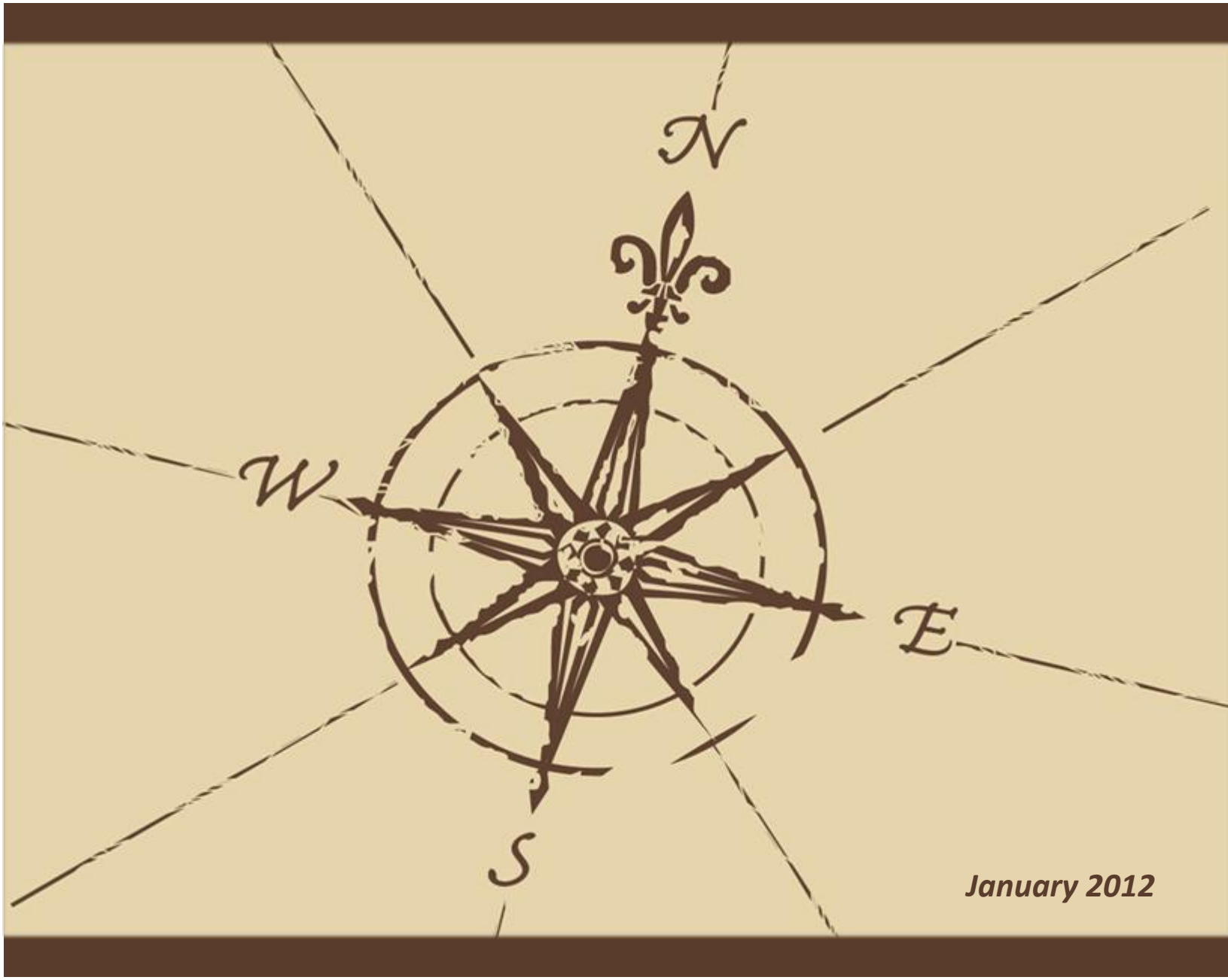
Moving Forward

Setting a Course for Climate Change Response on the Chequamegon-Nicolet National Forest



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Foreword

If we knew for sure that half of our attempts to reforest an area with native trees would fail in 50 years…

If we knew for sure that one tenth of our roads would experience a significant washout event in the next 20 years rendering them impassable for days or weeks…

If we knew there was a 20 percent probability that three new non-native pests would appear and would each decimate an abundant plant species that supported a native pollinator…

If we knew for sure there was a 66 percent probability that half of our snow-covered trails would be unusable for more than a month in the winter…

Our reality is that the relative predictability and stability of land and resource management is in great question. The desired future conditions we believe have a high probability of existing if we start things off on the traditional path may or may not occur because of the effects of an unpredictably changing climate. Our best understanding of climatic change is that it will create additional stress on ecosystems, demand greater resources for coping with these stresses, and add many new challenges to the management of the lands that we are entrusted to maintain.

Our agency and government is taking climate change seriously and engaging in many activities for responding to climate change. The Forest Service is looking at ways to improve the resiliency of our forests and grasslands to future changes as we work toward sustaining valuable public resources for future generations. Our efforts are tiered to the *National Roadmap for Responding to Climate Change* and our performance for being a climate change ready agency is evaluated with the Climate Change Scorecard.

I am proud that the Chequamegon-Nicolet National Forest is committed to being a leader around climate change for our agency. We have taken a leadership role in strengthening collaboration among researchers, partners, and land managers, as well as in the development of resources for people to use on the ground. We have accomplished a lot of work not only for our benefit on the CNNF, but also for our partners , the region, and the agency as a whole. Responding to climate change is one of the many things that the CNNF is doing to ensure the long-term sustainability of ecosystems.

Like the Safety Journey and our efforts to be part of Cultural Transformation for our agency, our climate change work is a journey without a precisely defined route or destination. The work we have done to date is part of the journey. This "***Moving Forward"*** document describes our trajectory for responding to climate change over the next several years. It outlines our approach, namely, to respond to climate change deliberately, to include climate change considerations in our current work, to demonstrate success in the near-term, and to build capacity and experience among all staff for focused long-term efforts. It also furthers a discussion for how to integrate climate change into our land management activities. While I realize that there is much to learn, difficult trade-off choices to make, uncertainty of what to do and how, and mistakes to endure, I am confident that the right thing to do is keep talking about what we have been doing, talk about new things we might choose to do, come up with some ideas that make sense, and try some of them.

Thanks to Maria, Linda, and Matt for excellent work that will influence our next steps, and thanks to all of you who are becoming climate change ready.

Paul Strong
Forest Supervisor, Chequamegon-Nicolet National Forest



Introduction

The climate of northern Wisconsin has changed, and the ecosystems within this region are already experiencing the effects of a different and more variable climate (Swanston et al. 2011, WICCI 2011). Future change is likely to exacerbate many stressors of northern Wisconsin ecosystems and this may affect the ability of land managers to achieve their goals and objectives (e.g., Joyce et al. 2009). For that reason, climate change is an important issue for the Chequamegon-Nicolet National Forest (CNNF) and many other regional land owners and managers. The CNNF has committed to being a leader on incorporating climate change considerations into its operations. Responding to climate change will not be a new and separate program, but instead will be integrated into existing programs and efforts.

This document provides assistance and guidance to CNNF employees as they begin to incorporate climate change into management activities. It provides a platform for discussion rather than making recommendations or providing specific guidance. Management responses to climate change vary based on CNNF staff expertise and the context of specific management situations.

This document is designed to do three things:

- Provide a ***foundation*** that describes how the CNNF will approach climate change and provides a set of principles for moving forward.
- Describe how climate change considerations **integrate** into existing plans and efforts.
- Acknowledges that there are many values at risk and identifies potential **priorities** for response in the near-term.

TAKING THE LEAD ON CLIMATE CHANGE

The CNNF has been working on a variety of activities related to climate change for several years, which has made it a leader both regionally and nationally on climate change and land management issues (Table 1). Over time, the scale and complexity of the CNNF's activities have increased.

Table 1. Activities occurring as part of the CNNF climate change work plan (FY11-12).

CLIMATE CHANGE RESPONSE FRAMEWORK ACTIVITIES   ***The CCRF was launched in northern Wisconsin in early 2009, catalyzing a variety of assessments, resources, and activities to enhance the ability of managers to respond to the anticipated effects of climate change.***
Climate Change Assessments: development of an *Ecosystem Vulnerability Assessment and Synthesis* (Swanston et al. 2011) for northern Wisconsin and the western Upper Peninsula of Michigan, continued work on a Mitigation Assessment for northern Wisconsin
Shared Landscapes Initiative: an effort to engage the forestry community of northern Wisconsin on climate change related issues
Climate Change Science Roundtable: a team of scientists working on climate change issues that provide perspectives to the CNNF and other land owners and managers
Communication and Education: educational activities have take place on the CNNF to educate the Forest Leadership Team, District and Supervisor's Office staff, and others about climate change science, ecosystem responses to climate change, and management strategies for adaptation and mitigation.
Forest Adaptation Resources- Climate Change Tools and Approaches for Land Managers: a document that contains a "menu" of adaptation approaches for land managers and an Adaptation Workbook to integrate climate change considerations into management (Swanston and Janowiak *in press*)
Demonstration and Implementation Activities: efforts occurring on each district and elsewhere in northern Wisconsin to integrate climate change into on-the-ground management and gain experience.

OTHER ACTIVITIES
Partnership with the *Wisconsin Initiative on Climate Change Efforts:* assist WICCI working groups on activities related to forests, watersheds, wildlife and other topics
Monitoring: integration of climate change into the Forest's monitoring plans and reports
Watershed Climate Change Vulnerability Assessment: a pilot project to assess vulnerabilities of select watersheds in the CNNF
Carbon Model: A UW-Madison-led effort to develop a tool that provides information on life-cycle carbon emissions associated with forest management
Green Team/Sustainable Operations: efforts to reduce the Forest's energy use, materials consumption, and carbon footprint
Climate Change Scorecard Reporting: established in 2010 as a way to encourage progress among Forests and Grasslands. The early work by the CNNF earned it a score of 9 out of 10 items in FY2011, which identifies it as a leader nationally.

Foundation

The CNNF can be proactive in enhancing the ability of ecosystems to adapt to climate change and its effects. Some actions can be taken now to reduce the risks associated with climate change and avoid negative impacts on ecosystems across the landscape of northern Wisconsin. Other possible actions look forward and capture new opportunities for managing resources and providing services. Actions to sustain the environments, resources and values of the CNNF will draw upon current and new experience and information to match the unique needs of the situation. Because there is no single "answer" or one-size-fits-all approach to responding to a changing climate, several principles outlined below provide the foundation for moving forward.

BOX 1: WHAT IS ADAPTATION?

Adaptation, in a broad sense, includes all planned and unplanned adjustments in natural and human systems in response to climatic changes and subsequent effects (Parry et al. 2007). For the purposes of this document, however, adaptation refers more specifically to ***actions that are taken to cope with or take advantage of changes in climatic conditions and the associated effects*** (Levina and Tirpak 2006).

1. THE CNNF WILL USE NEW INFORMATION AND IDEAS

"An individual without information can't take responsibility. An individual with information can't help but take responsibility." *~Jan Carlzon, Swedish businessman*

- ***Understanding the potential impacts of climate change is essential for moving forward.*** There is a great amount of information regarding climate change, and this body of work will only continue to grow. Working to increase our understanding of the science of climate change, the potential effects of climate change in northern Wisconsin and elsewhere, and potential management responses is critical for being able to think about climate change and respond appropriately.

- ***Learning is a continual process.*** Climate change is an extremely complex issue, and there will never be a point at which everything is known. Continuing to learn, from new information as well as from experience, will strengthen our actions.
- ***New analyses and tools will help to support decisions.*** The CNNF is fortunate to have a wealth of information and tools that have been developed specifically for Wisconsin (Box 2). It is valuable to know what is in these resources so that they can be used to incorporate climate change into reports, plans, and other documents as appropriate. Additional resources can be developed in the future as new needs are identified.
- ***Being prepared for change will help us reduce risks in the long term.*** Several recently completed assessments (e.g., Swanston et al. 2011, WICCI 2011) are available to help CNNF employees understand the types and severity of changes to natural resources in the coming decades. By preparing for these changes today, we can reduce risks to sustainability in the future. As the proverb says, "the best time to plant a tree is twenty years ago; the second best time is today".

BOX 2: FEATURED CLIMATE CHANGE RESOURCES FOR NORTHERN WISCONSIN

Wisconsin Initiative on Climate Change Impacts (WICCI) Products

- *Wisconsin's Changing Climate: Impacts and Adaptation* – This report summarizes climate change impacts identified on a range of issues by WICCI's working groups (WICCI 2011).
- WICCI Working Group Reports – WICCI working groups each developed an assessment of climate change impacts on a topic (e.g., forestry, wildlife, water resources) or place (e.g., Green Bay area)
- Interactive Mapping Tool – This tool allows users to examine observed climatic changes and projected changes in temperature and precipitation variables for the state of Wisconsin.

Northern Institute of Applied Climate Science (NIACS) Products

- *Ecosystem Vulnerability Assessment and Synthesis (EVAS)* – This report evaluates key climate change impacts vulnerabilities in forest ecosystems in northern Wisconsin under a range of future conditions (Swanston et al. 2011).
- *Forest Adaptation Resources: Climate Change Tools and Approaches for Land Managers* –This document provides information, and tools to help managers incorporate climate change considerations into management and adapt forest ecosystems in northern Wisconsin to a changing climate (Swanston and Janowiak *in press)*.

2. THE CNNF WILL TAKE ACTION

"Knowing is not enough; we must apply. **Willing is not enough; we must do."** *~ Johann Wolfgang von Goethe, German writer*

- ***Adaptation is needed to sustain the ecosystems present in the CNNF.*** Climate change has the potential to dramatically alter the ecosystems of northern Wisconsin, and subsequently, all of the resources and services that these systems provide to us. For this reason, the CNNF approaches climate change adaptation as a critical component of its mission of sustainable resources management. Rather than treating climate change as a new or separate program area, it is viewed as another management issue. Actions to respond to climate change will need to occur at a variety of spatial and temporal scales and be integrated across multiple levels of the CNNF's organization.

- ***Climate change brings uncertainty and variability, but we know enough to begin to act.*** Climate change undoubtedly adds additional complexity to managing resources because future conditions are less certain. Forest management, however, is already very complex and climate change just becomes an additional facet to management. Rather than managing to a specific future condition, management will increasingly examine a *range* of possible future conditions and develop actions that can accommodate a variety of potential futures. A variety of potential actions exist (Box 3). In the near-term, many management activities that consider climate change may not look very different than current management. At first, adaptation is more likely to involve "small tweaks" to management as we learn and gain the experience needed to take on bigger changes.
- ***Many actions can be taken now with "no regrets."*** There are many actions that will result in a wide variety of benefits under multiple scenarios of climate change and have little or no risk; these are excellent opportunities for action, especially in the near-term. Furthermore, in situations where vulnerability is extremely high, the precautionary principle suggests that actions with minimal or no risk should be taken in the near-term to reduce the anticipated impacts, even with existing uncertainty (WICCI 2011). Additional information can be used to refine actions over time as new information becomes available.
- ***Efforts and investments will need to be prioritized.*** The CNNF may not have the capacity to take on all potential adaptation responses at once, and it will be increasingly important to prioritize actions for adaptation based on both the vulnerability of resources and the likelihood that actions taken to reduce vulnerability will be effective. A "triage" approach helps to sort management issues when resources are limited based on the urgency of action and the capacity to act (Millar et al. 2007; Joyce et al. 2008). The Prioritization section of this document has more information on this approach on the CNNF.
- ***Adaptation helps to support mitigation of greenhouse gases.*** Adaptation is different from mitigation, which focuses on reducing the amount of greenhouse gases in the atmosphere that are responsible for climate change. Adaptation and mitigation work on different sides of the climate change issue, and are complementary in many ways. For example, forests that are well-adapted in the face of climate change and less susceptible to a variety of threats will be better poised to absorb carbon dioxide from the atmosphere and serve as a "carbon sink". Additionally, many adaptation actions are complementary with actions to mitigate greenhouse gas emissions.

Box 3: Different "Routes" of Action for Responding to Climate Change

When deciding how to go forward with a specific action for climate change adaptation, the answer is almost always "it depends." There are no one-size-fits-all answers. This can be frustrating, but it is important because the usefulness and appropriateness of a specific action will always be related to its unique situation, including the management issues at hand, management objectives, time frames, location, and other factors.

It may be helpful to think about adaptation as if you were at the top of a ski hill and deciding which path to take down the hill; there are a number of routes, and some are easier than others.

Easy— Actions that are "low-hanging fruit" that fit within existing plans and objectives. Many of these actions are already being implemented or can easily be incorporated into existing management. For example, many efforts to diversify forest tree species provide benefits to ecosystems in addition to making forests more resilient in the face of climate change.

Intermediate—Intermediate actions may be somewhat above and beyond what is typically done as a part of management now, but these actions are compatible with existing plans and objectives. For example, intensified efforts to remove nonnative species or enhance regeneration of species vulnerable to climate change may be needed to create better-adapted systems.

Advanced— Actions that are substantially more difficult, and may need changes in the Forest Plan or other policies and practices in order to implement. These actions may ultimately be taken, but a certain level of expertise and experience will be required in order to take these actions on and be successful.

Expert Only—Some actions will be even more difficult than the black diamond routes because of significant hazards or obstacles, and a large degree of expertise is necessary to navigate these paths.

Which trail is the Chequamegon-Nicolet National Forest taking?

Since climate change adaptation is a relatively new aspect of sustainable management, we can think of ourselves as relatively inexperienced skiers. Over the next few years, it is very likely that most of our work will occur on the Easy and Intermediate routes. We will look for "low-hanging fruit" and "win-win" opportunities in order to gain more experience and greater organizational capacity. Over time, however, we will eventually be able to take on more complex and challenging actions. While we won't become experts on this subject overnight, we are setting up a long-term approach for being able to cope with the challenges, as well as the opportunities, posed by a changing climate.

BOX 3 (CONT.): DIFFERENT "ROUTES" OF ACTION FOR RESPONDING TO CLIMATE CHANGE

The table below provides a few examples of selected adaptation activities that may be considered by the CNNF and their relative difficulty at this point in time. Because actions are dependent upon the context of the situation, this table is not endorsing or ruling out any particular action.

Easy	Intermediate	Advanced	Expert Only
▪ Increasing the diversity of native species to hedge against declines in some species ▪ Management activities to reduce the impact of pests. diseases, or invasive species ▪ Managing conifer in upland/lowland transition zones	▪ Enhanced regeneration efforts for native species expected to fare better in the future ▪ Identification and management of potential refugia for key species ▪ Targeting reed canary grass treatments in spruce grouse habitat	▪ Identification and use of seed sources that are better adapted to anticipated future conditions ▪ Artificially supply water to peatlands in priority spruce grouse habitat	▪ Facilitated movement of plant species that are currently in locations far from northern Wisconsin ▪ Translocate spruce grouse to jack pine forest of Bayfield Sand Plain.

3. THE CNNF WILL BE CREATIVE AND FLEXIBLE

"Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world."
~ Albert Einstein

- ***Adaptive management provides a framework for taking action.*** Because climate change is an emerging issue at the CNNF, an adaptive management approach allows for lessons learned regarding climate change and previous emerging issues to be used to improve management over time (Figure 1). The continual monitoring of past actions and the incorporation of new science into planning, policies, and decision-making processes are essential to this process. This approach also acknowledges the scientific uncertainty regarding specific future conditions and that the best actions may be those that allow for flexibility in the future. By keeping options open and not foreclosing future decisions, new knowledge and experience can be more readily incorporated into new actions.***What's the best response to climate change? It depends.*** There is no single "answer" to how to best respond to climate change—the best response will always be dependent upon a wide spectrum of variables, such as site conditions, management objectives, and local needs and constraints.
- ***A wide variety of ideas and tools, both old and new, will need to be used.*** Just as there is no single answer for "solving" climate change, there is also not a single tool for responding. Managers already have a "toolbox" that contains a number of tools, or possible management actions, that can be used to meet management goals and objectives. Many, and possibly all, of these tools will be important in the future, although some may be used in slightly new ways or under different sets of conditions. Because climate change adds uncertainty and variability to management, it will

be necessary to be flexible, quick to respond, and creative. Innovation and adaptability enhance the likelihood of success.

- ***Mistakes are inevitable as well as instructive.*** The CNNF may not be "good" at climate change response in the beginning—there is a lot to learn. Being open to making mistakes along the way, and equally important, learning from those mistakes is necessary for making progress.
- ***It's up to individuals on the CNNF to transform ideas to action.*** Because there is no single answer or tool, the responsibility falls to individuals to use their knowledge and expertise to take the information and resources that have been provided and use them to the fullest extent. If climate change is thought of as management issue, then it becomes the job of everyone on the CNNF to identify the ways that they can help the CNNF cope with this issue.

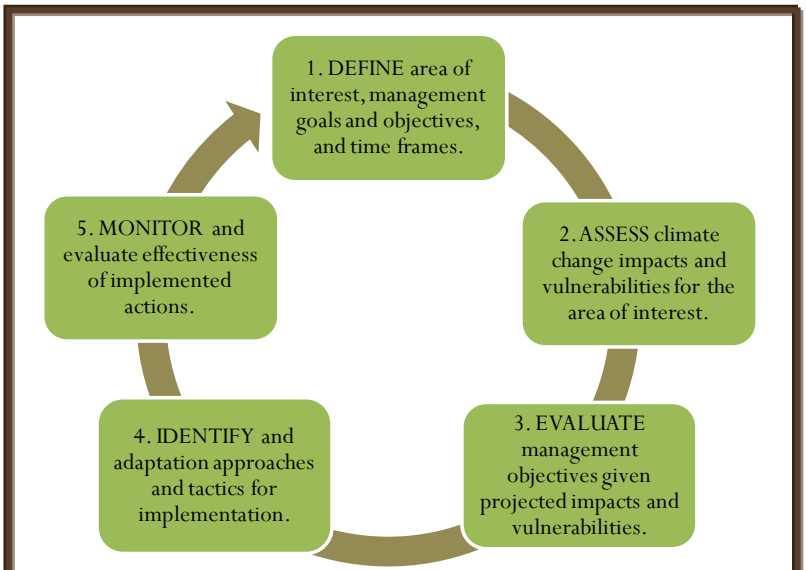


Figure 1. An adaptive approach will be important for incorporating climate change considerations into management. The process outlined in this figure is described in greater detail in the Adaptation Workbook portion of the *Forest Adaptation Resources* document (Swanston and Janowiak *in press)*.

4. THE CNNF WILL WORK COLLABORATIVELY

"It is about people working together for the good of all of us." *~ Alan Mulally, American businessman*

- ***Communication with neighbors and partners is critical.*** The CNNF must communicate with all of its neighbors, partners, and stakeholders regarding climate change. This conversation will allow the forest to both teach what it has learned, as well as learn from the lessons of other organizations.
- ***Climate change response will occur locally, regionally, and globally.*** The CNNF needs to work across boundaries at many different scales in order to respond to climate change. Partnerships and collaboration are essential.
- ***Collaboration across the landscape of northern Wisconsin is particularly important.*** The CNNF is a major element of the northern Wisconsin landscape, but it is only one part of it and does not operate as an island. Working across boundaries with the full spectrum neighbors, partners, and stakeholders is the only way that the CNNF will be able to successfully respond to climate change. The CNNF will continue to engage in landscape-level partnerships and engage in dialogue with the full community of northern Wisconsin.

Integration

Climate change is just one of many management issues faced by managers on the CNNF. An integrated approach to responding to climate change and other management issues will be the most effective and efficient means of sustaining the values, resources, and services present on the CNNF.

CLIMATE CHANGE AND THE FOREST PLAN

While climate change was not directly addressed in the 2004 CNNF Land and Resource Management Plan (Forest Plan; CNNF 2004), the current plan provides a great deal of flexibility for considering the effects of climate change on forest resources and management. The Forest Plan's emphasis on ecosystem restoration and sustainability complement the approach described above to focus on "win-win" actions for responding to climate change in the near term.

The *Forest Adaptation Resources* (Swanston and Janowiak *in press*) document describes ten categories of climate change adaptation strategies to consider in the evaluation of management actions (Table 2) and a "menu" of more specific approaches that can be implemented in northern forests. These strategies and approaches include, to varying degrees, actions that improve the **resistance** of the resource to the effects of climate change, promotion of **resilience** of the resource to recover from climate-related disturbances, and **response** actions that facilitate the transition of existing resource conditions to those that are better-suited to the projected future climate. Importantly, the strategies and approaches for responding to climate change that are presented in the *Forest Adaptation Resources* document are not prescriptive and the Forest Plan is sufficiently flexible to allow for implementation of a myriad of climate change adaptation actions that can also accomplish Forest Plan goals. Because Forest Plan goals are broad statements describing conditions the CNNF will strive to achieve, they describe the ends to be achieved rather than the means to these ends. Potential actions that are both responsive to climate change and that promote achievement of Forest Plan goals are expected to be commonplace, at least in the near term.

Table 2. Climate change adaptation strategies under three broad adaptation options (Source: Swanston and Janowiak *in press)*.

Strategy	Resistance	Resilience	Response
1. Sustain fundamental ecological functions.	X	X	X
2. Reduce the impact of existing biological stressors	X	X	X
3. Protect forests from severe fire and wind disturbance	X	X	
4. Maintain or create refugia.	X		
5. Maintain and enhance species and structural diversity.	X	X	
6. Increase ecosystem redundancy across the landscape.		X	X
7. Enhance genetic diversity.		X	X
8. Promote landscape connectivity.		X	X
9. Facilitate community adjustments through species transitions.			X
10. Plan for and respond to disturbance.			X

There are considerable synergies between the Forest Plan and climate change adaptation strategies (see Table 1). For example, forest health guidelines in the Forest Plan (p. 2-25) give preference to "mixtures of species and age classes over monocultures and large areas of a single age class." This emphasis on diversity is a well supported climate change adaptation strategy (Strategy 5 from Table 2). Other climate change adaptation strategies were considered in the development of the Forest Plan, though for landscape-scale ecological restoration purposes rather than as an intentional approach to resist and build resilience to climate change. Ecological Reference Areas (Management areas 8E, 8F and 8G) areas provide refugia for disturbance-sensitive species (Strategy 4) and create ecosystem redundancy throughout the landscape (Strategy 6). Emphasis on increasing patch size, particularly for hardwoods forest, and the restoration of riparian areas promotes landscape connectivity (Strategy 7).

> *"Valuing the past when the past is not an accurate indicator for the future may fulfill a nostalgic need but may ultimately be counterproductive in terms of achieving realistic and lasting restoration outcomes." Harris et al. 2006.*

While the Forest Plan generally has enough flexibility to allow for a wide variety of adaptation actions, areas of divergence between the Forest Plan and adaptation actions may become apparent over time. Under a changing climate, it may become more important to focus management on maintaining ecological processes, rather than ecosystem structures (Harris et al. 2006, Millar et al. 2007). At this point in time, however, the Forest's emphasis on taking action on and learning from "win-win" adaptation actions that are in accordance with the Forest Plan will help to adapt many systems and highlight potential areas for future changes to the Forest's policies.

Forest-level monitoring of climate change: Indicators, impacts and actions

Numerous efforts are underway across Wisconsin to monitor *indictors* of climate change (e.g., Ameriflux, USA National Phenology Network). Although the CNNF contributes in important ways to several of these efforts, the Forest may have a more important role to play in monitoring the *impacts* of climate change on northern Wisconsin ecosystems and species. As we stated earlier in this section, climate change was not addressed directly in the CNNF Forest Plan and is absent from our Monitoring Plan (programmatically) and our annual monitoring plan of operations. However, the CNNF annually monitors many elements that are sensitive to climate change impacts. These on-going monitoring efforts will be of great benefit in detecting and tracking the impacts of climate change on key resources.

Examples of on-going monitoring efforts that may indicate the consequences of a changing climate:

- Destructive insects and disease aerial detection surveys
- Non-native invasive plant surveys
- Population Trends of the seven Management Indicator Species in relation to habitat changes (36 CFR 219.19(a)(6)), including Brook Trout which are especially vulnerable to warming stream temperature
- Breeding bird surveys (25 years of continuous surveys)

The CNNF can also play a key role in monitoring the effectiveness of adaptation *actions*. On-going monitoring of ecosystem restoration actions will prove valuable since, as we pointed out earlier, many are also sound adaptation actions. As the CNNF tests out new approaches to climate change adaptation, it will be extremely important to conduct follow up monitoring. The Adaptation Workbook in the *Forest Adaptation Resources* document provides a useful approach for monitoring adaptation tactics.

CLIMATE CHANGE AND WATERSHED CONDITION CLASSIFICATION

The Watershed Condition Framework (WCF) is a comprehensive approach for watershed restoration that targets integrated efforts on watersheds on national forests and grasslands that have been identified as priority areas for restoration. While the WCF doesn't explicitly integrate climate change into its process, there are several areas where climate change may be taken into account in working with priority watersheds. For example, climate change could be a consideration in the identification of priority watersheds, particularly where the future impacts from climate change could be substantial if no action is taken in the near term. Additionally, tools such as the *Forest Adaptation Resources* could be used to incorporate climate change vulnerabilities into later steps of the WCF, including the development of action plans, the identification of tactics for implementation, or the selection of monitoring criteria.

THE CLIMATE CHANGE ROADMAP AND SCORECARD

The Forest Service developed a *National Roadmap for Responding to Climate Change* (USFS 2011a) in order to lay out the vision and rationale for agency-wide climate change response. The USDA Strategic Plan for 2010-15 includes a goal to "ensure our national forests and private working lands are conserved, restored, and made more resilient to climate change, while enhancing our water resources". Short-term and long-term actions that the Agency should take are identified in the *Roadmap*, and the Climate Change Scorecard as a means of tracking implementation of the Roadmap on the level of individual Forests and Grasslands is introduced. The Scorecard is a set of ten yes-or-no questions in four Dimensions: organizational capacity, engagement, adaptation, and mitigation (USFS 2011b). The Scorecard will be completed for each unit annually during 2011-2015. The goals is that all units throughout the Forest Service will be able to answer "yes" to at least seven of the ten questions, with at least one "yes" in each Dimension, by 2015. To date, the CNNF has achieved "yes" answers to nine of the 10 questions, and is actively pursuing additional activities related to each item.

Prioritization

The CNNF is responding to climate change, but does not have the capacity to take on all potential adaptation responses at once. ***Efforts and investments need to be prioritized*** based on the vulnerability of resources and the likelihood that actions taken to reduce vulnerability will be effective.

PRIORITIZATION IS A WAY TO MANAGE RISK

Resource managers manage risks every day. Deciding which risks to first address can be challenging, especially when there is a seemingly endless list of risks to consider. Climate change makes this even tougher because it is a "mega stressor" which can drive, combine, and interact with existing stressors to create novel conditions we may be unprepared for (Cleaves 2011). Risk management is an approach that can be used to deal with climate change; it promotes actions that reduce vulnerability and risk (TWB 2011).

"Triage" is one example of a systematic risk management approach that can help managers prioritize response by sorting management situations into categories according urgency of response needed and the capacity to achieve desired goals (Millar et al. 2007, Joyce et al. 2009). Cases are rapidly

> *"Risk management is how we are approaching the challenges of adapting to climate change."*
> *David Cleaves, Climate Advisor to the Chief*

assessed and divided into categories that determine further action. The categories might range from high (treat immediately) to mid- or low urgency (treat later), and may also include a category for items that are highly urgent but untreatable given current capacity (no action taken).

PRIORITIZING CLIMATE CHANGE RESPONSE ON THE CNNF

A list of priorities for climate change adaptation response may be useful to the CNNF in a number of ways. It can:

- help program leaders and specialists recognize that climate change is an important consideration when working on these issues
- feed into the CNNF's climate change response strategy
- be used to develop program area work plans
- be used to modify the CNNF's climate change work plan
- be incorporated into the annual Forest Objectives.
- identify areas of where climate change should be taken into consideration

In August 2011, CNNF program leaders worked collaboratively to identify the top resources or issues for *near-term* (within 3-5 years) adaptation response, based on a number of factors, including:

- the vulnerability of resources to the effects of a changing climate
- the timing and urgency needed to respond in a way that will reduce impacts
- the ability for the CNNF to be able to respond effectively
- the CNNF's capacity to respond based on current policy and likely resources (e.g., time, funding)

Based on the inter-disciplinary evaluation, the following six issues were identified as the highest priorities for climate change response on the CNNF in the next five years. (More detailed information on the process and results are captured in this document.)

- ***Changing species composition at developed recreation sites.*** Trees at developed recreation sites (e.g., campgrounds, picnic areas) provide important benefits to these places and the people who visit them, including shade and aesthetics. Tree mortality is currently being observed at many sites, particularly for short-lived species. It is anticipated that more trees may be lost in the future. Some mortality will be due to natural aging; however, climate change may also accelerate declines as suitable habitat changes, wind disturbances increase, or pest and disease issues become more severe. In addition to loss of shade and aesthetics, dead and dying trees at these sites can pose safety issues. This issue was identified as something that can be addressed now using current information.
- ***Changes in seasonal recreation trails.*** Warmer temperatures may reduce the duration and quality of winter conditions, leading to changes in recreational patterns on the CNNF. It is unclear exactly what changes may be expected. For example, shorter winters could lead to increased use of ATVs and greater demand for motorized trails. Alternately, longer periods of poor conditions between seasons (i.e., "shoulder seasons") may reduce recreational use, including the fees collected from these activities. In anticipation of these changes, an analysis of trail seasonality and potential changes to recreational uses on the CNNF was identified as a priority.
- ***Improvements to transportation infrastructure.*** Climate change is expected to result in changing precipitation patterns, including more severe precipitation events (Swanston et al. 2011, WICCI 2011). This may mean that the design parameters used for infrastructure (e.g., roads, bridges, culverts, stream crossings) will need to be reconsidered and design specifications may need to be changed. For example, culverts and stream crossings are currently designed to accommodate a

100-year storm event, but there are places where these events have occurred several times in the recent past. Additional considerations were identified for low-head impoundments and dams. Correctly addressing the design issues at the time of replacement has the potential for lower life-cycle costs as infrastructure will not need to be replaced after it fails or is deemed inadequate.

- ***Landscape connectivity, especially in riparian areas.*** As the suitable habitat for species change, a connected landscape will allow for easier movement and reduced lags in migration (Butler et al. *in press*). On the CNNF, riparian areas may be initial places to serve as migration corridors as they already have relatively high amounts of connectivity across the landscape. These areas, however, are also vulnerable to a changing climate. Many tree species in these ecosystems are projected to decline under warmer and drier conditions (Swanston et al., 2011), and reduced shade combined with warmer air temperatures may increase stream temperatures and affect aquatic communities (WICCI 2011). Efforts to enhance the resilience of these ecosystems are a priority.
- ***Increased frequency and severity of invasive species.*** Invasive species, including plants, animals, pests, and pathogens, have already been identified as a management issue for the CNNF. Ecosystems that are under increased stress from drought, increased disturbances, or other effects of a changing climate are likely to be more vulnerable to invasion. Further, climate change has the potential to increase the rate of invasion and spread of invasives (Millar et al. 2007). Some species that are not currently able to persist at the CNNF may experience more suitable conditions with longer growing seasons, warmer winters, and more disturbances.
- ***Changes in habitat for trees and other vegetation.*** Climate change is expected to affect entire forest ecosystems, as well as individual tree species that compose these communities (Swanston et al. 2011). In northern Wisconsin, many common tree species are expected to undergo declines in suitable habitat, including several species that are already in decline (e.g., hemlock, yellow birch). Wildlife species associated with these tree species may also be at risk. At the same time, species that are better able to cope with warmer and drier conditions and more disturbances are expected to fare better. The CNNF will need to consider of how tree species and associated forest communities may change over time.

Issues needing additional information

Some issues were identified as being highly vulnerable to climate change, with potentially significant impacts, but the CNNF program leaders felt that more information is needed before response actions are planned. These are priority areas for additional information or study.

- Increased water temperature and affects on water quality
- Changing water levels in lakes, and subsequent effects on recreation and lake ecosystems
- Declines in cool and cold water stream fish as waters warm
- Impacts to wetlands, especially bogs and vernal ponds
- Changes to stream flow, channel morphology, groundwater impacts, and groundwater recharge
- Specialty habitats, specialist wildlife species, rare plants at the south edge of range, and rare or declining ecosystems
- Potential for increased use of mineral materials (gravel) because of road/trail maintenance and loss of binding agents in aggregates due to of high flow events and extended dry periods
- Impacts of drier conditions on mesic soils and associated communities

Near-term monitoring needs

Monitoring will need to occur in conjunction each of the adaptation priorities that were identified by the CNNF. However, several questions remain: What are the monitoring needs associated with each of

these issues? What information needs to be gathered now to be able to determine if actions to adapt to a changing climate have been successful? As actions are identified for each of the priorities, plans for monitoring will also need to be identified. It will be important to plan for easy retrieval of information. As the CNNF begins to track and monitor large and small projects, protocols will need to be identified and put into place to ensure that information can be easily accessed in the future.

Literature Cited

Butler, P.R., C.W. Swanston, M.K. Janowiak, L.R. Parker, M.J. St. Pierre, and L.A .Brandt. In press. Adaptation Strategies and Approaches. . In: C.W. Swanston and M.K. Janowiak, editors. Forest Adaptation Resources: Climate change tools and approaches for land managers. Gen. Tech. Rep. NRS-87. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station, p 15-32.

Chequamegon-Nicolet National Forest [CNNF]. 2004. 2004 Land and Resource Management Plan. U.S. Department of Agriculture, Forest Service.

Cleaves, David. 2011. Managing Risk: Key to Climate Change Adaptation . Issue brief published on Office of the Climate Advisor website. http://www.fs.fed.us/climatechange/advisor/index.html Accessed September 13, 2011

Harris, J.A., R.J. Hobbs, E. Higgs and J. Aronson. 2006. Ecological restoration an global climate change. Resoration Ecology. 14 (2): 170-176.

Joyce, L. A., G. M. Blate, J. S. Littell, S. G. McNulty, C. I. Millar, S. C. Moser, R. P. Neilson, K. O'Halloran, and D. L. Peterson. 2008. National Forests *In* S. H. Julius, J. M. West, (eds.), J. S. Baron, L. A. Joyce, P. Kareiva, B. D. Keller, M. A. Palmer, C. H. Peterson, and J. M. Scott (Authors). Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research., U.S. Environmental Protection Agency, Washington, DC, USA.

Joyce, L., G. Blate, S. McNulty, C. Millar, S. Moser, R. Neilson, and D. Peterson. 2009. Managing for multiple resources under climate change: national forests. Environmental Management 44:1022-1032.

Levina, E. and D. Tirpak. 2006. Adaptation to climate change: Key Terms. . Organisation for Economic Co-operation and Development (OECD) and International Energy Agency.

Millar, C. I., N. L. Stephenson, and S. L. Stephens. 2007. Climate change and forests of the future: Managing in the face of uncertainty. Ecological Applications 17:2145-2151.

Swanston, C., and M. Janowiak, editors. Forest Adaptation Resources: Climate change tools and approaches for land managers. Gen. Tech. Rep. NRS-87. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station.

Swanston, C.; Janowiak, M.; Iverson, L.; Parker, L.; Mladenoff, D.J.; Brandt, L.; Butler, P.; St. Pierre, M.; Prasad, A.; Matthews, S.; Peters, M.; Higgins, D.; Dorland, A. 2011. Ecosystem vulnerability assessment and synthesis: a report from the Climate Change Response Framework Project in northern Wisconsin. Gen. Tech. Rep. NRS-82. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 142 p. http://www.nrs.fs.fed.us/pubs/38255 Accessed December 6, 2011.

The World Bank (TWB). 2011. Adaptation Guidance Notes - Key Words and Definitions. http://climatechange.worldbank.org/climatechange/content/adaptation-guidance-notes-key-words-and-definitions

US Forest Service (USFS). 2011. National Roadmap for Responding to Climate Change. FS-957b. Washington, DC: U.S. Department of Agriculture, Forest Service. http://www.fs.fed.us/climatechange/pdf/Roadmapfinal.pdf Accessed December 6, 2011.

US Forest Service (USFS). 2011. The Forest Service Climate Change Performance Scorecard, 2011 (version 1.3). Washington, DC: U.S. Department of Agriculture, Forest Service. http://www.fs.fed.us/climatechange/advisor/scorecard/The-Forest-Service-Climate-Change-Performance-Scorecard.pdf Accessed December 6, 2011.

Wisconsin Initiative on Climate Change Impacts (WICCI). 2011. Wisconsin's Changing Climate: Impacts and Adaptation. Nelson Institute for Environmental Studies, University of Wisconsin-Madison and the Wisconsin Department of Natural Resources, Madison, WI. www.wicci.wisc.edu/publications.php Accessed December 6, 2011.