Co-Designing Ocean Knowledge to Inform Area-Based Management:

Insights and Approaches from Diverse Experiences in the United Nations Decade of Ocean Science for Sustainable Development

Workshop Report

Authors: Jason P. Landrum,[1,2]*; Rebecca Martone[3]; Kathryn Sheps[3]; Gonzalo Cid[4,5]; Claudia Barón [6,7]; Frank Muller-Karger[6,7]; Mikayla Basanese[4]; Deirdre Brannigan[8];

1 Lenfest Ocean Program at The Pew Charitable Trusts
2 UN Ocean Decade Foundations Dialogue
3 Decade Collaborative Center for the Northeast Pacific - UN Ocean Decade Contribution
4 NOAA-ONMS MPA Center
5 MPA Sentinel Site Proposal - UN Ocean Decade Programme
6 University of South Florida College of Marine Science
7 Marine Life 2030 - UN Ocean Decade Programme
8 ProtectedSeas
*Corresponding author

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Introduction

Marine spatial, or place-based, management, including marine protected areas (MPAs), represent a critical approach to reducing overfishing, conserving ocean and coastal biodiversity, enhancing socio-ecological resilience, and sustaining thriving marine economies (USCOP, 2004; Ehler, 2021). The effectiveness of MPAs depends on a variety of knowledge sources and systems, but the people and approaches to generating and sharing this knowledge can have a crucial impact. A collective, inclusive and participatory approach to understanding our natural world is critical to managing our ocean in a sustainable way.

A growing body of evidence suggests that knowledge has a greater likelihood of being considered into management decisions when various rights and stakeholders and/or decision-makers engage collectively in determining what knowledge is known and what is needed. The concept of "co-design" has been gaining traction as an alternative approach to linear, or one-directional, knowledge translation (Cash et al., 2006; Chambers et al., 2021, 2022). The overall premise of "co-design" is simple: to facilitate an iterative, inclusive, and equitable engagement process between knowledge holders and users that results in a collective understanding of what's known, what's not known, and what knowledge is needed to reach sustainability goals. The effectiveness and potential impact of applying the principles and practice of co-design has been well documented in many topical areas (e.g., education, health, policy, etc.), but has only more recently been recognized as an important approach in the fields of marine science, conservation, and sustainability.

The United Nations Decade of Ocean Science for Sustainable Development (2021-2030; "Ocean Decade") has recognized the need to provide a broader platform to advance and expand the use of co-design and collaborative knowledge production to address global challenges facing the ocean and people. To support this effort, we developed a session on this topic at the Fifth International Marine Protected Areas Congress (IMPAC5; 6 February, 2023), a global forum that brings together ocean conservation professionals and high-level officials to inform, inspire and act on MPAs. This session offered a space for diverse communities and partners to gather and share their experiences and expertise in co-designing knowledge to inform marine place-based management. The convening team represented different perspectives from across the UN Ocean Decade, including the Foundations Dialogue and several Ocean Decade Actions (Song et al., 2023). All these groups support collaborative knowledge generation to inform solutions to issues facing the ocean and the people who depend on it. Thus, the session organized at IMPAC5 was effectively "co-designed" among the team members. Furthermore, it offered an opportunity to convene rights holders and stakeholders in the same room to discuss existing information needs for designing and managing MPAs, to share best practices on how to co-design knowledge to fill the needs of the communities of participants, and how to leverage the opportunity of the UN Ocean Decade to build greater capacity, coordination, and collaboration around this central concept.

Below, we present some of the observations and reflections offered in this session that serve to add to a growing understanding of the need to create inclusive, participatory knowledge systems for effective marine spatial management and protection.

Session Structure and Content

The session was open to all participants in the conference. Attendees of the session included Indigenous leaders and knowledge holders, scientists, conservation practitioners, members of the MPA monitoring community, MPA resource managers, providers of regulatory data tools, and funders from the philanthropic community. The session's facilitators structured the discussion to ensure that participants shared perspectives on needs for resource uses and conservation and restoration, historical approaches, and commonalities as well as differences across communities implementing MPAs and marine planning initiatives. The session had three main points of discussion: 1) to identify critical information needs to inform the process of selecting, implementing, and managing marine spatial protections; 2) to develop research and observations that are necessary to meet those needs; and 3) to integrate various information sources, including local knowledge, experiences, and ways of knowing to ensure benefits to all who use or benefit from ocean spaces and marine life. The questions used to guide discussion were:

- What are the specific knowledge needs in marine conservation planning and management and who needs to be involved in producing this knowledge?
- What are some examples of best practices?
  - Are there groups/organizations that do this particularly well?
  - Are there lessons to be learned from past mistakes?
- What knowledge gaps or needs can be identified?
  - Where can we do better?
  - Who else needs to be involved in creating sustainable solutions?

Three breakout groups engaged in a facilitated discussion about different stages of marine conservation planning and management. Each of the groups considered a different stage but all responded to the same general science and management questions listed above. Each group included 8-12 people from diverse backgrounds (academia, fisheries community members, industry, government, Early Career Ocean Professionals, Indigenous Tribes and communities, MPA management teams including Indigenous-led conservation areas, Ocean Decade programme leads). Participants self-selected into each group.

Here we describe the key points highlighted by these groups about each stage of marine planning in terms of knowledge needs. We then discuss the commonalities and differences among the groups. Breakout Group 1 discussed the information needs required to identify where and how much area to protect. Breakout Group 2 discussed management and/or conservation goals. Breakout Group 3 discussed strategies to monitor progress toward conservation implementation. All three groups were guided by the questions in the context of the stage in the process toward implementation, but many of the groups touched on aspects of all stages.

Group Discussions and Takeaway Messages

Question 1: What are the specific knowledge/science needs at various stages of the development of spatial marine protections, and who needs to be involved in producing this information?

Collaborative and Participatory Process

Collaboration and coordination should entail close engagement between and across different knowledge holders and users. Participants stressed that the identification, establishment and implementation of MPAs and management goals, and the assessment of MPA effectiveness through monitoring should be determined through a community driven, participatory process. It is imperative that a collaborative process be built into the process from the beginning. It should involve diverse and representative rights holders and stakeholders. This may include decision makers and managers, Indigenous Peoples and rights holders, local communities, natural and social scientists/researchers from various fields of study, individuals using the resources for commercial and/or recreational purposes, NGOs, communicators, and boundary spanners, among others. The process should allow for the consideration of multiple goals from different groups and include various perspectives. These groups should be engaged in proposing and considering adaptive management processes that are responsive to community needs

Building from a Baseline of Information

Identifying where and what to conserve should start with assessing what is known and not known about the species, ecosystems, and/or cultural heritage being considered. This includes evaluating the state of biodiversity and cultural heritage of the area and the environmental conditions and human pressures that may influence the area, social and cultural values associated with the ecological system, and defining what makes the place special and why it should be protected. The information collected should help understand which groups are interested in protecting the area, why, and what regulations already exist over a particular space, what will be the purpose of additional conservation measures, and which activities will be allowed. The assessment should describe the current management regime, if any. This information is a baseline that will later be critical for assessment of MPA effectiveness.

Data Accessibility and Inclusive Data Governance and Accessibility

Data accessibility, sovereignty, and governance questions should be discussed in the early stages of MPA development. Inclusive and equitable data governance strategies and policies should be in place to help guide the management of the MPAs agreed to by all relevant decision-makers, rights holders and stakeholders. When monitoring and management decisions are made in the marine conservation planning and management process, it is useful to review data collected in the earlier stages of the co-design process. Ideally, stakeholders will have agreed on a minimum set of indicators of ecological, environmental, and socio-cultural changes of the conservation process, and data collected related to these indicators can be used to inform decision-making and adaptive management. New tools and technologies now exist to help compile legal protection data for analyzing and understanding regulatory frameworks for areas being considered for new designations or expansions of MPAs.

Adaptive Management Strategies

Developing and maintaining adaptive management strategies should be prioritized given changing ocean conditions that are driven by climate change and other more localized human impacts. Creating a useful adaptive management strategy requires a well-articulated theory of change, or similar organizing framework, composed of targeted guidance questions and key science needs to help monitor the conditions within the MPA, and the success or failure of specific rules and/or actions to attain those goals and outcomes. The set of factors to consider in each region will be different, whether high-seas and offshore and remote, nearshore or coastal, the type and level of protection of an MPAs, and historical and desired new uses of an area and resource. Different types of knowledge should include quantitative and qualitative analyses and approaches, including Indigenous and local knowledge, that measure indicators of the ecological, environmental, social, and cultural components of the system, linked to the MPA objectives. For example, qualitative data about use and enjoyment of the marine conservation area, based on input from a variety of stakeholders and rightsholders, is critical to ensure continuity in the management of the MPA as well as to increase the likelihood that the strategy used in management accurately incorporates and reflects the needs and concerns of the local community (NRC, 2001; USCOP, 2004).

Inclusive Knowledge Systems and Management Practices

Multiple knowledge systems should be considered and engaged, including perspectives stemming from young or early career professionals and other groups representing and/or serving important rights holders and other stakeholders in the specific area being managed. Participants emphasized taking a very inclusive approach that engaged everyone that had been involved in earlier stages of designating areas and setting management goals, as well as expanding participation to include other knowledge sources. Data and knowledge holders as well as rights holders would need to be actively engaged in the overall process of establishing or maintaining/monitoring MPAs, and their voices should carry significant weight in decisions made therein about the MPAs (Ban et al. 2018; Bennett et al., 2020).

Community members living on or adjacent to MPAs need to be invited to participate in all aspects of the monitoring and management of the MPA, including what knowledge is used and who is shepherding that knowledge to decision-making. Empowering the community to support implementation, monitoring, and management of MPAs through training and education opportunities, as well as through processes that provide mechanisms for community members to engage will create a more inclusive process as well as ensure strong participation in adaptive management. Furthermore, engaging in these efforts can expand and improve ocean literacy in communities, further supporting cultural connections to place and ways of knowing.

Turtle in the Marine Protected Area | Foreign, Commonwealth & Development Office | Flickr

Question 2: What are some examples of best practices in this stage of marine planning and management?

Groups identified examples that showcase best practices at various stages of marine area-based planning and management. Examples included the Northern Shelf Bioregion/Great Bear Sea Marine Protected Area Network, Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve, and Haida Heritage Site (Canada), Easter Island MPAs (Chile), Cocos Island National Park (Costa Rica), California MPA Network, Chumash Heritage National Marine Sanctuary, Papahanaumokuakea National Monument in Hawaii (USA), and Puerto Morelos Reef National Park (Mexico).

Here we present two case studies describing elements of good practice that were repeatedly highlighted by the groups. The Great Bear Sea MPA Network is an MPA network planning process led by fifteen First Nations and co-developed with the British Columbia provincial and Canadian federal governments, which recently endorsed and released a Network Action Plan. This process highlights useful approaches for regional-scale co-governance and co-development of recommendations for MPA design and development. This is contrasted with the case from Puerto Morelos, Mexico, which highlights co-development and co-production of knowledge with the local community in the monitoring and management phase.

Haida Gwaii; photo curtesy of the Province of British Columbia

Cocos Islands; photo curtesy of the Ocean Image Bank / Amanda Cotton

Hawaii Coral; photo curtesy of the Ocean Image Bank / Kimberly Jeffries

Gwaii Haanas; photo curtesy of Wikipedia Commons

Case 1: Marine Protected Area Network of the Northern Shelf Bioregion/Great Bear Sea MPA Network in British Columbia, Canada

An MPA network planning process began in 2014 along the Pacific coast of Canada. The region, which encompasses 102,000 km2 of marine area, is referred to as the Northern Shelf Bioregion or the Great Bear Sea (NSB MPA Network). In 2023, fifteen First Nations, the Government of Canada, and the Province of British Columbia jointly ratified a network action plan (NAP) that described the approach used to develop the proposed design for the MPA Network and provided recommendations for its implementation, governance, and adaptive management (MPA Network Northern Shelf Initiative, 2023). Through review of the NAP and discussions with participants involved in the process, some aspects of the process were identified as useful examples to inform collaborative governance and MPA network design and development around the world. For more details on the NSB MPA Network process, see Beaty et al. 2024 (this issue).

Collaborative Governance

Building upon decades of collaborative governance and marine spatial planning processes among Federal, Provincial, and Indigenous governments. Tripartite governance was put in place to develop the MPA Network Action Plan, where partners from the Federal, Provincial, and First Nations governments agreed upon clear decision-making, leadership, and process structures to guide the development of the MPA network. Conflict resolution mechanisms and co-defined mandates, scope, and outcomes enhanced partners' abilities to work together. In addition, the governance partners recognized that financial and human capacity was needed to support the process, and mobilized resources so that all governments, particularly First Nations, could engage as true partners in the process. In addition to having staff from the individual partners participate, technical staff were hired to support tripartite governance, facilitate collaboration among the partners, and help engage stakeholders and the public – all of which enhanced trust and transparency in the process. Altogether, the co-governance arrangements ensured that all partners' interests and concerns were considered from the beginning and throughout the process.

Iterative Participatory Process

The governance partners took an iterative approach when designing the NAP, prioritizing meaningful and participatory engagement to ensure the NAP was informed by diverse perspectives. The MPA Network goals indicate that the process aimed to maximize the benefits and minimize impacts from the Network to communities and users of the marine environment. Input from other First Nations who were not part of the formal governance arrangement but with territory in the region, and stakeholder representatives and experts was gathered throughout the process, and over time broadened to include the general public.

Using Best Available Data and Decision Support Tools

The discussion on the NSB MPA Network design described how Network objectives, design guidelines, ecological and cultural conservation priorities, and zone-specific conservation objectives were the foundation of Network scenario development. Network scenarios identified areas or zones for conservation, and provided options for possible configuration of MPAs in the Network. Building from existing MPAs and other spatial conservation measures, new sites and conservation objectives were based on information on ecological and cultural conservation priorities, as well as human use and economic data. The social, cultural, economic, and ecology data were integrated into spatial decision-support tools, and outputs were further informed by Indigenous and local knowledge holders to develop and evaluate Network scenarios. This allowed for more transparent assessment of scenarios using performance measures and multiple rounds of feedback from stakeholders, rights holders, science advisory committee members, and internal governance partners.

Weaving Together Different Ways of Knowing

The NSB Network planning process brought together Indigenous and local knowledge, and western science systems to inform MPA Network design. Indigenous knowledge informed all aspects of Network development, and uniquely contributed to identification of cultural conservation priorities. First Nations governance partners built upon extensive Indigenous knowledge databases that had been developed during community-based marine use planning processes over the decade prior, and input was further solicited from First Nations governments, communities, and marine planning and science committees throughout the process. Local knowledge was included through stakeholder advisory committees that brought together members who were identified for their areas of experience and expertise and who represented sectoral interests. Further information was gathered from sectoral experts through engagement with local community members. Western science was developed by all partners and was further guided by a science advisory committee composed of

academic and government researchers and technical experts. Weaving together information from all of these sources ensured that best available information shaped the development of the Network action plan. Participants in the session described this process as a leading example of co-designing and co-producing knowledge from multiple knowledge systems to co-inform all aspects of MPA Network design.

British Columbia's Koeye River is in the Northern Shelf Bioregion; photo curtesy of Hakai Institute

Case 2: Community-Based Initiative to Protect Sea Turtles in Support of the Conservation Activities of Mexico's Puerto Morelos Reef National Park

Puerto Morelos is a small fishing town in the state of Quintana Roo, Mexico. Adjacent to the town, the Puerto Morelos Reef National Park (PMRNP), established in 1998, is a marine protected area located within the Great Mayan Reef or the Mesoamerican Reef, the world's second largest barrier reef. The reef in front of Puerto Morelos is very close to the coastline. Here, several species of coral and the associated high marine biodiversity in the area serve to support diving, snorkeling and other tourist and recreational activities. The beach of Puerto Morelos is also an important nesting site for sea turtles. Each year sea turtles species — such as the loggerhead (*Caretta caretta),* green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys imbricata*) — arrive to the coast of Punta Brava, within the PMRNP, to lay their eggs. The local population in Puerto Morelos benefits, directly or indirectly, from the eco-tourism activities around the PMRNP, so conserving their local ecosystem is in the interest of the local community. Helping the national park achieve its conservation objectives has become one of the key objectives of a community-based initiative to protect sea turtles nesting in their beaches and conduct surveillance in the coastal areas of the park against illegal activities.

National Park Community Collaborative Agreement

In recent years, tourism services have become an important economic activity to fishermen in Puerto Morelos. Guided snorkeling and diving tours, as well as other tours and services within the national park, represent one of the most important alternatives to fishing. Both the high risk of offshore fishing and higher incomes generated by tourism have made fishermen move into providing tourism services to the visitors of the PMRNP. Natural resources and ecosystems became an important asset for the Puerto Morelos community, and a group of fishermen decided to organize to provide voluntary surveillance against illegal activities in the park. About six years ago, the group realized that tourism pressure, debris pollution, and illegal poaching were also affecting the marine turtles that, between May and November each year, come to nest in the PMRNP area. Working with the National Park, whose enforcement capacity is very limited due to the lack of adequate staff and resources, the fishermen organized a volunteer group to monitor, research and protect the nesting areas of marine turtles in Puerto Morelos.
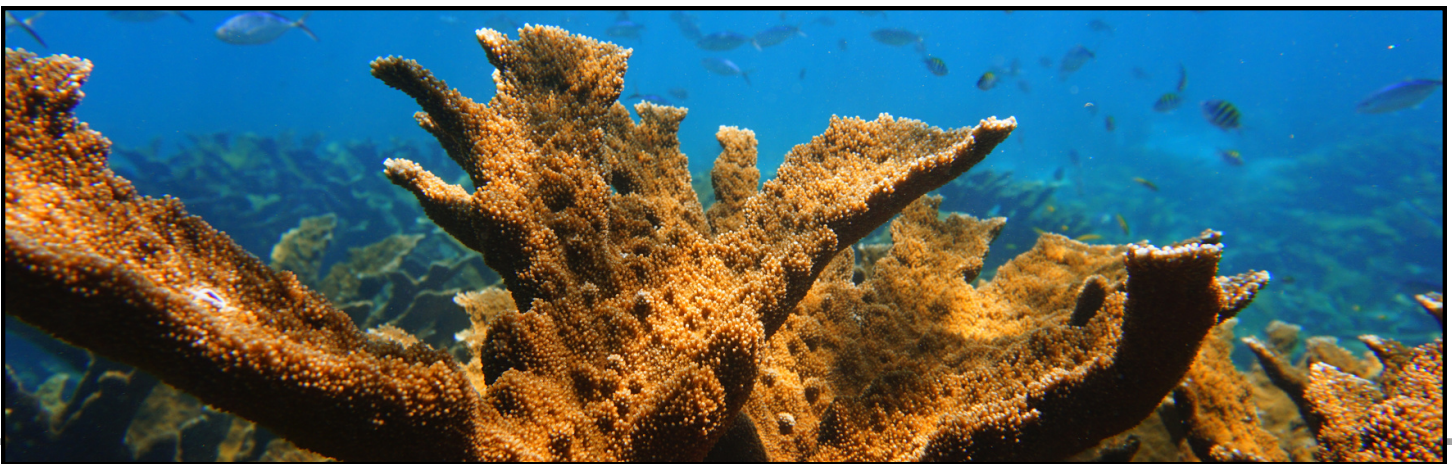
Arrecifes de Coral de Puerto Morelos/Puerto Morelos coral reef; photo curtesy of Wikipedia Commons

With the support of the park staff, this group applies every year for federal grants to fund their activities. The funding helps the group to buy surveillance equipment such as lamps and flashlights, tags, GPS equipment, gas, and transportation and helps provide a small stipend to the members of the group. The National Park has also provided training to the group to conduct sea turtle population surveys, identify and protect turtle nests, and rescue turtles and their hatchlings. The group started with eight volunteers, and today there are about 18 permanent members of the sea turtle protection group.

Generating Data to Support Decision Making

The monitoring and surveillance during the sea turtle nesting season in the PMRNP generates systematic information about the sea turtle population (through tagging and population surveys), nesting patterns, hatchling number and mortality, estimates of hatchlings reaching the water, and presence and impact of illegal activities such as poaching. Observations by the volunteer group also provide valuable information about coastal marine debris and extreme events, such as blooms of sargassum along the coastline. This information provides the staff of the PMRNP with the basis to make decisions, such as closing or opening areas for tourism, developing unified monitoring programs among regional MPAs and determining connectivity patterns among MPAs, and assessing conservation measures of the national park. The information generated by this group also helps develop educational materials for research and for public outreach.

Lessons Learned

One of the co-authors and participants in this session, a young leader of the "volunteer patrol" at PMRNP has expressed that community-based conservation initiatives are necessary when the formal protections (such as an MPA or a national park) do not have the resources or the reach to protect the ecosystems and natural resources adjacent to coastal communities.

> " *"The communities cannot wait for the government to protect their resources. Conservation is a priority action that should mobilize the community to do something for their own benefit."* "
> *- PMRNP volunteer and workshop participant*

This group's surveillance activities have not only benefited their economic activities, but also increased the quality of visitors' experiences in the national park by improving the interpretation services regarding the park's biodiversity and ensuring that they will be able to view iconic species in the park. The Community-National park partnership and surveillance activities have increased the interest of community members and youth to be part of the conservation activities. It has also increased community awareness of access restrictions and the benefits of these restrictions, as well as the level of environmental education and public perception of a national park. Every February, during the anniversary of the national park, the volunteer group organizes an information display highlighting their activities and how their actions are supporting both the national park and their own economy.

Question 3: What gaps or needs can be identified in this stage of conservation planning, monitoring, and management processes? And what can we do better?

Each breakout group session concluded with a discussion of the knowledge gaps that remain to be filled for collaborative and co-designed management processes. Some of this conversation was based on a 'lessons learned' approach stemming from past mistakes in marine conservation management processes, while others were articulated in terms of what would be ideal to do. Here we highlight a few general themes revealed through the discussion.

Inclusive and Iterative Engagement

While engagement and gaining trust of stakeholders, rights holders, and community members may be a slow process, it pays dividends for the communication and/or transfer of diverse knowledge sources throughout the life of the MPA. Furthermore, lack of inclusion can fuel distrust between MPA managers and may lead some stakeholders and rights holders to have inappropriate or wrong ideas about what MPA monitoring and management can and cannot accomplish. Developing monitoring and management plans without including a diverse array of stakeholders can lead to missing some important signals, knowledge, and data sources that might be critical to understanding changing conditions in marine conservation areas. Ways to improve current processes include creating enabling conditions for identifying key information needs and sharing knowledge derived from diverse knowledge sources, developing successful bridges with communities, and building capacity for networking and sharing knowledge.

Adequate Funding for Co-Design

Adequate resources are required to support long-term engagement and relationship building processes that are necessary for successful co-design and collaborative knowledge generation and sharing, are generally limited and challenging to find. Engagement, communication and relationship building are not often included in multi-year research funding and could also create and/or exacerbate inequalities between scientists, managers and community members who are all involved in knowledge creation and its use to inform decisions. This is true in near-shore or coastal marine conservation areas but is also the case in high-seas and conservation areas where multiple national governments may be involved in the management and governance of a marine area, each with separate and distinct interests, needs, processes and funding requirements.

Knowledge Gaps and Data Needs

Many knowledge gaps exist when it comes to determining what will successfully conserve important marine areas and the resources associated with those areas. Climate resilience, biodiversity hotspots, essential habitats for endangered species, and invasive species and climate migrants are often poorly understood or not well-identified when determining where and how much area needs to be conserved. This is particularly challenging when planning for changes that are based on often largely incomplete data and uncertain models. Recommendations from participants include designing MPA networks or groups of MPAs that include multiple replicates of representative habitats identified through observations, where possible, and/or models based on species distributions and habitat associations, to help provide insurance in the face of a changing climate.

Adaptive Management

Rapid ecosystem change reduces clarity for managers selecting which thresh holds or signals might be the most critical for monitoring and management of a particular area. This may leave practitioners wondering why a monitoring or management approach was not sufficient to diagnose what specifically was affected or changing until long after a problem is noticed. In these cases, the need for diverse stakeholders with different ways of knowing about the ocean becomes essential, as it is possible that social and cultural indicators may reveal these problems before they can be observed in biological or oceanographic data. This places greater emphasis on the need to build and maintain trusting relationships with all rights holders, stakeholders, and users local to the marine area being conserved, and to have them engaged throughout the process in meaningful ways. Ideally, MPAs would have review periods written into their management plans, which would allow for this information to be integrated into the process and help management account for changes that may happen in the future, or account for changes as more knowledge becomes available.

Conclusion

While place-based marine spatial management will continue to be critically important for protecting diverse and resilient species and ecosystems, co-designing the knowledge required to support these protected areas in a sustainable and equitable way remains a huge challenge. The UN Ocean Decade has built an important platform to help facilitate the expansion and growth of the principles and practice of co-design, and our IMPAC5 session embodied an example of how different groups can come together to share lessons learned, discuss best practices, and existing gaps on how to co-design the "science we need for the ocean we want." Our goal was to offer a venue where different rights holders, stakeholders, and other professionals could gather and share their knowledge and experiences in building the enabling conditions for co-designing knowledge that can advance sustainable development. Overall, while co-design is growing as an approach to creating and sharing knowledge among diverse groups, there is a lot of room for its advancement, improvement, and impact in the future. During the next 8 years of the UN Ocean Decade, the authors and the participants of this session will not only take what we've learned through discussions in the session, but will continue to support the principles and practice of co-design in our own ways, from community leadership, to funding more engagement and research, to coordinating diverse groups, to implementing endorsed programs, projects, and activities of the UN Ocean Decade.

Triquet Island is part of the Northern Shelf Bioregion; photo curtesy of Hakai Institute / Keith Holmes

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