Chicago Wilderness
Climate Action Plan for Nature

Version 1.0*

March 1, 2010

Prepared by the

Chicago Wilderness

Climate Change Task Force

* This plan is the first iteration needed to create momentum for climate action for nature in the Chicago Wilderness region. Climate change science, policy responses, and funding are changing rapidly. This is considered a living plan that will remain flexible in the face of evolving circumstances.

Chicago Wilderness and Climate Change

Chicago Wilderness is a regional alliance that connects people and nature. We are more than 250 organizations that work together to restore local nature and improve the quality of life for all who live here, by protecting the lands and waters on which we all depend (for more information see www.chicagowilderness.org). Chicago Wilderness works across southeastern Wisconsin, northeastern Illinois, northwestern Indiana and southwestern Michigan the region to:

- Manage and restore natural communities
- Enable organizations to come together, identify regional conservation goals, and work together toward those goals.
- Improve natural and social science
- Deliver more and improved environmental education.
- Promote sustainable development.
- Involve the region's residents in local conservation efforts.
- Enrich the quality of life the residents of the region

The broad goals necessary to achieve this mission were laid out in the Chicago Wilderness *Biodiversity Recovery Plan* in 1998 and still drive conservation activities of the alliance today. The science-driven process used to develop this plan in the mid-1990's identified three major systemic threats that create vulnerability for terrestrial and aquatic biodiversity of the Chicago Wilderness region: (1) habitat destruction and fragmentation, (2) invasive species, and (3) pollution. These remain among the top threats to biodiversity in the Chicago Wilderness region and at a global scale.

Today there is overwhelming scientific evidence that a fourth threat is adding stress and compounding the affects of the big three — climate change. The Chicago Wilderness Executive Council recognized the potential of climate change to jeopardize all conservation investment that has taken place in the Chicago Wilderness region and, in 2007, established Climate Change as one of four long-term, strategic initiatives that have become the focus of Chicago Wilderness members (see www.chicagowilderness.org). To carry out the Climate Change initiative, it established the Climate Change Task Force to "study and make recommendations on adaptation strategies and models for mitigation in order to address the local impact of climate change." In 2008 the Climate Change Task Force produced *Climate Change and Regional Biodiversity: A Preliminary Assessment and Recommendations for*

Chicago Wilderness Member Organizations that reviewed the current science of climate change, the dramatic changes projected for the Chicago Wilderness climate system, and expected impacts to regional biodiversity (Chicago Wilderness Climate Change Task Force 2008; see also Chicago Wilderness 2007-2008 Annual Report). The Chicago Wilderness Climate Action Plan for Nature grew out of this assessment as the logical next step to identify activities to respond to and mitigate potential threats.

In 2007, a group of retired military officers assessed how climate change could affect US national security (CNA Corporation 2007). They characterized climate change as a threat multiplier and that determining which parts of which threats will be multiplied represents the challenge faced by US national security agencies. This characterization, with its acknowledgement of uncertainty, applies completely to conservation practioners. Climate change by itself may not create stressed conditions for Chicago Wilderness biodiversity, but it can compound existing vulnerabilities. While there are many uncertainties about climate change impacts — and how Chicago Wilderness conservation practitioners should react — the cost of doing nothing may be far greater in the long-run than waiting until those uncertainties diminish to near zero. If the projections are correct, it would be too late. What we propose in the Chicago Wilderness Climate Action Plan for Nature are modest first steps for the conservation community to assure that our biodiversity mission is not jeopardized.

Preface

This initial version of the Chicago Wilderness Climate Action Plan for Nature was developed over the course of one year, from February 2009 to February 2010. The Climate Change Task Force, with representation from 37 member organizations, spent the first nine months developing a review draft through bi-monthly Task Force meetings, smaller subject-area working groups, and a special experts' workshop on adaptation. The Task Force presented a review draft to the Chicago Wilderness Executive Council on November 18, 2009, which began a broad review within the Chicago Wilderness alliance over the next three months. The review process yielded 34 separate comments from individuals and groups (a compilation of these comments is available upon request).

From the beginning, the objective of this version of the plan was to identify the initial set of actions needed to create momentum for the Chicago Wilderness alliance. While the alliance is a powerful collaborative force in many respects, there are also some limitations that tempered the Task Force's enthusiasm for approaching all possible types of climate action at once. The reality is that Chicago Wilderness:

1. has limited staff and none solely dedicated to climate change,
2. works primarily through representatives of member organizations, whose time devoted to teams and task forces is sanctioned by the employing organization and subject to change, and
3. has unclear funding streams for climate change action.

With this in mind, we were careful to include actions that can create momentum, that is, have a high likelihood of being implemented within the first 1-2 years. Upon approval by the Chicago Wilderness Executive Council, the Climate Change Task Force will begin designing and implementing the actions outlined in this plan. But implementation is contingent on marshalling representatives from member organizations and securing sufficient funding. Because of the capacity and funding variables, we also can't predict and project a timeline for accomplishing all the actions recommended, much like the *Biodiversity Recovery Plan*, which makes many recommendations, but has no implementation schedule. In order to successfully accomplish climate action goals, individual Chicago Wilderness member organizations need to step forward, participate, and help fundraise.

As you will see in Section 3, a climate change update to the *Biodiversity Recovery Plan* was developed in parallel with this initial iteration of the Climate Action Plan for Nature and is included as an Addendum. It is anticipated that the updated *Biodiversity Recovery Plan* will drive future iterations of the Chicago Wilderness Climate Action plan for Nature.

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Climate Change and Regional Biodiversity[1]

Scientists have been studying climate change for the last century and have extensively documented the significant increase of greenhouse gases contributed by human activities. For example, current atmospheric concentrations of carbon dioxide, the most prominent greenhouse gas in the atmosphere, are at levels unprecedented during the last 800,000 years of Earth's history (Brook 2008). Within this time period, the rapid spike in carbon dioxide concentrations started at the beginning of the industrial revolution and parallels the increase in the consumption of fossil fuels. Also well documented is the fact that, as carbon dioxide levels increase, so do global temperatures. While there is uncertainty as to the precise effects climate change will have on specific ecological systems, the altered precipitation and temperature patterns projected by the Intergovernmental Panel on Climate Change are expected to alter patterns of biodiversity by changing the abundance and distribution of both native and non-native species; affect rates of basic ecosystem processes; and compromise ecosystem services beneficial to humans. Unfortunately, due to the greenhouse gases already in the atmosphere already, some future changes are completely unavoidable. Therefore, action must be taken now in order to adapt to the inevitable climatic changes that will occur. It is possible, however, that the most devastating of projected changes do not have to happen if prompt action is taken to significantly reduce future emissions.

The climate of the Chicago Wilderness region is already changing fast. According to the Chicago Climate Action Plan, Chicago's annual average temperature has warmed by more than 2°F since 1945, with winter temperatures increasing the most. The projections for the coming century include warmer temperatures, more extreme heat events, and more extreme precipitation events for the Chicago area. The magnitude of these changes depends on choices society makes about our emissions of greenhouse gases (see Table A).

Globally, the Intergovernmental Panel on Climate Change (2007) suggests that the ability of many ecosystems to adapt naturally to climate warming will be exceeded this century. The

[1] This section is a summary of the 2008 *Climate Change and Regional Biodiversity: A Preliminary Assessment and Recommendations for Chicago Wilderness Member Organizations*, which has extensive citations. This was supplemented with these newer sources: City of Chicago (2008a) – *Chicago Climate Action Plan Research and Reports*, Union of Concerned Scientists (2009) - *Confronting Climate Change in the Midwest: Illinois*, and US Global Change Research Program (2009) - *Global Climate Change Impacts in the United States*, which also have extensive citations. See references in Appendix 2.

Chicago Wilderness Climate Change Task Force compiled a situation analysis in 2008 on the impacts of projected climate changes on regional biodiversity in the Chicago region. The changes in climate are expected to have a variety of direct and indirect impacts, including:

- Changes in the timing of natural events such as blooming, leaf drop, nesting and egg laying, migration, onset of hibernation, etc;
- Loss of suitable habitat for some species and increases in habitat for other species;
- Gradual shifting of mobile species (generally northward and eastward) as temperatures increase;
- Disruption of ecological communities due to differential responses of species to climate change;
- Disruption of predator-prey relationships and other inter-specific relationships; and
- Increased threats from invasive plant and animal species, as well as diseases and pathogens.

These impacts on native biodiversity will result in changes to the abundance and distribution of fish, wildlife, and plant species, with both winners and losers related to species' ability to persist in the Chicago Wilderness region. At this time, it is impossible to state with precision which species will be affected by climate change, or exactly how, but increasing scientific evidence suggests that many species in the Chicago Wilderness region will be impacted in some way. Species for which the Chicago Wilderness region is near the southern edge of their range may be at particular risk. Species for which the region is near the northern end of their range may increase in abundance, and species currently not found here may appear.

For terrestrial species, ongoing research on tree and bird species is elucidating potential gains and losses, especially for species at the edge of their range. Some research suggests that climate change may also negatively impact pollinator species in particular, because when plants and pollinators respond differently to climate change, pollinator reproductive success may be reduced. On the other hand, insect growth will be generally favored by higher temperatures, which may result in greater damage from insect pests.

Due to the limited capacity of stormwater systems, the projected higher frequency of large storm events will increase the amount and rate of runoff into waterways and lakes. This scenario is likely to stress aquatic species with more flood surges, more pollution, and higher temperatures. Water levels in the Great Lakes are projected to decline both in summer (due to increased

evaporation) and winter (due to a decrease in lake ice). Lake Michigan is considered particularly vulnerable. The groundwater systems of the Chicago Wilderness region, which are already entering the climate change era in deficit condition, are expected to decline further due to changes in precipitation, evaporation, and increased withdrawal. This, in turn, will affect wetland and stream habitats.

Most terrestrial and aquatic habitats in the Chicago Wilderness region are highly fragmented, exacerbating challenges for species whose suitable bioclimatic envelopes are shifting across the region. Endangered, threatened, and other at-risk species are likely to be particularly challenged by this fragmentation that – combined with the interaction of climate change with other stressors (e.g., invasive species and water pollution) – may push them beyond their ability to cope. A changing climate may favor the spread of invasive species, which generally are more adaptable than native species. However, invasive species that prefer cooler and wetter conditions may not compete as well against some native species. Overall, climate changes will likely amplify current management challenges involving invasives species, habitat fragmentation, urbanization, disease, parasites, and stormwater management.

Finally, the direct effects of climate change on Chicago Wilderness species and habitats indirectly affect human well-being by disrupting the services provided by healthy ecosystems. Ecosystem services encompass the functions by which the environment produces resources that provide economic value to the human economy and quality of life, such as clean water, habitat for fisheries, pollination, recreational opportunities, climate stabilization, and carbon sequestration. Millions of dollars in ecosystems services are lost every year to poorly-planned growth (Bagstad 2006). These losses are expected to grow as climate change continues.

Table A. Past Climate Changes and Projected Future Trends in the Chicago Wilderness Climate System

Recent Changes in Climate since the mid-20th Century

- Annual average temperature rose by more than 2°F since 1945
- Increase in temperature was particularly noticeable during winter
- Fewer cold waves, and a number of major heat waves in the last few decades
- Lengthening growing seasons
- Lake Michigan ice forming later, lasting for shorter periods, with some years having almost no lake ice
- Warmer and wetter growing season

*Changes Expected Over the Coming Century**

- Temperature increases — Chicago could expect an annual average temperature increase ranging from 3 - 4°F under lower emissions to 7 - 8°F under higher emissions; greatest increases likely during summer;
- Hotter summers — number of extremely hot days (over 100°F) could increase from the current 2 days per year to 8 days per year under lower emissions, or as many as 31 days per year under higher emissions;
- More heat waves —using the catastrophic 1995 heat wave as a baseline; under lower emissions there could be one every other year and under higher emissions there could be several heat waves like the 1995 event each year;
- More humidity — increased evaporation of surface water would result in increased humidity;
- Longer growing season — last spring frost would occur from 20 days earlier under lower emissions to about 30 days earlier under higher emissions;
- Less frost — fewer frost days each year and frost depth in the soil will decrease;
- Fewer extremely cold days and cold spells — the average coldest day of the year could warm by 4 - 6°F through this century;
- Large seasonal shifts in precipitation — most precipitation occurring in winter and spring, and increased chances of drought in the summer; and
- More heavy precipitation events — slightly greater increases for regions closer to the Great Lakes.

* The range of values/changes represents different scenarios for greenhouse gas emissions during the 21st century.

Sources: City of Chicago (2008a); Union of Concerned Scientists (2009)

Climate Action for Humans and Nature

"At present, climate change is seen as one problem for nature and another for people. This must stop. If human adaptation to climate change compromises biodiversity, then the loss of forests and other natural ecosystems will accelerate climate change, increasing the need for adaptation even as the planet's capacity to accommodate it diminishes. An integrated approach makes the circle virtuous: by conserving biodiversity, we decelerate climate change while increasing the adaptive capacity of people and ecosystems alike." (Turner et al. 2009)

Creating an Integrated Regional Solution to Climate Change

Recognizing the potential for climate change to disrupt its social and economic fabric, in 2008 the City of Chicago released a Chicago Climate Action Plan that outlines strategies for reducing greenhouse gas emissions, modifying city programs to adapt to a warmer future, and engaging civil society in this effort. Understandably, the plan deals almost entirely with the human population, built environment, and city services. Other Chicago-area climate plans for municipalities and institutions are similar (see Table B). But these only represent part of the solutions necessary to reduce the threat of climate change and adapt to its inevitability in the coming decades. A comprehensive approach would cover the full range of assets that make the Chicago region so vibrant, not only the human and social assets, but also nature and natural capital.

The Chicago Wilderness Climate Action Plan for Nature complements the municipal and institutional plans for the human community by including conservation of native species, natural areas, and ecosystem services as part of the solution. This is especially critical because the ability of natural systems to adapt to increasing rates of climate change is generally more limited than built systems. The Chicago Wilderness Climate Action Plan for Nature also expands the geographic scope beyond individual city boundaries to include the Chicago Wilderness region, which encompasses the land- and waterscapes in the four-state area around the southern end of Lake Michigan (see www.chicagowilderness.org).

Chicago Wilderness Climate Action Plan for Nature

What is represented in the following pages is the first iteration of what will be a dynamic program for climate action in the Chicago Wilderness region. Many aspects of climate change are evolving fast, so the Climate Change Task Force has created a living plan that will adapt

and become more comprehensive as new science, tools, policies, and funding become available.

The Chicago Wilderness Climate Action Plan for Nature includes three major components, all of which are tightly linked to other Chicago Wilderness programs and strategic initiatives:

1. Engagement - The primary engagement goals are for Chicago Wilderness alliance members to become fluent in the concepts, vocabulary, and programs of the new climate change era. Conservationists need to begin participating fully in this new era, both as part of the solution to reduce the threat and by taking advantage of new opportunities. Beyond the Chicago Wilderness alliance, we must also be leaders in communicating the need for urgency of climate action, for the sake of humans and nature, and to create recognition that our core mission of land and water conservation is part of the solution.
2. Mitigation - Mitigation is all about strategies to abate the threat of climate change by reducing levels of heat-trapping greenhouse gas pollution in the Earth's atmosphere. Our focus here is on the role that natural areas play in sequestering atmospheric carbon and the contribution that land protection strategies make in preventing the destruction of native habitats and the ensuing release of carbon dioxide. Our primary mitigation objectives are to create recognition of the need for land conservation in climate change decision-making; position conservation professionals to take advantage of new carbon finance for biodiversity; and advance carbon science in the Chicago Wilderness region. We also recognize that we must reduce the carbon footprint of our conservation business operations.
3. Adaptation - Climate adaptation programs recognize the inevitability of at least a century of warming before the Earth's climate system could begin to stabilize. In this initial version of the Chicago Wilderness Climate Action Plan for Nature, our emphasis is on catching up, that is, adjusting current conservation strategies to be climate smart. The basic premise is that we cannot fulfill our duties as stewards of Chicago's remaining natural ecosystems if we plan and manage for a world that no longer exists. While most of what we are currently doing will help make nature more resilient to a rapidly changing climate, the goals outlined in this section of the plan will evaluate and modify existing programs that were designed prior to knowledge of climate-induced challenges. A climate change update to the Chicago Wilderness *Biodiversity Recovery Plan* is part of the adaptation analysis and is a companion document being completed in parallel with

this version of the Climate Action Plan for Nature. The success of all our past conservation investments depend on our ability to recognize and adapt to the fact that climate change changes everything.

Though it may seem that the organization of this plan presents mitigation and adaptation as two unrelated sets of actions, in fact, there is considerable overlap. For example, preventing both the destruction of native habitats and release of carbon dioxide through land protection is a mitigation strategy to reduce greenhouse gases. Land protection for core natural areas and corridors is also an adaptation strategy that creates a resilient reserve system. Essentially, the same conservation tool (land protection) plays both mitigation and adaptation roles. Which brings up one final, related point: In biodiversity conservation, climate action is usually segmented into carbon sequestration (mitigation) programs or adaptation programs. Apparently these programs have never been bundled into a comprehensive set of actions for a geographic area, as has been done in climate action plans focusing on humans and social institutions. The Chicago Wilderness Climate Action Plan for Nature appears to be groundbreaking in this respect.

Table B. Comparison of Chicago Wilderness Climate Action Plan for Nature with Chicago-area Climate Plans, Illustrating the Complementary Human-Nature Linkage		
Plan	**Mitigation Actions**	**Adaptation Actions**
Chicago Wilderness: Climate Action Plan for Nature	carbon sinks through: land conservation ecosystem restoration (some direct emissions reductions)	focused on: native species ecosystems ecosystem services
City of Chicago: Chicago Climate Action Plan	reduce greenhouse gas emissions (mention of offsets/carbon sinks)	focused on: human population built environment city services
City of Evanston: Climate Action Plan	reduce greenhouse gas emissions (mention of offsets/carbon sinks)	no explicit adaptation actions
University of Illinois Chicago: Climate Action Plan (draft)	reduce greenhouse gas emissions (mention of offsets/carbon sinks)	no explicit adaptation actions
Chicago Metropolitan Agency for Planning: GO TO 2040 (draft)	reduce greenhouse gas emissions from transportation sector	no explicit adaptation actions (but Chicago Wilderness Green Infrastructure Vision is part of plan)
Chicago Metropolitan Agency for Planning: Northeastern Illinois Water Supply/Demand Plan	N/A	future water-use under five climate-change scenarios

Section 1
Engagement:
Actions to Create a Climate for Change

Introduction

The main emphasis of this version of the Chicago Wilderness Climate Action Plan for Nature is to help the Chicago Wilderness alliance reduce the threat of climate change and adapt to its inevitability. This means marshalling the alliance's awesome network of conservation practioners and closely integrating the Climate Action Plan for Nature with the goals of Chicago Wilderness' other strategic initiatives in order to create local solutions that have global impact. It will also be important to look beyond the alliance to decision-makers and the public at large. Many actions outlined here will produce information that we can use to clearly illustrate the positive contribution that biodiversity conservation makes to combating and adapting to a rapidly changing climate.

The science of climate change is new and it is complex. So, part of the intention of this plan is to help Chicago Wilderness members become more fluent in understanding and communicating the threat of climate change to biodiversity. And we have a steep learning curve ahead of us. The things you read or see in the popular media about climate change often have no obvious relation to Chicago Wilderness' core mission of biodiversity conservation. Think about some of the established conservation strategies we employ, such as prairie restoration. It is something we now understand very well, but in the beginning we had to learn (or invent!) the concepts, practices and vocabulary. So it is with addressing climate change.

It is critical that we rapidly climb the climate fluency curve because conservationists are looked upon by the public as leaders in this realm. Climate change is both complex and politically partisan, but has the potential to jeopardize all investments we've collectively made in conservation. A recent analysis by the American Psychological Association (2009) Task Force on the Interface between Psychology and Global Climate Change suggests that there are five elements that make up an effective climate change message:

1. Stress urgency.
2. Communicate as much certainty as can be mustered with integrity.
3. There can't be just one message: there must be messages targeted to different groups.

4. Messages should be framed in positive terms.
5. Give people the sense that they can be part of the solution and that their effort won't be in vain.

Telling the story of climate change with effectiveness is of equal importance to the scientific research behind documenting impacts and designing solutions.

The three goals in this section are aimed at engaging different audiences or constituencies in creating solutions to climate change. Goal 1, establishing a Chicago Wilderness Climate Clinic, is aimed squarely at bringing Chicago Wilderness members up to date in climate change-related programs, tools, and planning. The objective is to create useful products for Chicago Wilderness members. Education is Goal 2 and is also intended for an internal Chicago Wilderness audience, this time the Education Team, although it has implications for outreach to a much broader constituency over time. And finally, an external outreach component is presented in Goal 3. Climate messages will be embedded in the existing Chicago Wilderness public communication efforts in an effort to influence decision makers and elected-officials.

Engagement Action Plan

Goal 1 - Assist Chicago Wilderness members in designing mitigation and adaptation actions to fit their unique situations

This goal recognizes that each member of the Chicago Wilderness alliance is unique, with its own conservation priorities, strategies, political context, constituency, and resources. Even with the broad roadmap of the Chicago Wilderness Climate Action Plan for Nature, each member will need to tailor climate solutions to their own unique circumstances in order to mitigate the threat and to adapt to the daunting and uncertain impacts of abrupt climate change.

Engagement Strategy 1a: Chicago Wilderness Climate Clinic Create program (see Table E1).	**Responsibility**
Actions:	
Design a clinic that melds emerging climate science and tool development with the peer-to-peer creativity of conservation practioners in a process that creates content and useful products for application.	Climate Change Task Force
Implementation phase, following design.	CW members; Climate Change TF; CW Teams: Natural Resource Mgt., GIV, Sustainability

Goal 2 - Education

The education component is intended for internal Chicago Wilderness members and, specifically, the Education Team. The mitigation and adaptation sections of the plan will provide the scientific basis that the Education Team will use to create programs and tools tailored for the differing needs of Chicago Wilderness organizations. The actions are designed to create information sharing about climate change education that will enable the alliance to build upon initiatives that are successful and to learn from those that are not.

Engagement Strategy 2a: Education Programs Share and evaluate information on what has been developed for climate change education in the Chicago Wilderness region as the first phase in developing an effective program.	**Responsibility**
Actions: Phase I (Spring 2010 - Fall 2012)	
To promote the use of effective tools, collect information on the success and failure of Chicago Wilderness member endeavors to create climate change education programs.	Climate Change Task Force, Education Team
Develop the means or forums through which to share the above information, such as: • Climate change education track at the 2010 Chicago Wilderness Congress where educators share successes and challenges delivering climate change content to key audiences: teachers, student groups, decision-makers, and intergenerational audiences. Use this as basis for developing tools to support the broader Chicago Wilderness community of educators.	Climate Change Task Force, Education Team

• Separate workshop specifically for educators.	
Review existing Chicago Wilderness tools, materials, and programs to identify where there is a connection to climate change, for example: • Leave No Child Inside • An Educators Guide to Chicago Wilderness: Three Problem-Based Paths for Exploring Biodiversity Issues in Your Own Backyard • Illinois Biodiversity Basics • Tools for Teaching Biodiversity: Proceedings from the Chicago Wilderness Educators' Conference on Biodiversity • Tools Workshop for Non-formal In-service Providers	Education Team
Actions: Phase 2 (Fall 2012 - Fall 2014)	
The 2012 Chicago Wilderness Congress will represent the milestone date by which to complete Phase I actions. The results from Phase I (i.e., which programs were most successful or useful) will be presented at the 2012 Chicago Wilderness Congress and used as a benchmark to decide how to proceed with next steps and what additional tools or material will be needed.	Climate Change Task Force, Education Team

Goal 3 - Include key climate messages in Chicago Wilderness public communication efforts targeted to elected officials

This goal is embedded in the larger Chicago Wilderness public communication efforts currently being developed with a grant from Boeing. Key elements of the Mitigation Action Plan will be included as the Chicago Wilderness climate messages in the campaign.

Engagement Strategy 3a: <u>Public Communication Efforts</u> Use data products from Mitigation Action Plan to create recognition of the role that land conservation has in combating climate change	**Responsibility**
Actions:	
Use data from Mitigation Strategy: Recognition for Conservation and Restoration (see Section 2 - Mitigation) to craft messages for decision makers and elected officials.	Climate Change Task Force; CW Communications
Design and deploy strategy.	CW Communications

Table E1. Chicago Wilderness Climate Clinic topics from Mitigation and Adaptation Sections		
Strategy		**Clinic Topic**
Mitigation Action Plan (Section 2)		
1a	Create recognition for land conservation as a solution to combating climate change.	Provide tools and experience that will allow individual Chicago Wilderness land managers to refine their estimates of carbon sequestration benefits from their natural areas.
1b	Carbon finance for biodiversity conservation.	Stakeholder-designed carbon project standards; helping members take advantage of carbon finance for conservation projects.
2	Chicago Wilderness members calculate and reduce carbon footprint.	Tools and best practices for calculating carbon footprint baseline and reducing overall footprint.
Adaptation Action Plan (Section 3)		
1a	Make existing conservation strategies of Chicago Wilderness members climate ready.	Assist members in making existing conservation priority plans climate ready.
2a	Assess the vulnerability of priority terrestrial and aquatic species to climate impacts.	Workshop for land managers on Climate Change Vulnerability Index tool and ClimateWizard.
2b	Reduce the impacts of other ecological stressors that constrain the ability of native species to persist as they become stressed by changes in climate.	Assess current strategies for addressing the threat of invasive species and revise restoration guidelines/BMPs.
2c	Promote and maintain larger land- and waterscapes for biodiversity with internal redundancy and connectivity.	Deploy tools to assess the resiliency of current preserve designs to withstand disruptions in species dispersal and shifting microenvironments.

Section 2
Mitigating the Threat of Climate Change:
Actions to Reduce Greenhouse Gases in the Atmosphere

Introduction

Climate change mitigation actions are designed to do one thing: reduce greenhouse gases in the atmosphere to acceptable levels. In the broadest sense, this reduction will be achieved in two ways:

1. Reduce emissions from anthropogenic sources
2. Sequester atmospheric carbon in the Earth's biosphere

The first element alone, reducing emissions, will not prevent human society from surpassing the tipping point in the climate system, beyond which there is little chance of maintaining contemporary conditions. There will always be some human-caused emissions, so protecting, creating, and effectively managing carbon sinks is necessary.

The Chicago Wilderness goals for mitigation include actions that address emissions reduction and carbon sequestration, but in both cases, the focus is on the role that natural areas and open spaces play in mitigating the threat of climate change. Chicago Wilderness has always placed biodiversity value on these places. It is now time to start recognizing and giving credit to the services that these ecosystems provide to society, such as sequestering carbon.

Goal 1 mitigation actions focus squarely on two core conservation tools of the Chicago Wilderness alliance: land protection and ecosystem restoration. The three strategies of Goal 1 address the role that natural areas play in creating carbon sinks for atmospheric carbon (sequestration) and in avoiding the release of carbon dioxide through the destruction of native habitats (reduce anthropogenic sources):

- Strategy 1 – quickly communicates, with the most credible data currently available, that Chicago Wilderness conservation plays a vital role in reducing the amount of carbon dioxide that would otherwise enter the atmosphere and further contribute to the threat of climate change.

- Strategy 2 – longer-term, advances the science of measuring and monitoring carbon in Chicago Wilderness ecosystems and under different management regimes; we need better knowledge of carbon dynamics in our ecosystems.
- Strategy 3 - positions Chicago Wilderness alliance to take advantage of carbon finance for biodiversity conservation.

Goal 2 is secondary to the previous goal, but it recognizes that conservationists must be leaders in reducing anthropogenic sources of greenhouse gases by using less energy and consuming fewer materials. The Climate Change Task Force recommends three strategies to achieve emission reductions of conservation business operations in Chicago Wilderness:

- Strategy 1 - Chicago Wilderness members calculate a baseline carbon footprint from which to design and implement emission-reduction actions.
- Strategy 2 - Measure reductions and reward progress.
- Strategy 3 - Support the creation of a viable Chicago metropolitan area market for sustainable technologies that mitigate climate change.

Background[2]

Carbon Dioxide is our Gas

Greenhouse gases include a wide variety of gases that trap heat near the Earth's surface, slowing its escape into space and creating the "greenhouse effect." While greenhouse gases occur naturally in the atmosphere, human activities also result in additional greenhouse gas emissions, particularly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Humans also manufacture three gasses not found in nature that slow the release of radiant energy into space: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). These six gases are regulated by the Kyoto Protocols.

By volume, carbon dioxide accounts for three-quarters of global human-caused greenhouse gas emissions. It is also the gas we focus on in mitigation projects associated with biodiversity conservation. Natural lands reduce the threat of climate change through biological carbon

[2] Much of the information is this section is from the Pew Center for Global Climate Change (2010), notably the Climate Change 101 series (reference in Appendix 2). See also the Climate Change Glossary in Appendix 1.

sequestration, the process by which carbon dioxide from the atmosphere is taken up by plants through photosynthesis and converted into organic matter in plants and soil biomass.

Local Action Means Global Impact

Unlike most air pollutants, carbon dioxide and other greenhouse gases become well-mixed in the atmosphere after they are emitted. So, emissions have the same negative impact globally no matter where the emissions occur. Likewise, the global atmospheric impact of reductions is independent of the location where they take place. In other words, local actions taken in the Chicago Wilderness region that sequester carbon in a prairie restoration or reduce fossil fuel use are guaranteed to have positive global consequences to the Earth's climate system.

Land Conservation is Part of the Solution

Most media coverage and policy debate about emission reductions revolve around energy efficiency, new technology, and renewable energy. While these are absolutely necessary steps to take to solve the problem, we must also recognize the critical role that natural lands play. Globally, around 18% of all human-caused greenhouse gas emissions come from the destruction of native habitats and the subsequent release of carbon dioxide into the atmosphere. This accounts for more emissions than the entire global transportation sector.

It is time for us to communicate that the remaining natural lands in the Chicago Wilderness region — lands we have always valued for their biodiversity value — also provide important benefits by capturing and storing carbon. In the Chicago Wilderness Climate Action Plan for Nature, our long-term goal is to assure that land conservation and ecosystem restoration are part of an integrated regional solution to climate change, complementing the climate action plans of Chicago, Evanston, University of Illinois-Chicago, and others that focus on emissions reduction from fossil fuel consumption (see Table M1).

Two notes of caution: First, we should always keep in mind that our land conservation and ecosystem restoration work is being done primarily to benefit biodiversity, that is, to accomplish our conservation mission. Climate moderation through carbon sequestration is a co-benefit of this activity, one of the many ecosystems services provided to humans, but we should never reorient our land conservation goals to prioritize sequestration as the primary objective. Second, we should also not assume that restored, native landscapes are more productive in terms of

sequestration of carbon than weed infested lands. There is no research yet to prove this either way.

Value of Urban Forests

Urban forestry can also play an important role in controlling greenhouse gases in developed areas. In the City of Chicago, urban forests sequester 25,200 tons of carbon per year from the atmosphere (City of Chicago 2009). Deciduous trees provide shade and evapotranspirative cooling during the summer when energy use, power plant emissions, and urban heat island effects are at their highest rates, while letting solar radiation enter windows during the colder months. Trees planted in riparian areas can improve adjacent aquatic habitats by reducing water temperatures, stabilizing banks, attenuating stream-flow velocity and providing large woody debris to shelter many aquatic species. These functions will become even more critical should average summer temperatures continue to rise and flood risks increase. Coniferous trees and shrubs can serve as useful windbreaks around buildings, reducing infiltrative heat loss during the winter, helping to conserve energy and reduce winter greenhouse gas emissions. Finally, besides providing important urban habitats and reducing emissions, increased use of urban landscaping and tree plantings can also help mitigate air pollution risks both to people and to the ecosystem within the larger metropolitan airshed.

Carbon Finance for Biodiversity Conservation

Carbon markets involve the buying and selling of carbon between emitters and offset providers. Emitters are generally corporations in heavily polluting industries that purchase offsets to reduce their overall carbon footprint. Increasingly, service-sector businesses, households and individuals are also purchasing credits to offset their business or personal emissions footprint. Offset providers are legal owners of projects that sequester, destroy or displace carbon emissions. The conservation sector of the global carbon market, that is projects that have the co-benefits of biodiversity conservation and carbon sequestration, is a very small fraction of the $126 billion transacted in 2008. A majority of the activity revolves around trading pollution allowances – emitters above the cap buy offsets from emitters below the cap.

There are two types of markets for trading carbon: voluntary and compliance. The only market in the US is voluntary because there is no regulatory emissions cap, although one is being considered by Congress. The Chicago Climate Exchange is voluntary, but it is legally binding on members and has standards for accounting. There is also a large over-the-counter retail market

for carbon offsets, but it is not legally binding and has no standards. It is clear that there needs to be a regulatory cap before a robust mandatory trading system develops, including conservation offset projects that also have biodiversity benefits. Voluntary markets will not suffice to fully account for the cost of carbon pollution, a cost that is now largely externalized from our economic system. The two largest mandatory markets are the Clean Development Mechanism (CDM) under the Kyoto Protocols and the European Union's Emission Trading Scheme. Both of these created vigorous markets, however, only the CDM allows mitigation through conservation offsets.

There are technical and ethical concerns that have been raised about carbon sequestration projects. The market for voluntary carbon offsets is evolving quickly, with many organizations holding themselves to different project standards. These variances have led to increased scrutiny and skepticism of voluntary carbon offsets, although the Federal Trade Commission is beginning to develop some rules for this market. Issues related to additionality, leakage, permanence, measurement and monitoring, and standards for verification have all created concern (see glossary in Appendix 1). Among the stickiest of issues is the concept of "additionality". Additionality means that the purchase of a carbon offset must be additional to business as usual, that is, it must verifiably cause some new reduction in emissions that wouldn't have happened if the money hadn't been paid. Rightly or wrongly, considerable criticism has been leveled at offset projects on additionality grounds, claiming that many do not result in verifiable reductions over and above business as usual. These are all serious challenges that must be managed to produce real carbon offsets. Conservation offset projects, especially, must meet the highest available standards to assure that conserved and restored lands are valued for the greenhouse gasses they store and that they produce real and measurable reductions.

Mitigation Action Plan

Goal 1 - Mitigate the threat of climate change through land conservation and ecosystem restoration

This goal highlights the fact that current biodiversity conservation programs in the Chicago Wilderness region are creating, enhancing and maintaining carbon sinks in native ecosystems. Our conservation activities are providing an important regional ecosystem service that contributes significantly to combating climate change. We need to quickly communicate those societal benefits and get recognition for it. Although not explicitly included in the strategies

below, acquiring and restoring more land for biodiversity conservation is also a climate change mitigation strategy, as well as an adaptation strategy.

Mitigation Strategy 1a: <u>Recognition for Conservation and Restoration</u> Swiftly create recognition that land conservation and ecosystem restoration have value for sequestering carbon and mitigating the threat of climate change.	**Responsibility**
Actions:	
In a preliminary yet credible way, calculate the aboveground and belowground standing pool of carbon in Chicago Wilderness natural areas and estimate the amount of carbon dioxide that land conservation has prevented from being released into the atmosphere.	Climate Change Task Force, GIS Task Force
Following the natural areas calculation (above), expand analysis to entire Chicago Wilderness Green Infrastructure Vision.	Climate Change, GIV, and GIS task forces
As part of Chicago Wilderness Climate Clinic (see Section 1 - Engagement), provide tools and experience that will allow individual Chicago Wilderness land managers to refine their estimates of carbon sequestration benefits from their lands.	Climate Change Task Force; Chicago Wilderness members
As part of Chicago Wilderness public communication efforts (see Section 1 - Engagement), use products from Actions 1 and 2 to clearly illustrate the climate moderating value of natural areas and Green Infrastructure Vision to elected officials.	Climate Change Task Force; CW Communications

Mitigation Strategy 1b: <u>Carbon Finance</u> Position conservation land management in the Chicago Wilderness region to take advantage of carbon finance for biodiversity conservation.	**Responsibility**
Actions:	
Conduct a survey of existing and proposed carbon offset projects on natural lands in the Chicago Wilderness region to determine the range of standards and protocols currently being applied.	Climate Change Task Force
Develop credible Chicago Wilderness standards and protocols that can be applied by members to all grassland carbon projects in the Chicago Wilderness region (thereby creating efficiencies, like third-party verifications, over individual members going it alone). These Chicago Wilderness-specific standards will incorporate existing industry standards for conservation offsets.	Climate Change Task Force; NRM Team

Use the Chicago Wilderness Climate Clinic (see Section 1 - Engagement) to (1) bring stakeholders together to help design the common standard and (2) help members learn about and take advantage of carbon finance for conservation projects	Climate Change Task Force

Mitigation Strategy 1c: <u>Climate Mitigation Research Agenda</u> Below are an initial set of actions and research questions that need answering before advances can be made in CW carbon science. A planned research project spearheaded by the Science Team will address several of these questions.	**Responsibility**
Actions:	
Describe the current status of the science by performing a literature review of carbon relevant to Chicago Wilderness ecosystems.	Climate Change Task Force; Science Team
Describe the current status of who is already measuring/monitoring carbon pools/accrual in the Chicago Wilderness region.	Climate Change Task Force; NRM and Science teams
Research Questions:	Science Team; Climate Change Task Force
What is the current standing pool of carbon by habitat type within the Chicago Wilderness natural areas?	
How much carbon is being accrued through natural area restoration activities?	
How does net carbon change under different natural area management and restoration regimes, including invasive species control and prescribed fire?	
How do invasive species reduce or enhance carbon sequestration potential of natural areas?	
How do mitigated and remnant wetlands compare in their carbon sequestration potential? What are the greenhouse gas fluxes in wetlands (i.e., carbon dioxide sequestered vs. methane released)?	
How much carbon dioxide does natural land prevent from being released into the atmosphere indirectly through other ecosystem services, such as reduction of runoff into storm sewers, cleaner air, etc.?	

Goal 2 - Reduce carbon emissions from conservation business operations

This goal is focused on Chicago Wilderness member organizations and is aimed at reducing their carbon footprint resulting from energy usage associated with day-to-day operations.

Mitigation Strategy 2a: <u>Determine Carbon Footprint</u> Chicago Wilderness members calculate a baseline carbon footprint.	**Responsibility**
Actions:	
As part of Chicago Wilderness Climate Clinic for conservation practioners (see Section 3 - Engagement), include tools and best practices for calculating carbon footprint baseline.	Climate Change Task Force
Calculate annual carbon footprint for calendar or fiscal year and set organizational goals for reduction.	CW members

Mitigation Strategy 2b: <u>Reduce Footprint and Reward Progress</u> Chicago Wilderness members work toward carbon emissions reduction goals, while significant reductions are recognized by the alliance.	**Responsibility**
Actions:	
Use the baseline from Mitigation Strategy 2a to measure progress at reducing carbon emissions from conservation business operations of Chicago Wilderness members. Report to Climate Change Task Force where central report card will be held.	CW members; Climate Change Task Force
Create incentives program that recognizes progress.	Climate Change Task Force

Goal 3 – Strongly support existing and proposed greenhouse gas emissions reduction programs

The combined greenhouse gas emissions from all sources in the Chicago metropolitan area contribute to disruption of the global climate system. Many important emissions reduction efforts have begun or are planned. Chicago Wilderness, the central organization and the alliance, needs to strongly support ongoing efforts and advocate for new programs that fill gaps. While not the proximate threat to biodiversity that we are used to addressing, we nevertheless must recognize emissions as the ultimate source of the problem.

Mitigation Strategy 3a: <u>Metropolitan Emissions Reduction Programs</u> In ways yet to be determined, support programs such as the ones listed below (which is unlikely to be a complete list).	**Responsibility**
Mitigation actions in the municipal and institutional climate action plans and climate planning efforts listed in Table B of the Climate Action for Humans and Nature section (and listed in Appendix 2).	CW and CW members

Sustainable regional land use and development practices that result in reduced fossil fuel emissions, something Chicago Wilderness has a history of providing guidance to (see Appendix 2).	
Programs that educate citizens about lifestyle changes needed to reduce household emissions.	
Urban forest programs that both sequester carbon and reduce cooling and heating energy needs (mitigation strategy) and contribute to urban heat island reduction (adaptation strategy) (see Appendix 2).	
As Chicago Wilderness members begin reducing their carbon footprint (Mitigation Goal 2), use local renewable energy and greenhouse gas mitigation technologies to help create a viable Chicago area market for sustainable technologies that mitigate climate change, such as: • Locally-sourced renewable energy and renewable energy technologies. • Private commercial composting market that can handle all types of organic food waste.	

Table M1. Example of Carbon Sequestration Benefits of a Nature Reserve System

The Nature Conservancy (TNC) owns about 17,000 acres in Illinois. For calculating carbon sequestration benefits, these lands can be split into two categories:

1. Natural lands where protection prevented the destruction of native habitats, ~13,000 acres
2. Former cropland that are being restored to prairies or forests, ~4,000 acres

Calculating the carbon sequestered on these two categories of land is different.

Prevented Destruction of Native Habitats - Preliminary calculations indicate that land protection prevented the release of about 1.6 million tons of carbon dioxide into the atmosphere. This is the amount of carbon stored on these lands and is equivalent to:

- 3.6 billion miles driven by the average car *or*
- offsetting the electricity consumption of 213,000 American households for a year *or*
- (to put the issue in sobering perspective) the equivalent of 72 days of emissions from a typical Illinois coal-fired power plant.

Restoring Prairies and Forests - TNC calculates that its restoration activity sequesters about 12,000 tons of carbon dioxide from the atmosphere every year. This annual accumulation rate is equivalent to:

- 27 million car miles *or*
- offsetting the electricity of over 1,600 households for a year.

Source: The Nature Conservancy in Illinois, 2008 (contact Jeff Walk, jwalk@tnc.org, for more information about this analysis).

Section 3
Adapting to a Rapidly Changing Climate: Modifying Conservation Practice and Promoting Ecosystem-based Approaches

Adaptation and the Chicago Wilderness Biodiversity Recovery Plan

In the news everyday are stories about how greenhouse gas emissions, especially carbon dioxide, are causing an unnaturally rapid warming of the Earth's atmosphere. Often it is policy and economic responses to reducing future emissions that receive the most attention and media coverage. But carbon dioxide has a century-long residency once it gets into the atmosphere. So, even if carbon emissions are stopped immediately, there is still enough carbon dioxide in the atmosphere to keep the climate warming for another century or more. And that's the best-case scenario. The Intergovernmental Panel on Climate Change (2007) states that:

> "There is *high confidence*[3] that the ability of many ecosystems to adapt naturally to climate warming will be exceeded this century."

So, conservationists need to modify or adapt their activities to ensure that native species and their habitats are able to adapt to the inevitable rise in global temperature and the resulting changes to the climate. This makes adaptation the flip side - the pessimistic side - of the climate change issue. It's not about creating solutions to greenhouse gas emissions. It's about dealing with the expected impacts. The Chicago Climate Action Plan outlines a series of adaptation actions directed at human communities and the built environment. The plan presented here promotes a complementary set of adaptation actions that extend to the natural assets of the Chicago region (see Table A1).

Adaptation, as it applies to climate change, is defined as the actions taken by humans or nature that avoid, withstand, or take advantage of climate change impacts. The objective of adaptation planning is to decrease a social or ecological system's vulnerability, or to increase its resilience to impacts (see Glossary). Conservationists should be wondering about questions such as: How

[3] High confidence is defined by the Intergovernmental Panel on Climate Change as having an 8 out of 10 chance of being correct.

do we assess the vulnerability of ecosystems and species? How will the threats to biodiversity change? Will our definition of “invasive” species be changing? Will current reserve designs or configuration of the reserve network be able to withstand climate change? What local policies and strategies must we employ to safeguard the enormous investments we’ve made in land and water conservation?

Of the various ways that society will respond, the Climate Action Plan for Nature attempts to make Chicago Wilderness an anticipatory alliance when it comes to climate change, meaning we are prepared to respond thoughtfully when impacts are observed and, to the greatest extent possible, proactively plan for projected climate change impacts (see Table A2).

For conservationists, this is about systematically and explicitly taking into consideration the potential impacts of climate change on their strategies and actions. Conservation strategies are usually derived from a conservation priority-setting plan, such as a site conservation plan, species recovery plan, or even an organizational strategic plan. A major emphasis of the Adaptation Action Plan is intended to help conservation practitioners who already have a conservation plan of some sort, but who did not consider the potential impacts of climate change in their original assessment.

The main driver of Chicago Wilderness conservation strategies, the *Biodiversity Recovery Plan*, also falls into this category. The focal conservation targets and threats to viability were never evaluated with climate change in mind. As part of developing the Chicago Wilderness Climate Action Plan for Nature, we also prepared a *Biodiversity Recovery Plan* Climate Change Update. This is being developed concurrently with the review draft of the action plan and is a stand-alone addendum to the Climate Action Plan for Nature.

Climate-induced Threats to Chicago Wilderness Biodiversity

As a starting place to begin helping conservationists plan for uncertain climate impacts, US EPA, Chicago Wilderness and others convened an experts workshop in July 2009, focused on adaptation planning for biodiversity and for stormwater. The aquatic and terrestrial biodiversity sessions used conservation targets of the Chicago Wilderness *Biodiversity Recovery Plan*, especially ecosystem-level targets, as the fundamental units from which to answer two questions:

1. What are the key impacts of climate change that threaten the viability of these systems?

2. What are the priority set of adaptation strategies that conservationists can implement to abate the impacts?

Expert participants chose the top three threats from an extensive review of the literature by The Nature Conservancy's Great Lakes Climate Science Program. Priority threats for terrestrial and aquatic systems are listed below, but the full list of threats and their projected impacts on system targets are included as Appendix 3.

Priority Climate-induced Threats to Terrestrial Targets:

T1. Increased temperatures and changing patterns of precipitation will stress some native species and promote some invasives, suggesting that the threat of invasives will increase. Further, many new natives from the south may be able to colonize, and potentially become invasive. Of particular note, if lake levels drop, new shoreline may be rapidly colonized by *Phragmites*.

T2. Increased temperatures will promote range shifts in sensitive species. Some species will be constrained in their response by lack of connected habitats through which to move, and others will be constrained by habitat loss, lack of mobility, or lack of genetic variation.

T3. Species will respond in complex ways, and many key interactions may be disrupted (e.g. through mismatches in phenological shifts, or rate of range shifts). How do we characterize risk/vulnerability and move forward in light of uncertainty?

Priority Climate-induced Threats to Aquatic Targets:

A1. Increased storm frequency and intensity will increase non-point source pollution into aquatic systems and wetlands, leading to impacts on water quality in receiving waters (more sediments and pollutants, higher temperature). As increased quantities of stormwater move through streams, it is likely to promote stream channel destabilization, and degrade sensitive aquatic habitats.

A2. The pattern of precipitation is projected to shift to fewer rain events of greater intensity, leading both to more flooding from heavy rains and to more frequent and more severe dry spells. Increasing temperatures, increasing drought stress, and decreasing lake levels will put greater pressure on groundwater resources leading to higher rates of water extraction, and related impacts in priority aquatic, wetland and riparian systems. For groundwater, we enter the climate change era already in a deficit position that will only get worse.

A3. Increased temperatures will promote range shifts in sensitive species. Some species will be constrained in their response by lack of connected habitats through which to move, and others will be constrained by habitat loss, lack of mobility, or lack of genetic variation.

Adaptation Action Plan

Take Home Messages

Goals, strategies and actions contained in this Adaptation Action Plan were developed to address top threats from the July experts workshop. Specific actions were proposed by experts at the workshop, as well as by follow up meetings and from expert presentations and audience participation at the November 2008 Chicago Wilderness Congress. However, there were also some general results or messages that also emerged from all these discussions:

- The key "take home" message is clear – at the site scale, *most actions that are needed to help protect Chicago Wilderness biodiversity under future climates are the same types of actions that we currently engage in to abate the risk of a wide range of other threats*. For example, targeted restoration activities in forests, wetlands, and riparian areas all act to promote landscape connectivity (threat T2) and reduce the flow of contaminants and sediments into aquatic systems (threat A1). Similarly, work we do to detect and remove invasive species, and restore fire in fire-dependent systems "counts" toward climate change adaptation by reducing the impacts of additional stressors that could constrain the ability of native species to persist as they are more and more stressed by changes in climate. However, we now understand that these strategies might *change* when viewed from the perspective of climate change adaptation. We can use existing information on climatic gradients, future climates, locations of climatic refugia, and the location of other stressors, to help us be as strategic as possible in our decisions regarding *where* and *under what conditions* we implement these actions.

- The classic climate change question was posed by a participant during the climate track of the Chicago Wilderness Congress in 2008, "*How can we move forward with so many uncertainties and how much certainty do we need to take action*?" This same question may have been posed 20 years ago when members of the Chicago Wilderness alliance embarked on what are now major ecosystem restoration efforts that, at their origins, were fraught with similar amounts of uncertainty. Through testing, learning, and adjusting - classic

adaptive management - the region has become a leader in the restoration movement. Predictions of changes in temperature, precipitation, and other climatic factors are indeed all associated with high levels of uncertainty, making planning and priority-setting very challenging (see Table A3). Actions called for in this initial version of the Chicago Wilderness Climate Action Plan for Nature are applicable now despite uncertain outcomes of a changing climate. As uncertainty is reduced, future iterations of the plan will become more precise in recommending climate-adaptive strategies for biodiversity conservation.

- Because many of the strategies we identified are currently employed by the Chicago Wilderness alliance in addressing other threats, *there is a range of existing tools that can be modified and used to plan for climate change*. Thus, re-vamping existing tools, and continuing to work with experts to identify and develop additional tools, are key initial steps in the adaptation process. For example, The Nature Conservancy's "Active Rivers" model identifies the size of buffers needed to promote resilient river systems under a variety of flow scenarios. Additionally, current tools for regional conservation planning could be modified to account for the need to protect "moving targets", i.e., species shifting ranges in response to climate change.

- While direct threats to key systems are obviously important, *we also need to anticipate societal responses to climate change*. As quoted in an earlier section, human adaptation approaches that compromise biodiversity will ultimately have negative consequences for both humans and nature. Similarly, choices on where to act for conservation should take into account key benefits to society, such as improved floodwater containment as a benefit of restoring functional river basins.

Goal 1 - Catching up: Make existing conservation strategies of the Chicago Wilderness *Biodiversity Recovery Plan* climate ready

This goal is intended to help conservation practitioners more systematically and explicitly take into consideration the potential impacts of climate change on existing conservation strategies and actions.

Adaptation Strategy 1a: <u>Chicago Wilderness Members Becoming Climate Ready</u> As part of the Chicago Wilderness Climate Clinic program (see Section 1 - Engagement), assist Chicago Wilderness alliance members in making their conservation priorities and actions climate ready.	**Responsibility**
Actions:	
Design and deploy adaptation components of the Climate Clinic to make existing conservation priority plans climate ready through a dynamic adaptation planning practicum that melds emerging climate science and tool development with the peer-to-peer creativity.	Climate Change Task Force
Develop Chicago Wilderness guidelines/checklist for managers to assess how "climate aware" their projects are currently.	Climate Change Task Force

Adaptation Strategy 1b: <u>Chicago Wilderness Initiative Becoming Climate Ready</u> Review strategies of the three Chicago Wilderness strategic initiatives, asking the questions: • Are the strategies climate ready? • Do they adequately promote ecosystem-based adaptation approaches? • Are they doing all they can to communicate the climate adaptation benefits to people from these investments?	**Responsibility**
Actions:	
Assess the Green Infrastructure Vision first because it is vital for abating priority climate-induced threats to both aquatic (A1) and terrestrial (T2) systems.	Climate Change and Green Infrastructure Vision task forces
After the Green Infrastructure Vision, asses the Leave No Child Inside initiative. (The remaining Chicago Wilderness initiative, Restoring the Health of Local Nature, has been assessed as part of the *Biodiversity Recovery Plan* Climate Change Update).	Climate Change Task Force; Leave No Child Inside Task Force.

Goal 2 – Begin to promote resilience to the impact of climate change through prioritized, coordinated actions for land and water protection and management

This goal goes beyond the broad assessment of existing conservation strategies outlined in Goal 1 to include the initial set of specific climate actions that we know need to be done now. The list of actions is likely to expand in future versions of the Climate Action Plan for Nature as

the Goal 1 assessments are completed and the *Biodiversity Recovery Plan* Climate Change Update provides further guidance.

Adaptation Strategy 2a: <u>Species Vulnerability Assessments</u> Assess the vulnerability of priority terrestrial and aquatic species to climate impacts.	**Responsibility**
Actions:	
Use NatureServe's Climate Change Vulnerability Index tool to help identify plant and animal species that are particularly vulnerable to the effects of climate change and those that might be able to expand their ranges within or into the Chicago Wilderness region. The tool uses information on climate change "exposure" and a species' natural history, distribution and landscape circumstances to characterize its "sensitivity" to climate change. Threats T2, A2-3. (See Table A4)	Climate Change Task Force; Natural Resource Management Team
As part of Chicago Wilderness Climate Clinic (see Section 1 - Engagement), conduct a workshop for managers on NatureServe's Climate Change Vulnerability Index tool and a related web-based tool called ClimateWizard, which is used to characterize climate change "exposure" (the extent to which the temperature and precipitation patterns in a focal region are projected to change).	Climate Change Task Force

Adaptation Strategy 2b: <u>Reduce Impacts of Ecological Stressors</u> Reduce the impacts of other ecological stressors that could constrain the ability of native species to persist as they are more and more stressed by changes in climate.	**Responsibility**
Actions:	
Assess strategies for addressing the threat of invasive species given the projected changes in climate. Nearly all the strategies discussed in the July workshop are extensions of work that is already ongoing or planned – in what cases does climate change lead to a shift in strategies? The potential for new invasives is always a threat, but are there new pathways of arrival or new constraints to control that may arise due to climate change? Do we need to shift how we allocate control efforts across species or system types? How can we best exploit potential new climate change funding for invasive species control and restoration? Threat T1.	Natural Resource Management Team; Climate Change Task Force; CW members
Revise Chicago Wilderness restoration guidelines or best management practices in light of climate change. Especially important here is guidance on seed sourcing and the definition of "native" and "exotic" species given that we should expect to lose many colder adapted species, and gain others from the south. Associated closely with this is the issue of assisting the survival and migration of species to facilitate dispersal in fragmented habitats. Threat T1.	Natural Resource Management Team; Science Team; Climate Change Task Force

Implement this strategy through Chicago Wilderness Climate Clinic (see Section 1 - Engagement).	Climate Change Task Force

Adaptation Strategy 2c: <u>Promote Resilient Land- and Waterscapes for Biodiversity</u> Promote and maintain larger land- and waterscapes for biodiversity with internal redundancy and connectivity. Climate change has redefined the definition of large in this context. At its heart, this strategy is the Green Infrastructure Vision: core protected areas and corridors consisting of natural and semi-natural habitat, as well as "working" waters and lands permeable to native species dispersal.	**Responsibility**
Actions:	
Protected Areas: Deploy tools to assess the resiliency of preserves and current preserve designs to withstand site-level disruptions in species dispersal and shifting microenvironments. Implement through Chicago Wilderness Climate Clinic (see Section 1 - Engagement).Threat T2.	Climate Change Task Force
Corridors: Climate change considerations may shift priorities of actions employed to implement the Green Infrastructure Vision. In light of abrupt climate change, what pieces of the vision are most important in terms of contribution toward connectivity/water quality/or reducing some other stressor? This strategy overlaps with Adaptation Strategy 1b. Threats T2 and A3.	Climate Change Task Force; Green Infrastructure Vision Task Force
Stream Corridors: Increase connectivity by strategically reducing barriers to dispersal of native aquatic species. This needs to be done thoughtfully and strategically, acknowledging that this also has implications for sedimentation and aquatic invasive species dispersal. The first step is to model areas of key stream connectivity and raise the profile of these for restoration among regulators and conservationists. Threat A3.	Aquatics Task Force
Stream Corridors: Increase recognition in regulatory and conservation communities of the need to be able to restore all stream segments, not just the extremely degraded sites (current priority for regulatory funding) and streams of high ecological quality (current priority for conservation funding). Threat A3.	Aquatics Task Force

Goal 3 – Anticipate and plan for increased impacts to aquatic biodiversity from altered stormwater, groundwater, and drought regimes

Current climate projections foresee increased high stormwater events, greater stress to groundwater resources, and increased droughts. To a greater or lesser extent, all of these are contemporary threats, but certainly they represent increasingly significant threats to the future

vulnerability of aquatic systems in the Chicago Wilderness region. As soon as possible, we need to confront and plan for the future threats that they pose.

Adaptation Strategy 3a: <u>Stormwater</u> The increased frequency of large storm events projected during the next century is seen as one of the top threats to aquatic biodiversity (Threat A1). An enormous amount of attention is being paid to stormwater issues by municipalities and counties of the region, mostly for regulatory and economic reasons. Direct linkages between stormwater management and biodiversity conservation need to be strengthened, especially related to climate change impacts. The central objective here is to create those linkages, making aquatic biodiversity a target of stormwater management in the Chicago Wilderness region. This is a large-scale and complex undertaking that will require a range of approaches, such as broad multi-jurisdictional integrated water resource management at the watershed level, to site-level demonstrations of ecosystem-based adaptation. Actions proposed here are initial steps that will certainly be refined in future iterations of the Chicago Wilderness Climate Action Plan for Nature.	**Responsibility**
Actions:	
There is a lot of effort going into stormwater management right now. Specific to climate change, it is among the adaptation tactics in the Chicago Climate Action Plan. So, an important first step is to develop a dialogue with stormwater planners to figure out where/when input is most effective as new plans are devised. Another important piece is to identify applied research topics on aspects of biodiversity as a water quality target that will most effectively influence stormwater designers and managers.	Aquatics Task Force
To a considerable degree, strategies employed to implement the Green Infrastructure Vision include components of stormwater management. The degree to which the Green Infrastructure Vision is climate ready will be assessed in Adaptation Strategy 1b. Stormwater should be a major focus of this assessment.	Aquatics, Climate Change, and GIV task forces
Promote an integrated approach to water resource management for biodiversity conservation and climate change resiliency using watersheds as the organizing framework. This will include aspects of education, regional coordination and planning, green infrastructure, regulation, and demonstration.	Climate Change Task Force
Identify and promote effective site-level demonstrations of ecosystem-based approaches to stormwater management. Use these demonstrations to educate/communicate with audiences on the climate-adaptive benefits of ecosystem-based approaches.	Aquatics Task Force; Green Infrastructure Task Force

Adaptation Strategy 3b: <u>Groundwater and Drought</u> This strategy is meant to begin addressing Threat A2: Precipitation is projected to shift to fewer rain events of greater intensity, leading to more frequent and more severe dry spells. Increased temperatures, increased drought, and decreasing lake levels will put greater pressure on groundwater resources leading to higher rates of water extraction, and related impacts to priority aquatic, wetland and riparian systems. Another concern here is infiltrated stormwater that carries pollutants (such as nitrogen and chlorides) that are also very mobile in groundwater and can eventually affect surface systems.	**Responsibility**
Actions:	
Work with local officials, municipal water suppliers, and county stormwater management commissions to implement Chicago Metropolitan Agency for Planning's Regional Water Supply Plan (see Appendix 2) and county stormwater best management practices to reduce stress on the region's shallow aquifers and their associated aquatic and terrestrial ecosystems.	Sustainability Team; Aquatics Task Force
Determine minimum stream base-flow requirements needed to sustain healthy aquatic ecosystem functions for priority river and stream segments within the region.	Aquatics Task Force; Science Team
Reduce groundwater draw-downs by promoting increased use of native landscaping in new development, because deep-rooted plants adapted to prairie and savanna ecosystems will likely be more drought-resistant than turf and other imported ornamental landscape materials.	Sustainability Team; Green Infrastructure Task Force

Goal 4 - Monitoring and Research

We must strengthen monitoring to detect and prepare for climate change and fill key knowledge gaps with research. These two strategies are essential for a robust adaptive management process that is confronted with both: (1) overall uncertainty of how climate change will impact Chicago Wilderness biodiversity and, (2) new knowledge being generated from the rapidly increasing number of research programs aimed at reducing that uncertainty.

Adaptation Strategy 4a: <u>Monitoring</u> Monitoring for adaptive management.	**Responsibility**
Actions:	
Review and refine indicators being used by existing monitoring programs in the Chicago Wilderness region to detect climate impacts, refine projections for impacts, and identify new actions needed. Determine if new monitoring is needed.	Science Team; Climate Change Task Force

Support ongoing regional monitoring programs, especially the state-run Critical Trends Assessment Program. These programs are essential for maintaining an adaptively managed Chicago Wilderness climate change adaptation program.	Science Team; Natural Resource Management Team; Climate Change Task Force
Promote development and implementation of the Chicago Wilderness GIV Knowledge Base as an adaptive management tool for Chicago Wilderness and its members to meeting their goals, including climate change adaptation and mitigation.	Green Infrastructure Vision Task Force
Use the Chicago Wilderness Congress as a reporting mechanism for climate change monitoring and adaptive management.	Climate Change Task Force

Adaptation Strategy 4b: <u>Adaptation Research Agenda</u> Develop and initial set of research questions that need answering before advances can be made in modifying conservation practice to be fully climate ready and in adoption of ecosystem-based approaches to adaptation.	**Responsibility**
Action:	
Review ongoing and new research programs to determine the extent that adaptation knowledge gaps are being addressed. Develop new research agenda as needed.	Science Team; Natural Resource Management Team; Climate Change Task Force

Table A1. Framework for Adaptation Actions in the Chicago Region.

Relationship between the Chicago Wilderness Climate Action Plan for Nature and the Chicago Climate Action Plan. The bullets are examples of the attributes of the Chicago Wilderness region to illustrate the complementarity of the two plans.

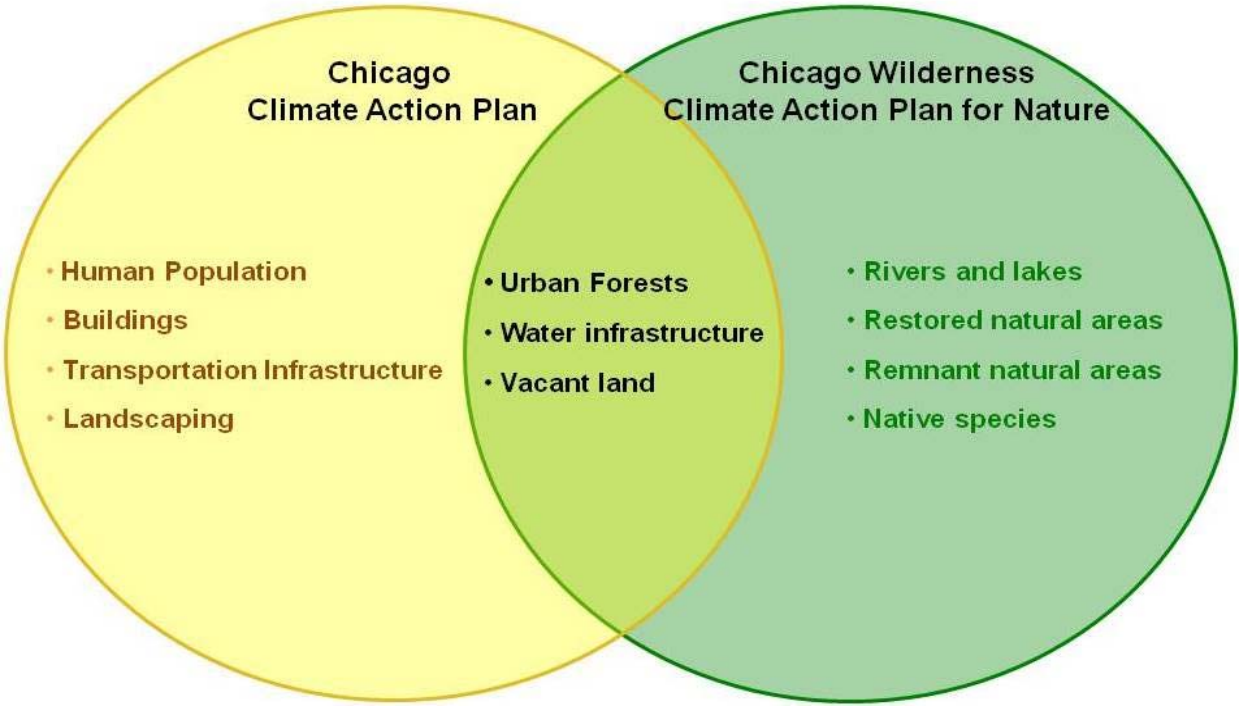

Table A2. Approaches to Adaptation Planning	
No adaptation	Future climate change impacts are not planned for and are not acknowledged as likely to occur.
Reactive adaptation	Climate change impacts are not planned for and adaptation takes place after the impacts of climate change have been observed.
Anticipatory adaptation	
Responsive	Future climate change impacts are acknowledged as likely to occur and responses to those changes are planned for when changes are observed.
Proactive	Climate change impacts are acknowledged as likely to occur and adaptation responses are planned for before the changes are observed.

Source: US Climate Change Science Program (2008) adaptation report.

Table 3. Handling Uncertainty

Guidelines that focus on evaluating risks and hedging bets, and are applicable to both aquatic and terrestrial systems.

- Use climate change scenarios to frame the potential range of impacts which systems may experience.
- Develop improved regional-scale modeling capacity, better tools, especially GIS-based tools.
- Protect a suite of sites that together capture the full range of climatic variation and gradient strengths.
- Move from focus on species and communities to capturing "drivers of biodiversity" (combinations of biotic & abiotic factors).
- Develop methods for quantifying/comparing conservation value that does not rely on current structure or species.
- Evaluate use of "indicator" species in monitoring -- are they likely to still indicate something meaningful?
- Promote flexibility in site selection strategies, maintain options.
- Anticipate thresholds and other sources of surprises.
- Protect evolutionary hotspots with high levels of endemism.
- Reduce other anthropogenic stressors.
- Increase representation of different genotypes, species, and communities under protection.
- Restore ecosystems that have been compromised or lost.
- Explicitly identify scales at which impacts and adaptation strategies apply.
- Prioritize actions, and identify those which will be cut so that resources can be used most effectively (triage).
- Coordinate with other monitoring networks to strengthen data available for pursuing adaptive management.

Source: Dr. Kimberly Hall, Great Lakes Climate Scientist, The Nature Conservancy.

Table A4. Climate Change Tools for Conservation Practioners

Two examples.

NatureServe's Climate Change Vulnerability Index

Climate change is affecting numerous plant and animal species right now. But how do you determine which species are most vulnerable and which ones need more focused attention sooner rather than later? The index can help answer these questions.

Here's how it works. You input information on the extent to which the temperature and precipitation patterns in a focal region are projected to change (this is called climate change "exposure", which can be obtained from ClimateWizard; see below), and basic information about a species' natural history, distribution and landscape circumstances (i.e., proximity to major barriers to dispersal) to characterize the species' "sensitivity" to climate change. From these estimates of exposure and sensitivity, the index assigns the species to one of five vulnerability categories, which can then be modified by additional input that may be available from studies that specifically focus on projections of change in range. This tool can be used to group species by vulnerability level and by key challenges (i.e., those that are constrained by lack of mobility and may show phenology mismatches, or those that may expand their range if habitats are available), which can help multiple groups work together on adaptation strategies that benefit many species.

Source: natureserve.org

ClimateWizard

ClimateWizard enables technical and non-technical audiences to access leading climate change information and visualize the impacts anywhere on Earth. This web-based tool allows the user to choose a region or state and both assess how past climate has changed over time and to project what future changes are predicted to occur in a given area under different emissions scenarios.

Features include the ability to:

- view historic temperature and rainfall maps for anywhere in the world
- view future predictions of temperature and rainfall around the world
- view and download climate change maps

Source: climatewizard.org

Appendix 1

A Glossary of Some Basic Climate Change Terminology

The Pew Center on Global Climate Change (see Appendix 2) has tons of great, basic information on all aspects of climate change. See especially Climate Change 101 series and Glossary of Key Terms, which was the basis for this glossary.

Additionality: In conservation, this refers to the amount of carbon dioxide captured, stored or prevented from reaching the atmosphere by a carbon offset project compared to what would happen without the project. In other words, is this something that would have happened anyway? Additionality is an important standard that must be verifiably met in marketing a carbon offset project. (see also Carbon Markets and Carbon Offset Project)

Adaptation: Actions by humans or nature that avoid, withstand, or take advantage of projected climate change impacts. Adaptation decreases a system's vulnerability, or increases its resilience to impacts. (see also Impact, Vulnerability, Resilience, and Climate Adaptive Strategy)

Cap and Trade: A cap-and-trade system sets an overall limit on emissions, requires entities subject to the system to hold sufficient allowances to cover their emissions, and provides an incentive-based means of compliance. Entities can comply by undertaking emission reduction projects at their facilities and/or by purchasing emission allowances (or offset credits) from the government or from other entities that have generated emission reductions. (see also Incentive-based Regulation, Command and Control Regulation, and Carbon Offset Project).

Climate: The long-term average weather of a region including typical weather patterns, the frequency and intensity of storms, cold spells, and heat waves. Climate is not the same as weather. Here's a way to think about the difference between weather and climate: weather is what determines if you will use an umbrella today; climate determines whether you own an umbrella. (see also Weather)

Climate Adaptive Strategy: In conservation, this refers to strategies that reduce the vulnerability of target biodiversity or conservation areas to abrupt climate change and increase their resilience to the inevitability of a warming world. There is also a counterpart in adapting social systems to climate change, such as agriculture, emergency medical care, city services, and many others. (see also Impact, Resilience, and Vulnerability)

Climate Change: Refers to changes in long-term trends in the average climate, such as changes in average rainfall, snowfall, temperature, etc. (see also Global Warming)

Carbon Dioxide (CO_2): CO_2 is a colorless, odorless, non-poisonous gas that is a normal part of the ambient air. Of the six greenhouse gases normally targeted, CO_2 contributes the most to human-induced global warming. Human activities such as fossil fuel combustion and deforestation have increased atmospheric concentrations of CO_2 by approximately 30% since the industrial revolution. Unlike nearly all other air pollutants, CO_2 becomes well-mixed in the atmosphere. So, emissions have the same impact globally no matter where the emissions occur. Likewise, the global atmospheric

impact of reductions or offsets is independent of the location where they take place. Also, CO_2 has a residency time in the atmosphere of over 100 years, so any reductions in CO_2 instituted now will not be felt until the 22nd century.

Carbon Footprint: Refers to the CO_2 emissions generated by the activities of individuals, households, and organizations, reported in metric tons of CO_2 equivalent (MtCO2e). For example, the carbon footprint of The Nature Conservancy in Illinois in 2007 was estimated to be 347 MtCO2e.

Carbon Markets: This is the buying and selling of carbon between emitters and offset providers, sold as metric tons of CO_2 equivalent (MtCO2e). Emitters are generally corporations in heavily polluting industries that purchase offsets to reduce their overall carbon footprint. Increasingly, service-sector businesses, households and individuals are voluntarily purchasing credits to offset their business or personal emissions footprint. For biodiversity, marketing carbon represents an opportunity to mitigate the effect of greenhouse gas emissions and achieve conservation benefits. There are two types of markets for trading carbon: voluntary and mandatory. The only market in the US is voluntary because there is no regulatory emissions cap and the US is not a Kyoto Protocol signatory. The two largest mandatory markets are the Clean Development Mechanism (CDM) under Kyoto and the European Union's Emission Trading Scheme (ETS), both unavailable to the US.

Carbon Offset Project: Projects undertaken outside of an emissions reduction system. For example, if a mandatory emissions cap on greenhouse gases is instituted in the US and offsets are allowed, a company in a regulated industry that cannot reduce its emissions below the cap can *offset* them through the purchase of credits from projects that do reduce emissions. In a regulatory system, a polluter may purchase carbon sequestration credits from a reforestation project that enhances the viability of a nature reserve, thereby offsetting its emissions above the regulatory cap. (see also Cap and Trade)

Carbon Sequestration: Opportunities to remove atmospheric CO_2, either through biological processes (e.g. plants), or geological processes through storage of CO_2 in underground reservoirs.

Carbon Sinks: Processes that remove more carbon dioxide from the atmosphere than they release. The biospheres on land and in the oceans can both act as carbon sinks.

Carbon Tax: A surcharge on the carbon content of fossil fuels that aims to discourage their use and thereby reduce carbon dioxide emissions (see www.carbontax.org). A carbon tax is seen as an alternative incentive-based regulation to a cap and trade system. (see also Cap and Trade and Incentive-Based Regulation).

Command and Control Regulation: A system of regulation that prescribes emission limits and compliance methods on a facility-by-facility or source-by-source basis and that has been the traditional approach to reducing air pollution. (see also Cap and Trade, Carbon Tax, and Incentive-based Regulation)

Emissions Cap: A mandated constraint in a scheduled timeframe that puts a “ceiling” on the total amount of anthropogenic greenhouse gas emissions that can be released into the atmosphere. (see also Cap and Trade and Emissions Trading)

Emissions Trading: The process within an emissions reduction system that allows the buying and selling of pollution credits or allowances created under an emissions cap. This is sort of the opposite of a Carbon Offset Project, which offsets emissions from a regulated source with projects from an outside provider.

Global Warming: The progressive gradual rise of the Earth's average surface temperature considered to be caused in part by increased concentrations of greenhouse gasses in the atmosphere. (see also Climate Change)

Greenhouse Effect: The insulating effect of atmospheric greenhouse gases (e.g., water vapor, carbon dioxide, methane, etc.) that keeps the Earth's temperature about 60^{o}F warmer than it would be otherwise. The **Enhanced Greenhouse Effect** is the increase in the natural greenhouse effect resulting from increases in atmospheric concentrations of greenhouse gases due to emissions from human activities.

Greenhouse Gas (GHG): Any of a wide variety of gases that trap heat near the Earth’s surface, slowing its escape into space - the "greenhouse effect." While greenhouse gases occur naturally in the atmosphere, human activities also result in additional greenhouse gas emissions. Humans have also manufactured some greenhouse gasses not found in nature (e.g., hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride) that slow the release of radiant energy into space. The Kyoto Protocol regulates six greenhouse gases, three of which contribute to 99% of the greenhouse effect: carbon dioxide, methane, and nitrous oxide. (see also Kyoto Protocol, Carbon Dioxide, Methane, and Nitrous Oxide)

Impact: An effect of climate change on the structure or function of a human or biological system. Understanding projected impacts is essential to developing climate change adaptation strategies. (see also Vulnerability, Resilience, and Adaptation)

Incentive-based Regulation: A regulation that uses the economic behavior of firms and households to attain desired environmental goals. Incentive-based programs involve taxes on emissions or tradable emission permits. The primary strength of incentive-based regulation is the flexibility it provides the polluter to find the least costly way to reduce emissions. (see also Command and Control Regulation)

Intergovernmental Panel on Climate Change (IPCC): The IPCC was established in 1988 by the World Meteorological Organization and the UN Environment Programme. The IPCC is responsible for providing the scientific and technical foundation for the United Nations Framework Convention on Climate Change, primarily through the publication of periodic Assessment Reports. The IPCC released their Fourth Assessment Report (AR4) in early 2007, the year in which they also won the Nobel Peace Prize for communicating the threat of climate change to the world. Their Summary for

Policymakers is a succinct synopsis of the state of our knowledge on climate change contained in the voluminous Fourth Assessment. (See link in Appendix 2 - Resources)

Kyoto Protocol: An international agreement adopted in December 1997 in Kyoto, Japan. The Protocol sets binding emission targets for developed countries that would reduce their emissions on average 5.2% below 1990 levels. The US is the only developed country not a signatory to the Protocol.

Leakage: In conservation, leakage occurs when sequestration activities at a project site leads to land clearing elsewhere. Leakage analysis for a project reveals the amount (expressed as a percent) of sequestration benefits shifted elsewhere and, therefore, must be held back from the amount of carbon marketable from a conservation project. (see also Carbon Market and Carbon Offset Project)

Methane (CH_4): CH_4 is among the six greenhouse gases to be curbed under the Kyoto Protocol, and the second most common after CO_2. Atmospheric CH_4 is produced by natural processes, but there are also substantial emissions from human activities such as landfills, livestock and livestock wastes, natural gas and petroleum systems, coalmines, rice fields, and wastewater treatment. CH_4 has a relatively short atmospheric lifetime of about 10 years, but it is 23 times more potent as a greenhouse gas than CO_2.

Mitigation: Actions to reduce atmospheric greenhouses.

Nitrous Oxide (N_2O): N_2O is among the six greenhouse gases to be curbed under the Kyoto Protocol, and the third most common after CO_2 and methane. N_2O is produced by natural processes, but there are also substantial emissions from human activities such as agriculture and fossil fuel combustion. The atmospheric lifetime of N_2O is approximately 100 years and is nearly 300 times more potent as a greenhouse gas than CO_2.

Resilience: The ability of a human or biological system to withstand negative impacts without losing its basic functions.

Soil Carbon: In grasslands, the only sequestered carbon that counts toward mitigating the impact of CO_2 emissions is that below-ground in the soil because it is relatively permanent. Above-ground biomass degrades every year and does not count in a carbon offset project. Soil carbon is accrued through root growth, incorporation of surface litter into the soil, and all the jillions of invertebrate animals and microbes that live below the soil surface.

Stern Review: The Stern Review is named after Sir Nicholas Stern who was commissioned by the British finance minister to review the economics of climate change with the objective to understand more comprehensively the nature of the economic challenges and how they can be met, in the United Kingdom and globally. The report was delivered in 2006. (See link in Appendix 2 - Resources)

Vulnerability: The potential for a human or biological system to be harmed by climate change, considering the impacts of climate change on the system as well as its capacity to adapt. (see also Impact and Adaptation)

Weather: Describes the short-term (i.e., hourly and daily) state of the atmosphere. Weather is not the same as climate. (see also Climate)

Appendix 2

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Appendix 3

Expanded List of Climate-induced Threats to CW Biodiversity

This table was compiled from the literature by The Nature Conservancy's Great Lakes Climate Science Program and used as a starting point for an experts workshop on biodiversity adaptation held in Chicago on 14 July 2009. The Natural Community targets are generalized from the CW Biodiversity Recovery Plan. See Section 3 - Adaptation for further explanation of how this table was used.

Source: Dr. Kimberly Hall, Great Lakes Climate Scientist, The Nature Conservancy.

Natural Communities				**Climate Change Threats**
Wetlands	**Streams/ Rivers**	**Lakes**	**Lakeshore**	**AQUATIC COMMUNITIES**
X	X	X	X	Increased storm intensity/frequency will increase non-point source pollution of aquatic systems and wetlands (nutrients, sediments...).
	X	X		Increased storm intensity/frequency will promote stream channel destabilization, leading to loss of aquatic habitats and sedimentation.
X	X	X	X	Increased water temperatures will favor warmer-water species and stress colder-water species.
X	X	X	X	Overland flow from storm events will expose sensitive systems to pulses of warm water (combination of increased temperature effect, and increased storm intensity).
X	X			Increased temperatures will lead to drying of wetland/ephemeral stream, further isolate/fragment and stress wetlands/riparian habitats that remain.
X				Increased temperatures and lake level drops will increase pressure on groundwater resources, threatening groundwater fed systems.
		X	X	Increased temperature will reduce the duration/extent of ice cover on lakes.
		X		Climatic changes will lead to changes in wind patterns, which alter the circulation of water in coastal areas (bays).
		X	X	Increased temperatures/evapotranspiration will lead to drops in lake levels & promote shifts in the location of coastal and nearshore habitats.

X	X	X		Increased demand for biofuels will intensify potential for run-off/erosion related impacts on aquatic systems as land is converted and usage of fertilizer and pesticides increases.
		X		Drops in lake levels will expose toxic sediments.
		X		Drops in lake levels will expose more nearshore areas to aquatic invasives like *Phragmites*.

Natural Communities		**Climate Change Threats**
Prairie Grasslands	**Savannas/ Forested Communities**	**TERRESTRIAL COMMUNITIES**
X	X	Increased temperatures will favor warmer-biome plant species and stress colder-biome forest species.
X	X	Increased temperatures will create conditions that promote additional drought stress (late summer).
	X	Increased temperatures will promote increases in tree pests (increased reproduction due to warmer temperatures and longer growing seasons, and range shifts).
X		Increased temperatures and changes in precipitation patterns will alter seasonal patterns of snow accumulation and snowmelt.
X	X	Increased temperatures will promote species that are invasive or act as disease vectors.
X	X	Increased temperatures will lead to mismatched shifts in timing of various ecological events (e.g., budburst), leading to disruptions in species interactions.
X	X	Increased temperatures and changes in drought stress (etc…) will lead to differential shifts in ranges due to differences in dispersal abilities/rates, leading to disruption of key species interactions (“tearing apart of communities”).
X	X	Increased temperatures and changes in precipitation will drive human changes in land and resource use, leading to more habitat loss.
X	X	Increases in ambient CO_2 concentrations, temperature, and drought stress may lead to changes in the competitive ability of native C3 and C4 plants relative to each other and to invasives (but interactions are complex).

Appendix 4

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