

# Climate Change and Landscape Preservation: A Twenty-First-Century Conundrum

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**The threat of climate change means that we must question the manner in which we see cultural landscapes, understand their significance, and plan for their future.**

For preservationists, *landscape* should always equal nature combined with culture. The dynamic of the cultural landscape over time, changed and altered by human activity, is especially important, as it reflects the very essence of both place and human experience. We care deeply about meaning in people's lives, and we seek ways to identify, understand, and protect those historic-landscape characteristics that have the most, and perhaps most enduring, meaning in our lives — characteristics and trajectories that root us in these places.

There is increasing concern, however, about undesired changes to our global landscape and the ways in which those changes are affecting significant cultural landscapes. While many others are attentive to the eroding condition of our natural environment and the subsequent impact on biological systems, this discussion addresses the impact of that erosion on significant human landscapes. The two are inseparable, of course, and at least some of the scientific research suggests that perhaps we have not yet reached the tipping point in this equation, although we may be very close.<sup>1</sup>

This article is about global climate change and the known and potential impacts of these changes on historic and cultural landscapes. While this idea is inextricably linked to aspirations of sustainability, it is not the same, as discussed below.

## Global Data about Climate Change

The data on climate change can seem confusing and overwhelming. There are no simple ways to view this complex and, at times, contentious issue.<sup>2</sup> Perhaps one of the most confounding aspects of the predictions of climate change is that it is both global and

local, that it can vary dramatically from locale to locale, even though it is a global problem.<sup>3</sup> A recent United Nations report summarized significant data on climate history:<sup>4</sup>

- Eleven of the last twelve years rank among the warmest in global surface temperature since 1850.
- Carbon dioxide is the dominant contributor to current climate change and especially global warming.
- Since the 1970s, more precipitation has been observed in the eastern parts of North and South America, northern Europe, and northern and central Asia in recent decades, but northern Africa, the Mediterranean, southern Africa, and parts of southern Asia have experienced drying.
- The rate of observed sea-level rise increased from the nineteenth to the twentieth century, and the total twentieth-century rise is estimated to be 0.17 meter, or more than half a foot. Geological observations indicate that sea-level rise over the previous 2,000 years was far less (Fig. 1).
- Snow cover is decreasing in most regions, particularly in spring. The maximum extent of frozen ground in the winter/spring season has decreased by about 7% in the Northern Hemisphere since 1900. On average, rivers that freeze do so some 5.8 days later than they did a century ago, and their ice breaks up 6.5 days earlier.
- Average Arctic temperatures increased at almost twice the global average rate in the past 100 years. Satellite data since 1978 show that the average extent of Arctic sea ice has shrunk by 2.7% per decade.

These are not projections; they are conclusions drawn from years, and in some cases decades, of data collection.



Fig. 1. Sea levels globally are estimated to have risen more than half a foot in the twentieth century, with considerable impact on historic resources, as seen here on the Pacific Coast near Newport, Oregon. All images by the author.



Fig. 2 Changes in plant communities as a result of climate change may result in a significant increase in the amount of biomass consumed by wildfire, as seen here in the Cascade Mountains, Lane County, Oregon.



Fig. 3. Cultural resources at national parks, such as these cliff dwellings at Mesa Verde, may deteriorate due to either an increase or decrease in precipitation.

The same report also outlines the reasons for the changes.<sup>5</sup>

- Human-caused emissions of greenhouse gases have made the atmosphere thicker and denser, trapping heat and leading to a global warming.
- Fossil fuels are the single biggest source of human-generated greenhouse-gas emissions.

And finally, the UN report provides some indication of the potential future global impacts of continued climate changes if there are no alterations to these patterns:<sup>6</sup>

- The poorest communities are most vulnerable to the impacts of climate change.
- The average global sea level is projected to rise by 10 to 20 inches due to ocean expansion and glacier melt by the end of the twenty-first century compared to 1989-1999 levels.
- Twenty to thirty percent of species are likely to face an increased risk of extinction.
- There will be greater heat waves, new wind patterns, worsening drought in some regions, heavier precipitation in others.

There is great geographic and seasonal variation in the projections of climate changes, as well as their impacts on the quality of our lives and the landscapes we inhabit. There is also a great deal of uncertainty about the magnitude of climate change, especially on local scales, and additional uncertainty about

how the earth's ecosystems will respond to these changes.

### Some Local Examples

What if the processes of nature have been severely altered by human activity? What if the oft-stated intention to "interfere as little as possible" is overtaken by the urgent need to respond to forces well beyond the scope of any landscape?

There are many examples of our economic, social, and historic landscapes affected by subtle, yet observable, alterations in the global climate. The following examples are all from the United States, but the issues and questions they raise apply globally in other locales.

The most recent study of forests in the U.S. West reveals trends that reflect an increasing rate of mortality in healthy conifer stands and no comparable rate of replacement seedlings that survive to become large trees, a process referred to as *recruitment*.<sup>7</sup> This study, with data covering a 50-year span from 76 forest sites in the Pacific Northwest, California, Idaho, Colorado, and Arizona, reviewed a wide variety of possible causes for this alarming alteration to ecological systems. The study looked at changes in forest structure, management processes focused on fire exclusion, and species' life histories and successional dynamics (such as shade tolerance) for clues to address their data and observations. In their final analysis the authors believed that the only culprit was the

consistent, if modest, warming of the forests' climate.

Another, more focused, study of the Rogue River Basin in southwestern Oregon seeks to define stressors on, and risks to, human and natural systems. This is a scientific study with implications for public policy, lifestyle patterns, and our economic system, with recommendations for increasing resilience and resistance in human, built, economic, and natural systems in the region.<sup>8</sup> It purposefully links natural systems we have inherited and cultural systems we have created.

There are four major areas of concern in this valley: increased temperature, especially dramatic in the summer; changes in precipitation and snowpack; increase in severe storm events and longer duration of wet and dry seasons; and a significant increase in the amount of biomass consumed by wildfire (Fig. 2).<sup>9</sup>

Other examples are from the U.S. national parks, among the country's greatest natural and cultural treasures (Fig. 3).<sup>10</sup> Recent studies strongly indicate that global-warming trends may be affecting Western parks at a faster rate than those in the East.<sup>11</sup> The national parks, unlike other public landscapes, are meant to be left "unimpaired for the enjoyment of future generations."<sup>12</sup> But what does "unimpaired" mean, when there are changes that are beyond the control of any one federal agency?

For example, Glacier National Park, in Montana, is in danger of losing its glaciers to climate change.<sup>13</sup> In 1968

there were 38 glaciers in the park. As of 2007 there were only 26. Other Western parks are being equally affected. North Cascades, Mount Rainier, and Olympic national parks, all in Washington, are also seeing their glaciers melt away, as has Yosemite in California.

Glacier loss is not the only measurable problem directly attributed to climate change. The loss of alpine tundra brings with it associated loss of habitat for a great variety of plant and animal species uniquely suited to these harsh, high-altitude environments, including plants such as tussock grasses, dwarf trees, small-leafed shrubs, and heaths, and animals such as pikas, marmots, mountain goats, bighorn sheep, elk, and ptarmigan.<sup>14</sup> Further effects may include the loss of plants for use by indigenous peoples, as well as the loss of native cultural practices such as hunting and fishing. There has already been a loss of forest cover in large areas of the West, as well as a loss of meadows and wildflowers.<sup>15</sup>

What is the impact of these losses in the parks and in the larger landscape? There is a greater opportunity for invasive plant species to take hold, as well as increased forest fires resulting in loss of native plant species. The same is true for wildlife: not only may we lose native wildlife, but invasive wildlife may also seek friendlier habitats (Fig. 4). The list of risks includes impacts on cultural resources, such as archeological sites, historic architecture, and cultural landscapes. A recent study, for example, describes the long-term impact of climate change on the flora of Thoreau's Walden.<sup>16</sup>

### Sustainability, Climate Change, and Historic Preservation

In the historic-preservation community there is growing awareness that preservation can contribute to a sustainable future. By protecting and reusing existing buildings, we are saving embodied energy, reducing the need for new energy, and contributing to the larger societal ethic that recognizes the limits to our growth.<sup>17</sup>

This is not a new idea, but much credit for establishing the connection between preservation and sustainability needs to go to the preservation commu-

nity in the U.S. During the last energy crisis, in the 1980s, the National Trust for Historic Preservation developed an enlightened public-relations campaign. Historic buildings in Washington, D.C., were draped with banners declaring the amount of embodied energy in each building, as measured through barrels of oil. It was a brilliant idea and established the connection between preservation as an ethic and the growing energy and resource depletion.

The idea that preservation can assist with community energy needs never quite captured the public imagination, however. Perhaps the campaign did not go far enough, or perhaps we, as a people, are simply too enamored with unbridled growth and immediate gratification. Nonetheless, it is fairly easy to understand that a historic building holds within its walls a certain amount of energy and that the destruction of that building not only represents the loss of history; it also means the loss of energy and a further dependence on limited fossil fuels.

Today, the National Trust and its partners are linking preservation to sustainability. As Richard Moe, president of the Trust, has said, "Any solution to climate change must address the need to reduce emissions by being smarter about how we use our buildings and wiser about land use."<sup>18</sup> While the Trust is admirably taking the lead on visibly establishing the connection between preservation and sustainability in the U.S., there are some major gaps.

### Cultural Landscapes in Historic Preservation

When it comes to historic and cultural landscapes, it is much more difficult to identify the values that matter and the resources that are being lost through the encroaching changes in the global climate. The questions and challenges that this issue raises are enormous, as we must first understand what we have and value, recognize the ways in which these resources are being impacted by climate change, and then find answers and solutions that look within preservation practice as well as to the larger environmental context.

In a 1981 article British journalist and writer Marion Shoard tackled many



Fig. 4. With changes in climate patterns at many levels, invasive wildlife may seek friendlier habitats, such as this example from Griffith Park in Los Angeles.

thorny issues around the difficulty of saving important landscapes.<sup>19</sup> Shoard listed a number of reasons why landscapes are much more difficult to protect than buildings.<sup>20</sup> These arguments are still valid today.

The first reason, Shoard argued, is the very nature of landscape itself. We understand buildings, she reasoned, as reflections of the need for shelter and commerce. Landscapes — and in the American context we need to specify cultural landscapes — are the product of the interaction of human activity with natural systems, namely the “geography, geology, and biology of our planet.”<sup>21</sup> The origins of this thinking in the U.S. lie with Carl Sauer's work in the 1920s.<sup>22</sup> The landscape is not easily understood by the casual or often even the educated viewer. As Shoard saw it, “any landscape is essentially a jumble of objects whose origin, function and relationship to each other are mysteries.”<sup>23</sup>

While the cultural landscape is much more than a “jumble of objects,” Shoard's point is valid. We have great trouble understanding the cultural landscape, largely because its processes and content are not readily and easily accessible to us.

Second, Shoard understood that it is hard to set the boundaries of a cultural landscape in space and time. We know when a building was constructed, but how do we set a date of origin or construction for most landscapes? For those with known designers, it is easy, but for others it is almost impossible. When did a landscape “start?” How far back in its

natural history do we have to go in order to understand it and recognize its meaning?

The question of spatial limits is also difficult to resolve. Where does a landscape start, and where does it stop? We tend to think of this in terms of land ownership, but what about the “borrowed landscape?” Is the landscape as far as we can see? If we disregard political boundaries, is the landscape never-ending?

There are two important developments in this regard that warrant attention. The first is the well-known work of the U.S. National Park Service, under the leadership of Hugh C. Miller, then chief historical architect, and the National Register of Historic Places to develop standards for the identification, documentation, and evaluation of cultural landscapes, beginning in the mid-to late 1970s.<sup>24</sup> The second important development is the work of ICOMOS, beginning with the Florence Charter of 1981.<sup>25</sup> These activities sought to establish the importance and relevancy of cultural landscapes within the preservation and heritage communities.

Third — and most importantly — the landscape is always changing. It is dynamic by design and nature. Thus, the protection of cultural landscapes often runs counter to the standard or traditional values of historic preservation that seek to arrest and limit change, rather than embrace it. Landscapes change, and hence, Shoard adds, “this feeling of constant change helps mask the effects of deeper, permanent alterations to a landscape.”<sup>26</sup> Because we anticipate landscape change, we often fail to see when that change is outside of accepted or normal patterns or boundaries due to seasonal fluctuations, normal weather patterns, or even the variations of light.

Mark Laird addressed cultural landscapes and climate change through a number of critical issues, especially planting conservation.<sup>27</sup> Laird maintained that we need to focus on “adaptation on the one hand, legislation on the other,” as well as the “historical realities of planting as improvisation, or gardening as experimentation and alteration.” This attitude reinforces Shoard’s assertion, as well as that of the larger community, that the dynamics of land-

scape are often poorly understood and little recognized in the preservation community.

In ecology there is a concept referred to as the historic range of variability.<sup>28</sup> Dynamism is important to the continuity and maintenance of certain functions, but the measuring stick for what is desirable to maintain those functions are the limits that have bounded change over some period of time. A concern with climate change is that those historical limits are not likely to hold anymore, leading us into uncharted territory where our options appear to be either to resist climate change (a short-term measure to protect valued resources), to enhance the resilience of ecosystems to climate change (their ability to bounce back after being stressed), or to facilitate the change to a new state compatible with climate change.

But these two directions — accepting inherent change in the landscape on the one hand and the preservationist’s desire to limit change on the other — present us with a set of contradictions and quandaries.<sup>29</sup>

We seek to protect those landscapes that have special meaning and significance in our society and our culture, much as we do with historic architecture and historic sites. Not all cultural landscapes are historically significant, however, a point that is often lost in the literature. But those landscapes that are significant will change, as Marion Shoard observes.

### **The Potential Impact of Climate Change on Cultural Landscapes**

What happens, however, when that change is not as the designer or builder envisioned? What happens when change in an extreme event, and without direct human intention, potentially removes or destroys the characteristics for which the landscape is known and revered? And what happens when that change is so slow, modest, and incremental that we can barely see it until it may be too late?

Climate change can be understood to have two major threads: the slow building of temperature and its side effects, such as sea-level rise and ocean acidification, which may appear as gradual, and those that are generated by extreme

events — droughts and storms, for example. The idea of resilience is a particularly important concept in ecology precisely because of the need to recover from extreme events.

We have, for some years, believed that change in the historic cultural landscape can be managed, or directed, in order to protect significant landscape characteristics. The National Register of Historic Places recognizes historically significant cultural landscapes, and there are historical-landscape architects and cultural-landscape specialists in National Park Service regional offices and in many national parks.<sup>30</sup> There is the Cultural Landscape Foundation, whose mission is to increase “the public’s awareness of the importance and irreplaceable legacy of cultural landscapes.”<sup>31</sup>

We understand historic buildings change as well, but the issues in the landscape are different, and the potential for reversibility — a key tenet of historic-preservation practice — is limited. This fact is one more example where the nature of the landscape and the landscape of preservation may not coincide.

There is some work being done in regard to historic landscapes and the pressing needs of changing ecological dynamics, but little of that appears to be in the U.S.<sup>32</sup> Not surprisingly, for example, an article on landscape preservation in the thirtieth-anniversary issue of the *APT Bulletin* did not mention climate change. It did, however, recognize the inherent connection between nature and culture in these landscapes and the importance of values, as opposed to legislation, in this discussion.<sup>33</sup> Additionally, the *APT Bulletin* issue on sustainability omitted any meaningful discussion of cultural or historic landscapes, as did the report on the APT Halifax Symposium on Sustainability.<sup>34</sup> As discussed below, the emphasis on sustainability, rather than the potential impacts of climate change, is common in the preservation community in North America, with few exceptions.

English Heritage’s Web site has a very informative section on climate change, as does the National Trust (UK) and the Royal Horticultural Society on the broader issue of sustainability, with reference to climate-change concerns for



Fig. 5. Significant historic designed landscapes — such as Kykuit, the Rockefeller estate in Westchester County, New York — will face management challenges if their historic plants cannot thrive in a changing climate.



Fig. 6. Natural disasters, such as Hurricane Katrina in New Orleans in 2005, may be partially caused by changes in weather patterns due to global warming.

British gardens, although there is scant direct reference to historic landscapes.<sup>35</sup>

Most importantly, the 2002 British publication *Gardening in the Global Greenhouse: The Impact of Climate Change on Gardens in the UK* outlines the impacts of climate change, as well as areas for future research and recommendations for direct action.<sup>36</sup> While these recommendations are aimed exclusively at designed gardens, they are nonetheless useful as a tool to explore other potential interventions (Fig. 5).

Other U.S. federal agencies and organizations have also attempted to address the impacts of climate change with varying degrees of success.<sup>37</sup> The America Society of Landscape Architects (ASLA) has primarily addressed sustainability concerns through the development of guidelines for new design, which corresponds to similar efforts in architectural design.

Richard Moe of the National Trust pointed out that a recent UN report does not stress the importance of reusing the buildings we have. Moe concluded that “incredibly, we propose to solve the problem by constructing more and more new buildings while ignoring the ones we already have.”<sup>38</sup> Similarly, the most recent efforts by the green community place heavy emphasis on new technologies rather than on preservation practices that focus on reusing existing buildings to reduce the environmental impacts associated with demolition and new construction. The most popular green-building rating system, the Leadership in Energy and Environmental

Design, or LEED, program, developed by the U.S. Green Building Council, was designed principally for new construction, underscoring the fact that words like *rehabilitation* and *reuse* have not had much resonance in the green-building lexicon.

Implicit in the idea of adaptive reuse is the possibility that we may need to accommodate new uses in our historic landscapes in order to save them. In the past, we have not talked about adaptive reuse of these landscapes the way we have for historic buildings. However, the Sustainable Sites Initiative (or SSI) of the ASLA is a forward-looking and visionary document, assisting landscape architects and others to depart from the world of traditional planning and design and to foster a transformation in land-development and land-management practices.<sup>39</sup> Through the creation and implementation of clear and rigorous design, construction, operations, and maintenance criteria, the SSI aims to supplement existing green-building and landscape guidelines, as well as to become a stand-alone tool for site sustainability.<sup>40</sup> It is meant as a call to action and a guide to the dramatic alteration in the very way we think about what we do as designers. The draft report describes an “ecosystems services framework” and promises in the future to deliver guidelines and performance benchmarks, a weighting system, and a reference guide. More importantly, the SSI articulates “Ten Guiding Principles of a Sustainable Site.” This document is an appropriately complex report that

bears review on its own. The ten guiding principles start with “Do No Harm,” an admirable aspiration, and also include the call to employ a decision-making hierarchy of preservation, conservation, and regeneration.

In the language of landscape systems, however, preservation often carries a different meaning from when it is associated with the historic preservation of architecture. In the SSI preservation refers to “existing environmental features,” which can include historic features, but not necessarily.<sup>41</sup> In ecological terms, preservation often implies the protection or reinstatement of a healthy and robust ecological system and leads to action parallel to architectural restoration. Change is inherent in this concept, a substantially different view from that often held by historic-preservation advocates and practitioners. As previously noted, the concept of landscape restoration is not universally accepted.<sup>42</sup>

What are the potential impacts of climate change on historic landscapes? What can we anticipate will be our challenge? Are there lessons we can learn from the ways that dynamism and change are incorporated into ecosystem management? While there has been little attention to these questions in the U.S., English Heritage and other agencies and organizations in Europe are addressing these very concerns.<sup>43</sup>

In January 2006 English Heritage released a report entitled “Climate Change and the Historic Environment,”<sup>44</sup> which outlined the potential threats of climate change to historic



Fig. 7. Character-defining cultural-landscape features, such as this blue-grass region near Lexington, Kentucky, are susceptible to gradual deterioration due to warmer temperature, increased or decreased precipitation, and changes in surrounding plant communities.



Fig. 8. Significant rural landscapes, such as Hanalei, Hawaii, have developed over decades or centuries in response to local soils and climate. They may be seriously threatened by substantial changes to the environment that has enabled them to grow and thrive.

environments, including historic landscapes. The primary threats noted are:

- rising sea levels and an increase in storminess that endanger historic landscapes, structures, buildings, and archaeology in the coastal zone
- increased extremes of wetting and drying that heighten the risk of ground subsidence and accelerated decay of stonework
- more frequent intense rainfall that causes increased erosion of archaeological sites and damaging flooding in historic settlements
- changes in hydrology that put buried archaeological remains at risk
- changes in vegetation patterns that threaten the integrity of archaeological remains and historic landscapes
- a warming climate that makes some historically authentic tree plantings difficult to conserve
- changes in the distribution of pests that threaten the integrity of historic buildings, collections, and designed landscapes
- possible increases in the frequency or geographical range of extreme weather that could pose an increased risk of damage to some historic landscapes and buildings.

In addition, according to the English Heritage report, some adaptive responses to climate change may themselves have an impact on the historic environment. For example, the construction of new seawalls to resist rising

water levels would alter the historic coastline.

With this information, and much other data, in hand, what does this mean for cultural landscapes? How does it affect conservation of cultural landscapes?

There are obvious tasks, of course — continuing to recognize, identify, and understand significant cultural landscapes; embracing the idea that climate change affects these landscapes; monitoring the impacts of global climate change on our local landscapes; adapting or modifying what we are already doing; and preparing for further disasters like Hurricane Katrina or the flooding in the Silo and Smokestacks National Heritage Area of northeastern Iowa — but there are more radical changes in our viewpoint that are necessary (Fig. 6).<sup>45</sup>

### Potential Actions

Building on the recent work of ecologists and other natural-resource scientists, there are a number of important preliminary considerations and approaches to these problems.<sup>46</sup> None of these may work on its own, but we may consider these as a “toolbox” of ideas and strategies.<sup>47</sup>

First, we must accept the premise of an uncertain but certainly variable future for these landscapes. We should directly embrace flexibility in our approaches, encourage frequent reassessment of conditions, and plan for the

need to change course as conditions change. These are not easy strategies, and they demand a dynamic approach.

Second, when addressing these challenges to historic landscapes, we must adapt to change and ways to mitigate it. For starters, we can create resistance to change. This resistance can be in the form of a more flexible understanding of what we mean by character-defining features, for example, especially when it comes to historic plant materials and plant communities. Does it matter more, in preservation terms, that a landscape retains the exact tree genus and species or that the spatial and visual consequences of those trees are maintained? Would it be better to plant replacement trees that are more resistant to warming, or to re-plant trees that will not survive their twenty-first-century environment (Fig. 7)?

Third, we should seek ways to promote resilience to change. This strategy may mean greater proactive intervention in certain highly valued landscapes, which, in turn, implies the setting of priorities. For example, we may want to engage in greater seed-banking or intensive management during re-vegetation, a labor-intensive and costly process that nonetheless may enable the protection of critical landscape features (Fig. 8).

Fourth, we should be prepared to make difficult decisions about what to try to save, what is salvageable, and what is not. In the extreme, this may mean that we practice a form of “cultural-landscape triage,” choosing to save

certain places while letting other ones remain only in the historical record. This course is not a long-term response but may be necessary as a short-term step while we develop the science for more lasting solutions.

Fifth, we should learn from the Noah's Ark Project in Europe, which "aims to improve this situation through a deeper understanding of the behavior and response of immovable cultural heritage and historic materials to the [impacts of climate change], discovering possible endangering synergistic processes and providing cultural heritage managers, decision makers and legislators with scientifically sound data and models."<sup>48</sup> This cannot be an emotional or humanistic argument alone.

And, finally, we should recognize the "historical ranges of variation."<sup>49</sup> Taking both the long and short views is vital in this preservation effort. While it is often tempting or convenient to look at the most recent past, landscape time demands that we consider variations over a long period.

## Conclusion

In the overlapping worlds of historic preservation, cultural landscapes, and environmental futures, we have worked for years to incorporate landscape issues into preservation thinking. In the process, that cosmology has grown and shifted to accept the inevitability of change and, whether for buildings or landscapes, has slowly moved away from the rigidity of arresting change to the flexibility of managing it. This has been good for all.

We now confront a level of change to those resources that is beyond our traditional understanding and management. We must re-think what we value and even what we can legitimately hope to achieve.

This is the conundrum, the confusing problem that leads us to question the manner in which we see these landscapes, understand their significance, and plan for their future.

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## Notes

1. See, for example, recent articles in *Nature*, [www.nature.com/news/2009/090619/full/news.2009.586.html](http://www.nature.com/news/2009/090619/full/news.2009.586.html), and the recent reports issued by the U.S. Environmental Protection Agency, [www.epa.gov/climatechange/](http://www.epa.gov/climatechange/).

2. For example, see Mark Steyn, "Climate Change Myth," *The Australian*, Sept. 11, 2006, and Tim Flannery, *The Weather Makers: How Man is Changing the Climate and What It Means for Life on Earth* (New York: Atlantic Monthly Press, 2005). These are just two examples of the widening discussion on climate change.

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4. See Gateway to the UN System's Work on Climate Change 2008, [www.un.org/climatechange/background/ata glance.shtml](http://www.un.org/climatechange/background/ata glance.shtml), and especially <http://www.un.org/wcm/content/site/climatechange/pages/gateway/the-science/at-a-glance>.

5. Ibid.

6. Ibid.

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9. Ibid., iii.

10. See, for example, Stephen Saunders and Tom Easley, with Jesse A. Logan and Theo Spencer, "Losing Ground: Western National Parks Endangered by Climate Disruption," *George Wright Society Forum* 24, no. 1 (2007): 41–81.

11. Ibid. See also Jennie Hoffman and Eric Mielbrecht, *Unnatural Disaster: Global Warming and Our National Parks* (Washington, D.C.: National Parks Conservation Assoc.: 2007).

12. National Park Service Organic Act, 64th Cong. 1st sess., 1916 (16 U.S.C. §§ 1-18f, 39 Stat. 535).

13. Saunders, 43.

14. Ibid., 46.

15. Ibid., 48–49.

16. See Abraham J. Miller-Rushing and Richard B. Primack, "The Impact of Climate Change on the Flora of Thoreau's Concord," *Arnoldia* 66 (2009): 2–9, and R. B. Primack, A. J. Miller-Rushing, and K. Dharaneeswaran, "Changes in the Flora of Thoreau's Concord," *Biological Conservation* 142 (2009): 500–508.

17. Donella H. Meadows, Jørgen Randers, and Dennis L. Meadows, *The Limits to Growth: The 30-year Update* (White River Junction, Vt.: Chelsea Green Pub., 2004).

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19. Marion Shoard, "Why Landscapes Are Harder to Protect Than Buildings," in *Our Past Before Us: Why Do We Save It?* ed. David Lowenthal and Marcus Binney (London: Maurice Temple Smith, 1981), 83–108.

20. Marion Shoard, *The Theft of the Countryside* (London: Maurice Temple Smith, 1980).

21. Shoard, "Landscapes," 91.

22. C. O. Sauer, "The Morphology of Landscape," *University of California Publications in Geography* 2 (1925): 19–53.

23. Shoard, "Landscapes," 91.

24. See, for example, J. Timothy Keller and Genevieve P. Keller, *National Register Bulletin 18: How to Evaluate and Nominate Designed Historic Landscapes* (Washington, D.C.: U.S. Dept. of the Interior, 1987). Linda Flint McClelland, J. Timothy Keller, Genevieve P. Keller, and Robert Z. Melnick, *Guidelines for Evaluating and Documenting Rural Historic Landscapes* (Washington, D.C.: U.S. Dept. of the Interior, 1989). Robert Z. Melnick, "Preserving Cultural and Historic Landscapes: Developing Standards," *CRM Bulletin* 3, no. 1 (1980): 1–7. Robert Z. Melnick, *Cultural Landscapes: Rural Historic Districts in the National Park System* (Washington, D.C.: U.S. Dept. of the Interior, 1984).

25. See [www.international.icomos.org/charters/gardens\\_e.htm](http://www.international.icomos.org/charters/gardens_e.htm).

26. Shoard, "Landscapes," 94.

27. Mark Laird, "The Impacts of Climate Change on Historic Landscapes," in *The Significance of Setting: Conserving Monuments and Sites in Changing Canadian Cultural Landscapes* (Toronto: ICOMOS Canada, 2005), CD available at [canada.icomos.org](http://canada.icomos.org). See also Mark Laird, "Climate, Weather and Planting Design in English Formal Design of the Early 18th

Century," *Die Gartenkunst des Barock*, ICOMOS Journals of the German National Committee 28 (1998): 14–19.

28. Thanks to Bart Johnson, University of Oregon, for offering clarity about this concept.

29. See, for example, Peter Del Tredici's writings, especially "The Role of Horticulture in a Changing World," in *Botanical Progress, Horticultural Innovations and Cultural Changes*, ed. Michel Conan and W. John Kress. (Washington, D.C.: Dumbarton Oaks, 2007), 259–265.

30. For more information on NPS historic- and cultural-landscape activities, see [www.nps.gov/history/HPS/hli/](http://www.nps.gov/history/HPS/hli/).

31. For more information see the Cultural Landscape Foundation's Web site, [www.tclf.org/](http://www.tclf.org/).

32. Shary Page Berg, "Applying Principles of Sustainability to Cultural Landscapes" (paper, Sixth National Forum on Preservation Practice: A Critical Look at Sustainability and Historic Preservation, Goucher College, Baltimore, Md., March 19–21, 2009). For further information on this conference, see [www.goucher.edu/x29529.xml](http://www.goucher.edu/x29529.xml).

33. Susan Buggey, "Historic Landscape Conservation in North America: Roaming the Field over the Past Thirty Years," *APT Bulletin* 29, no. 3–4 (1998): 37–42.

34. See *APT Bulletin* 36, no. 4 (2005) and John D. Lesak, "APT and Sustainability: The Hali-

fax Symposium," *APT Bulletin* 36, no. 4 (2005): 3–4.

35. See [www.english-heritage.org.uk/server/show/nav.18455](http://www.english-heritage.org.uk/server/show/nav.18455), [www.rhs.org.uk/learning/research/conservation\\_and\\_environment.asp](http://www.rhs.org.uk/learning/research/conservation_and_environment.asp), and [www.nationaltrust.org.uk/main/w-chl/w-countryside\\_environment/w-climate\\_change.htm](http://www.nationaltrust.org.uk/main/w-chl/w-countryside_environment/w-climate_change.htm).

36. Phil Gates, *Gardening in the Global Greenhouse: The Impact of Climate Change on Gardens in the UK* (Oxford: UK Climate Impacts Programme, 2002).

37. See, among others, National Park Service, "Climate Change Activities in the Southeast" (internal document, n.d.). Paul R. Epstein and James J. McCarthy, "Assessing Climate Stability," *Bulletin of the American Meteorological Society* (August 2004). ICOMOS Thematic Workshop on Cultural Heritage and Climate Change, Quebec, Canada, Oct. 1, 2008. For further information on this report, see [www.international.icomos.org/climatechange/.../ICOMOS\\_GCC\\_Cultural\\_Heritage\\_Workshop\\_Quebec\\_2008\\_Report\\_Final\\_EN.pdf](http://www.international.icomos.org/climatechange/.../ICOMOS_GCC_Cultural_Heritage_Workshop_Quebec_2008_Report_Final_EN.pdf). ICOMOS Scientific Council, "Recommendations from the Scientific Council Symposium, Cultural Heritage and Global Climate Change (GCC)," see [http://www.international.icomos.org/climatechange/pdf/Recommendations\\_GCC\\_Symposium\\_EN.pdf](http://www.international.icomos.org/climatechange/pdf/Recommendations_GCC_Symposium_EN.pdf). UNESCO World Heritage Centre, "Cultural Landscapes: The Challenges of Conservation. World Heritage Papers 7," see [http://whc.unesco.org/documents/publi\\_wh\\_papers\\_07\\_en.pdf](http://whc.unesco.org/documents/publi_wh_papers_07_en.pdf). U.S. National Park Service, "Climate Change and

Biotic Patterns. Interpretive Resource Bulletin Series," see <http://www.nps.gov/glac/nature/science/upload/climate%20change%20and%20biotic%20patterns.pdf>.

38. Moe.

39. American Society of Landscape Architects, "The Sustainable Sites Initiative: Guidelines and Performance Benchmarks," draft, Washington, D.C., 2008.

40. *Ibid.*, 3.

41. *Ibid.*, 7.

42. Del Tredici, 260.

43. See, for example, the Noah's Ark Project, <http://noahsark.isac.cnr.it/overview.php>.

44. English Heritage, "Climate Change and the Historic Environment," [www.english-heritage.org.uk/upload/pdf/Climate\\_Change\\_and\\_the\\_Historic\\_Environment\\_2008.pdf](http://www.english-heritage.org.uk/upload/pdf/Climate_Change_and_the_Historic_Environment_2008.pdf).

45. See [www.silosandsmokestacks.org/](http://www.silosandsmokestacks.org/).

46. Constance I. Millar, Nathan L. Stephenson, and Scott L. Stephens, "Climate Change and Forests of the Future: Managing in the Face of Uncertainty," *Ecological Applications* 17, no. 8 (2007): 2145–2151. See also the Noah's Ark Project.

47. Millar.

48. For additional information on Noah's Ark's objectives and plans, see <http://noahsark.isac.cnr.it/overview.php>.

49. See note 28.