, phone, video conferencing, in person, online forums, posting on websites, images, radio

Across the board, informants lauded in-person activities as the most critical component of network communication (see Cohen et al., 2012). Facetime among network members and participants makes communication more effective overall by creating connections and building relationships, which foster trust. When trusting relationships are established, more meaningful learning and dialogue are enabled in the network (Chandler & Kennedy, 2015).

> *"I think that there's a lot lost when local people don't interact directly and don't converse directly with scientists. And I think that in having learning networks, you're building trust...the benefit of a learning network is becoming a face, and not just like another one-page memo about the impacts of something coming at you."* — Informant, PTLC climate network

> *"You have to create the conditions where people have trust and are willing to be vulnerable and bring the real issues to the table."* — Informant, Big Ocean

By establishing such relationships, participant perceptions change, allowing them to view one another as resources and expanding their available sources of knowledge and expertise (Keast et al., 2004). The density of such trust in a learning network is related to the modes of communication and coordination utilized, with in-person activities and their associated high levels of informal interaction leading to the most trust (Provan & Kenis, 2008). By bringing people together in person, networks create space for the development of friendships, and interaction outside of events at meals and during free time. In this way,

the process of in-person communication and building trust within the network is an outcome in and of itself that is critical to network structure (see Section 4.5.1) (Philbin & Linnell, 2013).

Interestingly, the methods of communication in learning networks also tend to become more informal over time. As participants become more comfortable and develop relationships with others, they start communicating over informal channels like WhatsApp.

> *"At first, there was only communication when we were facilitating a workshop or a webinar or a call... now they have those relationships with each other and they have WhatsApp lists."* — Informant, MPAConnect

Learning, connection, and relationships are not cultivated in the same way in online l; the face-to-face and informal component is necessary to really engage people and provide them with tools, skills, and knowledge that they need. For this reason, online platforms cannot replace in-person meetings—they can augment and increase the number of activities and information exchanged, but they cannot replace them. For example, an advisor to the PTLC climate network mentioned that networks should use video conferencing only after establishing a rapport in person, otherwise the value of online communication is reduced. An informant from the Future Earth Ocean KAN expressed a similar sentiment, *"if you don't meet in person, it's very difficult to keep working virtually."* Two more informants expanded on the importance of engaging in person:

> *"You've got to talk to people in person and have meetings...just having a network through the internet is not going to work in the long run. You can use it for day-to-day things, but not for building the real relationships that are important."* — Informant, CTI-CFF

> *"And so that's why I've always kept an in-person training component, because I feel like, the network, if we just do online, it can service a certain thing but we won't have the connections between managers that result in them feeling comfortable reaching out to each other...and for us to get a better pulse on what they're doing. The in-person time is really hard to replace."* — Leader, global network

However, under certain circumstances, carrying out network activities online may be the only and/or best option. For example, engaging online removes the barriers of travel and political and financial issues with visas, travel restrictions, and other external factors, allowing for more diverse participation in the network. Conversely, if travel is a barrier, but so is access to high speed internet or other technology on the ground, then online communication is not an adequate substitute. Additionally, engaging in-person is far more resource intensive, and it can be difficult for networks to justify the expense to funders (particularly for global networks where people may be travelling farther).

To mitigate these issues, informants commonly recommended trying to piggyback off other existing events that members might already be traveling to in order to reduce costs and make connecting in person easier. This approach allows the network to capitalize on existing momentum and helps simplify coordination and planning. Communication can be better tailored, specified, and effective when the coordinator has the time and resources to do so. Informants also shared that meetings are more engaging when they are facilitated and/or contain a hands-on, activity-based approach, such as a learning exchange (see Section 4.5.2).

> *"They [community members] are more easily convinced by going to well-functioning MPA with all these things than if you were to teach them for hours about it."* — Informant, SMART Seas

Such informal tools can also help accommodate and include a wider variety of participants in network activities, and allow people on the ground to coordinate amongst themselves outside of the network structure. The downside is that the learning network can then no longer effectively track communication and exchange as it can when formal network platforms are used.

In general, the role of technology and online I presented a contradiction amongst informants. Technology and new ways of communicating and sharing information online are viewed both as ineffective (compared to in-person meetings), and as innovative tools for advancing the sharing of knowledge and increasing inclusion. The issue is that the type of online platform and technology needed varies between networks. Though developing these platforms is technically feasible, there is no one-size-fits-all format, and tailoring them would be expensive and difficult for learning networks to invest in, as per the discussion on funding in Section 4.2.2 (de Kraker et al., 2013). Additionally, one global network invested in developing a formal online forum, but had difficulty getting participants to engage consistently. The informants advised other learning networks to think twice before investing in a forum platform. While such platforms might sound like the perfect tool for facilitating engagement, in practice they appear much less effective.

4.3. Leadership in Networks

Marine-related learning networks engage with a diverse array of stakeholders and communities, gather expertise and essential practices from varied knowledge pools, and seek to use those collections of insights to bridge the gap between science and decision-making to improve effective, sustainable ocean resource management (Busschop, 2019; Cvitanovic et al., 2015; Gerhardinger et al., 2018). These

efforts require strong leaders—both with the network's core team and within the communities or stakeholders with which networks interact and engage (Bolden et al., 2018).

We focused on four leadership sub-themes: leadership qualities, leadership development, leadership change, and leadership limitations. The themes and patterns that emerged from our analysis provide insight into the ways leaders can boost or inhibit the effectiveness of network development, operations, and management.

4.3.1 Leadership qualities, skills, and types

Network leaders take many different forms and provide networks with a diverse range of functions. Leadership in adaptive management systems identifies champions, change agents, skilled facilitators and communicators, and dedicated energetic leaders as the types of leaders that are able to, through individual agency, influence and transform adaptive management governance systems (Feldman & Ingram, 2009; Napier et al., 2005; Stankey, 2005; Westley et al., 2019). Informants identified champions as the highly motivated, passionate, and dedicated individuals capable of generating interest in others to support a common cause. Essentially, champions can spark the emergence of networks. Keeping the momentum of a network moving forward once established, however, requires additional skill sets and capabilities including communication and facilitation skills. One core staff member of a regional network was careful to distinguish the difference in qualities that separate champions and leaders:

> *"[Leaders] understand how the jigsaw piece has come together. That's what a leader has to do. A champion doesn't have to do that. The leader has to figure out, okay, I've got GEF and WWF and ADB and USAID and three national governments. I've got three levels of government and I've got four themes. How do I make it work?"*

In the above case, the consultant was referring to a network coordinator. Coordinators were mentioned by several informants as the motors that keep networks relevant, engaged, and positioned as effective conduits of knowledge exchange. Passion and motivation are useful in network leaders, but the ability to process the flow of information and ideas within networks across various channels, detect themes and goals, and adapt network strategies is vitally important (Manolis et al., 2009). A regional network advisor said, *"if you don't have good coordination, don't even start a network, because it's useless. If it's not somebody's day-to-day job thinking about how this thing is running and making things move, it's just not going to happen."*

The suite of skills and leadership qualities required to ensure efficacy in something as dynamic and complex as a marine-related network are heavily based in communication skills, awareness,

inclusivity, and the capacity to manage and forge relationships with and between actors (Heifitz, 1994; Feldman & Ingram, 2009; Jacobs et al., 2005; Manolis et al., 2009). Our findings suggest that an effective coordinator is someone who is able to stay in touch and in tune with the realities on the ground where networks are involved, and ensure that network operations maintain relationships with the communities and members with whom the network engages. This observation emphasizes the importance of network leaders who can build trust, and communicate effectively across barriers (e.g. language, cultural, capacity-based) (Eglene et al., 2007; Mizrahi et al., 2001). Building trust and communicating across barriers and regions demands situational and social awareness in leaders (Berkes, 2009). One regional network advisor emphasized that people who are able to do this are few and far between, and emphasized the trust-building component:

> *"Somebody that has an appreciation for how you work at a regional scale with multiple countries. There are only a few people that can help me do that. It comes down to also building trust, you know, among these six countries. If you don't have their trust, they will pull away quickly."*

The ability to convince others of the value of a network, a process made easier by trustworthy leaders, is important because efforts to improve large-scale resource management are abundant and wide-ranging in both scale and scope (Bidwell et al., 2013). With so many actors attempting to provide solutions or gain influence with a region or community, emerging network leaders often find themselves entering into crowded decision-making arenas, where gaining respect, trust, influence and sharing new ideas is a challenge. Without the ability to gain the trust of locals, or the communities with whom networks engage, any attempt at sharing knowledge or better management practices can be met with dismissiveness or annoyance (Cohen et al., 2012; Hahn et al., 2006).

> *"The goal of the [network] is actually to bring in that cross-disciplinary, transdisciplinary perspective. But you're going to run into a lot of obstacles because existing groups feel, 'but that's what I do. And why do we need another one that's going to draw away resources, glory, you know, impact from what I do?'...They have their disciplinary or sectoral specialty and they're not so convinced that by working together across all the disciplines that you can learn so much more compared to what they can learn in their own discipline. So, there's another structural element there that causes some resistance..."* — Leader, global network

Box 1. A story about the importance of trust

"I think marginalized fishing communities have seen people come and go and they've been disappointed. They've been promised stuff and now they're bearing the brunt of an imminent catastrophe. I mean, fish stocks are declining, they can't keep this going. It's really tragic what's happening, and they've been forgotten and forsaken by their governments, but also, they've been pushed to do illegal fishing. So, they're really at the forefront, I would say, of the impact of overfishing subsidies, of distant water fishing fees, et cetera...I build trust with local actors. Sometimes it works, sometimes it doesn't. And then if we have a common vision we just try and go deeper and deeper. So as the project's been evolving, I've been able to take more risks with people, situations, and it sees results. But to come back to the trust thing, I think that's a non-communicative thing. I think people can tell whether you're genuine or not, whether you're just there to tick a box on your campaign or if you're just using them for some kind of political tool, people can tell what you're up to. But it takes time and also, I can't say it's easy. I mean, even with the journalists that I've worked with, it's taken them time to trust me. You know, I've had massive arguments with people, but now we're very close friends. But they were like, "Who's this woman? Why is she coming in here to do all this stuff? You know, we don't trust anybody from Europe," which is also another big problem to overcome. People don't trust the West, they don't trust the West's intentions in their communities... ...But in the end, if you're persistent and slightly rebellious, I think maybe it pays off."

— Advisor, global network

Network leadership encompasses more than just coordinators and directors at the top level. Network leaders exist at multiple levels both within and outside of a network's core team. These leaders include advisors, consultants, or local community members (Bolden et al., 2018; Stori et al., 2019). The ideal suite of general network leader skills is inexact, as network needs and goals often change over time, by region, or due to the fluid dynamics of the resources being managed. In addition to the skills discussed above (passion, communication and facilitation, trust-building, awareness, and relationship forging) informants identified adaptability, patience, flexibility, kindness and respect, and the ability to lead without authority over others as essential leadership qualities (Heifitz, 1994; Manolis et al., 2009).

4.3.2 Leadership transitions and changes

Based on our informant responses, the burden placed on network leaders (e.g., coordinators or directors) that are responsible for maintaining channels of communication, forging relationships, and balancing network goals is immense.

> *"I'm burned out. I've been doing this for a while and it's tough, and, you know, you start losing ideas too, right? At a certain point you want to bring in new people because they'll help be more creative than you are."* — Coordinator, global network

Continuity mechanisms for transitioning between key leaders, attracting and developing new leaders, and establishing clear governance structures could be potential solutions. Bringing in new leaders to alleviate some of the burden placed on key leaders arose as a common theme throughout our interviews, not only to address key leader burnout, but to address another common leadership limitation: the departure of key leaders due to lack of funding, excessive burden, or other obligations.

Still, retaining certain key leaders, especially those whose potential departures were labelled by informants as catastrophic, does seem to correlate with network progress. One leader of a regional network mentioned that the networks that retained key leaders *"seem to perform better than the ones that are continually changing. Those are the organizations that are struggling, and so retention has to be one of the main focuses of the learning network."*

This implies that governance structures that can balance key leader retention and attract new leaders would be more effective, a notion supported by a leader of a regional network, *"Just for continuity processes, that executive committee has five people, then you have three roll out and three come in, and two stay, for example. So those rules of how to operate were developed early on, which is very good..."* One leader of a global network suggested that this type of governance structure—if made clear to network members in the early network development phase—can extend the retention of key leaders, and also help attract new members with different perspectives and ideas.

> *"So even if they say, 'Hey, can you do another term?' You say, 'Well I can't because I'm out.' And that actually does help to encourage new leaders to come in because they can see, [he] will be out of my way soon, so I don't have to deal with that guy anymore. And I can bring my new ideas forward. But if that's not clearly articulated, then this is a bit more, 'I wonder when the King dies, and the new person will come in.' So, it's not plannable. I think this is why I'm a big fan of clear structures."* — Leader, global network

4.3.3 Leadership development

Strong leadership is correlated with effective management of MPAs and fisheries, as well as improved ecological outcomes (Christie et al., 2009; Gutiérrez et al., 2011). It is therefore crucial for marine-related networks to develop leaders, either formally (e.g., workshops, seminars) or informally (e.g., knowledge mobilization and distribution). Early career researchers frequently came up in the interviews as essential for network growth and progress. Whereas more established researchers and academics might be more boxed in to certain ways of thinking and behaving, younger researchers are more enthusiastic, motivated, and passionate about network potential and missions.

> *"I really do think the focus on early career researchers and professionals is key because they ... tend to be engaged, interested ... have enthusiasm and reason and good ideas,*

new ideas and then reason to participate because they're still building their networks."
— Coordinator, global network

In addition to providing new ideas, perspectives, and passion to a network, a global network advisor said that early career researchers seem more willing to travel and participate in the crucial face-to-face meetings important for network functions given that they have fewer time restrictions and more energy. Face-to-face meetings are one of those most effective communication methods for networks, as described in the Section 4.2 of these results.

Once a network has attracted new leaders, whether within the network or in the communities the networks interact with, providing organized trainings, workshops, and mentorships to develop individuals into more effective network members is critical (Manolis et al., 2009). Not only does providing leadership development trainings to new leaders improve network effectiveness, and provide opportunities to locals and communities to take the reins from internal network leaders, but the growth and development of new leaders can actually be used as a metric for measuring a network's success in a particular region.

"We've seen a lot of the people that we've worked with, we kind of call them like 'gen one PIMPAC-ers'. Now they're in leadership positions ... ...and if you talk to them they'll say things like, "I had no clue about anything when I started back in this organization, but it was through all the training and support I got with PIMPAC that I really understood how to go about management work with communities." — Informant, PIMPAC

A second PIMPAC informant further lauded the network's influence on leadership growth and development in the region:

"There's a growing number of [leaders] because of the support that PIMPAC has provided. So, you see the changes and the growth in these individuals all over Micronesia now because of the work that we provided to these, especially to the young, and emerging leaders that we have. And more and more women leaders are getting involved, running organizations, running programs, projects. And that's really exciting."

For the network responsible for leadership development and growth within a region, the ability to point to the new leaders in positions of influence can be a measurable network 'win', and a metric that networks might be able to use to convince donors and funding sources of a network's value and reach.

Leadership growth as a result of network development trainings can serve to empower community locals, especially women. Over the course of five years, one of the most effective networks in regard to leadership development, CTI-CFF, trained over 300 women in multiple countries who now lead and manage conservation projects. At this network's most recent workshop, an open source leadership training module that trains women in leadership competencies was developed collaboratively

with women leaders from multiple countries. This level of empowerment has a direct connection to systemic change, as women are often some of the most active and influential network leaders in their respective government agencies, according to one core staff member of a regional network:

> *"The impact, you know, this is quite considerable. The key women are actually quite active in their respective government agencies. They took great projects to the field level, engaging other women in specific actions on the ground. So, it's also providing confidence to this particular group, that they have a key role to play in and also engage them in decision-making."*

Box 2. Stories of Empowerment

"There were several stories of empowerment that were shared throughout the week. There was one cool example of someone who now is, I believe a warden in Kenya, and she had started out with no swimming skills. I think only 10 or 20% of employees were able to swim at the start of the program, and I think now it's up to 80 or 90%. Maybe I'm making up those numbers, but a substantial shift. This individual described not only not being able to swim several years back and gaining swimming skills because of the program, but she also is now, I believe, a dive master at this point. She's like one of three dive masters in the Kenya wildlife service and she's, I believe, the only female dive master in the Kenyan wildlife service." — Advisor, regional network

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"[He] is like the perfect example for me because he's more involved in the community now. Instead of 'Oh, I'm just a teacher. I go to work, I get paid. I teach kids and that's the end of it,' he's now in a leadership position in the state education sector. He gets to visit all the schools on the Island. Even get on boats and go out to the outer islands. And, to me, hearing him present when I first started getting involved with [Network] and then the last, at the [Region Name] teacher's conference too. The last one that just happened a few months ago. He knows he's a leader now, so he, he's not like standing in the background waiting for somebody to say, 'Can you come and do this now?' He's like, 'No, this is how we do this and that'." — Coordinator, local network

In addition to online leadership modules, informants mentioned leadership development trainings in the form of in-person workshops, and mentorship as important. Another informant mentioned that giving emerging leaders leadership opportunities (e.g., discussion facilitation, leading workshops), followed by private, closed-door debriefings about areas for improvement was an effective form of development. Some trainings are designed to train future trainers, who can then return to their communities and train other locals in leadership skills and competencies. Other organized trainings, workshops, or mentorships are meticulously crafted around the development of certain skills like those mentioned as important above, such as facilitation and communication skills.

"One of the skill sets that we teach frequently when we have the space to do it is the facilitation and communication skills. And that's something that marine managers haven't often had training on. And I feel like those skills really, really help them move their work forward." — Leader, global network

One leader of a regional network emphasized that attention must be paid to how trainees respond to development trainings, because if the leader being trained for a coordinator-type role is not developing the proper skills, the transition phase can lead to network momentum stalls, and personal or financial resources expended can be wasted. To address this, some networks resort to one-on-one mentorship trainings for emerging leaders destined for key roles which, although time consuming, ensures that the proper skill sets are actually absorbed. Networks also use mentors who are specifically knowledgeable in certain topics for more extensive, regional leadership development. These mentors are often locals, valued by their communities already and able to provide specific advice and training in their regions.

"We have some folks who have, who have stayed with their protected areas and, and been there for a very long time and they've become mentors in the network. We actually bring them to other sites and they can provide targeted assistance and training and serve as mentors for the network." — Leader, regional network

4.4. Participation

What is a network without participation? The core—or heart—of any network begins with human connection. While our 40 informants all mentioned participation as a network priority, perspectives diverge on what constitutes network membership, which structures best actualize potential participation, how to attract participation and motivate commitment, what a strategy for investment in participation looks like, and whether it is possible or important to measure the network's impacts on its members. Through the use of sub-themes including membership, engagement, and limitations, our informants offered diverse yet convergent responses identifying essential practices, priorities, and ongoing reflections around network participation.

4.4.1 Membership

The sub-theme of Membership considers participation through the point-of-view of participants themselves. Interview findings revealed desires and motivations of network members throughout our sample of 40 informants at 16 networks. Informants reflected on their own experiences as network members while also noting patterns in the behavior of wider network membership. A network's members form the structure of interdependence recognized as essential to network functionality (Keast

et al., 2004). Networks vary substantially both in defining membership as well as expectations of network members. Across our 40 informants, we coded the sub-theme of Membership to include official membership, attending training, utilizing online resources like an email list-serv, contributing as a volunteer, participating in network decision-making, and communicating between the network and local stakeholders. Some networks differentiated official membership as applying only to those participants performing regular, official tasks for the network. Others resist formalities in defining membership and network roles, fearing such constraints could preclude participation.

> *"It was this organic development and establishment of these clusters because the network grows continuously, grows in people and ideas."* — Coordinator, global network

> *"My recommendation is that you have a clear objective for what you're trying to achieve and then you bring the right people for that conversation."* — Leader, global network

The quotes above illustrate the spectrum of perspectives on defining potential participation structures. Network participation design begins with the overall goals of the network. Although some networks prefer a regimented approach to goals and decision-making, those networks do not necessarily favor a more formal membership structure. Networks advocating for an organic and issue-responsive stance may gain from fluid membership development in order to quickly bring on new members to adapt to changing priorities. Future research may focus on whether consistency across the network design should be the top priority while preserving some ability for timely response to changing external circumstances (e.g. an environmental disaster). Presently, scholars affirm one of the primary advantages of networks is their ability to maintain flexibility to quickly respond to new challenges (Witte et al., 2000). Flexibility also applies to a network's ability to quickly attract new participants suited to confronting rapidly emerging socio-ecological problems.

Most informants highlighted the important presence of volunteers within networks. Networks must be aware of the expectations of volunteers, particularly concerning the benefits of participation. Interviewees frequently mentioned professional development opportunities, technical tools, and community as essential attributes of membership. However, desire for a sense of community superseded professional development and tools as the primary emphasis of members. Liebernan and McLaughlin (1992) confirm the importance of interpersonal outcomes of colleagueship and professional growth through participation in network activities. Even when the stated focus identifies technical training, community, and personal relations remain priorities:

> *"I think so much of this is really about relationships and communications and building those. The thing about all of these trainings, and stuff that you do, is the building of relationships."*— Advisor, regional network

Although relationship building involves all network participants, interviewees highlighted two types of ideal members: technical experts and local champions. Networks invested in providing scientific knowledge to decision-makers recognized the necessity of recruiting experts while networks oriented towards change at the local level sought out respected community members. Reliance on experts may result in the production of technical knowledge that struggles to connect with community members such as fishers.

> *"We take advantage of the conference attracting a lot of scientists. You know, it's the most important conference."* — Coordinator, regional network

> *"Some of the fishermen who are unhappy with the park mentioned feeling like the managers thought they knew everything but that the fishermen understood the area better. You know, some of those echoes of practical experience are way more valuable than whatever they say they know from books. So that suggested maybe they didn't feel like their information was being properly valued."* — Advisor, regional network

Given the complex problems facing ocean conservation around the world, it comes as no surprise that networks aspire to attract diverse stakeholders to membership roles. Unfortunately, engagement with diverse participants is limited by the expectations and priorities of funding agencies (Ruddle & Hickey, 2008). Networks will benefit from planning for various types of members or participants along with equitably balancing how authority and prestige is distributed based on professional standings (such as a scientist or fisher). Before moving to a discussion of participation and engagement, it is important to note the presence of varying levels of membership, and participation, across networks. Often network membership begins with a particularly charismatic and socially-connected individual at its core. This individual (or small group) drives operations while outer circles of membership include increasingly less committed members. Core membership functions as "motors" within the network, participating to a much greater degree than peripheral members. Informants suggested that ensuring commitment across all levels of membership may pose some difficulties, but this spectrum of participation reflects the realities of majority-volunteer organizations.

> *"Then there's a smaller group that are behind a lot of things that you see. Then the second group are contributors. They're all members, but whenever we call for contribution this call for contribution is always voluntary."* — Leader, global network

> *"I think people that are core people, I would say probably 40. And then probably another 50 people, let's say, around the region that are regular folks that have been engaged in activities that we've been doing."* — Advisor, regional network

One informant suggested appointing a Board of Directors to guide long-term priorities, enabling membership to be more flexible with immediate concerns. The above considerations on network

membership and its impact on participation demonstrate the diversity of network approaches. A network's approach to defining membership stems from the network's operating preferences. Defining membership represents the first step of growing participation by developing formal, documented membership structures or prioritizing flexibility in participation expectations.

4.4.2 Engagement

Development of Membership occurs in the form of the sub-theme of Engagement. Engagement begins before an individual becomes a member or participant and continues throughout the individual's involvement in the network. A network's choice in engagement approaches plays a central role in determining who participates and how that participation occurs. For example, engaging members through academic conferences will focus participation in that sector.

Similar to members' expectations that a network provides community and invests in their professional development, networks encourage participation by developing both individual and network capacity. Development of individual capacity includes professional skills such as leadership. Professional skills represent a frequently occurring priority of informants as well as serving as a strategy for engaging participants. Development of participant capacity may occur through training on technical, social, or organizational skills. Investment must be reciprocal, but some networks acknowledged that the more they invest in an individual, the more likely the network member is to leave. Informant responses indicated that when networks develop members through professional or technical skills training, these members become highly sought after by other local or regional actors. Ultimately networks are made up of individuals who in the end drive the success of the network through their commitments and member attrition represented a potential challenge:

> *"That's expected. So, you might get someone who's really good and a great member of the planning team of the Big Ocean network, and they are really engaged. And then next minute they're off on another job. They're out of it."* — Informant, Big Ocean

> *"We've seen a lot of turnover, you know you've got staff who often work in remote locations, not very well paid, on the frontlines of conservation. Frankly it's a very difficult job. Politics often come into this, so we do see changes in staff either on the ground or in leadership level. And you know as a network that's another aspect of my work as a coordinator is to continually make sure that these people are brought into the network. And that we keep pace with changes on the ground."* — Coordinator, regional network

Networks range in attitudes towards this unavoidable turnover of human resources. Shifts in individuals' roles from networks to local governments or organizations may even correspond with network goals related to increasing technical capacity in the region's public or private sector. As networks reinforce

existing governmental organizations and local communities alike, the positive impacts of engaging participation continue even after members leave. Development of leadership skills is a strategy for participant engagement and links to outcome goals such as regional or local capacity building. Networks often find themselves stepping in for the shortcoming of governments or even form between members of the non-governmental organization (NGO) sector (Kilby, 2008).

> *"Since MIHARI, the voices of communities are better represented and strengthened. It is the unique platform that really represents the voices of small-scale fishers, and also it is a key partner."* — Informant, MIHARI

While the creation of leaders or participation in government processes may be clear indicators of a network's engagement goals, informants frequently mentioned other less tangible, yet important, engagement qualities. These essential engagement drivers include trust, space to contribute, or solidarity, and improved understanding of networks (Busschop, 2019). As previously discussed in Section 4.3.1, these values may be encouraged through the actions of leaders or through the network's activities and stated priorities (Section 4.2.4). Trust, space to contribute, and solidarity drive the personal connection and even friendships are frequently identified as the most highly-valued participation outcomes of networks. Of these engagement drivers, informants often linked trust to face-to-face interactions. In-person engagement occurs mainly at meetings, which themselves function to recruit and engage new or existing network members:

> *"It's also a nice way if there's another event to bring new people into the fold, right? Introduce them to it, bring them, invite them to the meeting, invite them to a reception or some social thing that we have so that people can start to understand."*
> — Leader, global network

Just as face-to-face meetings link to engaging participation through developing trust, these in-person interactions relate to creating space for participation. Interviewees acknowledged facilitation of in-person encounters was especially important for engaging diverse participants who otherwise might feel out-of-place at a table with scientists and academics.

> *"The community members that went to Kenya from Tanzania really loved the experience and wanted another opportunity to do so, or to go to other Tanzanian areas and talk with people. Community members loved the exchange idea and felt like they got a lot out of it."* — Informant, SMART Seas

In-person meetings are essential but underappreciated by funders and the benefits are difficult to measure (see Section 4.2.4).

> *"It's super hard. And I think, again, it really is about the resources available because compared to the demand for people from developing countries to come to conferences*

in the States or in Europe or any of these places the supply of funding is just ridiculously low." — Leader, global network

While face-to-face meetings embody the interpersonal benefits of networks, care must be given to plan for the post-meeting dynamics in addition to lead-up and participant recruitment. Networks should have a clear idea of how to keep meeting participants engaged once the excitement of the in-person encounter subsides. An informant from RRN remarks on how they have completely redesigned their training activities in order to facilitate future engagement and gauge impact:

> *"Post-training is just as critical as pre- and during- but yet post-training mentorship is [almost] never funded or never even written into most people's trainings. So now I always try to write in money for my team to do types of follow-up calls, or contract experts to answer questions after a training...We've changed our whole way of designing trainings because we felt like it was so short sighted."*

Given the expense of engagement through face-to-face meetings and conferences, what are methods for maximizing participation at such events? One successful method recognized by a number of informants and highlighted elsewhere in this report is the use of expert facilitators. Facilitation helps create the space needed for network participants to feel comfortable contributing their perspectives and expertise. Respect is an essential ingredient for diverse and democratic participatory decision-making in networks. As alluded to in the section on membership (5.4.1), hierarchical networks sometimes preclude this space. Interviewees did not want to discourage participation from any individuals/sectors of society based on network structure and strategy. Rist (2006) points to the benefits of expanding decision processes outside typical powerbrokers. Beyond involving stakeholders not found in the typical science and academic communities, informants included participant age group as a key component in engagement strategy. Interviewees focused on the importance of young adults and young professionals as key sources of cutting-edge perspectives and continuity towards network longevity. The recent emergence of emphasis on interdisciplinary knowledge suggests that the perspectives of young adults may be especially receptive to complicated interactions of environment, society, and politics found in conservation challenges (Fazey, 2007).

> *"Well, I think we should have more youth. So young people, millennials but also younger, get more engaged and look at school programs or learning exchanges. Learning exchanges are so valuable."* — Core staff member, regional network

Reaching out to younger participants also connects to networks' intentions to build regional capacity.

> *"We wanted to build the capacity of the junior people, because twenty years ago the manager didn't have a college degree, but now more and more of them have college degrees and even some their master's degrees."* — Coordinator, regional network

The participatory nature of networks highlights the value of collaboration through sharing of lessons learned and the collective development of interactive and innovative practices.

> *"I think most people in Big Ocean were willing to engage just because it all seems pretty novel and daunting. And like I said at the very beginning, there's a lot to be learned and a lot of lessons learned from other sites. So instead of reinventing the wheel, having shared experiences was a valuable reason for people to come and work..."* — Informant, Big Ocean

Before moving to a discussion of types of knowledge within networks, it is important to acknowledge the cumulative impact of investing in knowledge and participation through cultivating respect, creating space for diverse voices, and engaging early career age groups. Networks are capable of breaking down silo mentalities found in scientific institutions, governmental organizations, and private sectors through expanding participation to the greater community. Participatory processes may lead to important valorization of local knowledge in addition to greater long-term success for conservation interventions (Macedo et al., 2019).

Box 3. Expanding Participation

"Having the old man from the village come and join, he said he only made it to like second, third grade because he didn't really like sitting in a classroom for hours and hours and listening to one person talk. He learned better by doing stuff. You meet by going fishing with them. They're going to do the different activities. That's how we met. And then the fact that these learning networks bring people from all levels of education and they all learn about whatever topic. For the farmer, the fact that what he shares is all still being taught in the classroom. He's indirectly also teaching, teaching through coming together and sharing his knowledge with the teachers. The network brings together those people, the scientists and the non-scientist, a local scientist and a formal science. That's the perfect way to bring them together. To me, I learned there's just as much value and valuable information from the farmer, the fisherman that has never stepped a foot in the classroom has zero, you know, high school degree, college degree. There is as much learning as from graduate students or the scientists. It's bringing those two people together and showing respect for both. The network should validate the local knowledge, validate informal science, validate the science behind the fishermen's knowledge. Cause some people, especially like my generation, we grew up with: people that don't go to school, don't have anything valuable to say. We don't listen to someone who didn't go to school because only people with brains go to school. If you didn't go to school, you don't have brains. Respect each other. That's it. That's very important because everybody, different people involved in the network, they're all from different places, different values. And the fact that they're all focusing on marine knowledge, it already shows that they value marine life, conservation of marine wildlife, so that deserves respect."

— Informant, PTLC climate network

4.4.3 Types of knowledge

Scientific knowledge based on Western epistemologies continues to receive considerable prestige across conservation organizations even as some conservation professionals increasingly connect the two in ecosystem-based management (Lertzman, 2010). To expand our consideration of participation, we queried informants on what types of knowledge learning networks communicate and exchange. Throughout our interviews, informants referred to a range of systems and sources of knowledge, which we collectively coded as "types of knowledge." We found that the different types of knowledge and information exchanged generally relate to the shared goal of capacity development to support decision making, inform policy, and make research more applicable to management (see Section 4.1.3). The knowledge itself falls into three general categories: technical information (including western science), personal experience-based knowledge/practical skills, and finally traditional ecological knowledge (TEK). In the first category, there is often interaction with recognized experts and training on specific topics that provide critical information to network members. In the second, the sharing and exchanging of lessons, experiences, practices, and stories is emphasized, focusing more on peer-to-peer and horizontal movement of information. The third, TEK, embodies traditional forms of knowing exchanged between generations, often dating to a community's collective emergence.

These knowledge categories are not mutually exclusive—in particular, scientific knowledge and experiential knowledge often occur in tandem in the field. For example, at a training, members may receive mentorship from an expert on a particular topic, while also gathering insightful perspectives from peers from different regions. All knowledge within networks should emphasize the two-way exchange, or interdependency between participants that avoids unidirectional transfer of information (Cvitanovic et al., 2015). These insights and experiences can build capacity not only for the larger marine outcomes the networks work towards, but personal capacity through the development of skills such as public speaking that will assist them in their own career development.

> *"In learning networks, I think you have to take an assessment of who the network is. We've got thematic things we have to talk about, but what are the soft skills that we need to level the playing field? ...they can contribute even more."* — Informant, CTI-CFF

While the development of individual skills contributes to building collective capacity, learning networks become more sensitive to context by considering the shared knowledge of their community of practice. Many informants specifically discussed the importance of integrating traditional or local ecological knowledge into network activities, as well as knowledge across different disciplines, geographies, and age groups. Learning networks with more community-focused goals and priorities discussed knowledge

in terms of participation and highlighted the situated needs of the population the network serves. Some informants suggested using existing institutions and structures makes it easier and more effective to include community members in network decision-making and other processes. However, this approach carries the risk that institutions' existing norms and cultures may not encourage horizontal knowledge exchanges integral to learning networks. Diversifying the voices included in the network introduces different ways of knowing that may not have been previously represented or acknowledged. As one informant from Big Ocean said, *"...recognizing that none of us have all the answers. And we need input from everyone from local people, stakeholders, industry people, rights holders, indigenous groups. A lot of these areas really depend on that sort of input. And you can't teach that, it almost has to come from within."* Having local contacts within key institutions is essential to make sure the network operates respectfully and can deliver relevant outcomes to those with whom the network engages. It is also important to strike a balance between the transfer of knowledge and the production of knowledge through novel processes. Networks should avoid "reinventing the wheel," and focus on driving progress based on the priorities of the network participants and members.

Network participants and members frequently seek western science and technical expertise. The challenge for learning networks lies in conveying academic scientific knowledge in a way that does not undermine existing cultural or local norms and practices and is tailored to fit local needs.

> *"I'm not sure how much that information makes its way into management plans or practices, or if traditional ecological knowledge or local knowledge is in conflict with academic or managerial knowledge; I get a feeling that managers would prefer their own knowledge over local knowledge."* — Advisor, regional network

> *"We don't tell countries what to do. How could we, what do we know about their country? Nothing. But what we can do is share stories from the countries where these things [technical interventions] have gone in and share lessons learned."*
> — Leader, global network

Because knowledge depends on interpretation, it becomes personal, preferred, and biased depending on the interpreter (Cvitanovic et al., 2015). Informants advised frequent communication and collaboration with the targeted network members and participants in order to "ground-truth" the approach before application (e.g., programs, activities).

In considering the breadth of responses emerging from our sample, we find that all forms of information and knowledge can be effectively shared through learning networks, both formally and informally, within and outside of official network activities. The informal exchange (as discussed in Section 4.2.4) is valuable and tends to occur organically as long as a network provides appropriate

spaces for the exchange to occur. The main challenges include customizing the knowledge exchanged, providing the knowledge to the actor(s) that the network is working with, and ensuring that the knowledge is appropriate, respectful, and relevant. A network's role in building capacity may involve assisting compiling and/or validating existing knowledge, forging connections and developing resources, rather than producing new information. This is particularly true for local networks:

> *"...just trying to support what they were already doing, and really acknowledge that they know a lot, they have a lot of local information that just needs to be aggregated..."*
> — Informant, PTLC climate network

> *"[Research] should validate the local knowledge, validate the informal science, validate the science behind the fishermen's knowledge."* — Informant, PTLC climate network

There is no standardized ideal design for the iterative process that learning networks undertake to bridge and fill knowledge gaps. Each network will approach knowledge exchange or creation differently depending on context, available resources, and objectives. As networks emphasize reflexivity, collaboration, and relationship building, the approach privileges co-production of knowledge and interventions, an iterative, collaborative process that is context-based, pluralistic, goal-oriented, and interactive (Norström et al., 2020). These four principles for co-production align with the values and lessons learned from our informants, indicating that learning networks can remove barriers between scientists, policymakers, practitioners, and decision-makers by crossing disciplinary boundaries, provoking transformation, and promoting learning along with the generation of social capital (Cash et al., 2003; Norström et al., 2020). The capacity of networks to create space for co-production leverages participation to subvert the hierarchies often present in conservation management.

Box 4. Breaking Down Knowledge Hierarchies

"We had the senior warden, we had the people driving the boats to the sites and stuff like that. I had even the accountant and customer service and everyone in the room, SMART Seas had broken this hierarchy because among this group from different levels we had the boat driver who became the coral specialist and this other guy who became the sea grass specialist. The senior warden was asking them for information. They became his experts. It felt to me that it brought everyone to the same level where everyone was being respected for their knowledge and that was great... ...I've also experienced how excited that people working in customer service were to be actually having part of their work, going to work on the beach and in the sea. To see how confident the boat driver was explaining things to his senior warden. It's amazing to be in this room and see that happening."

— Informant, SMART Seas

4.4.4 Limitations

Before concluding this discussion of participation in networks, we acknowledge the limitations and challenges encountered by our informants in encouraging participation. Interviewees mentioned limitations for participation in reference to North-South dynamics, using English as a language for materials, and negotiating diversity or activism while maintaining a commitment to scientific objectivity. Previous scholarship recognizes the development of North-South partnerships as a challenging yet important goal for collaborative networks (Tarifeño-Silva, 2002). Additionally, larger networks frequently mentioned the challenges of communication and organizing collaboration across great distances, adding to the challenge of North-South knowledge exchange barriers. Cheng et al. (2005) emphasize the advantages of operating across smaller geographic scales through, "belonging to a shared, place-based group" (p. 40). However, the collaborative nature of network functionality maintains a hopeful opportunity to transcend geographic distance (Friedlander et al., 2016). While NGOs frequently provide pathways for North-South partnerships, dependence on established experts and NGO leadership may ignore long-term participation needs.

> *"One thing with international networks is ensuring that you are integrating developing countries into the network and that they are able to bring in expertise. But at the same time, they commonly don't have the expertise. So, you either pick the same people all the time or you bring someone whose understanding or education may be slightly different. And so that's a challenge, certainly."* — Advisor, global network

> *"It's really difficult because they have all of this procedure and it's a lot of communication. They have to agree on so many things. It slows down actions that we want to do. And sometimes that means that they [big NGOs] also have a word in what we're doing, which is a problem because why would they have a word, but not all the members? And they shouldn't, because they [big NGOs] are not the network. The network should be the one deciding. But at the end, as they hold the money, they have the power to say."* — Core staff member, national network

Often, networks emerge from the contexts of academia or professional organizations whether government (e.g. NOAA) or nonprofit (e.g. The Nature Conservancy). The resources and expertise of these founding influences allow networks to establish themselves across the globe (Tobey & Volk, 2002). However, interviewees discussed fears that their networks continued to attract the same type of participant despite intentions of expanding participation. As discussed in Section 4.4.3, interviewees described networks as being situated in the production and communication of a certain type of knowledge. Regardless of the network's preferred focus, knowledge production should rely on local experts when possible (Wescott, 2002). Networks that reported more diverse participation tended to also highlight the importance of local knowledge. Repeatedly, interviewees identified a dynamic of

contestation between local values and scientific knowledge. Some networks are able to bridge that gap and demonstrate respect as well as use both through valorizing local voices in the creation of network knowledge.

> *"The interest in creating learning networks that involve the communities and the people that are still sensitive about the educated and then non-educated—these learning networks bring people from all levels of education."* — Informant, PTLC climate network

> *"I would also say it's not just a diversity of voices, but even a diversity of knowledge systems and needing to have people at the table with open minds and diverse enough backgrounds to really have an appreciation for truly diverse knowledge systems."*
> —Coordinator, global network

While all interviewees remarked on diverse participation across sectors of society as a goal, they acknowledged the real limitations of expanding across such a large collection of stakeholders

> *"They [participants] come from very different backgrounds, different mixes in a way. It's great. On the other hand, it's also more challenging to support such a network as the needs are so different. They range from the government to the local NGOs, individuals, women, young, old people. Quite a diverse group."* — Coordinator, global network

Expanding the network's audience too widely creates challenges, as does the dependence on the English language by the academic, scientific, and NGO communities.

> *"The other point is the language issue. If you're going to be leading something on an anglophone basis, you're only going to reach anglophones, and then the elite within other countries who have been able to have access to learn English. So, you're leaving out a whole big chunk of talent, expertise, and so on. This is a common problem."* — Advisor, global network.

Given that networks can creatively fill roles vacated by the government or the private sector, perhaps future network strategies will deliver methods for overcoming dependence on mono-cultural communication approaches.

Voluntary (unpaid/uncompensated) participation is a challenge for learning networks, and ensuring people personally gain through participating is an important component (see also 4.4.1). Networks last as long as the collaboration creates value for its participants, and vice versa (Cleveland et al., 2015). At the very least, networks should provide for travel expenses, some food, and lodging when participants attend network activities; otherwise people will not, or cannot, invest their own resources. However, when people participate without the motivation of monetary gain, contributions may be more honest and long-lasting.

> *"...you also have the reverse, if you pay people to participate, if you later lose funding or stop paying, they often stop participating. And from a psychological perspective, if you give them enough money that they can justify participation based on, 'Oh well, I'm getting paid' then you get rid of intrinsic motivation to be a part of something."*
> — Informant, SMART Seas

Bodin and Crona (2009) support this finding, arguing that the relationships within social networks need to be voluntary in order to sustain the network long-term, and to produce desired outcomes.

Considering the successes and challenges of cultivating participation and membership in a network, findings suggest a network must initially determine whether to favor a top-down or bottom-up approach. Both approaches carry advantages and disadvantages. However, the choice is important as it will determine the character of the network as well as types of participation the network attracts (Schafft & Greenwood, 2003). The tension between community-focused and science-oriented perspectives emerge most profoundly on the question of activism. Interviewees ascribed a legitimacy to focusing on technical knowledge which could be compromised by a turn to advocacy. Given recent ideological shifts in international politics contributing to the contestation of scientific consensus, perhaps apolitical networks will be increasingly forced to contest government decisions. (Funtowicz & Ravetz, 1993).

Across the three participation sub-themes of membership, engagement, and limitations, informants consistently emphasized the importance of encouraging participation through in-person meetings and training, prioritizing trust and space for contribution, investing in the personal development of members, and connecting with younger generations to ensure the network remains adaptive to emerging challenges. While limitations involving communication and the inclusion of new perspectives impact both membership and engagement, our findings indicate that these limitations are common across networks and thus predictable. Networks can therefore anticipate barriers to engagement in the network, allowing them to make concerted efforts to mitigate and avoid these obstacles in order to improve participation levels and increase the likelihood of success for program operations and outcomes.

4.5. Activities and Outcomes

A central objective of our interview process was to understand the various outcomes and impacts that marine-related learning networks can have, and how effective informants viewed network activities to be at achieving their goals. Learning networks have a known role in supporting the exchange of knowledge between different actors to support innovation in environmental management and

sustainable development practices (Cummings & van Zee, 2005; Roome, 2001). More recently, authors such as Bodin & Prell (2011) and Matous & Todo (2015) provide evidence of the significant roles that social learning and information exchange play in supporting environmental stewardship, the functionality of socio-ecological systems, and the adoption of resource conservation practices. While learning networks can improve collaboration between actors engaging in environmental governance and build their underlying potential management capacities, these networks will not resolve complex resource governance issues alone (Gerhardinger et al., 2018). There are also considerable challenges to gauging, quantifying, and measuring their impacts and effectiveness (Bessant & Tsekouras, 2001), as discussed in Section 4.2.3. Nonetheless, common themes emerged from our informants' answers to questions about network outputs and successes which illustrate the outcomes and impacts that marine-related learning networks have.

Marine-related learning networks cultivate trust and long-standing relationships (Busschop, 2019), often support targeted "knowledge-to-action" initiatives that build marine management capacity or inform policy (Christie et al., 2016; Cinner et al., 2012; Gerhardinger et al., 2018), and can empower network members to develop as leaders or take on larger roles in their communities and professional fields (Bustamante et al., 2018; Syakur, 2012). Many marine-related learning networks also create products for practical and applied uses, such as informational databases or guidebooks, that further support the aforementioned outcomes (Chuenpagdee et al., 2017; Lewis et al., 2017).

4.5.1 Long-term connections, trust building, and motivational support

Many informants emphasized their network's prolonged and consistent presence in the region as a key component of establishing credibility, maintaining member involvement, and achieving successes. Aswani et al. (2017) support this finding and identify the provision of practitioners with time and tools to inform and improve local resource management programs as a critical component of management capacity building. Unlike many environmental projects and initiatives that occur on short time scales with clear start and end dates, the vast majority of marine-related learning networks aim to operate over extensive periods of time, and in many cases the foreseeable future (Chandler & Kennedy, 2015; Gardner et al., 2018). The long-term nature and face-to-face components of networks build strong relationships and lasting connections between network members. As a result, these learning networks act as sources of motivation and support for members that often work in isolated or difficult-to-reach areas or in management settings with few peers or co-workers present (Cummings & van Zee, 2005;

FAO, 2017). Terms like "trust", "family" and "community" are often used by informants to describe the relationships that develop and the strong sense of community that arises due to network activities:

> *"[Big Ocean] feels kind of like a family. The people who come new [to network meetings], that's one of the first things they remark on is, 'wow, it feels like you guys have known each other forever and thanks for letting me in on the family.'"* — Informant, Big Ocean

Regular gatherings and meetings are often cited as important components of achieving this collective outcome. As another informant puts it, *"we really make sure that people can really meet regularly, I mean every year so that you start to build a kind of family. Yeah. And this is really key for MedPAN."* These meetings allow for informal interactions between network members to take place. As previously discussed in Section 4.2.4, these interactions may be just as important as formal meetings or sessions for motivating members to push through challenges at work and sustain the momentum for networks to achieve their conservation and management goals. A longtime advisor with a global network links the development of personal relationships to network success:

> *"An important thing is making them [network meetings and activities] fun and then also trying to not just make this all about work, but finding ways...where people get to know each other on a personal level because that is really what's going to carry these networks long term."*

Even if funding is not available to support a workshop or other network activity in a particular setting one year, network coordinators still aim to be reachable in the interim and will return to that area in subsequent years. Many networks, including CTI-CFF, MPAConnect, CaMPAM, and PIMPAC, aim to run workshops or host meetings on a rotating basis in a variety of geographic settings in order to promote participation and accessibility and more evenly spread costs between hosting institutions and parties. A coordinator of a regional network explains how their long-term presence in the region helps establish and preserve a sense of trust:

> *"I may not always be able to provide that training this year, but I'll be here next year, you know, I'm not going anywhere, [the network] is not going anywhere. So, I think it's that trust that we've been able to build over the years."*

In their discussion on communities of practice and networks for learning, Cummings and van Zee (2005) recognize the important social component of knowledge sharing. The authors argue that individuals derive a sense of satisfaction and belonging from their participation in a network. As a result, their engagement in and commitment toward the work of the network continually increases. Over longer terms, this leads to improved approaches and programs, and eventually more positive outcomes (Cvitanovic et al., 2015). Our results support these conclusions and indicate that peer-to-peer learning

and information exchanges provide valuable knowledge, expertise, and inspiration for learning network members to sustain and improve conservation and management approaches across a diverse array of communities and geographies.

We must note that some informants did suggest that tensions, often related to funding, partner institutions, and other external influences, can strain relationships within the network. For example, informants from several networks expressed concerns that their network's agenda has been or could be influenced and shifted by NGOs that provide their funding. Indeed, a number of network coordinators and other staff members are funded partially or wholly by government institutions or large conservation NGOs. In another case, one network fractured into two because of funding conditionalities imposed by an international agency that conflicted with the priorities of core network staff.

4.5.2 Improving marine management by building capacity and closing information gaps

Many marine-related learning networks focus their efforts on improving the effectiveness of marine resource management by building the capacity of on-the-ground practitioners, particularly those working in marine protected areas (MPAs) or other marine managed areas (Davis et al., 2018b; Philibotte et al., 2019). Learning networks facilitate the sharing of good resource management practices, build technical expertise, and close information gaps, thereby allowing network members to learn from others rather than from trial and error (Chuenpagdee et al., 2017; Friedlander, 2016; Roome, 2001). Furthermore, these networks leverage the trust and long-term relationships they have built to galvanize action at local scales, engender buy-in and participation, and strengthen institutional capacities (Chilvers & Evans, 2009; FAO, 2017). As presented in Box 5, an informant working with SMART Seas described how a management agency in Kenya embraced the network's participatory, peer-to-peer approach to management and monitoring, resulting in improved problem solving and better ecological results compared to other environmental reserves.

Box 5. Creating a 'cultural change within the agency'

"If only one person were to be trained and become an expert in everything, once they move [to a new job] that agency loses that particular [person's] resources. What they do with that extensive peer to peer learning is that they make sure that expertise is distributed...I spoke to people who worked in customer service or accountants and who before were not involved directly with the marine environment. But after SMART Seas was initiated, they were involved in MPA beach profiling or the aquatic monitoring or things like that...It's the first time I've seen enforcement managers talk so enthusiastically about specific parts of marine ecosystems, you know, like, 'okay, the sea grass is doing this way, the coral cover is doing this way. When the bleaching happened, this happened.' Usually when you speak about it to enforcement managers, it's usually, 'Oh, we don't have enough boats. We don't have enough resources'... ...Yeah, it [the peer-learning approach introduced by SMART Seas] has created a cultural change within the agency, which was very impressive. And I remember this interview with one of the resource procurement officers in one of the MPAs and he told me that when they were out doing the aquatic surveys, they noticed that the reserve was doing better than the park, and it was supposed to be the other way around, because one was only partially protected and one was fully protected and the partially protected one was doing better. And he was surprised and that's when they brought everyone together and then tried to [understand] why this is happening. The enforcement officers ended up saying, 'Oh, we don't have enough fuel to go to that other part.' And having the procurement officer involved in the monitoring made him aware and then they were able to fix that very easily. I got a couple of examples like that, how on a day-to-day basis... having this network, even within the agencies, making connections to these monitoring practices just helps problem solving."

— Informant, SMART Seas

Many networks will provide broad or targeted responses, such as learning exchanges or training activities, to tackle ongoing and emergent environmental issues. Experts, advisors, and knowledgeable peers are brought in, models for success are provided, and participants are equipped with tools or knowledge to execute changes or improvements in management (Bustamante et al., 2018; Davis et al., 2018a). For example, in 2018 MPAConnect organized a training activity on how to handle a new coral disease that MPA managers in Mexico had identified as a growing problem for them. As described in Box 6, attendees came away better equipped to identify the disease and work with their local governments to navigate legal processes, comply with applicable regulations, and treat affected corals. An informant from MPAConnect highlights the value of these types of meetings where managers learn from one another and from others:

> *"The outputs from the meeting directly targeted the needs expressed by the managers, e.g., they asked for a template monitoring and response plan that they could easily adapt and tailor to their own sites and countries, which we've since produced and is in use...There were excellent efficiencies that came from a subset of MPA managers*

working with me on developing these outputs, which we then shared with the rest of the network to save them from re-inventing the wheel."

In marine-related networks, member knowledge and experience that comes from living and working in island and coastal environments informs network strategies and activities and serves to expand the wealth of information available to other members (Pietri et al., 2015; Rocliffe et al., 2014). In addition to MPAConnect, marine-related learning networks that utilize adaptive, member-informed approaches to provide management training sessions or capacity building workshops include PIMPAC, RRN, MedPAN, CaMPAM, CTI-CFF, and SMART Seas (Davis et al., 2018a; 2018b).

Box 6. Responding to Stony Coral Tissue Loss Disease with peer-to-peer learning

"In 2018, the Caribbean started to see the [Stony Coral Tissue Loss] disease and it was something that our MPA managers in Mexico first highlighted to us and asked...'What do we need to know about this topic, this is new. We're not sure what to do, what it is, [or] how to identify it'...And so we very quickly slung into gear and I was able to coordinate a quick little learning exchange over to Florida for our Mexico managers. Then of course the disease appeared in more places in the Caribbean... [We] quickly got some funding in place to be able to bring together actually quite a large group, all Caribbean MPA managers, marine biologists, rangers, people who are in the field who needed to know what this thing looks like, how to identify it, what can they do about it, how to communicate about it. And Florida Keys National Marine Sanctuary hosted that for us. We did a really rapid response, quick agenda, quick meeting, face-to-face, and learned all about what's going on...And now in follow up to that...two places were able to confirm that yes, they have the disease, [and] we've been able to get resources to them. We've been able to help them work with their government agencies to look at responses. I think that's been a really good example of the network coming together in relation to a crisis information need." — Informant, MPAConnect

Integral to the success of networks is the peer-to-peer-learning aspect of their activities, where participants exchange information and methods for confronting shared or recurrent problems based on experiences, stories, and past practices (Cummings & van Zee, 2005; Lowry et al., 2009). Informants highlight learning exchanges as an excellent tool for improving management practices or generating support for sustainability initiatives. As part of learning exchange programs, network members travel from one site to another to teach others or learn in-person about conservation and management successes that have occurred on another island or in another part of the world. An informant from RRN explains how these exchanges not only provide ideas and methods for tackling complex issues, but also provide motivational support, as previously discussed in Section 4.5.1:

"We took four Caribbean managers to a training in Guam, it was on climate change and local action and communities, and they were like, 'basically everything you guys are saying in Guam, we have.' Just having a face...someone saying like, 'on my island I'm having the same issue' helps them, I think, emotionally to not feel alone. And then hearing other people's stories, sharing how some action that they took worked. That's been really impactful."

Learning exchanges are utilized to engage other groups of stakeholders in marine management initiatives as well. An informant from MedPAN describes how they facilitate communication on the benefits of effective marine management and no-take zones:

"What we organize that work better than any product is to organize exchange visits to bring some fishermen from the new MPA [that was] created to another old MPA... so that they can meet some fishermen that are really now supporting the MPA because they now see the results of effective management of an MPA [that uses] effective no-take zones."

Many informants link these types of exchanges to network success and longevity. This was echoed by marine-related learning network experts and practitioners from around the globe that participated in a learning exchange and community of practice conference hosted by NOAA in December 2019. A poll of these attendees found face-to-face learning and exchanges to be the top preferred element for ensuring "success and efficiency" of a new community of practice (Philibotte et al., 2019). A fundamental tenet of learning networks is that they consider the people involved – their members – not as passive recipients of information but as knowledgeable, collaborative participants who not only make decisions and take actions based on what they learn from outside experts and advisors, but also serve to collectively build the capacity of others in the network through peer-to-peer mentorship (Christie et al., 2016; Cummings & van Zee, 2005). This aspect of marine-related learning networks was emphasized by many informants in our study.

4.5.3 Addressing government capacity challenges and informing policy

A big challenge in achieving effective marine management is that many governments have limited capacities and resources to devote toward developing new policies, implementing effective management measures, and supporting ongoing operations (Mitchell, 2010). Regime changes and staff turnover, access to relevant information, and inadequate dialogue between scientists, policymakers, and community members can further complicate and compound this issue (Armitage et al., 2012; Cvitanovic et al., 2015; Rochette et al., 2015). Networks can address some of these capacity shortfalls and barriers to productive communication by convening stakeholders to inform decision-making and build collective understanding of the need for action at the government level, advancing scientific and

technical understanding, and serving as a resource for staff to exchange information and collaborate on similar initiatives (Li & Fluharty, 2017; Toonen et al., 2013; van der Hel, 2016). CTI-CFF's work has resulted in progress at the administrative and ministerial level within the six Southeast Asian and Melanesian nations with whom they work (Christie et al., 2016; Lowry et al., 2009). An informant from CTI-CFF provides an example how their international meetings helped improve marine management in Timor-Leste:

> *"They've got a good viable marine protected area now working with Timor-Leste. I think they wouldn't have had it if it hadn't been for the CTI, because they got enthusiastic about it and the minister came away with the knowledge of the importance of doing that work and making it function."*

An informant within PIMPAC similarly points toward governance outcomes that have resulted from their work, particularly in the field of fisheries management: *"We identified about twenty different policies, for example fisheries regulations, that have been implemented because we had science to show policymakers..."* The informant provides several examples of particular policies and recalls a conversation with one of their network's lead advisors, *"...he agreed, these regulations wouldn't have happened if we weren't collecting this data, analyzing it, managing it, and then leveraging additional funds from private organizations...to provide additional training for effectively communicating science to policymaker."*

While some networks focus primarily on building management capacity at local scales, the above quote illustrates how networks use their connections with a broad variety of members and partner organizations to influence and inform the development of marine-related policies at the national level. Similarly, Big Ocean network meetings, technical assistance workshops, think tanks, and informal collaborations have supported the design and implementation of more effective management regulations for large scale marine protected areas (LSMPAs) around the world (Friedlander, 2016). In more recent years, they have helped promote the incorporation of human dimensions considerations in ongoing protected area management and development processes for new LSMPAs, resulting in new 'codes of conduct' for large scale ocean conservation initiatives. (Bennett et al., 2017; Christie et al., 2017). International NGOs such as Pew Charitable Trusts and Conservation International are two such organizations that have developed new conservation practices that now place greater emphasis on socioeconomic, political, and other human considerations (P. Christie, personal communication, March 12, 2020; Smyth & Hanich, 2019). One of the goals of the Future Earth Network, launched in 2015, is to promote the co-production of knowledge between scientific and non-scientific actors in order to influence policy action at national and multilateral scales (van der Hel, 2016).

It can be difficult to link regional- or national-level efforts of marine-related learning networks to improvements in society and environmental health at local scales. Christie et al. (2016) indicate that this has been the case for CTI-CFF's initiatives in certain instances and suggest that there could be better integration between regional and local network activities, such as increasing the number of visits by government officials to local communities. Examples of networks achieving policy action that engages at the local level have typically involved in-person meetings or on-the-ground activities. In Madagascar, MIHARI helps to support resolutions for solving social and environmental problems by representing local community interests and convening meetings and other events that bring together diverse cohorts of decision makers and stakeholders. An informant from MIHARI describes how they organized three workshops at various levels to discuss illegal fishing of undersized mangrove crabs:

> *"[The network and our partners were able] to get people together from the ministry, from the committees, from NGOs, private sector, to come up with solutions in order to support the communities so they can still fish, but so it preserves the environment and the species...It was a lot of discussions and at the end, the ministry agreed, and one result out of it was to implement a [temporary] national closure."*

RRN aims to improve the management of coral primarily through management training workshops. This network also takes a bottom-up approach to influencing policy by providing officials at resource management agencies with tools and skills to communicate with upper management and other government decision makers. But even in cases where these managers are able to advocate for and influence policy agendas, making connections to positive ecological outcomes is a distinct challenge. As previously discussed in Section 4.2.3, many actors influence the management of marine resources and measuring and assessing environmental change requires significant levels of funding and sustained monitoring over long timescales. This makes it extremely difficult to establish causality between network activities and ecological benefits.

Furthermore, networks that attempt to influence policy at a high level can suffer from over-centralized operations and power imbalances in their membership, reducing their ability to connect with and act upon information from local managers and other stakeholders (Pietri et al., 2015; Weiss et al., 2012). Our informant interviews indicate that most successful examples of informing and shaping policies stem from in-person meetings and activities that connect people across geographies and disciplines and provide opportunities for local managers and community members to express their needs and pass on knowledge to higher level officials and decision makers.

4.5.4 Empowerment and professional development

As discussed in Section 4.3, Leadership in Networks, marine-related learning networks expose people to opportunities in conservation and management fields by providing them with a variety of arenas and platforms to share their perspectives, learn new skills, and develop into better educators and leaders (Christie et al., 2016; Cleveland et al., 2015; Jupiter et al., 2014). Informants described how these networks can reduce resource, accessibility, and equity barriers by connecting members with varied backgrounds and across stratified social and professional hierarchies. For example, the PTLC climate network brought teachers together with fishermen, scientific experts, and other members of society to exchange knowledge and information about climate change impacts and community health in Pohnpei. An informant describes a first grade teacher's perspective on the experience:

> *"She was like, 'I'm communicating with scientists and they're actually listening to what I have to say about how I [teach] my first graders!' To her, that was...very valuable to her, it made her comfortable to where she felt like they're also learning from [her]...she had something valuable to contribute to people coming together."*

In 2014, CTI-CFF launched the Women Leaders Forum, which specifically aims to empower women to engage in decision-making processes related to coastal and marine conservation programs. The forum has helped over 300 women develop as leaders in coral reef conservation and sustainable fisheries fields in the Coral Triangle region, as mentioned in Section 4.3.3 (Djohani, 2019). In other regions, marine-related learning networks are also taking concerted actions to elevate, train, and empower members. Informants speaking from involvement with networks such as CaMPAM, MedPAN, MIHARI, MPAConnect, PIMPAC, RRN, and SMART Seas mention running skill development sessions on a wide variety of topics, including public speaking, science communication, enforcement, policy writing, socioeconomic and biological monitoring, and excel and other software, among many others.

In addition to equipping members with valuable technical and interpersonal expertise and providing them with resources to improve at their own jobs and positions, marine-related learning networks encourage further dissemination of knowledge by members. Some conduct leadership and other capacity building programs aimed at instructing members on how to teach skills or run training workshops within their own communities, as previously mentioned in Section 4.3.3 (Bustamante et al., 2018; FAO, 2017; MedPAN & Telašćica Nature Park, 2018). MIHARI supports an ambassador project related to information sharing and the discussion of marine conservation and management issues. These ambassadors *"go from one place to one place in order to make awareness and to build capacities within those topics...so this is just one more project we have to really empower those people that have the capacity to lead the others,"* explains an informant from MIHARI. Similarly, CaMPAM has conducted

courses on capacity building in subjects related to MPA management in the Caribbean through its Training of Trainers (ToT) program (Bustamante et al., 2018). Graduates of the program go on to conduct their own courses throughout the region and have reached approximately 1500 MPA practitioners and stakeholders since 1999 (Davis et al., 2018b). According to a network audit based on a survey of 29 respondents, 99% of those who participated in CamPAM's Training of Trainers program expressed that "ToT positively impacted their ability to utilize and disseminate best practices to solve local problems" (Bustamante et al., 2018).

Marine conservation and management efforts, particularly in the context of large marine protected areas, often raise social justice concerns (Bennett et al., 2015; Jones & De Santo, 2016). Conservation measures can infringe upon the rights of indigenous communities and deprive small-scale fishers and coastal communities of access to vital ocean resources. As such, there is strong recognition of the importance of establishing roles for local and indigenous communities in marine management and planning initiatives (Bennett et al., 2017; Friedlander et al., 2018). Marine leaning networks present opportunities for indigenous communities or other peoples that have often been marginalized in marine resource governance to engage in the policy and management process (Aswani & Ruddle, 2013; Friedlander, 2016; Jupiter et al., 2014). In the Marquesas, the indigenous community is helping to lead the creation of a LSMPA called Te Tai Nui A Hau. Although the French Polynesian Government is still in the process of legally establishing the protected area, indigenous leaders and mayors wrote a letter to the Big Ocean network of LSMPAs asking for their inclusion in the network, helping to formalize their role and amplify their voice. An informant from Big Ocean reflects:

> *"That was super powerful. Right? To have them be inspired by the network and sit at the table and see other indigenous leaders as well as government agency representatives, you know, really people talking and working together. I definitely think Big Ocean has been very successful as a convener of diverse voices and perspectives within the field."*

Marine-related learning networks can also provide people with a variety of in-person and electronic arenas and platforms to share their perspectives. Networks often provide grants and resources for conferences and workshops, other professional travel opportunities, and research projects (Informant interviews, 2019; 2020). They organize activities themselves and also serve to inform members about opportunities that members can apply for and engage in (Davis et al., 2018a; 2018b).

4.5.5 Guidebooks, informational databases, and other products and resources

In response to interview questions about marine-related network outputs and successes, informants often spoke about the products that their networks have created or collaborated on. These

include online databases and training courses, management guidelines, coral restoration guidebooks, and policy assessments. Many of these materials are developed in response to an expressed desire for access to this information by network members or larger communities, or to fill a gap in collective knowledge about emerging topics and issues in marine management and policy (Chuenpagdee & Pauly, 2008; Lewis et al., 2017). For example, TBTI developed the Information System on Small-scale Fisheries, a crowdsourced web portal (Too Big To Ignore, 2020) that integrates and disseminates information on the small-scale fisheries sector, in response to a well-known scarcity of aggregated knowledge on the subject (Chuenpagdee et al. 2017). PIMPAC developed a management planning guidebook to assist marine area managers and contributes toward the work of the Guam Community Coral Monitoring Program and their region-wide coral database (Clarke et al. 2008; NOAA Coral Reef Conservation Program, 2016).

In 2017, Big Ocean and the International Union for Conservation of Nature (IUCN) published the LSMPA Guidelines for Design and Management, which were created to aid those who work on and support LSMPAs with lessons learned and good practices for LSMPA planning, implementation, and ongoing management (Lewis et al., 2017). The guidelines have since been utilized by those working to develop MPAs in Niue, Palau, the United States, and many other nations (Informant interviews, 2019; 2020; P. Christie, personal communication, March 13, 2020). Products such as these also serve as an entry point to engagement in the network, which can then provide practitioners, researchers, or other information users with updated or more specific information as well as access to the network's partners, advisors, and collaborative member activities. For example, an advisor with Big Ocean speaks about this added value of creating the LSMPA Guidelines:

> *"I think the guidelines are something we're very proud of...they're out of date the day they were published but they're still, I think, a pretty good compilation of information. There's no way you can get everything into a document of guidelines, so it's just enough to get people interested and then go off and start seeking more information that's more up to date."*

Just as the LSMPA guidelines were intentionally designed for practitioners and governments engaged in the fields of marine protection and conservation, many informants posited that the most worthwhile and meaningful products developed by their networks were created for specific purposes. For this reason, networks support the development and publication of materials across a wide variety of mediums in order to reach target audiences and equip them with scientific and sociological findings, important stakeholder and community perspectives, or other relevant information. A leader of a global

network explains their goal of taking knowledge, synthesizing it, and distributing it in such a way that it can be applied to inform decisions:

> *"The idea here is to take the knowledge that's out there, package it, apply it to questions that allow decision makers, societal actors to take actions that lead towards more sustainability."*

This informant went on to explain that information means different things to different people, and that they take in this information in different ways. Other informants similarly expressed this belief and highlighted the importance of tailoring a network's communication outputs to the people they aim to reach. To this end, these types of products take the form of policy briefs, science communications pieces, journal publications, magazine articles, and short instructional and informational videos. These materials are sometimes authored by the network itself but also arise indirectly as a result of connections that were formed within the network.

5. Key Findings and Conclusion

We conducted this research to examine the need for, goals pursued by, and efficacy of marine-related learning networks, which are relatively nascent and understudied. By comparing findings from informant interviews with publications on learning networks, we identified evidence that support the need for networks, as well as key elements which strongly contribute to the efficacy of both emerging and established marine-related networks.

Our findings suggest that networks are needed to fill gaps in ocean and coastal governance and to build capacity of individuals working in marine fields. In many cases the need for a network arises from pressing issues that demand urgent action yet lack solutions in existing governance structures. When networks are efficiently and effectively run, they serve as conduits for the translation, aggregation, validation, and dissemination of knowledge and information that supports more inclusive, sustainable, and adaptive ocean governance systems. While marine-related networks are not a panacea for ocean and coastal issues, they allow for the inclusivity of societal actors that have previously been left out of environmental governance management regimes. Despite this value, certain mechanisms still exist outside of network control that can inhibit whether or not the outputs that result from network activities have the intended impacts. For example, after transferring useful, usable knowledge into the hands of decision makers, those decision makers may refuse to acknowledge or utilize that information. Knott and Wildavsky (1980) find this as one critical barrier to effective knowledge dissemination. For networks that work towards producing knowledge to encourage improved policy implementation, this

barrier poses a significant challenge. Other barriers include ignorance of existing knowledge as well as distrust or a lack of dialogue between those with knowledge and those who need it. Our findings strongly suggest that in marine-related contexts, network systems can help circumvent the latter two obstacles.

5.1 The genesis of marine-related networks

The genesis phase of a marine-related network is a critical moment that can encourage a network's success and longevity or, alternatively, severely undermine its functionality. During the important genesis and development phase, it is essential that emerging networks "define their universe." Network leaders must clearly define (1) why the network is needed, (2) what the goals of the network are, (3) the audience the network intends to target or the members the network will engage with, (4) the process by which the network will achieve its goals, and (5) what the network's outputs will be and how these outputs will help the network achieve its goals. The process of establishing these intentions and definitions is extremely important, but flexibility and adaptability are just as essential for ensuring that the network continues to respond to changing issues and the evolving needs of members. Such adaptability is more important during later network phases rather than at the genesis.

5.2 Partnerships and diverse representation

Another key finding highlights the importance of the types of knowledge learning networks exchange, create, or share. We noticed underlying tensions in how the systems of knowledge represented had implications for the membership and participation that the network was able to attract. Networks struggled to bring together diverse perspectives without also diversifying the types of represented knowledge. As such, demonstrating that the network values the perspectives, time, and inputs of its participants forms the foundation of expanding membership across all relevant stakeholders. Our analysis suggests that increasing the representation of the localities where a network conducts work will lead to innovative methods of creating knowledge, and will help improve how that knowledge is communicated and shared. Pursuant to the goals and target audience of the network, each network should purposely package, translate, and present knowledge and information so it is accessible and actionable for those who will use it. Connecting to the right people and organizations on the ground to help deploy vital knowledge and institute conservation interventions is essential, and without the right connections, networks may be limited in their ability to address environmental challenges; in fact, many informants emphasized the essential role of partnerships, collaborations, and working with other local networks and organizations in order to better integrate activities into local context and build trust

with relevant actors. Rather than arriving in a geography or community with a predetermined set of goals, methods, and desired outcomes, networks offer an opportunity to engage in truly dialogical learning and problem-solving (Freire, 1970) with affected stakeholders including governments, industry, local organizations, education systems, and resource users.

5.3 Network longevity and trust

Our findings also indicate that a marine-related learning network's longevity is integral for achieving success. While these networks typically operate with limited budgets and resources, they are set apart from most conservation, human rights, or sustainable development projects that take place over short time periods. Instead, networks generally aim to exist for the long term – for ten years or more, and in many cases de-facto perpetuity. Networks will last as long as members benefit from participation. This longevity allows networks to develop trust with members and communities, cultivating long-term relationships that pay dividends in the form of improvements in marine management or ocean and coastal governance or in some cases - empowerment. In addition, this builds resilience within networks to adapt and continue generating positive outcomes despite changes in leadership within the network, staff turnover in government agencies or management offices, or other external political and environmental influences.

Networks must also respond effectively to inevitable short-term challenges. MPA managers, fishers, and government officials live busy lives, as do most of the other individuals with whom marine-related networks engage. To effectively and efficiently leverage the resources and knowledge of the network's membership over the long term, networks must earn the trust and respect of their members, convincing them that they are not wasting their time. To do so, networks must be reliable and responsive and demonstrate that their efforts are worthwhile. In many cases, networks also provide funding or other forms of support to make member participation and engagement possible—a fundamental component of trust building. Informants stressed that establishing a shared sense of community and building trust with members did not come naturally. In most cases, building trust required a purposeful focus because leaders and other key members saw trust as a critical factor for achieving the network's intended goals. Twenty-three key informants (over 50% of our sample) used the terms "trust," "family," or described "strengthening community" or "cultivating relationships" when discussing the definition of their network, lessons learned, outcomes, and participant engagement. These informants represented 11 of the 16 networks included in this study. The five networks that did not indicate trust or related terms as a critical component of their network were represented by only

one or two informants - a limitation of our study sample that suggests that our results may actually understate the importance of trust for networks. Overall, a network's ability to react and succeed in the short-term is predicated on trust established in the long-term.

5.4 Network coordinators and funding

Partnerships and collaborations are central to a networks' ability to evolve, and coordinators are most often responsible for preserving existing relationships and establishing new ones. Coordinators simultaneously work to secure network funding and oversee the network's general activities and functions. Effective coordinators are inclusive, communicative, passionate, dedicated, and understand the big picture. As coordinators will inevitably change over the course of a network's lifetime, networks should develop clear governance systems or procedures that support smooth transitions between these key leaders.

The most common challenge our informants identified was limited funding. Without funding, the challenge of effectively running a network is amplified, and questions arise about how best to allocate limited financial resources. Our findings suggest that finding and retaining skilled, effective network coordinators should be a top priority for funding allocation. Some informants mentioned that they had assumed that once a network was up and running it could be self-sustaining, which they learned was not the case.

5.5 Measuring success

Finding ways to measure the influence and usefulness of a network is also essential for network success and longevity. Convincing donors, policymakers, and participants of a network's value requires having metrics that link network activities to progress. Networks should clearly establish which metrics for success they will use and how they will use them to determine whether they are achieving their intended results and impacts. There is no one metric or indicator preferred for measuring success in all learning networks. In many cases, empirical evidence can be too difficult or too costly to collect. However, success stories, leadership growth through network engagement, participation numbers, member feedback surveys, and other methods may be used to demonstrate value. Most importantly, a network should clearly define its theory of change, including what the network is attempting to achieve, for whom, and why, and devise a way to measure whether the network is doing so effectively. Goals and objectives can, and in many cases should, change over time. Networks should build adaptive capacity into their structures (see Section 4.1.) to ensure they succeed through such changes.

5.6 Network outcomes

Most marine-related networks in our study aim to support healthy marine environments and to improve the lives of those who depend on ocean resources. While directly linking a network's activities to positive ecological outcomes is difficult, stories of success, on-the-ground improvements in management, and cases where network activities influenced and informed good policy suggest that networks play integral roles in benefiting both society and marine environments. The most pervasive strategy across networks for generating such outcomes is through capacity-building activities of those in management, governance, or policy-making positions. Developing capacity within the communities in which networks exist is often a critical priority, especially since over reliance on external assistance is often costly or ineffective.

While many networks do not appear to explicitly target individual empowerment, Pietri et al. (2015) and Christie et al. (2016) found that capacity building can result in empowerment outcomes in the context of CTI-CFF and their regional exchanges. However, very few studies have set out to establish the extent of the relationship between capacity building and empowerment in other marine-related learning networks. While our research suggests there may be a promising correlation, our informant interviews indicate that the strength of this connection varies widely across the marine-related networks included in this study. To better understand and verify this connection, we recommend investigating this issue further through studies that prioritize interviews with learning network participants who are not leaders, core advisors, or staff (see Section 5.7).

In cases where our informants were unable to point toward multiple clear-cut examples or instances of success, networks typically exhibited one or both of two conditions: (1) they were established relatively recently, and/or (2) they are struggling to "define their universe." Beyond the fact that newly established networks have had less time to generate outcomes, they also lacked sufficient time to establish strong relationships and connections with their membership. As previously discussed, the trust developed within networks over time is an extremely important factor in galvanizing engagement and achieving successes. In addition, networks experience difficulties linking their activities to substantive outcomes when they lack well-defined goals and priorities, or have been unable to establish rational metrics of success or a practical theory of change. Our results indicate that networks with more generalized missions or broader scopes of work tend to encounter more difficulties and challenges within this process. Both of these conditions are exacerbated in situations where scarce financial resources further limit the capacity of the network to achieve its desired impacts.

5.7 Future Research Opportunities

Given the lack of literature on marine-related learning networks and their effectiveness, our study serves as a launching point for further research. Due to the broad scope of our project, additional research could focus more narrowly on any of the major thematic sections of this report, such as why different types of networks form, the role of leadership in networks, the drivers of and limitations to participation in networks, or links between network activities and positive socio-ecological outcomes. Future studies could also focus on any of these themes or other lessons learned for specific subsets of marine-related learning networks, such as MPA networks, knowledge-sharing networks, or research networks. Examinations of marine-related learning networks that incorporate the perspectives of participants and non-staff members, rather than administrators and leaders, would provide a more comprehensive understanding of how networks operate and influence participants. Additionally, interviews with donors would contribute presently absent data on funder preferences for network programs. Our findings also illuminate other key, unresolved questions such as the extent to which marine-related learning networks empower various communities around the world, or how pedagogy on learning and knowledge converge with the network theory covered in this report.

5.8 Conclusion

Knowledge and uncertainty for decision makers are key challenges for addressing wicked problems (Bindoff et al., 2019; Funtowicz & Ravetz, 1993). In response, the IPCC recommends creating adaptation networks, improving community participation, co-producing and integrating knowledge, and improving coordination and communication (Bindoff et al., 2019). Our research demonstrates that marine-related learning networks have the potential to address challenges created and exacerbated by climate change and other complex problems involving ocean and coastal systems. However, since networks are not immune to external influences, including the agendas of funding entities, political turbulence, and ideological shifts (Gerhardinger et al., 2018), simply creating more learning networks to operate and engage in marine contexts is not the solution. Learning networks must be developed in response to identified needs of marine managers, resource users, governments, or other communities. When there is a clear lack of information or insufficient capacity to address a shared challenge, marine-related learning networks leverage the trust and partnerships they build to collectively address complex ocean challenges.

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Appendix

Appendix A: Interview Guide

- How did you become involved in the network?
    - What is your current role?
- Why was the network created?
- Can you share a story about the history of this network?
- What are the goals of this network?
    - How are these goals prioritized given the limitation of resources?
- What are the tangible outcomes of this network?
- Can you share a story of impact your network has made that you are particularly excited by?
    - What were the key resources that enabled this impact?
    - What were the biggest challenges that the network had to overcome to make it happen?
- Has there been a moment that served as an important learning experience?
- How do people get involved with your network and how do you keep them engaged?
    - Is there a formal process to become a network member?
    - In the absence of funding how does your network sustain itself and keep people motivated to participate?
- How do leaders emerge within your network?
    - What do leaders bring to the table that helps your network succeed?
    - How does your network foster leadership?
    - We've noticed that leadership transitions can be a challenge, has your network had to overcome this and how was it handled?
- In general, how do you define success within your network?
    - How do you monitor or measure success?
    - What indicators do you use to tell if the network is successful in building capacity?
- What kinds of knowledge get exchanged within your network and how does this process happen?
    - What results or outcomes has this knowledge exchange led to?
    - Would you recommend this knowledge exchange to other networks?
- What are good practices for including diverse perspectives in a network's decision making?
    - Are there any relevant perspectives that are missing in your network that you wish were included?
    - What are the issues of equity that matter in your learning network?
- What external pressures impact your network?
    - How did your network overcome these external pressures (or shocks)?
    - How do domestic or international politics impact your network?
- What are the core challenges of the network?
- What is something that you wish to see the learning networks word towards in the future? Where do you see your network in five years? Ten years?
- At what phase do you engage with actors outside of the network?
- Does your network bridge with outside networks or institutions and how is that collaboration sustained?
- Do you have any key lessons learned that are relevant to an emerging learning network in Brazil?

Appendix B: Network Websites[1]

Network	Website
Big Ocean Network	https://bigoceanmanagers.org/
Brazilian Future Ocean Panel (PainelMar)	https://www.facebook.com/painelmar/
Caribbean Marine Protected Area Management Network and Forum (CaMPAM)	http://campam.gcfi.org/
Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI-CFF)	http://www.coraltriangleinitiative.org/
Future Earth Earth Systems Governance Project (ESG)	https://futureearth.org/networks/global-research-projects/esg-earth-system-governance/
Future Earth Ocean Knowledge-Action Network (Future Earth Ocean KAN)	https://futureearth.org/networks/knowledge-action-networks/ocean/
Global Socioeconomic Monitoring Initiative for Coastal Management (SocMon)	https://www.socmon.org/
Madagascar Locally Managed Marine Area Network (MIHARI)	https://mihari-network.org/
Mediterranean Protected Area Network (MedPAN)	https://medpan.org/about/
Mesoamerican Reef Fund (MAR Fund)	https://marfund.org/en/
MPAConnect	https://www.gcfi.org/initiatives/mpa-capacity-program/
Pacific Islands Marine Protected Area Community (PIMPAC)	http://www.pimpac.org/activities.php?pg2=2&pg3=5
Pohnpei Teachers' Learning Community (PTLC) climate-related knowledge network[2]	http://pcep.prel.org/
Reef Resilience Network (RRN)	https://reefresilience.org/
SMART Seas Africa Programme (SMART Seas)	http://www.smartseas.org/about.html
Too Big To Ignore (TBTI)	http://toobigtoignore.net/

[1] *Current web addresses as of March 16, 2020.*

[2] *The website provided is for the regionally affiliated network, the Pacific Islands Climate Education Partnership.*

Appendix C: Interview Themes

Learning Network Themes				
Background Information on Learning Network				
History of the learning network				
How have the goals and objectives of the learning network changed over time in the context				
Phases of a Learning Network				
Genesis of the Network Network Design → Network Launch → Organizational Learning → Broader Group Engagement → Network learning → Industry/Outside Engagement				
Practical/Pragmatic Information				
Example: How often do you meet				
Example: Who are the members				
Example: How often do you communicate and how?				
- Conceptual themes achieved through practice and pragmatic decision making -				
Conceptual Purpose Themes				
Impacts/Outcomes			Internal Workings	
1. Societal Outcomes	**2. Ecological Outcomes**	**3. Policy Change**	**4. Capacity/Leadership**	**5. Participation (Democratization)**
Social Equity, Empowerment...	Improved health of MPA...	New policies, management change	Traits, resources...	Engagement, diverse perspectives...

Appendix D: Code Categories

Code Theme	Code Category
Rationale	**Definition:** *Definition of the learning network, knowledge network, network, what terminology does the network use* **Need:** *What gap does the network fill, the impetus for its inception* **Goals:** *What are the goals of the network, if goals change over time, prioritization, goal making*
Operations	**Administration:** *Time and staffing, connections to other networks, how the network can mobilize or respond to issues, process, inputs, logistics, what is expected of leaders in each network, what is expected of all positions* **Communication Methods:** *How are members communicating? Platforms and tools used, types of meetings, etc.* **Metrics:** *Things the network does to track and measure their internal network development and their outcomes; indicators they use (e.g. surveys, assessment tools, feedback), lack of measurement* **Resources/Funding:** *Anything to do with network resources and funding* **Types of knowledge:** *types of knowledge being communicated/exchanged, what they're communicating*
Leadership	**Qualities:** *Qualities or skills of leaders, how to be a good leader, good practices, bad leader/bad practices, leadership responsibilities, inputs from leaders* **Change:** *Leadership turnover/succession in network, or those trained by the network what happens, how to deal* **Development:** *About leaders developing within the network or members developing as leaders in their communities and fields of work, the emergence* **Limitations:** *Things that inhibit leadership, other people, funding, governance, capacity, time constraints*
Participation	**Engagement:** *Motivation, diversity, inclusion, maintaining engagement, incentives* **Limitations:** *What limits and prevents participation in the network* **Membership:** *Who are the members, who is participating, partners (external or internal)*
Outcomes	**Capacity:** *Building capacity amongst network members and outside network (e.g. MPA managers), improving ability to manage marine areas, intangibles, etc.* **Ecological:** *Outcomes focused on ecosystems* **Personal:** *Personal reflections, growth, new skills acquired* **Policy:** *Attempt to influence policy, or actual policy change* **Products/Research:** *Reports, videos, papers, any physical/online products produced* **Societal:** *Behavior change, cultural values, (gender involvement) indigenous rights, rights, marginalized communities, empowerment* **Other:** *Connections between other people or groups in the network; things that don't fall into any of the other categories*

Other emphasis*	**Challenges/Obstacles:** *Overarching challenges and obstacles that can apply to all categories or on their own, failures included* **Lessons Learned:** *Specific recommendations or solutions to challenges, realizations for learning networks and specific to Painel Mar. This will most likely be a double tag with another code theme* **External Influence:** *What external (politics, funders, governance) impact the network - both negative and positive. What changes the focus, ability, purpose of the network.*

**These codes were primarily used as double codes in combination with the other themes*