

CHAPTER 3: ADAPTATION WORKBOOK

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Climate change imposes many challenges on the long-term management of ecosystems and is becoming an increasingly important consideration in land management planning and decisionmaking at a variety of spatial scales. The process outlined in this chapter helps managers incorporate climate change considerations into management planning and activities, while complementing existing processes and procedures for making decisions (Box 5). Moreover, it uses a workbook method to provide instructions for land managers to translate adaptation strategies and approaches (Chapter 2) into management tactics that can help forest ecosystems adapt to climate change.

About the Adaptation Workbook

As more information becomes available about the expected effects of climate change, natural resource managers are placing greater emphasis on responding to climate change. However, the amount of information that has been specifically developed to help land managers make on-the-ground management decisions is currently limited. Given the uncertainty around future conditions at specific locations or points in time, the most substantial challenge of managing forests in the face of climate change may be to begin using the tools and information currently at hand (Janowiak

Box 5: Using the Adaptation Workbook

The Adaptation Workbook can:

- Help managers view climate change as an emerging management consideration that can be incorporated into many aspects of existing management planning and decisionmaking.
- Integrate a wide variety of adaptation strategies and approaches into management decisions based upon existing management goals and objectives.
- Provide a platform for discussion of climate change-related topics and issues with co-workers, team members, and other collaborators.
- Document considerations and decisions regarding climate change and management.

The Adaptation Workbook does not:

- Make recommendations or set guidelines for management decisions or actions.
- Establish a plan for implementation of the selected tactics and monitoring efforts. Rather, that step is reserved for managers to pursue after completion of the workbook.

et al. 2011, Lawler et al. 2010). For this reason, an iterative adaptive management process (e.g., Stankey et al. 2005) that incorporates monitoring and the re-evaluation of management goals is well-suited to climate change adaptation activities (Lawler et al. 2010).

To meet this need, we have developed the Adaptation Workbook to help forest managers more effectively bring climate change considerations to the spatial and temporal scales where management decisions are made. The workbook is an analytical process built upon a conceptual model for adaptation (Fig. 7) that was derived from adaptive management principles. It has been designed to draw upon regionally specific information. Resources developed as part of the Climate Change Response Framework project in northern Wisconsin include the *Ecosystem Vulnerability Assessment and Synthesis* (Swanston et al. 2011) and the previous Adaptation Strategies and Approaches chapter (Chapter 2) of this document.

The workbook features a five-step process that can be used to incorporate climate change into resource management at a variety of spatial scales (e.g., stand, large-ownership) and at many levels of decisionmaking (e.g., planning, problem solving, implementation). By defining current management goals and objectives in the first step, the process is designed to integrate climate change adaptation into existing management efforts and consider what actions may be useful for responding to climate change. It is not intended to provide specific guidance or replace other forms of management planning; rather, it relies on the experience and expertise of natural resource professionals and is meant to complement existing management planning and decisionmaking systems¹. The workbook is designed for flexibility and can be used for a wide

¹The Adaptation Workbook is designed to supplement and support existing decisionmaking processes in the Forest Service and other agencies or institutions, but does not in any way replace, supersede, or circumvent those processes.

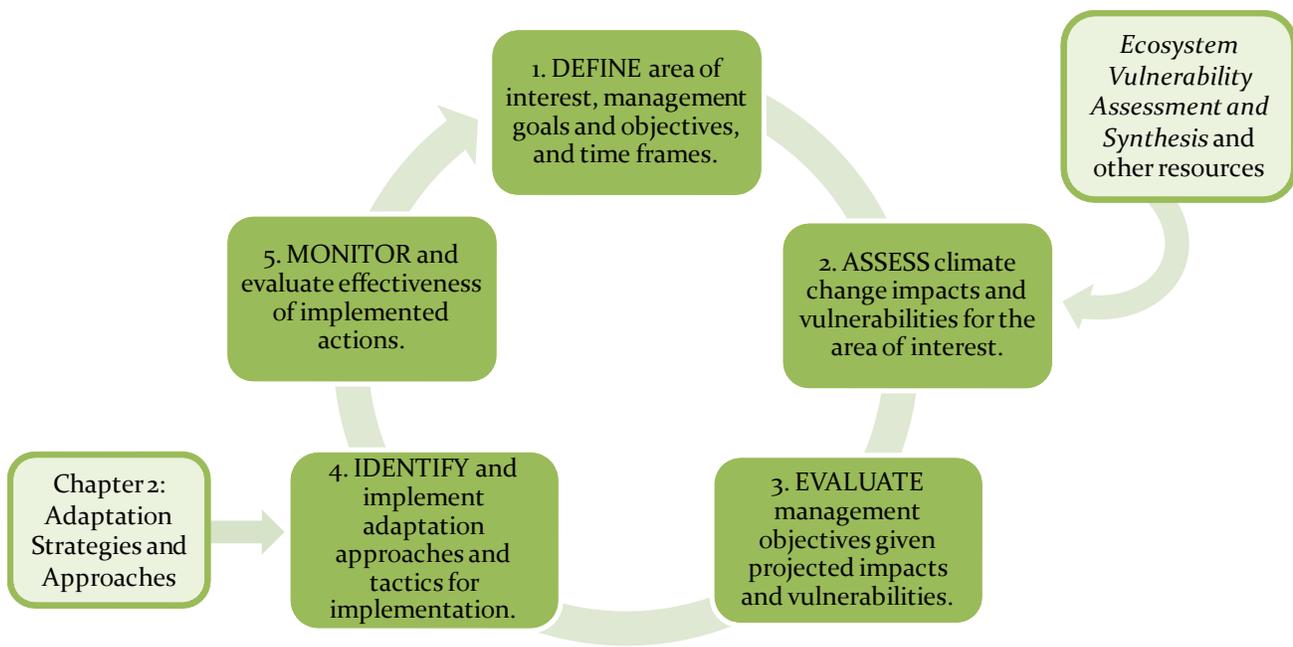


Figure 7.—The Adaptation Workbook presents a five-step process (dark green rectangles) that can be used to incorporate climate change as a management consideration and help ecosystems adapt to the anticipated effects of climate change. Additional resources (light green rectangles) provide information and tools that support the process.

range of applications; however, it is probably most useful for management activities at small to medium scales of management.

Adaptation Workbook Instructions

Welcome to the Adaptation Workbook! This process is designed to help you consider climate change adaptation in your resource management activities. The process consists of five sequential steps (Fig. 7); each step is described in detail with a corresponding table for recording information. A certain amount of flexibility is built into the Workbook; you can adjust it to include more or less information if desired.

When using this workbook, land managers in northern Wisconsin can draw upon information from specific resources such as the Adaptation Strategies and Approaches chapter (Chapter 2). Because the understanding of the impacts of climate change is continually changing and growing, we recommend that you consult recent information and resources that are relevant to your area of interest. We have noted several resources where appropriate. Additionally, we encourage you to consult with scientists and others with expertise on climate change impacts in your area of interest.

To get an overview of the process before you begin the workbook, we recommend that you read the entire Adaptation Workbook as well as the Illustrations in Chapter 4. Collect any needed information, including relevant maps and management plans, and then start the workbook.

Tables have been provided in the workbook to show how information is arranged, and electronic spreadsheets can be used for capturing your notes as you use the workbook.

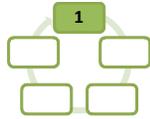
The workbook also uses forest types as a way to group information (see Chapter 2 for regional forest type descriptions). If you are working in multiple forest types, you may find it easier to complete the process for each forest type individually during some steps of the workbook.

Integration with Other Chapters

The workbook is designed to be used with the Adaptation Strategies and Approaches outlined in the previous chapter or other adaptation strategies and approaches deemed relevant.

- In this workbook, you will use the Adaptation Strategies and Approaches from the previous chapter to select the strategies and approaches that will help you meet your management goals and objectives, given projected changes to the climate and ecosystems. Then, you will develop more specific actions (tactics) to implement your selected approach.
- The Illustrations chapter (Chapter 4) provides two examples of how the Adaptation Workbook was used with the Adaptation Strategies and Approaches to identify management tactics for adapting forest ecosystems to climate change. You may also find it helpful to refer to the Illustrations as you complete the workbook.

Step #1: DEFINE area of interest, management goals and objectives, and time frames.



About this Step

In this step, you will write and record basic information about the area of interest, which can be either a specific location (geographic area) or an issue (topic area). It is likely that you already have this information available to you; this step is intended to record this information and help you to keep it in mind during subsequent steps (Worksheet #1, below; full-size worksheets for the user to cut out or copy are located in the back of this document following page 121).

Depending on what you've selected as your area of interest, you might complete this step in different ways. For example,

- You may want to define the geographic location first and then describe the management goals and objectives for that particular location. This may make more sense if you are working in a relatively small geographic area that is clearly defined (e.g., a particular stand or project area).
- Alternatively, you may prefer to define the management goals and objectives first and then the location or locations where those apply. This may make more sense if you are working at a larger spatial extent, such as a large ownership, or focusing on a specific management goal (e.g., habitat for a single species).

Worksheet #1. Full-size worksheets are located in the back of this document.

Area of Interest	Location	Forest Type(s)	Management Goals	Management Objectives	Time Frames

Description of Worksheet #1 Items

Area of Interest – Describe the area of interest, which can be either a geographic area (such as a management unit) or a topic area (such as a particular feature that is being managed for).

Location – Describe the geographic location or locations (e.g., stands, management units, or other information) for the area of interest.

Current Forest Type(s) – List the existing forest types (refer to list in Chapter 2: Adaptation Strategies and Approaches) that are relevant to your location.

Note – If desired, describe current conditions or desired future conditions in more detail.

Note – If the management goals or planned activities include the conversion of current forest types to another forest type, also list the desired future forest type (and conditions, if desired).

Management Goals – List the management goals for the area of interest (Box 6). Management goals may include the desired future forest types or conditions, habitat characteristics, the production of products, or other ecological features or services.

Management Objectives – List any management objectives for the area of interest (see Box 6). These will explain how management goals will be achieved, and there may be multiple objectives for a single management goal.

Time Frames – List approximate time frames for implementing management actions and for achieving management goals and objectives. Management horizons often span decades to incorporate all aspects of assessment, implementation, monitoring, and evaluation. For example, a management action such as a harvest may be planned to occur within 10 years (short-term) as a means to achieve an objective. A corresponding management goal related

Box 6: Goals and Objectives

Management Goals

Management goals are broad, general statements, usually not quantifiable, that express a desired state or process to be achieved (Society of American Foresters 2011). They are often not attainable in the short term, and they provide the context for more specific objectives. Examples of management goals are:

- Maintain and improve forest health and vigor.
- Maintain wildlife habitat for a variety of species.

Management Objectives

Management objectives are concise statements of measurable planned results that correspond to preestablished goals in achieving a desired outcome (Society of American Foresters 2011). These objectives commonly include information on resources to be used and form the basis for further planning to define the precise steps to be taken to achieve the identified goals. Examples of management objectives include:

- Regenerate a portion of the oldest aspen forest type through clearcut harvest in the next year in order to maintain and improve forest health and vigor in young aspen stands.
- Implement silvicultural treatments within 5 years in order to increase the oak component of selected stands and enhance wildlife habitat.

to species composition or forest structure may have a time frame of 30 years or more (long-term), with immediate and short-term actions nested within that time frame. As a default, use the following categories to identify your relevant time frame(s), but allow the objectives and ecosystems to dictate the most appropriate time frames. As you progress

through the workbook, feel free to revisit and adjust them as necessary:

- Immediate: 2 years or less
- Short-term: 2-10 years
- Medium-term: 10-30 years
- Long-term: 30 or more years



Photo by Maria K. Janowiak, U.S. Forest Service and Northern Institute of Applied Climate Science

National Forest managers discussing management options in an aspen stand.

Step #2: ASSESS climate change impacts and vulnerabilities for the area of interest.



About this Step

Identifying the ecosystem components that are most vulnerable is a critical first step in considering climate change impacts and developing responses to help systems adapt (Glick et al. 2011, National Research Council 2010). Careful consideration of impacts across vulnerable and resilient ecosystems can help you prioritize management responses for the areas where the largest impacts are likely to occur.

In this step, you will draw upon the ever-growing body of information about the projected effects of climate change as well as your expertise and experience in order to more specifically assess ecosystem vulnerability to a range of projected climate change. Because there is a lot of variability among different locations, your understanding of specific site conditions in the area of interest will help tailor management responses in this and later steps (Worksheet #2, below).

We recommend that you review the *Ecosystem Vulnerability Assessment and Synthesis* (Swanston et al. 2011) in this step because it summarizes impacts to forests in northern Wisconsin. Additionally, other

Worksheet #2. Full-size worksheets are located in the back of this document.

Broad-scale Impacts and Vulnerabilities	Climate Change Impacts and Vulnerabilities for the Area of Interest	Vulnerability Determination
	<p>How might broad-scale impacts and vulnerabilities be affected by conditions in <u>your area of interest</u>?</p> <ul style="list-style-type: none"> • Landscape pattern • Site location, such as topographic position or proximity to water features • Soil characteristics • Management history or current management plans • Species or structural composition • Presence of or susceptibility to pests, disease, or nonnative species that may become more problematic under future climate conditions • Other.... 	

information can be included to supplement that assessment. The use of multiple information sources during this step will provide a greater amount of background on anticipated climate change effects.

Description of Worksheet #2 Items

Broad-scale Impacts and Vulnerabilities – List climate change impacts and vulnerabilities for the region that you are working in (e.g., northern Wisconsin) as well as the source of this information. These may be specific to the forest type(s) that you have listed. As a starting point, broad-scale impacts and vulnerabilities for northern Wisconsin were

described in the *Ecosystem Vulnerability Assessment and Synthesis* (Swanston et al. 2011) and have been summarized below as a starting point for completing this item (Table 3). Additionally, many resources on climate change impacts and vulnerabilities exist, such as reports and peer-reviewed papers on climate change (see Box 7 for a short list of resources).

Climate Change Impacts and Vulnerabilities for the Area of Interest – The broad-scale impacts and vulnerabilities that you have listed apply generally across wide areas, but may be more or less important for your area of interest because of specific conditions or features associated with the

Table 3.—Climate change-related impacts and vulnerabilities for northern Wisconsin, from Swanston et al. (2011). The forest types presented in this table are defined in Table 1 of this document.

Extent	Potential climate change impacts and vulnerabilities for northern Wisconsin Forests
All forests in northern Wisconsin	Warmer temperatures Longer growing seasons Altered precipitation regimes Drier soils during summer Increased threats from insects, diseases, and invasive plants Altered disturbance regimes may lead to changes in successional trajectories Many common tree species are projected to have reduced habitat suitability Decline of associated rare species Decline of associated wildlife species
Aspen	Increased medium- and large-scale disturbances Decline of quaking aspen abundance or productivity Low within-stand diversity may increase risk of substantial aspen declines Medium-scale disturbances may not adequately allow for reestablishment Lack of genetic diversity within clones may be a likely disadvantage
Balsam fir	Habitat suitability may be substantially decreased Forest is less resilient to disturbances Increased competition with shade-tolerant species, such as red maple
Hemlock	More summer storms and wind events may lead to shifts in prevailing natural disturbance regimes Acceleration of current decline Drier conditions and increased disturbances may exacerbate current regeneration limitations Static ecosystem is less resilient to disturbance
Jack pine	Increased risk of fire occurrence Decline in productivity, especially on very dry sites
Lowland conifer	Altered hydrology and precipitation patterns may lead to reduced duration of soil saturation or ponding Increased risk of fire occurrence in dried organic soils Habitat suitability may be substantially decreased Reduced soil moisture or saturation may cause declines in hydrophytic tree species Static ecosystem is less resilient to disturbance

Table 3 (continued).—Climate change-related impacts and vulnerabilities for northern Wisconsin, from Swanston et al. (2011). The forest types presented in this table are defined in Table 1 of this document.

Extent	Potential climate change impacts and vulnerabilities for northern Wisconsin Forests
Lowland hardwood	Altered hydrology and precipitation patterns may lead to reduced duration of soil saturation or ponding Black ash habitat suitability may be substantially decreased Low within-stand diversity may increase risk if black ash declines substantially Drier conditions may lead to increased competition from other tree and plant species Emerald ash borer may interact with other stressors to cause widespread mortality
Northern hardwood	More summer storms and wind events may alter prevailing natural disturbance regimes Increased root damage from altered freeze-thaw cycles Decline of sugar maple productivity, especially on drier sites Increased disturbances may accelerate current decline of eastern hemlock and yellow birch Drying of ephemeral ponds may increase stress on associated species
Oak	Decline in productivity, especially on very dry sites
Paper birch	Increased fire and wind disturbance Increased disturbances may accelerate current decline Wind or other medium-scale disturbances may not adequately allow for reestablishment
Red pine	Increased risk of fire occurrence Low within-stand diversity may increase risk of substantial declines Younger stands may be vulnerable to pests that are currently present in warmer locations, especially under drought conditions Increased competition from some deciduous species, such as red maple and red oak
Spruce	Habitat suitability may be substantially decreased for white spruce and several associated species Drier soils may affect shallow-rooted white spruce Interactions among pests, drought, and other stressors may exacerbate current declines
White pine	Decline on drier sites due to drought-intolerance Super-canopy structure may increase individual tree mortality Increased competition from some associated species, such as red oak

area or ecosystem. For example, a site may have greater vulnerability to anticipated increases in the frequency and intensity of storm events because of its age structure or species composition, or less vulnerability to late-season moisture deficits due to a combination of topographic position and high water table.

Drawing upon your experience and knowledge of your area of interest, describe how you might expect the broad impacts and vulnerabilities to be modified in your area (see Box 8 for a list of considerations). You may want to reword the statements in the previous column to better reflect their more specific interaction with your area. Additionally, information

from the other resources used to assess the broad-scale impacts and vulnerabilities may be useful in providing more information focused on the area of interest.

Vulnerability Determination – Vulnerability is the susceptibility of a system to the adverse effects of climate change. It is a function of its sensitivity to climatic changes, its exposure to those changes, and its ability to cope with climate change impacts with minimal disruption (Glick et al. 2011, Levina and Tirpak 2006; Fig. 8). For example, an ecosystem subject to few potential impacts and having a high adaptive capacity would be determined to have low vulnerability.

Box 7: Climate Change Effects

Impacts and Vulnerabilities

It is important to consider both climate change impacts and vulnerabilities in this step:

- *Impacts* integrate the degree of change (exposure) that a species or system is likely to experience and the likely response to change (sensitivity; Glick et al. 2011).
- *Vulnerability* is the susceptibility of a system to the adverse effects of climate change. Vulnerability is a function of its sensitivity to climatic changes, its exposure to those changes, and its capacity to adapt to those changes with minimal disruption (Glick et al. 2011; Levina and Tirpak 2006).

Sources of Climate Change Information

Many resources are available that provide information on climate change impacts and vulnerabilities in northern Wisconsin and the region:

- The *Ecosystem Vulnerability Assessment and Synthesis* (Swanston et al. 2011) summarizes information on climate change impacts, vulnerabilities, and expected changes for forested ecosystems in northern Wisconsin.
- The Wisconsin Initiative on Climate Change Impacts website (WICCI 2011a) contains information on projected changes in temperature, precipitation, and extreme weather for Wisconsin. Information on climate change impacts statewide were also compiled into an assessment (WICCI 2011b).
- *Scanning the Conservation Horizon: a Guide to Climate Change Vulnerability Assessment* (Glick et al. 2011) is a good starting resource for creating a new vulnerability assessment.
- The report, *Global Climate Change Impacts in the United States* (U.S. Global Change Research Program 2009), describes climate change impacts for all regions of the United States.
- The series, *Confronting Climate Change in the U.S. Midwest* (Union of Concerned Scientists 2009), describes the potential consequences of climate change for individual states in the region.

Box 8: Climate Change and Your Area of Interest

Most of the available information on climate change impacts has likely been developed for spatial scales that are larger than your area of interest. It is important to consider not only these broad-scale impacts, but also how they may be expressed in your particular area of interest. Factors that may alter broad-scale impacts include:

- Landscape pattern
- Site location, such as topographic position or proximity to water features
- Soil characteristics
- Management history or current management plans
- Species or structural composition
- Presence of or susceptibility to pests, disease, or nonnative species that may become more problematic under future climate conditions.

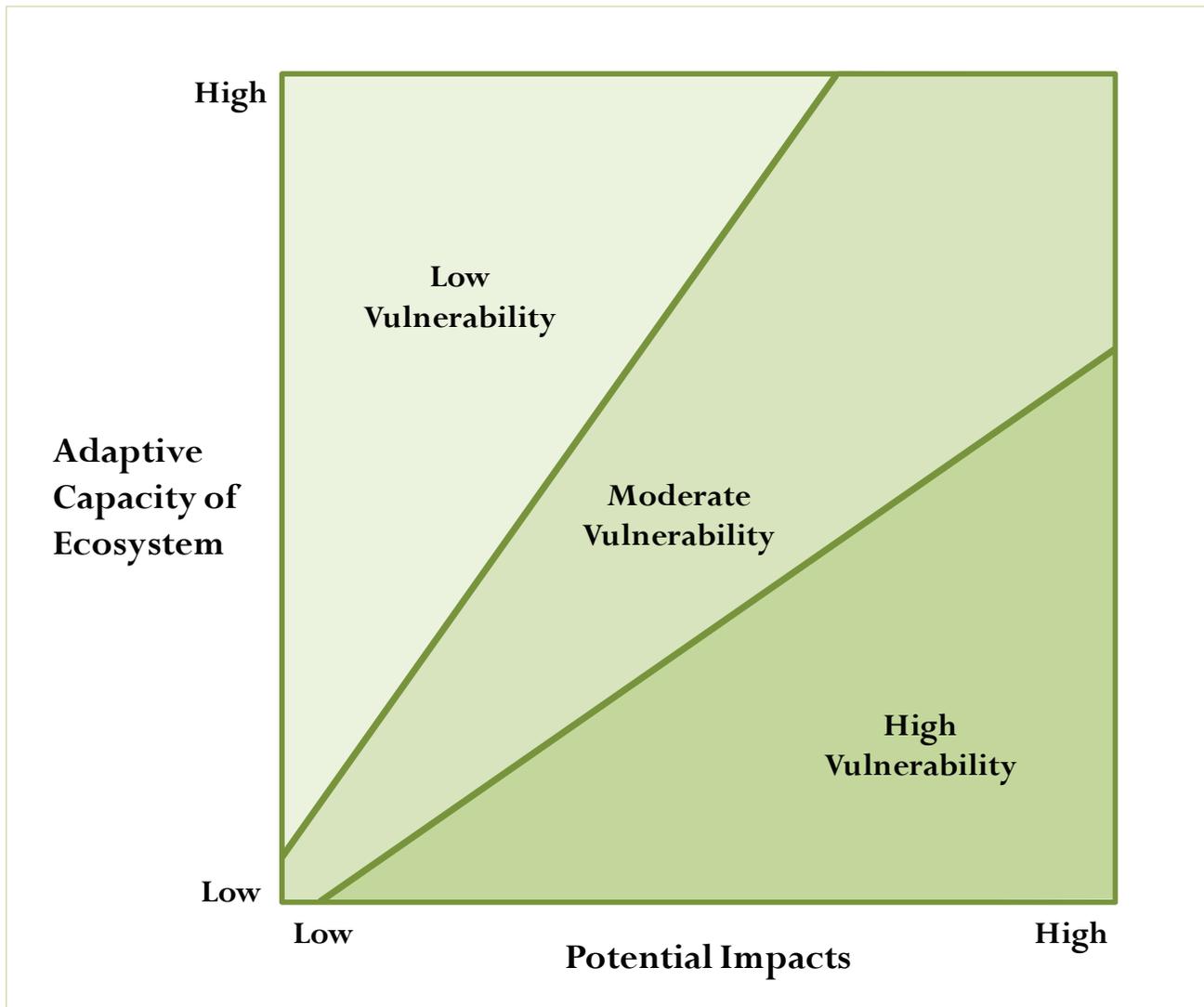


Figure 8.—The vulnerability determination considers an ecosystem's sensitivity to climatic changes, its exposure to those changes, and its capacity to adapt to those changes with minimal disruption (Glick et al. 2011, Levina and Tirpak 2006).

- **High** – Potential climate change impacts are expected to exceed the ability of the ecosystem to cope with impacts. Ecosystems may undergo changes that will disrupt important ecosystem functions and key environmental benefits.
- **Moderate** – Potential climate change impacts are expected to cause alterations to ecosystems, but ecosystems will be able to cope with some impacts.
- **Low** – Ecosystems are expected to readily cope with potential climate change impacts. It is not anticipated that climate change will have substantial negative effects on important ecosystem functions and environmental benefits.

Step #3: EVALUATE management objectives, given projected impacts and vulnerabilities.



About this Step

In earlier steps, you defined management goals and objectives for your area of interest (Step #1) and considered climate change impacts and vulnerabilities for this area (Step #2). In this step, you will identify management challenges and opportunities associated with climate change. You will also evaluate the feasibility of meeting your management objectives under current management and consider whether they should be altered or refined to better account for anticipated climate

change impacts. It is inevitable that discussion will jump ahead at times to identifying approaches or developing tactics; rather than lose these ideas or skip critical steps in the process, any ideas that will be useful in later steps should be written down to revisit later (Worksheet #3, below).

Description of Worksheet #3 Items

Management Objectives – Insert the management objectives that you identified in Step #1 (column 5).

Challenges to Meeting Management Objective with Climate Change – List ways in which climate change impacts and associated vulnerabilities may make it more difficult to achieve each management objective. Focus on concerns related to ecological or environmental challenges, since other considerations

Worksheet #3. Full-size worksheets are located in the back of this document.

Management Objective (from Worksheet #1, column 5)	Challenges to Meeting Management Objective with Climate Change	Opportunities for Meeting Management Objective with Climate Change	Feasibility of Meeting Objective under Current Management	Other Considerations

(e.g., financial, social) will be included later in this step. For example, warmer temperatures and drier conditions may limit regeneration of a desired species and make it more challenging to maintain that species into the future.

Opportunities for Meeting Management

Objective with Climate Change – List ways in which climate change impacts and associated vulnerabilities may make it easier to achieve each management objective or create new management opportunities. Focus on concerns related to ecological or environmental challenges, since other considerations (e.g., financial, social) will be included later in this step. For example, increases in small- and medium-scale disturbance may help increase structural heterogeneity within a stand or landscape.

Feasibility of Meeting Management Objective under Current Management – Consider the challenges and opportunities for managing under climate change in order to evaluate the feasibility of meeting your management objectives using *current* management strategies and actions. This feasibility determination is based primarily on ecological factors; other considerations are included in the next entry. Feasibility can be determined for individual or multiple time frames.

- **High** – Existing management options can be used to overcome the challenges for meeting management objectives under climate change. Opportunities likely outweigh challenges.
Moderate – Some challenges to meeting management objectives under climate change have been identified, but these challenges can likely be overcome using existing management options. Additional resources or enhanced efforts may be necessary to counteract key challenges or promote new opportunities.
- **Low** – Existing management options may not be sufficient to overcome challenges to meeting management objectives under climate change. Additional resources or enhanced efforts will be necessary to counteract key challenges or promote new opportunities.

Other Considerations – List any social, financial, administrative, or other factors that would be part of your decision to pursue your management objectives. You may also want to note reasons why you would continue pursuing a management objective with low feasibility, such as requirement by law, a high social value, or likelihood of meeting management objectives across a broader geographic area (i.e., an area with low feasibility may still have the highest likelihood of success when compared to other areas with low feasibility).



Slow Down to Consider...

It is very important to recognize that climate change may make management goals and objectives more difficult to achieve in the future (Joyce et al. 2008, 2009; Millar et al. 2007) and that there may be times in which they need to be altered or refined to better account for anticipated climate change impacts.

After completing the worksheet in Step #3, you should have a much better idea about whether your management objectives are feasible, given the current management options that are available to you. You've also identified social, economic, or other considerations that may affect your decision to pursue certain management objectives.

If you have high or extremely high feasibility of meeting all of your management objectives and these objectives are still sound, given projected climate change impacts, proceed to Step #4.

If some or all of the management objectives that you've identified have moderate feasibility or lower, or if they no longer seem sensible under climate change (e.g., managing a species that is very likely to experience a severe decline), you may want to consider whether you want to continue pursuing

your management objectives, as well as your broader management goals. Additionally, because management objectives were assessed under the assumption of current management practices, there may be new or different management actions that could be used to meet your goals and objectives.

Are you going to continue with the management objectives that you have identified?

If yes:

- You may choose to provide documentation for why you will continue under Other Considerations in Step #3 (column 5).
- Proceed to Step #4 to explore Adaptation Strategies and Approaches.
- Note that you may choose to return to Step #1 and alter your management objectives at any point.

If no:

- Return to Step #1 to alter your management objectives or to develop new goals or objectives. Use the information that you have gathered up to this point to create goals and objectives that are more likely to succeed, given projected impacts from climate change.

Step #4: IDENTIFY adaptation approaches and tactics for implementation.



the challenges you’ve identified (Worksheet #4, below).

About this Step

New or modified management practices may be needed to address the challenges to ecosystem management brought about by climate change. In this step, you will actively brainstorm management approaches for climate change adaptation that address the challenges identified in the previous step. Then, drawing from the approaches, you will develop and evaluate tactics that describe the type and timing of management activities needed to achieve your management objectives and overcome

This step is designed to use Chapter 2: Adaptation Strategies and Approaches, where a number of adaptation approaches have been summarized and described for forest types and conditions common in northern Wisconsin. These approaches were identified based on a number of expert reviews and may provide valuable options to guide management under climate change. However, because there may be adaptation approaches that have not been identified in the Adaptation Strategies and Approaches chapter, you may also want to develop additional approaches for meeting the management goals and objectives for your area of interest (Box 9).

Worksheet #4. Full-size worksheets are located in the back of this document.

Adaptation Approach	Tactic	Time Frames	Benefits	Drawbacks and Barriers	Practicability of Tactic	Recommend Tactic?

Box 9: Adaptation Approaches

The Adaptation Strategies and Approaches chapter of this document compiled approaches for forest adaptation from many resources and used expert feedback to refine the approaches for northern Wisconsin forest types. If you want to develop additional adaptation approaches, you may find it helpful to consult the following resources:

- *Strategies for Managing the Effects of Climate Change on Wildlife and Ecosystems*, prepared by the Heinz Center.
- *Biodiversity Management in the Face of Climate Change: a Review of 22 Years of Recommendations* by N.E. Heller and E.S. Zavaleta.
- *Managing for Multiple Resources under Climate Change: National Forests* by L. Joyce et al.
- *Forestry Adaptation and Mitigation in a Changing Climate: a Forest Resource Manager's Guide for the Northeastern United States* by J.S. Gunn et al.
- *Climate Change and Forests of the Future: Managing in the Face of Uncertainty* by C.I. Millar et al.
- *Adaptation to Climate Change in Forest Management* by D.L. Spittlehouse and R.B. Stewart.
- *Responding to Climate Change on National Forests: a Guidebook for Developing Adaptation Options* by D.L. Peterson et al.
- *Climate Project Screening Tool: an Aid for Climate Change Adaptation* by T.L. Morelli et al.
- *Adapting to Climate Change at Olympic National Forest and Olympic National Park* by J.E. Halofsky et al.

Description of Worksheet #4 Items

Adaptation Approach – Review the Adaptation Strategies and Approaches presented in this document (Chapter 2). Select any approaches that may be helpful in reaching your management goals and overcoming the challenges identified in Step #3. Include approaches that will help manage potential catastrophic events (pre- and post-disturbance), as well as any additional approaches that you devise that are not included in Chapter 2.

Tactics – Describe more specific actions that you can take in your area of interest to implement the adaptation approaches using your experience and expertise. You may have several tactics that can be used to implement a single approach, or one tactic that addresses multiple approaches. For example, an approach that favors existing species that are better-

suited to future conditions may include several tactics, including favoring future-adapted species that are present on site, modifying stand structure to increase natural regeneration of future-adapted species, and planting some areas using southern genotypes of species currently not found in the area of interest.

Time Frame(s) – List the approximate time frame(s) in which the tactics would be implemented. The nature of the action can help determine an appropriate time frame. Some actions may occur in the near term (i.e., next 2 years), while others may not occur for several decades or will occur only in certain situations (such as after a large disturbance). As a default, use the following categories to identify your relevant time frame(s), but allow the management objectives and ecosystems to dictate the most appropriate time frames:

- Immediate: 2 years or less
- Short-term: 2-10 years
- Medium-term: 10-30 years
- Long-term: 30 or more years

Benefits – For each tactic, list any benefits associated with using this tactic. For example, note if a tactic addresses your biggest challenge, addresses multiple challenges, or has a side benefit, such as improving overall ecosystem health.

Drawbacks and Barriers – For each tactic, list any drawbacks that may arise, such as negative ecosystem impacts, or any barriers to implementing the tactic, including legal, financial, infrastructural, social, or physical barriers.

Practicability of Tactic – Consider the benefits, drawbacks, and barriers associated with each tactic in order to determine the practicability of meeting your management goals and objectives using that tactic (Box 10). This determination is based on both ecological and non-ecological factors.

- **High** – The tactic is expected to be both effective and feasible. Benefits of the tactic clearly outweigh drawbacks and barriers.
- **Moderate** – There are drawbacks or barriers that could reduce the effectiveness or feasibility of the tactic. Some drawbacks or barriers may be overcome through the use of other adaptation tactics or management actions.

Box 10: What's Practicable?

An adaptation tactic is practicable if it is both effective (it will meet the desired intent) and feasible (it is capable of being implemented). Both of these characteristics increase the likelihood of success and are desirable in selected adaptation tactics.

- **Low** – The tactic does not appear to be effective or feasible. The drawbacks and barriers are insurmountable or the benefits are too small relative to the required effort. The tactic may need adjustment to be made more effective or feasible.

Recommend Tactic? – Consider the time frame, benefits, drawbacks, barriers, and practicability for each tactic and select the tactics that you recommend for consideration in future management decisions. Tactics that overcome or avoid challenges, have high practicability, or have major benefits should be favored. Box 11 contains additional considerations for evaluating the tactics.

For each tactic, determine whether you would recommend it for consideration in future management decisions:

- **Yes** – This tactic will likely be helpful in overcoming management challenges from climate change and meeting management objectives, and it should be considered in future management decisions. If needed, note any barriers that need to be overcome to use this tactic.
- **No** – This tactic is not helpful in overcoming management challenges or meeting management objectives, and it is not recommended for current consideration in future management activities.

It is important to reiterate that this workbook is intended to supplement existing decisionmaking processes, not replace them. In this step you are recommending further consideration of tactics in subsequent decisionmaking processes, but additional consideration does not mean that the tactics must be implemented or that the recommendations must supersede other considerations.

Box 11: Evaluating Tactics for Climate Change Adaptation

This Adaptation Workbook is designed to streamline the process of making decisions to help forest ecosystems adapt to climate change, but it is important to recognize that these types of decisions will always be complex and a number of variables need to be considered. For example:

- **Likelihood of Success** – Is an adaptation tactic likely to be effective in the future, given a variety of potential conditions? Will implementation of an adaptation tactic help achieve existing management objectives and goals?
- **Tradeoffs** – What are the potential tradeoffs associated with selecting and implementing a tactic? If you select an adaptation tactic, will there be negative consequences on other parts of the ecosystem or on other management actions? Can adverse impacts be avoided or mitigated?
- **Urgency** – Is there a need to implement an adaptation tactic in the near term? Will implementing a tactic now provide clear benefits in the future?
- **Cost** – Does an adaptation tactic have a high financial cost? Will implementing a tactic now prevent greater costs in the future?
- **Effort** - Is the adaptation tactic labor- or time-intensive? Will implementing a tactic now reduce the amount of work needed in the future?

The considerations above can be used to help select and prioritize approaches. In the short-term, you may want to emphasize tactics that can be described as “low-hanging fruit” because they are relatively easy to implement, have a high likelihood of success, and have few or no negative tradeoffs. At the same time, you can also identify barriers (such as cost, institutional structures, or social constraints) for tactics that you may want to implement in the future and work toward improving the feasibility of these actions for future efforts.



Slow Down to Consider...

It is important to have a suite of management approaches that address potential challenges and help to meet management objectives. After completing the worksheet in Step #4, you should have a much better idea about whether the approaches and tactics that you selected will help address the management challenges that you identified. If the tactics that you’ve selected don’t address all challenges or if many have low practicability, you may want to consider additional approaches or tactics before moving on to Step #5.

If you have decided that the identified challenges to meeting your management objectives cannot be overcome even after considering all possible tactics, you may want to alter or refine the tactics to be better aligned with the anticipated climate change impacts. Similarly, if there are substantial challenges to meeting your management objectives that may not be able to be overcome, you may also want to evaluate whether you will be able to achieve your broader management goals.

Are you going to continue with the adaptation tactics that have been selected?

If yes:

- For any tactic with moderate, low, or extremely low practicability, you may want to record the reasons that you are proceeding with that tactic in the last column of Step #4.
- Proceed to Step #5.
- Note that you can return to Step #1 and alter your management goals and objectives at any point.

If no:

- You may want to evaluate additional approaches and tactics before moving on to Step #5. You can reread the Adaptation Strategies and Approaches in Chapter 2, read other papers and documents on climate change adaptation, and consult with colleagues to identify other approaches that may be viable.
- If you were not able to identify approaches and tactics that could be used to meet your management objectives, you may want to return to step #1 to modify your objectives or to develop new goals or objectives. Use the information that you have gathered up to this point to create goals and objectives that are more likely to succeed, given projected impacts from climate change.

Step #5: MONITOR and evaluate effectiveness of implemented actions.



monitored over time and used to help determine whether management should be altered in the future to account for new information and observations (Worksheet #5).

About this Step

Monitoring is critical for understanding what changes are occurring as a result of climate change as well as whether selected actions were effective in meeting management goals and adapting forests to future conditions. This step helps to identify metrics that will be used to monitor whether management goals are achieved in the future and to determine whether the recommended management tactics were effective. The outcome of this step is a list of realistic and feasible items that can be

There are several types of monitoring, and many efforts are already underway to monitor some indicators in northern Wisconsin (Appendix 1). Most of these efforts are not designed to specifically monitor climate change, but they can still be useful in the context of climate change. Drawing upon and contributing to existing monitoring efforts when possible will help to detect changes that may not be detectable at smaller spatial scales and may also require fewer resources to implement. Consider what existing monitoring efforts are available and if they

Worksheet #5. Full-size worksheets are located in the back of this document.

Monitoring Items	Monitoring Metric(s)	Criteria for Evaluation	Monitoring Implementation

need to be modified to better monitor the results of your adaptation actions. Also consider what new monitoring items may be needed to evaluate whether you have met your management goals.

Description of Worksheet #5 Items

Monitoring Items – Identify monitoring items that will be used to evaluate whether you have achieved your management objectives and goals, or whether you have achieved a milestone that indicates that you are working toward your goal. When possible, select monitoring items that will also help you to understand whether the adaptation tactics recommended in the previous step were effective in working toward your management goals under climate change.

Monitoring Metric – Identify a metric for each monitoring item that can be used to evaluate your monitoring item. For example, if a monitoring item is to determine whether the conifer component within a stand was successfully increased through management activities, a metric could be the basal area of hemlock in the stand in 5, 10, and 20 years.

Criteria for Evaluation – Identify a criterion (e.g., condition or threshold) to evaluate whether the management goal was met or the tactic was successfully implemented. In the hemlock example above, a specific basal area value could be given to determine whether the conifer component was effectively increased.

Monitoring Implementation – Describe when information on the metric will be gathered and how the information will be collected (e.g., forest inventory data). The use of existing monitoring efforts is encouraged and some examples of ongoing efforts in northern Wisconsin are listed in Appendix 1. In completing this item, focus on creating a monitoring implementation plan that can be realistically carried out for the necessary period of time.

Next Steps

By using this Adaptation Workbook, you have considered the effects of climate change on your area of interest. You have also identified management tactics and monitoring efforts to help you meet your management objectives under a changing climate. Now that you have completed this very important step toward improving the ability of your area of interest to adapt to the anticipated effects of climate change, you can work to integrate the information from the workbook, especially Step #4 and Step #5, into existing management plans and decisionmaking processes.

As you work toward this integration, it is important to keep in mind that the tactics you developed by completing the Adaptation Workbook have been recommended for further consideration (Step #4). Taking this step does not necessarily mean, however, that the tactics must be implemented or that the recommendations must supersede other considerations. The workbook was designed to

lead you through a process for considering climate change, and it is up to you and your organization to determine the ways in which you will use the information and ideas you have developed.

Finally, the workbook is designed as part of an adaptive management process, which by definition needs to be able to incorporate new information as it becomes available. When developing a plan to implement your adaptation tactics and then monitor the results, also make plans to revisit this workbook as often as necessary to evaluate whether any changes are needed. Consult with experts whenever possible to gather new information and further refine your management decisions. As new information becomes available through scientific research, monitoring activities, or other avenues, use that information to consider how it may change your expectations regarding future conditions and whether it is appropriate to adjust your management or monitoring to better help the systems adapt to a changing climate.