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Habitat connectivity and island biogeography: A call for community-engaged scholarship to address isolated parks and protected areas

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"Systemic threats to parks and protected areas"

Abstract

Using the theory of island biogeography as a framework, we seek to determine the potential impact of the lack of connectivity between parks and protected areas on large-scale conservation efforts. We analyze lessons learned from the current Yellowstone to Yukon (Y2Y) initiative and develop recommendations to improve connectivity while incorporating the motivations, needs, and emotions of stakeholder groups. We strongly encourage ecologists, geographers, biologists, and other academics and activists to partake wholly and enthusiastically in community-engaged scholarship through outreach, capacity building, and social capital building through the proven frameworks of consensus-based and structured decisionmaking. Further, we argue that large-scale conservation initiatives may greatly benefit from an approach focused on small, more tangible actions when working toward a larger goal. As human populations and urban–wildland interfaces continue to grow rapidly, former models of park and protected area development become increasingly ineffective. We must adopt new strategies, such as those listed here, in order to increase landscape connectivity and provide effective conservation for all species.

Introduction

Parks and protected areas have long been recognized as a key strategy for protecting biological diversity and intact ecosystems, acting as the foundation of conservation and the protection of nature. Today, in the face of rising pressure on the natural environment, the critical role of parks and protected areas is becoming more evident than ever before. Despite their imperative role in the preservation of biodiversity, protected areas were not always established with ecological criteria in mind; indeed, it is only in recent decades that ideas and theories from ecological sciences such as landscape ecology, conservation biology, and island biogeography were incorporated into protected area systems design. Given the importance of ecological sciences to the preservation of biodiversity, the relatively recent inclusion of these scientific principles in the designation and management of protected areas is concerning. In reflecting on some of the systemic threats associated with parks and protected areas, this paper uses the theory of island biogeography as a framework to consider the history and developing landscape of protected areas in North America and the future of biodiversity conservation in park and protected area management.

Defining parks and protected areas

The term "protected area" has been defined and redefined for decades. Today, the most widely accepted definition comes from the International Union for Conservation of Nature (IUCN), the leading international authority on nature conservation. According to IUCN, a protected area is "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (IUCN 2020). This globally applicable definition is a broad description that covers the variety of sizes, strategies, and purposes of protected areas around the world. Along with this broad definition, the IUCN presents six management categories of protected areas (Table 1) defining the management objectives of each.

Category	Management Objective
Category Ia Strict Nature Reserve	Preserve species, habitats, and ecosystems for scientific purposes
Category Ib Wilderness Area	Preserve natural attributes for future generations
Category II National Park	Protect natural/scenic areas of national significance for research, education, and recreation
Category III Natural Monument/Feature	Preserve specific outstanding natural features
Category IV Habitat/Species Management Area	Conserve habitat of significant species through active management
Category V Protected Landscape/Seascape	Maintain harmonious interaction of nature and culture; provide for recreation/tourism
Category VI Protected Area with Sustainable Use of Natural Resources	Provide for sustainable use of natural resources through sound management, while maintaining biodiversity

TABLE 1. The six IUCN protected area management categories and their management objectives. Adapted from https://www.iucn.org/theme/protected-areas/about.

Parks and protected areas (PPAs) are often cited as the most effective conservation tools we possess to safeguard biodiversity, preserve intact landscapes, and mitigate the effects of climate change (Mittermeier et al. 2003). Beyond their conservation value, protected areas are also important economic drivers for local communities, vehicles for recreation and leisure services, and a means of preserving cultural resources. North America has a long history of protecting natural landscapes through protected areas, especially through national parks, with Yellowstone established as the first national park in the world in 1872. Yellowstone's creation sparked a worldwide movement to protect natural spaces, and today nearly 240,000 protected areas exist globally, spanning approximately 9% of Earth's total surface area (Figure 1; UNEP-WCMC 2018).

Parks and protected areas following the Yellowstone model are generally established to protect large tracts of relatively pristine nature and safeguard wildlife or the scenic values of wilderness, leaving nature largely protected from sustained human development. However, the Yellowstone model is highly contested, with critics calling into question whether this model of conservation adequately protects wildlife, promotes economic development of local communities, or promotes healthy human–nature relationships (Schelhas 2010). One important consideration of the Yellowstone model of conservation is that it prioritizes the establishment of large, stand-alone parks, which can lead to habitat fragmentation and insufficient protection for species-at-risk. As such, there is a need to consider scale-dependent solutions for nature protection that take into consideration the theory of island biogeography, including conservation corridors and connectivity initiatives through private and public land partnerships.

The theory of island biogeography

The isolation of ecosystems through habitat fragmentation lends itself to the application of MacArthur and Wilson's (1967) theory of island biogeography, which addresses the ecology of isolated islands through the balance of immigration and extinction. The theory

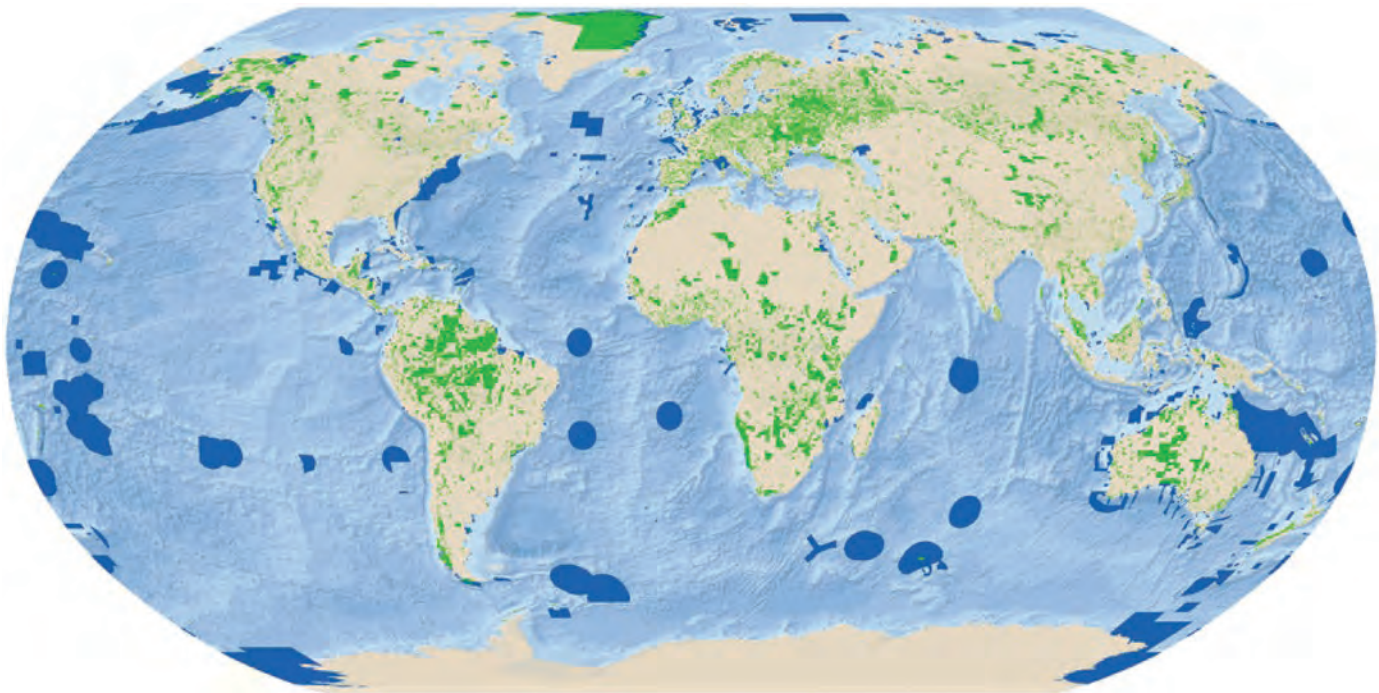

FIGURE 1. Terrestrial and marine protected areas across the globe as of July 2018. Adapted from UNEP-WCMC 2018.

states that larger islands can support more species, resulting in lower levels of extinction than smaller islands, while islands closer to the mainland allow for higher levels of immigration. It follows then, that there is an equilibrium number of species on the island that maximizes immigration and minimizes extinction (Figure 2). While MacArthur and Wilson originally posed the theory to better understand species richness on geographical islands, it has since been applied to the current lack of connectivity between parks and protected areas, which function as habitat islands, separated by human development and landscape conversion. This has given rise to the Single Large or Several Small (SLOSS) debate, asking which technique is better: large, isolated reserves of intact landscape, or several smaller reserves that allow for more habitat fragmentation but greater large-scale connectivity. However, one tactic may not be inherently better than the other, and different species of interest or conservation goals may require entirely different strategies.

The future of parks and protected areas

When considering environmental threats to PPAs, it is important to acknowledge the complex impacts of rapidly changing factors such as habitat viability, pollution, over-exploitation, invasive species, and climate change. However, given the inability to address all of these in detail here, we choose to focus on habitat changes, specifically the impact of limited connectivity between PPAs. In the United States, PPAs were historically relegated to areas unsuitable for agriculture, resource extraction, or further forms of economic development. The delayed development of protections, along with the push for Euro-American settlement, have significantly hampered our ability to create large-scale ecosystem cohesion. Habitat loss remains one of the most powerful threats to life today, and as both human populations and wildland–urban interfaces continue their rapid expansion, managers of PPAs must develop a new strategy to protect biodiversity. We envision increased use of newer techniques such as wildlife corridors, overpasses, and stopover points for migratory species. Further, the systematic ranking of areas in terms of preservation priority may prove valuable in determining how to best allocate limited conservation funding. In addition, smaller PPAs, private land, and grassroots preservation efforts may become crucial aspects of large-scale ecosystem conservation.

A metacommunity approach

Despite increases in the prevalence of protected areas around the world, there is an ongoing dialogue about the ability of isolated PPAs to effectively preserve species and their territories. However, we think that by applying a metacommunity approach to conservation, we can gain superior appreciation for how spatial dynamics and proximate ecological interactions form community structure and biodiversity, thereby mitigating the threats posed by isolated PPAs. Leibold and Chase (2018) define a metacommunity as a "larger-scale 'region,' made up of several smaller 'localities' (i.e., communities)" and the associated "spatial and interaction processes." If we are to think about the landscape as a true metacommunity, we need to consider not only the communities within the natural environment, but the complexities of human communities as well, engaging all relevant stakeholders in any future conservation efforts.

Potential strategies

As an example suggesting potential strategies to combat the threat of isolation among parks and protected areas, we briefly look at a prominent connectivity initiative, Yellowstone to Yukon (Y2Y), which seeks to preserve habitat, and the nature and people therein, from the Yellowstone region of the United States to the Yukon region of Canada (Figure 3). As with many large-scale conservation efforts, this organization's work has been met with significant conflict. While some conservationists praise Y2Y's mission, others fear the lack of a clear goal, wondering what successful connectivity looks like. Further, many residents within the Y2Y corridor have expressed concerns for their communities and their livelihoods—worried that conservation efforts may cut them off from the natural resources in their local region. Moreover, some local residents

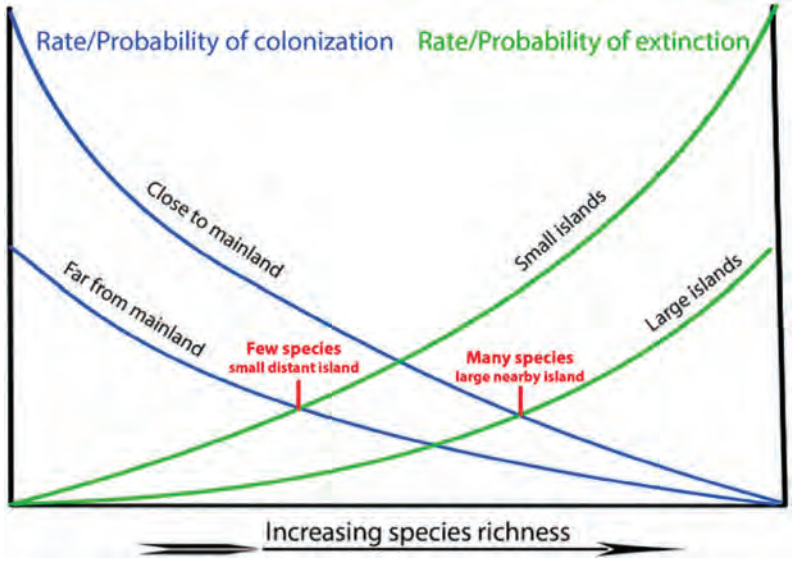

FIGURE 2. Classical island biogeography model. Adapted from islandbiogeography.org.

FIGURE 3. The Yellowstone to Yukon Region. Adapted from Chester 2003.

stress the efforts already in place to encourage sustainable harvest of resources and which regard human populations as part of the healthy ecosystem, rather than as a competitor to it (Chester 2003).

Recognizing these concerns, in 2003, ten years after Y2Y's founding, its leaders met to discuss the future of the initiative. These results emphasized a need for partnerships with local communities, accountability among a more diverse group of stakeholders, and a clearer focus (Mattson et al. 2011). Since these meetings, leaders have begun to address these concerns by employing "bite-sized" projects to address the larger goal in a more feasible and less threatening manner (Yellowstone to Yukon 2020).

The problems Y2Y faces are typical of large-scale conservation projects, and call for decisionmaking techniques that can help conservation organizations improve their community relations. We believe two such techniques—consensus-based decisionmaking (CBDM) and structured decisionmaking (SDM)—hold strong potential as tools that can be used to incorporate local working knowledge, institutional knowledge, human dimensions, ecological sciences, and overarching habitat protection goals in determining equitable, long-term solutions to connectivity challenges.

The effort we invest in the process of group decisionmaking is paramount to our success in connecting fragmented landscapes. The impulse to be reactive when it comes to preserving what's left of our disappearing habitats is strong, and, in some cases, it is imperative that we take swift, decisive action. Long-term solutions will require a more thoughtful and deeply internal global shift. The path forward will require a commitment from all parties to an ongoing collaborative process. Group decisions require trust, assurances of being listened to, and learning a common language in order for each group to be heard. It requires strong leadership to fulfill that vision.

Consensus-based decisionmaking

Consensus-based decisionmaking is a deliberate approach that enables members of all stakeholder groups to actively participate in and contribute to the decisionmaking process. While the specific process may differ between facilitators, this technique focuses on ensuring the needs of each participant are expressed and understood. In general, facilitators follow an iterative journey of seven stages:

1. Introduce and clarify the issue;
2. Open out the discussion;
3. Explore ideas in a broad discussion;
4. Form a proposal;
5. Amend the proposal;
6. Test for agreement; and
7. Work out how to implement the decision (MacKinnon 2013).

Peterson et al. (2005) state that "although argument and CBDM approaches can coexist, a fundamental difference that is critical to conservation management remains: an emphasis on argument legitimizes and facilitates change, whereas an emphasis on consensus further legitimizes continuity and stability." There is credence in the idea that, in the wrong hands, CBDM can be disastrous to achieving conservation goals, but we argue that skilled facilitation utilizing CBDM has the potential to achieve lasting results in the realm of conservation and land management that far outweigh the perceived pitfalls.

The concept of "bounded conflict," put forth by Peterson et al. (2005), argues that consensus implies

a unanimous agreement among all stakeholders. In contrast, we see community consensus as acceptance rather than unanimity. "Consensus" does not mean "harmony"; it means "acceptance." CBDM is social collectivism that, when executed skillfully, can lead to the phenomenon of "emergence," or group acquiescence. Stakeholders may not agree with the entirety of the proposed decision, but they can accept it and can continue moving forward. By focusing on language; leadership; stakeholder engagement and degree of involvement; the social, cultural, and political context within a community; and the nature of proposed land management strategies, we can collectively work towards conserving biological diversity while enhancing the human condition. In doing so, these goals become complementary rather than in conflict.

Structured decisionmaking

Structured decisionmaking (SDM), as outlined by Hammond, Keeney, and Raiffa (1999), is a quantitative approach to determining which of several potential solutions best satisfies the needs of all stakeholders. Representatives of each stakeholder group come together to define the problem, identify specific objectives that need to be met, and develop a list of potential solutions. Each group must then weight the relative importance of these objectives in achieving their ideal solution and the ability of each solution to address each objective. The latter is measured using quantitative units (e.g., dollars, number of visitors) or scales (such as a five-point scale). The solution that best satisfies the most objectives for the most stakeholder groups receives the highest point total at the end. However, these results are only a part of an iterative process. From this point, discussions can continue, and new solutions can be proposed and scored. While difficult and time-consuming, this technique is popular with the US Geological Survey and US Fish and Wildlife Service for its ability to provide objectivity in otherwise subjective and personal debates. As with CBDM, with skilled facilitation and stakeholder buy-in SDM can produce high-quality solutions that are equitable and sustainable.

Conclusion

To ensure ecosystem resilience in parks and protected areas, we must strive to understand how large-scale, systemic issues impact regions at various levels from continents down to the smallest islands—literal or figurative. Anthropogenic climate change, as well as changes to land use and land cover, expose humans, animals, and their environments to multi-scalar risk. In western North America, long histories of Euro-American expansion primed the landscape for fragmentation, leaving islands of relatively pristine nature as refugia. Coupled human–natural systems face increased risk, particularly in the continually expanding wildland–urban interface zones where private property abuts public and protected lands with a potential multitude of land managers and their various lawscapes. Unique geography, culture, existing political–legal landscapes, climate zones, and other considerations preclude a one-size-fits-all approach to understanding and acting on systemic threats to culturally, economically, and ecologically valuable parks and protected areas.

The Y2Y project demonstrates challenges associated with "biting off more than you can chew." The Y2Y region of interest is characterized by smaller nuanced landscapes reliant on combinations of watersheds, lawscapes, communities, economic dependence on extractive services, and other factors. Despite a lack of cohesion in its initial vision, Y2Y has since proved successful at multiple localized projects throughout the region, such as supporting safe migration for amphibians across busy transportation networks through small fences and tunnels. Such locally specific solutions to global problems exemplify the strengths of understanding challenges specific to coupled human–natural systems.

We strongly encourage ecologists, geographers, biologists, and other academics and activists to partake wholly and enthusiastically in community-engaged scholarship through outreach, capacity building, and social capital building through the proven frameworks of CBDM, SDM, and similar methodologies. Outreach and community-engaged scholarship must be considered an essential piece of an interdisciplinary solution. By engaging stakeholders at all levels, we can collectively move towards bigger goals in the transition from project- to process-based conservation. Meaningful interaction and dialogue with stakeholders create space for participants to share their knowledge, personal experiences, and varying skill sets as well as identifying new areas of overlap in priorities, despite pre-existing categorical labels. Creating process-based templates for conservation and incorporating decisionmaking focused on consensus as acceptance may prevent conservation goals from being becoming overly rigid— while enabling adaptive management in the future.

While continental-scale projects such as Y2Y are novel and attention grabbing, starting small and local remains a noble and valid approach. Long-term success in connecting and conserving fragmented and threatened landscapes must begin with connecting local stakeholders in meaningful dialogue.

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