Iconic Parks as Environmental Arks

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As the vast majority of natural and physical scientists interpret the evidence, global climate change is occurring at a pace now observable in decades rather than in centuries or millennia. On land and in the oceans, global climate change is likely to have profound consequences for all life. Simultaneously, global social change is affecting the geopolitical and socioeconomic conditions of human existence across the planet to challenge the way biophysical change and other areas of human interest are perceived and addressed.

Together, the environmental and social processes comprising global change are of particular importance to the world's most famous natural protected areas. Iconic national parks, preserves, and heritage areas in various countries draw tourists from around the world, capture the imaginations of vastly more non-visitors, and symbolize a society's commitment to maintaining reservoirs of species diversity, intact ecosystems, and congruent landscapes. As such, iconic protected areas provide a critical venue for international research and education on the environmental, social, and management responses to global change, and the complex feedback effects on the parks themselves. More than this, our iconic parks and protected areas become the environmental arks during a time of possible torrential climate change.

For example, the world's protected national parks and preserves face increasingly daunting challenges in their efforts to sustain viable populations of plants and animals, especially large, wide-ranging wildlife and marine life that are often keystones to ecosystem integrity. These identified and created refuges are fast becoming ecologically disconnected islands in a sea of human-altered landscapes. International boundaries and permeable entrance points (for humans as well as for animals and plants) suggest the vulnerability of protected areas. Area managers must inevitably include the problems and interests of local communities, visitors, and stakeholders to address the problems of permeable boundaries. Thus, complex interrelationships and feedback effects from human societies are necessary parts of the environment of protected areas to be analyzed and understood. By studying the effects of

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global climate and environmental changes on protected areas within their ecosystems, and by including the biosphere, geosphere, hydrosphere, atmosphere, and human social effects in such studies, we may begin to understand how management practices can advance goals of biodiversity, sustainability, and resilience of protected areas.

The collection of papers in this special issue reflects these concerns, examining how we think about and study our iconic parks. The researchers represented here were brought together through contacts initiated by Australia's University of the Sunshine Coast, and all are conducting research on national parks, especially iconic national parks. We have been guided by a set of understandings developed as we met over the past four years to discuss the research conducted in "our" parks. Specifically, we believe that the study of selected iconic protected areas will shed light on the social and environmental sources of vulnerability to global change for parks and other protected areas as well as for nature-based tourism.

To focus our studies we considered the concept and meaning of the iconic national park. As discussed by Carter, Walsh, Jacobson, and Miller in the first article in this issue, "Iconic status is attributed to a national park when it is associated with international recognition and concern for its protection and the sustainable utilization of its valued resources." As the park and its boundaries, as well as its iconic status, are human constructs, "the concept of iconic park is culturally determined and subject to challenge depending on perspectives." Iconicity therefore rests in the acknowledged value of the park and the significance attributed to these values. A number of important considerations emerge from a park having iconic status, they argue. Not least of these considerations is the presaging of possible changes facing all protected areas. That is, iconic national parks are probably useful early indicators of changes all protected areas may experience as a result of global change.

In the second article, Miller, Carter, Walsh, and Peake continue the discussion of iconic national parks by developing a framework identifying key components or elements that help to shape the influential human impacts on the parks, and that may also increase management complexity. An especially important component in the national park system is the human actors, such as park-dependent communities, native peoples' groups, local land owners, and tourist brokers. As the number and types of human actors increase, the social complexity of park management will also increase.

Four case studies follow, illustrating a number of the concerns of these two conceptual articles. Fidelman reviews the damage already done by climate change to the Great Barrier Reef. As the Great Barrier Reef produces more nutrient value (net primary production, NPP) than any other ecosystem, damage to the reef is of grave concern. Rising global temperatures may warm the surface layers of the reef's ocean waters, preventing nutrients from circulating. Over-fishing in a reef system may lead to a species' inability to recover and thus the reef system declines in NPP. Similarly, beach erosion and damage from ocean storms may increase with global climate change, affecting edge species between ocean and land. These changes will undoubtedly affect the reef-dependent communities and the activities on which those communities depend, especially tourism and fishing. The decrease in receipts from work in and around the Great Barrier Reef will constitute an economic loss to the region, just as federal help is arriving to assist the reef in its resilience to global drivers of change.

Quiroga notes that the Galapagos National Park and Marine Reserve (Ecuador) is emblematic of one of the most famous examples of scientific interest, Charles Darwin's theory of evolution. Located at the confluence of three main ocean currents, the Galapagos Islands have a climate that is different from what one might imagine based on its equatorial location. The prevailing currents include both warm and cold surface ocean waters, along with deep up-welling of cold water. Thus the climate in Galapagos contains colder than expected equatorial waters, nutrient rich environments that ultimately result in the unique ecology of the islands. Should ocean waters warm due to climate change, marine animals may adjust to warmer water by altering migration patterns. This will affect Galapagos penguins, sea lions, and other fish-dependent species, as well as sustainable fishing for ocean-dependent communities. If more marine species become "stock straddlers" (fish stocks that migrate through, or occur in, more than one exclusive economic zone), the ecosystem risks greater loss of biodiversity. To protect this ecology, in 1988 Ecuador increased its fishing limits from 15 miles to 40 miles off-shore. Yet tourism is growing so fast in the Galapagos, argues Quiroga, that there are serious effects on the sustainability of the biophysical environment. Some of these effects include: disturbing the animals, contaminating the waters, increasing human immigration, introducing non-native species, and destroying habitats to construct tourism infrastructure. As the tourism industry grows, many of the endemic and native species become more vulnerable to predation and competition as their original habitats are disturbed. The only way to assure local compliance with regulations to protect the Galapagos' ecosystem is to involve all manner of stakeholders, including large-scale and small-scale tourist operators. This inevitably increases the complexity of decision making processes that focus on the security and long term health of the marine reserve.

Similarly, Kruger National Park in South Africa is one of the world's largest intact ecosystems, with one of the highest levels of biodiversity, including every known major predator in Africa within its boundaries. But less rainfall and greater evaporation mean less water for the park flora and fauna as well as for the bordering communities on the park edge where approximately 2 million people live. Under these conditions, park animals leave park boundaries to eat crops, and local community members and others poach animals within the park. Thus the idea of conservation becomes the focus of hostility when there are not enough resources to improve the livelihoods of local populations. While conservation of resources is critical for the health of a protected area, Peake and Carter argue that environmental interpretation efforts may have even more profound long-term impacts. Environmental interpretation leads to an appreciation of the history of a park and its resources. Moreover, "interpretation aims to build long-term behavior change through creating attachments to intrinsic environmental values," while environmental education emphases conservation and a country's wealth. In the face of global climate change, an attachment to environmental values is critical to the long-term survival of park resources.

Climate change is also evident in Yellowstone National Park. Cheatgrass is forcing out native grasses, which have higher protein content and are more resistant to fire. Pikas are being forced to move to higher elevations in mountain terrain, and wolverines may find themselves isolated as snow corridors shrink. Additionally, the Greater Yellowstone ecosystem

is facing the loss of whitebark pines, which provide an important source of food for grizzly bears. A successful grizzly bear recovery program begun in 1993 means that there are more bears competing for forage. Fortunately, bears are omnivorous and eat a wide variety of foods. Yet the competition for food sources may drive the bears into more populated areas in search of food, creating more human–bear conflict and, with it, a serious risk to the bears' long-term survival. While park programs educating visitors have helped to alert visitors to the dangers of human–bear contact, Taylor, Gunther, and Grandjean show that a significant number of visitors still do not consistently endorse the regulations established by the park.

The final article in this special issue examines the importance of biocomplexity feedbacks in ecosystems, and proposes ways of modeling the feedbacks' effects. As argued by Walsh, Carter, Lieske, Quiroga, and Mena, the world's iconic parks and ecosystems represent a range of biomes; as well, they illustrate a range of significant global social and environmental issues that confront protected areas. Moreover, these parks represent significant economic investments by their countries' governments, and by the local communities which have come to depend upon tourism for much of their livelihood. A proposal to examine feedback effects between parks, natural resources, and tourists along with local communities is outlined, including a more explicit and systematic set of inclusion criteria for protected areas. The modeling begins with the ecosystem goods and services considered as the "prey," whereas tourism and the resident populations are predators. This perspective can help us to appreciate feedback effects, such as those illustrated with the example of the Galapagos.

Taken together, these papers suggest the dynamic nature of parks and protected areas. This dynamic status can be tapped to help assure the health of the parks. For example, iconic status rests in part on the extensiveness of the protected area. To protect ecosystems, iconic parks must necessarily protect the flow of flora and fauna across their boundaries. The more extensive the protected area (e.g., a national park,with surrounding national forests) the greater the buffer and therefore the greater the protection of the park's resources, as in the case of Yellowstone. Additionally, iconic parks, so as to remain intact, must be able to control the resources underneath their surface areas, to assure that their fauna, flora, geomorphic, and hydrological processes are preserved. Such is the case for the Great Barrier Reef, Yellowstone, and the Galapagos. Finally, iconic parks must have sufficient funding to carry out both conservation and protective service work to assure the park's health in the present and for the future. As managers in Kruger and the Galapagos address the concerns of human populations in and around their parks, having resources will be essential to assist and educate the local populations, to maintain secure boundaries, and to develop healthy populations of endemic park animals such as black rhinos or sea turtles. Each of these processes (maintaining extensive land or sea areas, controlling resources not only on but also under their surfaces, and securing funding) will help to ensure that these environmental arks will help our earth systems adjust to new global conditions.

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