How to Design Connected Networks of Marine Protected Areas

SEC 01 WHY THIS SCIENCE BRIEF?

The global ocean faces increasing pressures from human-mediated activities, some of which can be managed locally, such as resource extraction, while others require global cooperation, such as climate change. Ocean managers frequently use Marine Protected Areas (MPAs) as a tool to conserve biodiversity, minimize habitat loss and preserve ecosystem services. Canada has committed to protecting a total of 30% of marine areas by 2030, including coastal and marine environments, through effectively and equitably managed, ecologically representative, and well-connected networks of MPAs. An effective network of MPAs (MPAn) should address conservation objectives that require connections among individual MPAs and, thus, represent more than the sum of its parts. For example, if animals move among MPAs to feed or reproduce, they may require protection both within the origin and in the destination MPA. Designing networks of MPAs that can deliver desired conservation outcomes requires a careful assessment of connectivity among individual MPAs within a network, as well as their connectivity with locations outside the network.

SEC 02 OUR RECOMMENDATIONS

The collective work across CHONe identified the following recommendations:

- For each species, community, or ecosystem of interest, determine whether the design of an MPAn should integrate connectivity in order to address the associated conservation objectives.
- Identify the information required to assess connectivity as early in the planning process as possible. Based on available information, select the best approach to estimate connectivity among target populations, communities, ecosystems, or MPAs within an MPAn.
- Preferably, assess connectivity during the design phase of MPAn. If this is not possible, assessment of connectivity can be used to modify the design by incorporating stepping stones, source populations etc.
- Climate change may significantly affect the future strength and direction of connections, and designs should consider this possibility.
- In some cases, designs may aim to interrupt connectivity (e.g. invasive species, sediment loading)

SEC 03

THE CHALLENGE, NEED, AND OPPORTUNITY

Identifying links and connections among individual MPAs presents a major challenge, particularly given the difficulty and expense in measuring the strength and direction of connections. Ecologists consider different types of connectivity based on the geographic distance of suitable locations (seascape connectivity); passive movement of particles, such as eggs and larval propagules (read more), and energy/nutrients through food webs (functional connectivity); or directed movement of organisms (migratory connectivity). Measuring each type of connectivity requires different tools such as models of ocean currents or genetics. Importantly, because of the elusive translation of measurements of connectivity to conservation targets, most MPA networks to date have not included connectivity as a design element.Mounting evidence points to the need to preserve connectivity to ensure a species can resist and recover from stressors. For example, we now understand that we must protect the multiple locations that an endangered species occupies during its lifetime or the spawning populations that cause spillover of propagules or nutrients. Management interventions that fail to ensure that sufficient propagules reach populations to make them sustainable or to account for the spread of invasive species will fail.Canada's ongoing effort to protect 30% of our oceans in networks of MPAs provides a unique opportunity to bring scientists and managers together and facilitate the implementation of connectivity in conservation. This collaboration can identify the types of connectivity that are: (i) relevant to conservation objectives, (ii) relatively simple and inexpensive to measure, and (iii) can be used to develop meaningful conservation targets.

SEC 04

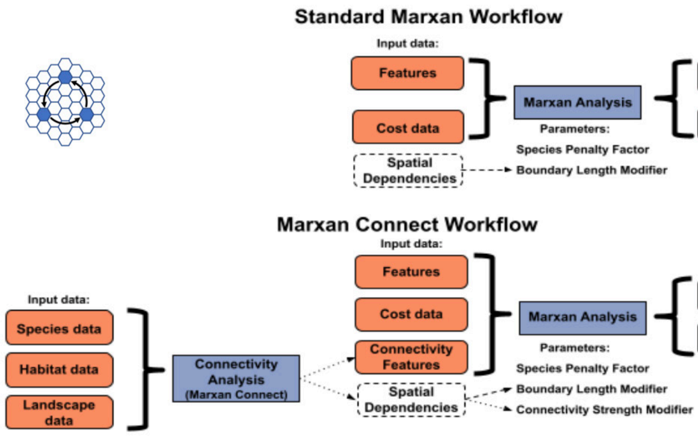
OUR APPROACH

Researchers in CHONe have used many different approaches to support the integration of connectivity in the design of MPAn. Our research illustrates the multitude of connections among different shallow-water and deep-sea ecosystems in reviews of the scientific literature and measured connections in habitats ranging from seagrass and kelp beds to hydrothermal vents, both on the seafloor and in the water column. Our work evaluates connectivity in existing and planned MPAn both in the Pacific and Atlantic Oceans of Canada and with respect to the management of fisheries, and it often bridges the science-policy interface. We have developed approaches for evaluating connectivity in an MPAn and produced a software application that integrates measures of connectivity in decision support tools, used by managers worldwide for the design and implementation of MPAn. One of our findings underscores the limited integration of connectivity as a criterion in the current design of MPAn worldwide, which we attribute to a gap in communication between scientists and managers and policymakers. To address this gap, CHONe researchers, students, and PDFs contributed data, presentations, and advice through multiple channels, including participation nationally in MPAn technical advisory committees, the Canadian Scientific Advisory Secretariat (CSAS) process, and expert witness testimonies to Canadian parliamentary committees and international organizations (e.g. International Union for the Conservation of Nature, International Seabed Authority, North American Marine Protected Area Network). This brief, which is part of a CHONe series, provides a further communication tool.

SEC 05

CHONe EXAMPLES

The incorporation of measures of connectivity into common decision-support frameworks and tools remains technically challenging and typically requires customized computer coding and workarounds that can hinder their inclusion in spatial planning processes. Building broad capacity within the conservation community to include ecological connectivity in spatial planning processes urgently requires technical documentation, best-practice guidelines, and user-friendly tools. We developed the Marxan Connect software application to guide conservation practitioners as they preprocess and prepare connectivity data for inclusion in the widely-used decision-support tool, Marxan. We designed the app as a Graphical User Interface (GUI) to help conservation practitioners include "connectivity" in their protected area network planning. The Marxan Connect allows for multiple definitions of "connectivity" so that researchers and managers can optimize protected area networks for various connectivity objectives.



With the goal of informing the MPA planning process on the Northern Shelf Bioregion in British Columbia, CHONe researchers developed a method for incorporating connectivity achieved through the movement of adult stages of marine species in locations with limited data availability. The area was selected to capitalize on ongoing MPA network planning jointly by the Government of Canada, Province Government of British Columbia, and 16 First Nations. Using habitat data, researchers identified hotspots of connectivity and, based on these hotspots: (1) inferred moderate connectivity among existing MPAs, and (2) identified other important sites for maintaining connectivity that should be proposed as additional MPAs within the network. Using future ocean conditions for 2065-2078, we predicted a decrease in the connectedness of existing MPAs for adult stages of commercially important Dungeness crab and shortspine thornyhead.

SEC 06 CHONe EXAMPLES

Well-designed networks of MPAs based on the criteria of representation, replication, connectivity, and site viability are more likely to deliver successful conservation outcomes. In particular, ensuring that MPAn helps to maintain important connections among populations and ecosystems can mitigate the success of MPAn in the face of climate change. Even if not considered in the original planning process, incorporating connectivity considerations post-implementation can improve the performance of MPAn.

SEC 07 ANTICIPATED BENEFITS

Well-designed networks of MPAs support a clean, healthy, productive, sustainable and predicted ocean. These outcomes benefit Canadians and support United Nations Sustainable Development Goals 14 and the United Nations Decade of Ocean Science. The likelihood of successful outcomes, however, significantly increases only by engaging coastal communities, Indigenous groups, industry, and other ocean stakeholders, including the governments that represent them.

SEC 09 GET IN TOUCH

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