Adaptation

Climate change scenario planning: A tool for managing parks into uncertain futures

By Don Weeks, Patrick Malone, and Leigh Welling

The challenge of a changing climate

National Park Service Director Jon Jarvis stated in a recent interview that climate change is “the greatest threat to the integrity of the National Park System (NPS) that we’ve ever faced” (The BigOutside Blog 2010). Global temperatures are rapidly rising. The National Oceanic and Atmospheric Administration (2011) has announced that for the entire planet, 2010 is the hottest year on record, tied with 2005. And the period 2001 to 2010 is the hottest decade on record for the globe (fig. 1).

Rising temperatures will influence many aspects of Earth’s hydrologic systems, such as precipitation, snow, ice, and permafrost, which will in turn affect plant and animal life and processes such as fire. These cascading effects are already impacting the natural and cultural resources the National Park Service is charged to protect. The range of impacts land managers will need to address are unprecedented and most are not well understood. There is much uncertainty about the specific ways in which ecosystems, populations, and species will respond to these changes.

Over the last several years, there has been renewed commitment in the federal government to addressing the important issue of climate change. The National Park Service, in particular, is looking at new ways to think about, and plan for, the effects of climate change. In fall 2010, the National Park Service published its Climate Change Response Strategy, which outlines a broad framework for how the agency will address climate change. Planning for climate change within an adaptation framework is a cornerstone of that document. But even before that, the Service had been quietly exploring and testing ways to plan more effectively in this dynamic environment.

Planning with uncertainty

Forecast vs. scenario planning

The NPS Park Planning Program Standards (Director’s Order 2.0) were released in 2004 as the new planning road map for park management. This framework represents a series of planning elements, starting with a Foundation Statement that identifies the fundamental resources and values a park is committed to preserving and maintaining based on legislation. These priorities are then carried through the remaining planning framework.

The next planning element, the General Management Plan (GMP), defines desired conditions for park-specific fundamental resources and values and identifies the preferred alternative for park management to follow. In the idealized framework, the GMP is followed by a Resource Stewardship Strategy (RSS), which quantifies the desired conditions so that park management has measurable targets for establishing specific management goals and generates strategies to achieve them. These strategies then feed into the park’s five-year Strategic Plan, which reflects a prioritization of action items the park commits to implement. This approach is one of forecast planning and it is based on expectations for the future, as park management follows a preferred management alternative for the next 15 to 20 years (fig. 2a).

When considering a changing climate in park planning, the forecast approach is limited by incomplete knowledge of highly consequential factors that are largely unpredictable and outside of management control but influence a park’s future conditions. The far-reaching effects of climate change, coupled with high uncertainty about local impacts, produce a range of plausible futures (constrained by the best available science), to which park managers will have to react (fig. 2b). How does the National Park Service identify what future, or potential futures, to plan for? What are the best response options when faced with a range of potential climate futures? These are not easy questions. Exploring the potential consequences of climate change can lead to management paralysis or, if structured correctly, can stimulate new ways of thinking and planning.

Scenario planning

Scenario planning is a process designed for managing into futures with high uncertainty and lack of control (fig. 3). Scenario planning was developed during the Cold War as a way for the United States to...
analyze the relationship between Soviet weapons development and U.S. military strategy (Kahn 1960). The planning approach caught on in the corporate world, starting with Royal Dutch/Shell in the 1970s, and has since led companies from many different industries, such as Microsoft, Nissan, and United Parcel Service, to use scenario planning as a tool for managing into uncertain economic, social, and political futures.

Scenario planning is not a technique for predicting the most probable future. Rather, the objective is to develop and test decisions under a variety of plausible futures. Doing this proactively, essentially rehearsing for multiple futures, strengthens an organization’s ability to recognize, adapt to, and take advantage of changes over time (Global Business Network 2009). As such, scenario planning was selected by the National Park Service as a tool to explore for managing parks into a future of climate uncertainty.

Climate change scenario planning in the National Park Service

History
In 2006 the National Park Service began exploring the use of scenario planning in the context of climate change. Over a three-year period, the Service and several partners held workshops to evaluate the utility of a scenario-building technique for helping managers to explore the key uncertainties and park impacts related to climate change and begin to evaluate the most appropriate and effective response strategies. Participants completed five case studies during this exploration phase at Joshua Tree National Park (California), Kaloko-Honokōhau National Historical Park (Hawaii), Assateague Island National Seashore (Maryland), and Wind Cave (South Dakota) and Glacier (Montana) national parks. While several of the case
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studies considered the broader landscape within which parks are located, the Glacier National Park workshop explicitly examined the use of climate change scenario planning in the larger Crown of the Continent ecosystem, which is the transboundary landscape of Waterton-Glacier International Peace Park and more than 20 other state, provincial, and tribal governments in this U.S.-Canadian transboundary region. For each of the five case studies, managers developed several potential climate futures using recent climate data along with model projections, and then evaluated these futures in the context of management challenges and options. Partners involved in this investigative work were the National Interagency Fire Center, the National Center for Landscape Fire Analysis at the University of Montana, the USGS Northern Prairie Wildlife Research Center, the NOAA-funded Climate Assessment for the Southwest at the University of Arizona, and the Global Business Network (GBN).

Building from the favorable reactions and lessons learned during the case studies, the National Park Service teamed with the Global Business Network, a pioneer in the evolution and application of scenario planning, to begin the next phase of scenario planning in 2010. This second stage focused on raising awareness of and building capacity in the scenario planning process within and outside the National Park Service, as well as exploring how scenario thinking may complement landscape adaptation and long-range planning. Thus the National Park Service completed four training workshops in 2010–2011, each focusing on specific bioregional landscapes.

Workshop 1: Alaska’s Arctic and Coastal bioregions (Anchorage, Alaska, August 2010)

Workshop 2: Great Lakes and Atlantic Coast bioregions (Duluth, Minnesota, October 2010)

Workshop 3: Urban Landscapes and Eastern Forests bioregions (Shepherdstown, West Virginia, December 2010)

Workshop 4: Western Mountains, Pacific Islands, and Arid Lands (Denver, Colorado, February 2011)

These workshops introduced approximately 150 participants to the climate change scenario planning process. The disciplines of the participants ranged from climate change science, to natural and cultural resources and facilities management, to education, planning, and interpretation, and included a variety of land management agencies.

Basic steps
So what is the process for climate change scenario planning? The first step is assembling an interdisciplinary core team to design, facilitate, and bring in the appropriate climate science and management expertise for the planning exercise. According to GBN, participants should include knowledge holders, stakeholders, and the curious and creative. More specifically for the National Park Service planners, educators, scientists, natural and cultural resource managers, facility managers, superintendents, and partnership coordinators, along with representatives from other jurisdictions within the landscape, have important voices in the process.

With a variety of approaches available for scenario development, an approach practiced by GBN and applied to the NPS training can be divided into five steps, illustrated in figure 4. These steps resemble a basic adaptive management process and provide a solid framework for NPS scenario planning that is familiar to park managers.

1. Orient: Define the strategic issue and the scale at which to address it. This is framed as a focal question, such as “How will climate change effects impact the landscapes within which management units are located over the next 50 to 100 years?” or “How can managers best respond to long-term change over a 20-year planning horizon?”

2. Explore: Identify the driving forces and major effects that influence the future of the focal question. For climate change scenario planning, a climatologist is engaged to synthesize current science and create a list of relevant climate variables (e.g., temperature, precipitation, storm frequency) along with the projected trend and confidence for
### Table 1. Summary of projected climate changes for Alaska

<table>
<thead>
<tr>
<th>Climate Variable</th>
<th>General Change Expected</th>
<th>Specific Change Expected and Reference Period</th>
<th>Size of Expected Change Compared to Recent Changes</th>
<th>Patterns of Change</th>
<th>Confidence</th>
<th>Source and Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>Increase</td>
<td>2050: +3°C ± 2°C</td>
<td>Large</td>
<td>More pronounced in north and in autumn-winter</td>
<td>&gt;95% (sign)</td>
<td>IPCC 2007, SNAP 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2100: +5°C ± 3°C</td>
<td></td>
<td></td>
<td>Very likely</td>
<td></td>
</tr>
<tr>
<td>Precipitation</td>
<td>Increase</td>
<td>2050: 10–25% ± 15%</td>
<td>Large</td>
<td>Greater overall percentage increase in north</td>
<td>&gt;90% (sign)</td>
<td>IPCC 2007, SNAP 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2100: 20–50% ± 20%</td>
<td></td>
<td></td>
<td>Very likely</td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>Little change</td>
<td>2050: 0% ± 10%</td>
<td>Small</td>
<td>Absolute humidity increases</td>
<td>50%</td>
<td>SNAP 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2100: 0% ± 15%</td>
<td></td>
<td></td>
<td>About as likely as not</td>
<td></td>
</tr>
<tr>
<td>Wind speed</td>
<td>Increase</td>
<td>2050: +2% ± 4%</td>
<td>Small</td>
<td>More pronounced in winter and spring</td>
<td>&gt;90% (sign)</td>
<td>Abatzoglou and Brown1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2100: +4% ± 8%</td>
<td></td>
<td></td>
<td>Likely</td>
<td></td>
</tr>
<tr>
<td>Pacific Decadal Oscillation (atmospheric circulation)</td>
<td>Decadal to multi-decadal circulation anomalies affecting Alaska</td>
<td>Unknown</td>
<td>Large (comparable to climatic jump in 1970s)</td>
<td>Major effect on Alaskan temperatures in cold season</td>
<td>Natural variation, essentially unpredictable</td>
<td>Hartmann and Wendler 2005</td>
</tr>
<tr>
<td>Extreme events: Temperature</td>
<td>Warm events increase, cold events decrease</td>
<td>2050: increase 3–6 times over present conditions for warm events; decrease 1/5–1/3 of present conditions in cold events 2100: increase 5–8.5 times present conditions in warm events; decrease 1/12 to 1/8 present conditions in cold events</td>
<td>Large</td>
<td>Increase in frequency and duration of extreme hot events, decrease in extreme cold events (winter)</td>
<td>Modeled and observed</td>
<td>Abatzoglou and Brown1, Timlin and Walsh 2007</td>
</tr>
<tr>
<td>Extreme events: Precipitation</td>
<td>Decrease/Increase</td>
<td>2050: ~20% to +50%</td>
<td>Large</td>
<td>Increase in frequency and contribution, especially in winter</td>
<td>Modeled and observed</td>
<td>Uncertain</td>
</tr>
<tr>
<td>Extreme events: Storms</td>
<td>Increase</td>
<td>2050: 40–60% loss in Bering Sea (winter/ spring); 20–70% loss in Chukchi/Beaufort (summer)</td>
<td>Any increases exacerbated by sea ice reduction and sea-level increase</td>
<td>Increases at southern periphery of Arctic; little information for central Arctic</td>
<td>&gt;66%</td>
<td>Likely</td>
</tr>
<tr>
<td>Sea ice</td>
<td>Decrease</td>
<td>2050: 40–60% loss in Bering Sea (winter/ spring); 20–70% loss in Chukchi/Beaufort (summer)</td>
<td>Comparable to recent changes</td>
<td>Nearly ice-free summers by 2050 with ice-free summers by 2100; less loss of sea ice in winter than in summer</td>
<td>&gt;90%</td>
<td>Very likely</td>
</tr>
<tr>
<td>Snow</td>
<td>Increased snowfall during winter; shorter snow season</td>
<td>Winter snowfall 2050: 10–25% 2100: 20–50%</td>
<td>Recent changes not well established</td>
<td>Cold-season snow amounts will increase in interior and north of Brooks Range; increased percentage of precipitation will fall as rain (especially in spring and autumn)</td>
<td>Large uncertainty in timing of snowmelt (warmer springs, more snow to melt)</td>
<td>AMAP 2011</td>
</tr>
<tr>
<td>Freeze date (freshwater lakes)</td>
<td>Later in autumn</td>
<td>2050: 10–20 days later near north coast; 5–10 days later elsewhere 2100: 20–40 days later near north coast; 10–20 days later elsewhere</td>
<td>Large</td>
<td>&gt;90% (sign)</td>
<td>&gt;90% (sign)</td>
<td>SNAP 2010</td>
</tr>
</tbody>
</table>

CONTINUES ON PAGE 30
The ability to synthesize climate data and projections into a form that is both accurate and easily understandable by nonscientists is a critical factor upon which many other steps in the process depend. Once the important variables are identified, they must be understood and ranked within the dual context of “uncertainty” and “importance.” The objective is to narrow down the list to those variables that are most important and most uncertain to further explore. A variable that does not meet the criteria of important and uncertain may become a “predetermined” variable that is a factor in all scenarios or may not be considered at all (table 2). It is useful at this stage to explore what kinds of conditions may be associated with the extreme uncertainties of a given variable (e.g., would a 10% increase in precipitation result in very different conditions from a 20% decrease?). The NPS approach also develops a table of known and potential resource impacts during the exploration stage, which is drawn upon in the next step.

3. Synthesize: Participants combine information from select climate variables in a way that allows them to envision
different future conditions (scenarios) that may result. We used a 2 × 2 matrix approach with climate variables represented on the axes. For example, precipitation and thaw days may be selected as two axes for generating four different climate futures (fig. 5). Several scenario matrices can be constructed by trying different combinations of two axes, each generating a set of four scenarios. Selected axes are combined in this way until participants settle on one matrix that best fits the criteria of plausible, divergent, relevant, and challenging, which are important for capturing a robust set of scenarios that will allow participants to consider a wide array of potential actions. Once the scenario matrix is selected, participants describe each scenario in detail, using the table of impacts that was created during the exploration phase. The group then identifies the implications of these four climate futures (fig. 5) and the actions needed to respond and adapt.

4. Act: Implement effective management actions. Managers may choose to act on one scenario that appears to represent the most probable future or they may identify several actions that are common to all scenarios (often termed “no regrets” actions). It is also important to identify current practices that are “no gainers” and need to be discontinued. An example of a no-regrets action for southwestern Alaska parks is to improve connectivity across landscapes and jurisdictional boundaries. A no-gainer action at Assateague Island National Seashore, Maryland, would be to build permanent structures on the island despite

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**Figure 5.** Climate variable framework example from the Southwest Alaska Network workshop. The x axis depicts changes in precipitation; the y axis shows changes in the number of thaw days per year (above freezing), taking into account the compounding effect of the Pacific Decadal Oscillation (PDO), an oscillating pattern of warm and cool water in the northern Pacific Ocean that shifts about every 20–30 years, influencing air temperatures in Alaska.
high confidence in a climate future of sea-level rise.

5. **Monitor:** As new information unfolds, managers should continue to validate the scenarios and evaluate the effectiveness of their response. Is there evidence of moving toward one or a select group of scenarios? Can decisions and actions be adjusted to incorporate new information? While continuing to monitor key indicators, managers should look for signals that a particular scenario is becoming a reality and adjust decisions as necessary (fig. 6).

**Nested scenarios: Considering the sociopolitical landscape**

The $2 \times 2$ approach can be used with other types of variables besides climate, such as social, political, and economic variables, which are also uncertain and highly consequential to decision making. When exploring different types of scenario matrices for the same focal question, a method known as “nesting” can be very useful, whereby one matrix is embedded in another. For the NPS-GBN workshops, we created a sociopolitical matrix to describe the broader decision environment within which climate change will manifest, yielding an even broader array of possible futures to consider.

**NPS role in climate change response**

The National Park Service can, and does, play an important role in the national and global responses to climate change. Protected lands help to conserve biodiversity, support ecosystem adaptation, provide laboratories for fundamental and applied research, and offer many opportunities to engage communities in learning and environmental stewardship (see articles in the “Communication and Public Engagement” section beginning on page 56). Scenario planning is an important tool in the Service’s four-pronged Climate Change Response Strategy (i.e., science, adaptation, mitigation, and communication). It allows managers to synthesize the information and potential implications from climate change in a way that is relevant to the conservation of park resources and landscape values.

With its flexible approach to accommodating changing circumstances, scenario planning is one way in which the National Park Service could change its planning paradigm. It is a process that encourages collaboration with other federal land management agencies, climate scientists, and academic institutions. As Director Jarvis said at the conclusion of his interview with The BigOutside Blog (2010), “If there’s any silver lining, climate change is forcing us to think and act at the landscape scale. No longer can we think of parks as islands.”

Clearly the challenge of managing resources in the face of climate change is daunting. As George Black (2011) points out in a recent magazine article published by the Natural Resources Defense Council, “Adapting to climate change is a singularly complex challenge. It requires money, new technology and infrastructure, institutional capacity, accurate data, different ways of producing and consuming energy, changes in culture and lifestyle, and the nimbleness to adjust to constantly shifting and uncertain circumstances.” The National Park Service has made a commitment to addressing these challenges and will continue to take a leadership role in navigating the uncertainties of climate change, exploring and using a variety of scenario planning techniques and other tools to enable effective management response. After all, perpetuity is part of our mission, and that means we are in it for the long haul.

**References**


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