The Interdisciplinary Journal of Place-Based Conservation | volume 36/3 | 2020

PSF
PARKS STEWARDSHIP FORUM

Humanizing the *Seas*

A Case for Integrating the Arts and Humanities into *Ocean Literacy and Stewardship*

CITATION
Johnson, Dana, Sara Brune, Dani T. Dagan, Erica Meier, Emily J. Wilkins, and Hongchao Zhang. 2020. A holistic strategy for carbon reduction programs in parks and protected areas: Leveraging three "fixes." *Parks Stewardship Forum* 36(3): 477–482.

A DOI for this citation is available at: https://escholarship.org/uc/psf

Plastic Catch · Susan Schultz
porcelain and wood sculpture

A holistic strategy for carbon reduction programs in parks and protected areas: Leveraging three "fixes"

Dana Johnson, *University of Illinois at Urbana-Champaign*
Sara Brune, *North Carolina State University*
Dani T. Dagan, *Clemson University*
Erica Meier, *Clemson University*
Emily J. Wilkins, *Utah State University*
Hongchao Zhang, *Utah State University*

Corresponding author
Dani T. Dagan
Clemson University
Department of Parks, Recreation, and Tourism Management
263 Lehotsky Hall
Clemson, SC 29634
ddagan@clemson.edu

Papers from the 2020
George Wright Society Student Summit:
"Systemic threats to parks and protected areas"

Abstract

Anthropogenic climate change is a systemic threat to conservation goals and society at large, and parks and protected areas (PPAs) are uniquely positioned to play an important role in mitigating this crisis. Reducing global carbon emissions is critical for tackling climate change and we believe PPAs serve an important role in facilitating these reductions. Drawing from Thomas Heberlein's framing of *cognitive*, *technological*, and *structural* fixes, and particularly the lesson that the most effective approaches include all three, we discuss ways that PPA managers can leverage each fix to reduce global carbon emissions. We present the three fixes as pillars of a holistic carbon emission mitigation approach in PPAs and use examples to contextualize each type of fix. However, each PPA is characterized by context-dependent attributes that require climate change "fixes" to be tailored to unique social, cultural, physical, and natural conditions for maximizing long-term sustainable solutions. Therefore, managers who seek to implement or expand carbon emission mitigation strategies may refer to this article, and the examples included herein, as a framework to identify the strengths of their current approaches and to explore areas that can be further developed.

Introduction

Global climate change, largely driven by increasing concentrations of carbon dioxide in the atmosphere, threatens an enormous number of systems worldwide, including parks and protected areas (PPAs). The socio-ecological impacts of anthropogenic climate change have left PPAs vulnerable to threats such as increasing temperatures, decreasing precipitation, and outsized biophysical effects (Gonzalez et al. 2018). These changes are also impacting the high-quality experience that many PPAs provide to visitors around the globe, which can lead to cascading negative effects on local economies that rely on tourism, for instance (Halofsky et al. 2018). Altered ecosystem function and extended visitor use seasons as a result of climate change may have long-lasting negative impacts on visitor experiences, PPA infrastructure, and biodiversity (Halofsky et al. 2018). Public land management agencies, which often hold dual mandates of maximizing ecosystem health and human enjoyment of landscapes, play an important role in mitigating carbon emissions and reducing the impacts of climate change on PPAs and their surrounding socio-ecological systems.

Many PPAs are leading extensive efforts to combat the impacts of anthropogenic climate change, including implementing strategies and innovative approaches for reducing emissions or sequestering carbon to conserve ecosystems and their services (Manning et al. 2016). For example, several protected area management plans include long-term strategies for becoming carbon neutral, a goal already achieved by Golden Gate National Recreation Area in the US. This goal has been upheld by partner organizations committed to reducing carbon emissions in PPAs, exemplified by initiatives such as the Go Zero program of the US Fish and Wildlife Service and the Conservation Fund, which

provided carbon offsets for planting native trees in national wildlife refuges (North American Intergovernmental Committee on Cooperation for Wilderness and Protected Area Conservation 2012). Structural changes have also been adopted to reduce carbon emissions in PPAs, such as using electric buses to transport people in Zion and Yosemite National Parks, while interpretive initiatives in numerous PPAs aim to educate visitors about climate change and individual emission reduction strategies. Finally, by their nature, PPA designations often include protections against unbounded extractive activities, protecting charismatic landscapes and wildlife, and thus are innately part of the solution to some extent (Manning et al. 2016). However, there are ample opportunities for PPA managers to expand current initiatives for reducing carbon emissions. While several effective efforts have been made by managers of PPAs to mitigate global carbon emissions, we posit that long-term, sustainable solutions would benefit from framing strategies around holistic changes to protected area systems.

Rather than identifying novel solutions for PPAs to mitigate carbon emissions, we suggest reframing current initiatives to maximize the longevity of sustainable solutions. We will explore potential solutions through Heberlein's (2012) "three fixes" framework, which delineates three approaches to changing individual attitudes and behavior: *cognitive*, *technological*, and *structural* fixes. We aim to present a vision of holistic carbon reduction initiatives in PPAs and to provide managers a framework for identifying strengths and opportunities in existing or future approaches to mitigating carbon emissions.

The three fixes: Cognitive, technological, and structural

In his 2012 book *Navigating Environmental Attitudes,* the sociologist Thomas Heberlein posited that policymakers or practitioners interested in reducing environmental degradation "fix" distinct aspects of a system using interdisciplinary expertise to encourage pro-environmental attitudes and behavior. To educate the public, the *cognitive fix* provides individuals with new information about an environmental system to influence attitudes and behavior. This fix emphasizes individual responsibility to modify behavior in light of new information in a way that benefits the environment. However, while education is important for changing behavior, Heberlein and subsequent researchers acknowledge that education alone is unlikely to change attitudes and behaviors. Not only can attitudes be difficult to change, but research related to the correlation between attitudes and behavior is inconclusive (Kollmuss and Agyeman 2002).

To extend efforts beyond modifying human cognition, Heberlein describes two additional approaches for changing attitudes, and perhaps behavior. The *technological fix* requires altering a component of the environment using technology or engineering, bypassing human behavior. For example, supplying power plants with renewable energy is a *technological* fix that reduces carbon emissions from electricity use. Because attitudes toward such alterations may be unknown or controversial, Heberlein warns about unintended consequences that may arise from relying on the technological fix.

The most effective approach for changing human behavior, according to Heberlein, is the *structural fix,* which entails modifying the context in which behavior occurs. In Heberlein's classic example of the structural fix, to minimize the number of Styrofoam cups used by employees in an office, replacing Styrofoam with a more sustainable material will alter the *system* and foster a change in human behavior. Heberlein suggests that this fix will likely be most successful for changing human behavior because it requires changes to the system, rather than relying solely on individual behaviors or technological components of the system, and will encourage adoption of new social norms that promote the adoption of long-term sustainable behaviors. Critically, Heberlein notes that it is important to leverage all three approaches simultaneously to change human behaviors in the context of sustainable solutions.

To elucidate how PPAs can play a role in mitigating global carbon emissions, the three fixes can help guide specific solutions that target different aspects of human behavior and the environment. While examples of all three fixes have already been adopted by many PPA managers, we suggest that leveraging all three in tandem can strategically promote long-term solutions for mitigating carbon emissions and, thus, combatting climate change.

Cognitive fixes. Promoting pro-environmental behaviors through the cognitive fix is a popular approach and, in the context of PPAs, often includes developing environmental education and interpretation efforts. Although evidence indicates structural and technological fixes can be more effective in promoting sustainable behaviors, we posit that cognitive fixes can build on existing PPA management priorities and contribute to the holistic behavior change efforts we envisage in this article. We believe that high-quality cognitive fixes include: (1) environmental education and interpretation efforts that emphasize hands-on activities and place-based learning, (2) a strong focus on engaging

the younger generation, and (3) opportunities to encourage stronger connections among the public, such as local stakeholder involvement and stewardship.

PPAs are suitable environments for demonstrating tangible impacts of climate change (e.g., flooding, wildfires, melting glaciers, species migration) using hands-on and place-based tools, which influence knowledge and attitudes through experience (Armstrong and Fukami 2009). In this way, the public has an opportunity to observe impacts of climate change and become motivated to engage in actions to mitigate carbon emissions. Thus, we encourage PPA educational initiatives to go beyond traditional approaches that rely on a passive interpretation of nature and begin to foster hands-on, place-based experiences. For instance, PPA managers or partners can design guided tours in which participants are encouraged to identify potential impacts of climate change observed during the tour and share their observations with other visitors.

Younger generations have grown up witnessing—and sometimes facing—environmental threats more than any previous generation. Youth have demonstrated their desire for change through activism, noticeable in the efforts of young activists such as Greta Thunberg, Luisa Neubauer, Isra Hirsi, and Autumn Peltier. PPA managers have an opportunity to leverage young people's desire for justice using strategic environmental education and interpretation programs at PPAs. Environmental education managers and practitioners should consider effective, ethical ways to encourage young people to take an active role in shaping the world they want to live in. Building programs that encourage participation from the younger generation and include clear advocacy efforts that embody the participation of scientists or conservationists will likely increase pro-environmental behaviors (Powell et al. 2019). For example, PPAs might align with partner organizations to design programs that encourage visitors to use place-specific information to create and share advocacy tools, like digital media messages or advocacy letters. We are hopeful that youth will use their increased environmental consciousness and activism to inspire generational shifts in how we relate to the environment.

Finally, PPA managers should foster stronger connections with and among the public to encourage local stakeholder stewardship. To increase local support, managers should invest in increasing *social capital*—defined as the networks of relationships among people who live and work in a particular context—among local communities and stakeholders to enhance prospects of using PPAs as spaces for social interaction, co-creation of knowledge, and collective decision-making. We posit that the future of PPA-led efforts to mitigate carbon emissions will rely heavily on the capacity to invigorate communities. While the cognitive fix is traditionally understood as stimulating cognitive constructs (i.e., affecting knowledge), research has shown affective responses (i.e., attitudes and emotions) to be a powerful predictor of behavior change (Armstrong and Fukami 2009). Leveraging social capital to create a sense of community around PPAs can foster affective connections and encourage pro-environmental attitudes and behavior.

Applying the cognitive fix to climate change-related issues can be useful if the target population is already environmentally oriented (Heberlein 2012). However, as mentioned earlier, one of the main criticisms of this fix is that changing people's behavior requires more than providing information, so it needs to be paired with either or both of the other fixes. For example, climate change education programs in PPAs (cognitive fix) could be supplemented by offering carbon offset programs (structural fix) as a voluntary add-on to entry fees. This additive strategy directly promotes climate-friendly behavior while also addressing the carbon cost of PPA visitation.

Technological fixes. Technological fixes require a modification to the environment. Examples in the context of PPAs include reducing total energy consumption, switching to renewable energy sources, and providing virtual park experiences. To reduce carbon emissions from vehicles, PPA managers could provide more public transit within park boundaries and to the nearby gateway communities. In busy parks, public transit could be mandatory during the peak season. Not only would this help reduce carbon emissions, but it would also reduce vehicle congestion in parks. When possible, managers should aim to include electric or hybrid buses in their fleet, as has been done in Zion and Yosemite National Parks. Additionally, work vehicles can be transitioned to electric or hybrid vehicles. Reducing the number of personal cars, as well as transitioning to electric vehicles, would help reduce total carbon emitted by vehicles within PPA boundaries. This solution would be particularly successful at cutting emissions if the electricity was generated from renewable energy. Managers may also reduce the use of non-renewable energy in PPAs, for example, by increasing their PPA's use of solar panels, wind turbines, or geothermal energy. They could also shift their power sources to companies that provide renewable energy, as has been done in Golden Gate National Recreation

Area (US National Park Service 2019). New buildings within parks should be designed to be energy efficient by using natural lighting, good insulation, and strategic window placement, as has been done at Zion National Park (US Department of Energy 2000).

In addition to reducing carbon costs of visitation through technological fixes on-site, PPA managers can significantly reduce carbon emissions by enhancing alternatives to in-person visits. Virtual experiences that allow visitors to enjoy the benefits of PPAs from their screens are increasing in popularity and diversity. PPA managers have leveraged technology to maximize accessibility to these invaluable landscapes by allowing visitors to learn interpretative lessons from park rangers, monitor sled dog puppies at any time in Denali National Park and Preserve, observe marine life in Channel Islands National Park, or take a virtual hike on the Pa'rus Trail in Zion National Park. Whether the virtual visit is targeted toward a specific activity or is flexible regarding visitors' preferences, these online experiences are important ways for visitors to access parks while reducing carbon emitted from personal vehicles to travel to these locations. Also, providing experiences to virtual visitors is one technological solution that requires a relatively low management investment.

While technological fixes have potential for mitigating carbon emissions, they are limited in their effectiveness and implementation. For example, transitioning to renewable energy, lowering consumption of fossil fuels, introducing additional public transportation in parks, and building energy-efficient buildings are expensive (though the latter reduce the cost of heating, cooling, and electricity needed to operate) and require further investments into the indefinite future. Additionally, technological fixes may have unintended consequences that limit whether they effectively achieve the goal of reducing carbon emissions. For example, virtual visitation may not decrease in-person visitation, and more research is needed to understand how PPA-related digital content influences travel and visitation behavior. Further, in many PPAs the implementation of technological solutions requires some level of public acceptance, which is typically uncertain during developmental phases of technological fixes. Finally, because such fixes are aimed at altering the environment rather than encouraging environmentally friendly behaviors, they may serve only as temporary solutions.

The use of a technological fix in isolation can also prove ineffective. In this article, we propose that PPA managers use the three fixes simultaneously, and by doing so, many of their limitations can be lessen. For example, public opposition to technological approaches can be addressed through education programs, a cognitive fix. Additionally, structural and cognitive fixes may help transition short-term technological fixes to long-term norm changes. For example, switching a bus to renewable energy power relies on continued maintenance and therefore may prove to be a temporary technological fix if funding dries up, but involving visitors in the process by teaching them about the use of renewable energy and making bus use mandatory could potentially alleviate conflict and legitimize decisions.

Structural fixes. The structural fix requires changes to situational factors that, subsequently, influence norms and human behavior. In the context of PPAs, we categorize these situational factors as (1) conditions that minimize impacts related to visiting PPAs, and (2) *in situ* mechanisms that reduce carbon emissions broadly. As described in the introduction of this paper, structural fixes are often considered to be the most effective, and while many PPAs already implement them, we propose additional or alternative actions for consideration.

Structural fixes related to the first situational factor reduce emissions generated as a byproduct of park visitation. PPAs are uniquely positioned to model sustainable tourism and create conditions that incentivize reducing travel-related emissions to foster more environmentally friendly travel norms. Many PPAs already do this, deliberately or as a byproduct of achieving parallel goals, by structuring costs on a per-vehicle basis and, in some cases, by providing shuttle busses at a reduced entry cost or by requiring public transport within the park. One example is Denali National Park and Preserve, where personal vehicles are not allowed into the heart of the park. We consider the initial investment in public transportation to be a technological fix by way of modifying the environment, and its widespread implementation as a structural fix that will shift norms associated with experiencing parks. Managers may further encourage large-scale adoption of public transit by discounting admission costs for visitors who show proof of using public transit to travel to the PPA. In PPAs that require many visitors to travel through an airport, shuttles could reduce the number of individual rental vehicles. Managers could also extend efforts to incentivize local visitation by offering a discount for those with proof of a local address, thereby discouraging traveling to distant PPAs and reducing carbon emissions. In general, we recommend PPA managers partner with transportation agencies and concessioners to accomplish these actions.

The second type of structural fix leverages *in situ* factors to generate behaviors that reduce emissions globally. For example, managers could embed a carbon offset into the entrance fee while letting visitors choose to opt out. As another example, donors could partner with PPAs and create matching programs, where they donate a certain amount for every visitor. Alternatively, PPAs could partner with makers of sustainable products or product vendors to incentivize more pro-environmental behaviors at home. Ultimately, these *in situ* structural fixes will require changes to the structure of protected area management and visitor experience. These changes will likely lay the groundwork for developing pro-environmental norms associated with the PPA visitor experience.

Even those PPAs that already have extensive empirical data on visitor demographics and patterns may want to consider partnering with social scientists to conduct more in-depth research to better understand which incentives and structural changes are most effective for maintaining visitor satisfaction while mitigating carbon emissions. We also suggest doing empirical research to monitor the outcomes of structural interventions to assess whether they achieve their intended outcomes. Additionally, fixes that leverage carbon offset funds or sustainable purchase choices are only effective if the partner products or organizations are genuinely mitigating the impacts of climate change. In some cases, organizations and companies may be "greenwashing" their products and programs and generating less good than they advertise. The opportunity costs associated with PPA managers investigating and implementing these programs must also be considered. As many PPAs are operating with limited funding and staff, time and money spent on climate change programs could take resources away from other conservation actions. Partnerships with economists, social scientists, and others who specialize in studying human behavior and environmental impacts can evaluate whether the environmental benefits of these interventions outweigh the cost of implementing them.

Applications and limitations

The suggestions included in this article are not framed as novel ideas for combating climate change, nor are they all practical for implementation in every scenario. Instead, we suggest considering the three fixes as pillars of a holistic climate change program strategy, drawing from our examples to develop mechanisms most appropriate for individual PPAs, regions, or agencies. Many PPA managers are already engaged in climate change mitigation strategies, and carrying out the framework outlined here could require examining existing climate change programs to identify how each category of fix might be leveraged, and whether there is potential for other fixes entirely. In PPAs where climate change mitigation programs are still developing, long-term strategic plans may explicitly or implicitly include all three fixes. Categorizing existing and new solutions for reducing carbon emissions can serve as a helpful guide for PPA managers to navigate the strengths and weakness of different management strategies. Overall, the application and significance of this perspectives article is to recognize the potential of leveraging PPAs to mitigate climate change, and to consider using the "three fixes" framework to deliberately approach that goal.

Citizen science programs are an example of how effective this approach can be. These programs draw from the cognitive fix to inform citizens about how to monitor environmental conditions and do outreach initiatives, including hands-on and place-based elements. Technologically, citizen science programs can be designed to minimize carbon emissions by transporting and housing volunteers using renewable infrastructure or utilizing PPA shuttles while conducting surveys. Finally, these programs can provide a useful structural fix by building reduced carbon behaviors, such as using public transit, into the program, with the ultimate aim of modifying social norms around park use and climate change behavior. Normalizing citizen science programs may foster changes in what it means to be a park visitor and supporter—a structural change that could help with efforts to combat climate change. Expanding localized initiatives such as citizen science programs that entail simultaneous cognitive, technological, and structural fixes to PPA systems can cultivate long-term solutions for mitigating carbon emissions globally.

While the "three fixes" can serve as a holistic framework for managing PPAs to reduce total carbon emissions, there are limitations in applying these fixes that should be considered. First, effective cognitive fixes depend on local social and ecological relevance. In other words, for a cognitive fix to be considered successful, we do not recommend a "one-size-fits-all" approach, but rather implementing educational programs that focus on the localized impacts of climate change, tailored to local populations and visitor demographics. Second, the technological solutions explored here have only suggested reducing carbon emissions related to visitation; however, in conjunction with the other two kinds of fixes PPAs can also influence carbon emissions more broadly. Further, technological fixes often require significant changes to PPAs' infrastructure or regulations that impact visitors, with the result that public

perceptions of technological fixes are often uncertain and may even be contested. Structural fixes, while touted as the most successful for changing attitudes and behavior over the long term, require extensive resources that may not be realistic for achieving short-term goals. Combining strategies from all three fixes will better position PPAs to reduce carbon emissions and maximize their role in combating global impacts of climate change.

Conclusion

Anthropogenic climate change poses serious challenges globally and PPAs can play a crucial role in fostering pro-environmental behaviors that help mitigate its impacts, particularly by reducing carbon emissions. As climate change continues to impact ecosystem health and function, recreational resources, and visitor behaviors, PPAs managers should consider strengthening their climate change mitigation approaches to achieve environmental and social sustainability. In this article, we described three fixes (*cognitive*, *technological*, and *structural*) to promote pro-environmental behavior, specifically by reducing carbon emissions, and advocated for holistic approaches that integrate all three. Ultimately, enhancing existing PPA initiatives for reducing carbon emissions through the simultaneous use of the three fixes can provide a comprehensive framework for identifying solutions and maximizing the long-term sustainability of these valuable landscapes.

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