

Climate Change: Wilderness' Greatest Challenge

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Abstract: Anthropogenic climatic change can no longer be considered an abstract possibility. It is here, its effects are already evident, and changes are expected to accelerate in coming decades, profoundly altering wilderness ecosystems. At the most fundamental level, wilderness stewards will increasingly be confronted with a tradeoff between untrammelled wilderness character and primeval, natural conditions, accompanied by increasing impetus for management intervention. Possible strategic responses to climatic change fall into four broad classes: restraint (do nothing), resilience and resistance (near-term ways of buying time), and realignment (long-term adaptation). Planning responses will be made challenging by the unprecedented and unpredictable nature of future changes; fortunately, robust planning approaches, like scenario planning, are available.

Some 20,000 years ago, the area that we now know as the Marjory Stoneman Douglas Wilderness in Everglades National Park was not graced by the sprawling “river of grass,” dense mangrove forests, and the rich waters of the Florida Bay. With a sizeable amount of the earth’s water locked up in continental ice caps, the present Bay was high and dry, the nearest ocean shore was miles away, and the land supported pine woodlands and scrub. On the other side of the continent, the parched salt flats of today’s Death Valley Wilderness were drowned under a 600-foot-deep lake. The Yosemite Wilderness’ stately forests, lush meadows, and high mountain lakes were buried under hundreds of feet of ice.

What a difference a few degrees can make! These dramatic changes accompanied a Pleistocene-to-the-present global warming of about 4 to 7° C (Jansen *et al.* 2007). Yet the earth is now poised to undergo another round of warming of comparable magnitude. Current projections indicate that a 4 to 6° C global warming could be reached by as early as the end of this century (IPCC 2007), when global temperatures could exceed any reached in the last several million years. The earth has already gained about 0.6° C since 1975, and the pace of warming is expected to accelerate. Even the relatively modest warming so far has affected hydrology, fire regimes, and biota in national parks and wildernesses (Gonzalez 2011). The message is clear: In the coming decades wilderness seems certain to face its greatest challenge yet, in the form of profound climatic and other global changes.

Wilderness stewards must determine how best to respond to this greatest of challenges, and the goal of this paper is to help by offering relevant ideas and provoking discussion. First, we briefly re-examine the Wilderness Act in the light of rapid climatic changes, and conclude that stewards will be forced to confront tradeoffs that were not anticipated by the Act’s authors – tradeoffs that will be accompanied by increasing impetus for management intervention in wilderness. Next, we briefly outline four broad classes of management actions (or inaction) that wilderness stewards might consider in

1 their efforts to adapt to a rapidly changing climate. Finally, we highlight some
2 considerations for planning in the face of rapid climatic changes.

3 4 **The Wilderness Act in the era of rapid climatic changes**

5 The Wilderness Act of 1964 famously defines the idealized concept of wilderness
6 as an area where the earth and its community of life are “untrammeled by man,” with
7 “untrammeled” meaning unrestrained, self-willed, and allowed to run free (Landres *et al.*
8 2008). However, the authors’ careful choice of the term “untrammeled” was underlain
9 by a critical assumption: that for generations to come the earth’s environment would be
10 inherently stable within its historically observed bounds of variation. The dominant
11 thinking of the era had not yet awakened to the onset of rapid, human-induced, boundary-
12 transcending global changes. The term “untrammeled” in the Act thus primarily referred
13 to an absence of *intentional* human influences, as was neatly encapsulated by one of the
14 author’s pleas that humans act as “guardians not gardeners” of wilderness (Zahniser
15 1963).

16 If untrammeled was meant to refer to an absence of intentional human influences,
17 what are we to make of pervasive unintentional human influences, like anthropogenic
18 climatic change? Imagine the following scenario – the sort of scenario that seems likely
19 to play out with increasing frequency in the future:

20
21 With rising temperatures and earlier snow melt, a forested wilderness experiences
22 a massive crown fire well outside of the range of historical fire behavior. Most of
23 the local seed sources are killed, and subsequent rains cause extensive erosion.
24 Rising temperatures and soil loss preclude the reestablishment of continuous
25 forest cover, and the wilderness is colonized by shrubs and an array of non-native
26 invasive grasses and forbs adapted to disturbed sites.

27
28 This wilderness remains untrammeled in the sense that its new condition is not a
29 consequence of intentional human influences. But does it remain untrammeled simply
30 because the massive changes ultimately were the consequence of *unintentional* human
31 influences (anthropogenic climatic changes and introductions of non-native invasive
32 species)? If, in an alternative scenario, the wilderness’ managers had intentionally
33 thinned the forest, enabling it to survive the fire relatively intact, would the resulting
34 forest have less wilderness character than the eroded shrubland of the first scenario?

35 These sorts of questions are not new (e.g., Sydoriak *et al.* 2000), and we will
36 never know how the framers of the Wilderness Act would have addressed them. But
37 hints are embedded in the second sentence of the Act’s definition of wilderness, which
38 was intended to provide a more pragmatic definition of wilderness areas (Scott 2002):
39 areas that retain their “primeval character and influence” and that are “protected and
40 managed so as to preserve [their] natural conditions.” The terms “primeval” and
41 “natural” usually carry a sense of historical fidelity – conditions that fall within the
42 bounds that occurred in the centuries preceding the influences of modern technological
43 society. At the time of the Act’s passage it would have been normal to assume that a
44 protected (untrammeled) landscape would necessarily express a high degree of historical
45 fidelity, so the two ideas usually were conflated. We now know this assumption is false,

1 and we must explicitly consider the relationship between untrammelled quality and
2 historical fidelity (e.g., Aplet and Cole 2010).

3 In the future, tradeoffs between these two strongly defining characteristics of
4 wilderness – untrammelled quality and historical fidelity (primeval and natural character)
5 – will be inevitable. Climatic and other global changes will increasingly act to erode
6 historical fidelity, as in the forest scenario presented above. But any efforts to maintain
7 critical and sometimes legally-protected aspects of historical fidelity – such as native
8 biodiversity and key ecosystem functions like hydrologic regulation – will require
9 increasing management intervention (trammeling). When this tradeoff is assessed in light
10 of rapidly accelerating global changes, it seems inevitable that reasons to intervene in
11 wilderness will increase through time.

12 **Classes of actions to consider**

13 Appropriate management actions in anticipation of (or in response to) rapid
14 climatic changes will vary widely among wilderness areas, and in many cases will need
15 to be founded on careful, site-specific thought and research, well beyond the scope of this
16 article. However, it is useful to think of the spectrum of possible management actions as
17 falling into four broad classes that include the more familiar “three Rs” – resilience,
18 resistance, and realignment (Millar *et al.* 2007) – plus a “fourth R” that is particularly
19 relevant to wilderness – restraint. We begin with restraint.

20 *Restraint (leave some places alone).* For reasons well articulated by Landres
21 (2010) and others, wilderness stewards usually should be (and usually are) very wary
22 about intervening in wilderness. Yet for other well-articulated reasons, management
23 interventions do occur in wilderness (Sydoriak *et al.* 2000, Cole *et al.* 2008), and
24 expected climatic changes seem sure to increase the impetus to intervene. Yet even if
25 managers decide they have good reason to intervene in a particular wilderness, the
26 realities of limited staffing, funds, and access will usually mean that interventions can
27 occur only in relatively small, strategically-chosen parts of a wilderness landscape,
28 focused on resources of particularly high value and vulnerability (such as a grove of giant
29 sequoias or an endangered species). Thus, by default, large parts of the landscape will
30 remain untrammelled, in the strict sense of lacking intentional human influences. In those
31 rare cases when managers might have the ability to affect every part of a wilderness
32 landscape, strong consideration should be given to restraint – selecting certain areas in
33 which no interventions will occur (Landres 2010). The remaining “three Rs” described
34 below therefore will usually apply only to limited, high-value parts of a wilderness that
35 are strategically selected for intervention. The first two classes of actions, resilience and
36 resistance, are perhaps best considered as near-term actions.

37 *Resilience (enhance ecosystem resilience).* Resilience is an ecosystem’s ability to
38 absorb a stress without flipping into an entirely new state, such as from forest to eroded
39 shrubland. Of all possible near-term actions wilderness stewards can take, maintaining or
40 increasing resilience is one of the most important. Resilience should not be viewed as an
41 end in itself. Rather, it is a means of buying time while (1) wilderness stewards, policy
42 makers, and the public more carefully assess the policy and management implications of
43 climatic changes for wilderness, and (2) wilderness stewards and researchers develop and
44 test possible long-term adaptive responses. Actions that maintain or increase resilience
45

1 might include, for example, strategically controlling selected non-native invasive species
2 and thinning forests.

3 *Resistance (resist changes)*. Resistance can be a property of an ecosystem itself,
4 but here we use it to refer to management actions designed to resist change (e.g., Millar *et*
5 *al.* 2007). Like enhancing ecosystem resilience, in the near term resistance can provide a
6 critical means of buying time. Resistance might include intensive actions taken to protect
7 an endangered species, such as creating fuel breaks to diminish the probability of severe
8 wildfire, controlling a tree-killing beetle outbreak, or keeping an endangered plant
9 population healthy by drip irrigation.

10 In the long term, climatic changes are likely to be so large that most strategies
11 focusing only on resilience and resistance eventually will fail, perhaps catastrophically.
12 But the value of a near-term focus on resilience and resistance is that it can buy us
13 valuable time while we seek long-term strategies for the final R, realignment.

14 *Realignment (facilitate changes)*. In the long term, maintenance of native
15 biodiversity and key ecosystem functions into the future may be most successful if
16 wilderness stewards actively facilitate change. A few examples illustrate facilitation. If a
17 species is unable to migrate fast enough to keep up with geographic shifts in suitable
18 habitat, physically moving the species – assisted migration – might sometimes be
19 appropriate, especially if the alternative is losing the species entirely. Following a major
20 disturbance, it may be appropriate to plant an area with species better adapted to warmer
21 conditions. Finally, adaptive potential of some species might be increased by
22 purposefully mixing genotypes from other regions. Of course, any one of these actions
23 would demand deep forethought and extreme caution, and depending on site-specific
24 context might be rejected as undesirable.

25 26 **Planning considerations**

27 Implementation of any of these classes of strategic management actions must be
28 preceded by careful planning, but planning for a changing climate presents some unique
29 challenges. We offer the following ideas for consideration.

30 *The past may no longer provide a useful target for the future*. The profound
31 Pleistocene-to-the-present landscape transitions described earlier give us a feel for the
32 magnitude of changes wilderness could face by the end of this century. Wilderness will
33 also be affected by an array of other novel anthropogenic global changes, such as
34 pollution, altered disturbance regimes, habitat fragmentation, and non-native invasive
35 species. Collectively, these changes mean that our world has entered an era in which
36 keystone environmental drivers – those that define the possible range of characteristics of
37 a wilderness area – simply have no analog in the past, no matter how distantly we look
38 (Saxon *et al.* 2005, Stephenson *et al.* 2010). An important consequence is that historical
39 wilderness conditions will no longer automatically provide a useful target for restoring or
40 maintaining wilderness ecosystems (Millar *et al.* 2007, Stephenson *et al.* 2010). While
41 wilderness stewards will almost certainly want to maintain certain broad aspects of
42 historical fidelity (such as native biodiversity and key ecosystem functions), attempts to
43 maintain precise historical fidelity will almost certainly need to be abandoned.

44 *Familiar planning approaches may become ineffective*. At the scales, accuracy,
45 and precision most useful to wilderness stewards, the future not only promises to be
46 unprecedented, it promises to be unpredictable. Model projections can help us envision

1 the possible nature and magnitude of future landscape changes, but such projections carry
2 large uncertainties and therefore cannot be used as precise predictions (Stephenson *et al.*
3 2010). A corollary is that surprises are inevitable. A critically important class of
4 surprises is threshold events, in which gradual environmental changes eventually trigger
5 sudden, dramatic, and sometimes irreversible changes in ecosystem conditions (Scheffer
6 and Carpenter 2003); for example, in parts of western North America gradual warming
7 has contributed to sudden and extensive outbreaks of bark beetles, killing large swaths of
8 forest. A consequence of uncertainty is that familiar planning approaches, which usually
9 assume we either know the future or can accurately predict it, are likely to become
10 ineffective (Weeks *et al.* 2011).

11 *Use planning approaches that consider a broad array of possible futures.* In the
12 face of such uncertainty, the most useful planning approaches may be those that seek to
13 identify management actions that are likely to succeed under a broad array of possible
14 future conditions. Such approaches include scenario planning and its relatives (Nydick &
15 Sydoriak 2011, Weeks *et al.* 2011). All planning efforts will likely benefit from
16 considering scenarios that include abrupt, threshold changes.

17 *Define undesired future conditions.* Another consequence of the unprecedented
18 and unpredictable future is that the familiar planning approach of defining relatively
19 precise desired future conditions is likely to become less effective. Instead, planning
20 efforts might benefit from including explicit definitions of undesired future conditions –
21 conditions to be avoided. For example, undesired future conditions might include loss of
22 native biodiversity or critical ecosystem functions. A broad array of future wilderness
23 conditions might be deemed acceptable as long as they do not fall within the undesired
24 future conditions.

25 *Plan appropriate responses before abrupt changes occur.* Sudden threshold
26 changes can effectively denude large portions of a wilderness landscape in a matter of a
27 few years, months, or in the case of fire, days or hours. While we cannot predict exactly
28 how or when such transformations will occur, we can predict with high confidence that
29 their frequency and severity will increase in the future. Possible management responses –
30 such as erosion control or planting native species that are better adapted to a warmer
31 future – usually will be most effective in the months immediately following the event.
32 Yet planning for management intervention in wilderness, along with necessary legal
33 compliance, can take years to accomplish, meaning that the opportunity to effectively
34 intervene after a major disturbance often will be lost. While most wilderness stewards
35 already carry a full load of planning responsibilities, it seems wise to seek opportunities –
36 perhaps beginning as case studies in a few wilderness areas – to complete plans that
37 anticipate sudden, broad-scale disturbances before those disturbances occur, so that
38 responses are more likely to be well-planned, timely, and deliberate.

39 *Hedge your bets.* Another corollary of our inability to precisely predict the future
40 is that it may be best to plan a variety of different management interventions. For
41 example, in many regions the magnitude and direction of future changes in precipitation
42 are unknown. If the decision is made to restore a landscape denuded by wildfire by
43 planting species adapted to a warmer future, some areas could be planted with species
44 adapted to a warmer, wetter future, some to a warmer, drier future, and some with a mix
45 of both. Each treatment could be repeated in widely-dispersed locations, reducing

1 vulnerability by creating redundancy. Similarly, implementing a mixture of restraint,
2 resilience, resistance, and realignment strategies is a means of hedging bets.

3 *Broaden the geographic scope of planning.* More than any other threat, climatic
4 changes highlight the importance of planning across administrative boundaries. While
5 challenging in itself, regional planning can make certain decisions and actions easier. For
6 example, if climatic changes are driving a species to extinction within a particular
7 wilderness, an initial reaction may be to take expensive, heroic actions to slow the
8 species' decline. But viewed in a regional context, the species might simply be migrating
9 into wildlands farther north. Regional planning could forge agreements ahead of time to
10 allow or facilitate migrations across administrative boundaries as a means of maintaining
11 native biodiversity.

12 **Conclusion**

13 The era of rapid climatic changes is here, and seems sure to bring the greatest
14 challenge wilderness stewards have yet faced. Efforts to plan for and respond to the
15 challenge are still in their infancy, and solutions are unlikely to come easily or quickly.
16 In addition to the considerations we have presented, planning will require a broader
17 engagement of wilderness stewards, policy makers, and the public to assess the
18 implications of climatic changes for wilderness values and policy, a topic well beyond the
19 scope of this article. We hope, however, that we have presented some ideas to help move
20 the process forward; the time for engagement is now.

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