2010 Project Abstract
For the Period Ending June 30, 2013

PROJECT TITLE: Engaging Students in Environmental Stewardship through Adventure Learning
PROJECT MANAGER: Nicole Rom
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FUNDING SOURCE: Environment and Natural Resources Trust Fund
LEGAL CITATION: M.L. 2010, Chp. 362, Sec. 2, Subd. 8b

APPROPRIATION AMOUNT: $250,000.00

Overall Project Outcome and Results

The Will Steger Foundation developed *Engaging Students in Environmental Stewardship through Adventure Learning (MCC)* with the understanding that environmental stewardship begins with a local connection and sense of appreciation, or environmental sensitivity, towards the natural environment. This project's primary audience, educators, have the unique opportunity to lead their students through the environmental education continuum of knowledge, awareness, and skills that lead to an informed and active environmental citizenry.

Climate change is one of the most critical environmental issues of our time and educators have an important role to play in educating their students and providing them the skills to mitigate and adapt to climate change. In order to make the issue relevant and connected to the lives of those reached through our project, we focused specifically on the impacts of climate change on Minnesota's biomes. Additionally, we wove in stories from Will Steger's life and examples of his own early observations of the natural world and his curiosity of weather and climate. We also tapped into the expertise of many Minnesota scientists and educators in the development of our Grades 3-12 curriculum, online classroom and two public forums and three Summer Institutes for climate change education.

Over the three years of the project we were able to reach and increase the climate literacy of over 5000 educators, members of the public and students via our Summer Institutes for Climate Change Education, year round workshops, conference presentations, school visits, field trips, public forums and our online classroom (classroom.willstegerfoundation.org). The project also resulted in the development of a number of valuable, mutually beneficial, and long-term partnerships. The partnership with the Mississippi River Fund, National Park Foundation and Mississippi National River and Recreation Area resulted in the ability to support 20 student service projects and field trips for over 500 students to enhance their learning on Minnesota's changing climate. *MCC* was recognized in 2012 by Environmental Initiative in the area of environmental education in part due to these important partnerships. A final evaluation report showed overall success for the project in providing a curriculum and training that increased climate literacy, environmental stewardship and educator confidence in teaching about climate change.

Project Results Use and Dissemination

Directions:

1. *How has information from your project been used and/or disseminated?*
   Over 500 formal and informal educators from all four biomes received a copy of the *Minnesota's Changing Climate Curriculum* via three Summer Institutes and customized workshops for school districts and at professional education conferences. The curriculum was used to teach over 10,000 Grades 3-12 students about Minnesota's unique biomes, what makes them unique, how they are

threatened by climate change and what they can do to mitigate the impacts. Additionally, the curriculum has been shared nationally and regionally via the Climate Literacy Network, the Great Lakes Education Collaborative, Green Teacher, Humphrey Institutes Innovations in Education Forum and the North American Association for Environmental Education as a model of place based climate change education.

Additionally, over 1,000 students submitted their observations of Minnesota's biomes during the school year to our online classroom, with at least 2,000 more viewing and/or commenting on their observations.

What communications and outreach activities have been done in relation to your project? For example: have tools or techniques developed through your project been adopted by a group; presentations relating to the project been made; has work pertaining to the project been published?

Minnesota's Changing Climate curriculum has been used as a framework to develop curriculum specifically focused on the Mississippi River and climate change impacts on Wisconsin. Additionally the Minnesota Phenology Network and Minnesota Master Naturalists have used portions of it and endorse its effectiveness for communicating the connection between phenology and climate change. The curriculum has been aligned with the St. Paul Public Schools "power standards" and Minneapolis Public schools elementary STEM standards and used as an example of how to meet those standards. Finally, teachers from Minnesota American Indian reservations that are participating in The CYCLES project, a project of the STEM Center at the University of Minnesota, received training and are using the curriculum in their schools because the place based focus of the curriculum resonates culturally.

The online classroom, created in partnership with Hamline's Center for Global Environmental Education, has been used by educators around the state to learn more about Minnesota's unique biomes, their cultural history and climate change impacts. Finally, the Minnesota Phenology Network has utilized it has the perfect curriculum for connecting individuals with a reason why phenology is important.

Environment and Natural Resources Trust Fund (ENRTF)
2010 Work Program Final Report

Date of Report: August 8, 2013
Date of Next Progress Report: Final Report
Date of Work Program Approval:
Project Completion Date: June 30, 2013

I. PROJECT TITLE: Engaging Students in Environmental Stewardship through Adventure Learning

Project Manager: Nicole Rom
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Location: Minnesota Statewide

Total ENRTF Project Budget:	**ENRTF Appropriation**	**$250,000.00**
	Minus Amount Spent:	**$250,000.00**
	Equal Balance:	**$0**

Legal Citation: M.L. 2010, Chp. 362, Sec. 2, Subd. 8b

Appropriation Language:
$250,000 is from the trust fund to the commissioner of natural resources for an agreement with the Will Steger Foundation to provide curriculum, teacher training, online learning, and grants to schools on investigating the connection between Minnesota's changing climate and the impacts on ecosystems and natural resources. This appropriation is available until June 30, 2013, by which time the project must be completed and final products delivered.

II. FINAL PROJECT SUMMARY AND RESULTS:

The Will Steger Foundation developed Engaging Students in Environmental Stewardship through Adventure Learning (MCC) with the understanding that environmental stewardship begins with a local connection and sense of appreciation, or environmental sensitivity, towards the natural environment. This project's primary audience, educators, have the unique opportunity to lead their students through the environmental education continuum of knowledge, awareness, and skills that lead to an informed and active environmental citizenry.

Climate change is one of the most critical environmental issues of our time and educators have an important role to play in educating their students and providing them the skills to mitigate and adapt to climate change. In order to make the issue relevant and connected to the lives of those reached through our project, we focused specifically on the impacts of climate change on Minnesota's biomes. Additionally, we wove in stories from Will Steger's life and examples of his own early observations of the natural world and his curiosity of weather and climate. We also tapped into the expertise of many Minnesota scientists and educators in the development of our Grades 3-12 curriculum, online classroom and two public forums and three Summer Institutes for climate change education.

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III. PROGRESS SUMMARY AS OF October 31, 2010:

To support the *Engaging Students in Environmental Stewardship through Adventure Learning* project positions were posted and hired for an Education Program Manager, Videographer, Graphic Designer, Evaluation Team, and project assistant/intern.

Significant effort was put into raising awareness about the project and recruiting classrooms to participate during the 2011-2012 school year. To assist in the effort a number of different materials, both multimedia and paper based tools were developed in collaboration with a Videographer, Webmaster, Graphic Designer, Education Program Manager and Project Assistant. Outreach occurred through our Summer Institute for Climate Change Education, conferences, our website, and established educator networks.

A "teaser lesson" that showcases Will's archived journals from his childhood and later in life was developed and shared via the Summer Institute and in subsequent conference presentations. In addition, an activity was piloted at two conferences that will be used in the final curriculum.

<u>Please note budget amendment request in Section V approved January 26, 2011.</u>

IIIa. PROGRESS SUMMARY AS OF March 31, 2011:

Engaging Students in Environmental Stewardship through Adventure Learning content research and creation have been the focus of this period of time. The first draft of the *Minnesota's Changing Climate* curriculum was researched, written and sent out for review in March. In addition, we hired Hamline's Center for Global Environmental Education (CGEE) to design much of the online classroom and we have worked with them to ensure consistency between the curriculum and the online component. Recruitment and planning for the Summer Institute has continued and we have been pleased with the number of applicants we have (70) with a few months to go (Summer Institute is August 11-12, 2011). Finally, through a unique partnership with the National Park Foundation, Mississippi River Fund and the Mississippi National River and Recreation Area we gained the opportunity to offer $500 mini grants to metro middle school teachers that attend the Institute. We also applied for a grant from the Donald Weesner Charitable Trust to offer each educator attending the Institute an "Explore Minnesota Biomes" kit that will include equipment and cameras to observe their natural environment.

IIIb. PROGRESS SUMMARY AS OF August 31, 2011:

The *Minnesota's Changing Climate* Grades 3-8 and 9-12 curriculum was finalized and had its first printing. In addition the *Minnesota's Changing Climate* online classroom (classroom.willstegerfoundation.org) was made public including a learning module, curriculum and supporting materials and a social networking feature. The 6th annual Summer Institute for Climate Change Education occurred on August 11 and 12, with over 100 registrants representing all four biomes of Minnesota. Initial evaluation of the project occurred at the Institute.

<u>Please note there is a budget amendment request in Section V approved October 12, 2011.</u>

IIIc. PROGRESS SUMMARY AS OF November 30, 2011:

Minnesota's Changing Climate teacher support began this fall, as well as continued outreach and dissemination of the curriculum. Will Steger made four school visits to recognize those implementing *Minnesota's Changing Climate*. Two more visits are planned for the winter and early spring. The use of the online classroom observations section has been consistent. Initial outreach and planning for Summer Institute 2012 began.

IIId. PROGRESS SUMMARY AS OF April 30, 2012:

We were honored to learn that the *Engaging Students in Environmental Stewardship through Adventure Learning* project was one of three environmental education projects statewide to be nominated for the Environmental Initiative Awards (http://bit.ly/Kpbfuj). The online classroom continues to be posted to by students around the state and we were able to offer two additional curriculum trainings. Registration for Summer Institute 2012 continues and we are busy editing a second edition of the curriculum based on educator feedback to be ready for this summer's educator cohort.

Amendment Request Result 1 May 23, 2012:

- Due to an unanticipated demand for school visits and presentations on the curriculum our expenditures were greater than expected in Deliverable 6. Additionally, Deliverable 5, web support for the curriculum, expenditures exceeded our expectations. Based on our needs for the final printing and distribution of the curriculum we request to move $1822.36 from Deliverable 4, printing and add $1319.50 to Deliverable 5, web support and $502.86 to Deliverable 6, curriculum outreach.

Amendment Request Result 2 May 23, 2012:

- Our expenditures for Deliverable 1, Summer Institute 2010, exceeded expectations, but because of unanticipated in kind donations, we under spent for Deliverable 2, Summer Institute 2011. We request to move $3973.25 from Deliverable 2 to Deliverable 1.

Amendment Request Result 3 May 23, 2012:

- Will Steger's journals became more integral to the curriculum than expected and we exceeded our expenditures in Deliverable 1 by $375. Looking ahead we have adequate funds to maintain our online program and request to move $375 from Deliverable 2 to Deliverable 1.

Amendment Approved: June 14, 2012

IIIe. PROGRESS SUMMARY AS OF August 31, 2012

We held our seventh annual Summer Institute for Climate Change Education featuring a newly revised version of *Minnesota's Changing Climate* August 7 and 8. 90 educators attended and evaluation results show overwhelmingly positive reviews, as well as increased knowledge on climate change in Minnesota. We were able to bring Dr. Genie Scott from the National Center for Science Education to speak at both a public forum before the Institute, and at the Institute. The online classroom continued to be utilized and our evaluation team was able to get final curriculum survey results that they are developing into a final report.

IIIe. PROGRESS SUMMARY AS OF March 6, 2013

We continue to support educators using our curriculum through workshops, exhibiting at conferences and the online classroom.

Amendment Request Result 1 March 6, 2013

- We have spent less on travel/mileage than anticipated and request to move a total of $2722.89 from Deliverables1 ($1183.77),3($1.49) and 4($1537.63) to Deliverable 5, web support, to ensure the online classroom is maintained for the duration of the project. This is reflected in the Attachment A Result 1with a movement of $0.97 moved from the supplies line and $2721.92 from the travel line to Online/Web Support.

Amendment Request Result 2 March 6, 2013

- We request to move $300 from the line for travel/mileage to the line for online/web support.

Amendment Request Result 3 March 6, 2013

- In the Attachment A we request to move $1480.25 from the line for travel/mileage to the line for printing. This will enable us to print our last batch of curriculum for distribution to educators.

Amendment Request Result 4 March 6, 2013

- In the Attachment A we request to move $870.98 from the line for travel/mileage to the line for printing. This will enable us to print our last batch of curriculum for distribution to educators.

Amendment Approved: April 1, 2013

IV. OUTLINE OF PROJECT RESULTS*:*

RESULT/ACTIVITY 1: Minnesota's Changing Climate Adventure Learning Curriculum for Grades 3-12

Description: An age-appropriate climate change curriculum for grades 3-5; 6-8; 9-12 that is reviewed by Minnesota educators, the Union of Concerned Scientists and the National Education Association. The curriculum will be interdisciplinary and experiential in nature. The curriculum will foster an understanding of Minnesota's diverse ecosystems and develop a sense of place, educate on the basics of climate change and implications for Minnesota, the Midwest and the globe, and ultimately empower student leadership and action on climate change solutions. The curriculum will include an adventure story from polar explorer Will Steger's archives, units on Minnesota's ecosystems and foster skills necessary to be a citizen naturalist – observing and documenting Minnesota's changing climate and investigation implications of a changing climate. The curriculum will reach 10,000 students in grades 3-12 throughout Minnesota schools by 2013.

Amendment Request Result/Activity 1 Approved January 26, 2011:

- In going through the Result 1 budget in the Work Program we noticed that it did not include all of funds included in the budget lines in Attachment A. This is an oversight from the original workplan and we are requesting to add these funds to the **Work Program** to cover supplies, travel expenses, and digitizing service. The budget for these expenses is accounted for in Attachment A.

Summary Budget Information for Result/Activity 1:
***Revised* ENRTF Budget: $91,313.84**
Amount Spent: $91,313.84
Balance: $0

Deliverable/Outcome	**Completion Date**	**Budget**
1. Research, Development and Revision of Grades 3-12 Minnesota's Changing Climate Curriculum • Multidisciplinary curriculum on Minnesota's diverse ecosystems (bogs and fens, prairie, deciduous, coniferous), the impacts of climate change, and lesson planning for student-led action projects • Aligned to MN standards	June 2013	$52,827.61

2. Graphic design, and revision – final production of curriculum	June 2013	$2947.50
3. Archive research for curriculum components	June 2011	$1437.39
4. Printing and distribution of curriculum	June 2013	$22,806.59
5. Web support for curriculum, software, evaluation	June 2013	$9791.89
6. Curriculum outreach	June 2013	$1,502.86

Result/Activity Completion Date: June 2013

Result 1 Status as of: August 31, 2012
We were able to consolidate teacher feedback and make revisions to MCC curriculum for a second printing. The new version was distributed at the June Minnesota Association for Environmental Education conference (15 teachers), an August and September workshop for St. Paul Schools science teachers (70 teachers) and the Minnesota Independent School Forum conference session (30 teachers). Additionally educators at the 2012 Summer Institute for Climate Change Education received the curriculum (90 teachers), as well as a kit of materials for implementing a number of the activities.

The 2012-2013 school year will focus on supporting teachers using the curriculum and continuing with distribution of the curriculum via training institutes and conferences. A workshop is scheduled for December with teachers that work at schools primarily serving American Indian youth.

Result 1 Status as of: April 30, 2012
We have continued to gather feedback from teachers on the curriculum as we work on editing the curriculum for distribution at Summer Institute 2012. Additionally, teachers who download the curriculum, attend a training or information session on MCC, or attended our Institute receive bi-monthly communications with updates and resources.

The curriculum was distributed at trainings for the Minnesota Science Teacher's Association and the Minnesota Phenology Network's annual meeting. We were able to reach over 250 educators at the MnSTA conference and discuss further partnership opportunities with the Minnesota Phenology Network, focusing on the phenology strand of our curriculum.

Will Steger, our education program manager and education assistant made visits to Proctor Middle School and Hawley Elementary and High School. Will did school assembly presentations at the schools and then classes shared what they had been learning. We were also taken outside to the areas where students were doing their journaling and observations. Through these visits, we were able to document educators increased comfort and confidence with bringing their students outside and important 21st century skills being used by their students. The student's questions and well-developed skills of observation and journaling outdoors were a great testament to what the outcome of teacher training in combination with a well-developed and implemented curriculum can be.

Result 1 Status as of: November 30, 2011

As teachers begin to implement the *Minnesota's Changing Climate* curriculum in their classroom we are gathering feedback and extensions to add to the second edition. Teachers who download the curriculum or attended our Institute receive bi-monthly communications with updates and resources.

Curriculum outreach and distribution continued with presentations at the Minnesota Homeschoolers Association (10 participants), the Friend's School of Minnesota (5 teachers), and Education Minnesota (35 participants in session, 9000 conference attendees).

Will Steger, our education program manager and education assistant made visits to Crosby Farm Park with the Friends School of Minnesota, Salem Hills Elementary, Roseville Middle School and Metro Tech Academy. During the visits Will talked about climate change, his adventures and heard from the students about the work they have been doing around *Minnesota's Changing Climate.* A few schools have created public service announcements about action projects they have or will be implementing. These videos can be watched at: http://classroom.willstegerfoundation.org/get-social/view-observations-by-others/itemlist/tag/video.

Result 1 Status as of: August 31, 2011
Late spring and summer consisted of consolidating the Grades 3-8 and 9-12 *Minnesota's Changing Climate* curriculum reviews and editing, sending the curriculum to the designer and finally running the first printing. The curriculum was introduced and distributed to 25 teachers at the Minneapolis Public Schools Elementary Science Institute, 90 participants of the Will Steger Foundation Summer Institute, and 20 teachers at the Minnesota Independent School Forum. Over 90% of educators introduced to the curriculum said that it was useful and engaging and matched their curricular goals. In addition, 84% said that the curriculum meets a need for which they have inadequate resources.

We additionally reached over 100 other educators through presentations at the Midwest Environmental Education Conference in Rochester, and the Minnesota Master Naturalists Conference. The fall will include curriculum distribution via presentations at Education Minnesota, and the Minnesota Homeschoolers Alliance. In addition the curriculum is available free to download from the Will Steger Foundation website, http://classroom.willstegerfoundation.org.

The 2011-2012 school year will focus on supporting teachers using the curriculum, making revisions and continuing with distribution of the curriculum via training institutes and conferences.

Result 1 Status as of: March 31, 2011
Winter and spring were focused on research and writing of the curriculum by the Education Program Manager and the Project Assistant. Some coordination with the online classroom development team at CGEE was necessary to maintain connections with the content for both. The curriculum was sent out to a number of curricula, science and climate change experts in Minnesota for review and their comments are being incorporated into the curriculum final draft. The graphic designer designed a few

activities for piloting at conferences and for teachers to use in their classroom, as well as worked on the overall look of the curriculum final. We exhibited at the Minnesota Science Teachers Association Conference and raised awareness about the project with over 200 science teachers from all over the state. The Education Program Manager attended the Minnesota State Science Standards workshop to learn more about aligning the curriculum with state standards and hired a short-term intern from the St. Kate's pre-service STEM program to align the curriculum with science standards.

This spring and summer will be spent finalizing the curriculum, designing and printing it and getting it ready to share at the Summer Institute.

Result 1 Status as of: October 31, 2010
Videographer, graphic designer and project assistant positions were posted and filled. In anticipation of the opportunity to share news of this project at the 2010 Summer Institute for Climate Change Education a "teaser" lesson was developed (see attached). The lesson featured the importance of journaling to connect with the outdoors and included excerpts from Will Steger's journals. The Education Program Manager spent time developing the lesson in collaboration with a graphic designer, an archive researcher, and printer. In addition the lesson and the opportunity to be involved with the project as a whole was posted to our website (http://www.willstegerfoundation.org/new-minnesotas-changing-climate) and blog (http://www.willstegerfoundation.org/climate-lessons). The lesson was then shared at the Summer Institute for Climate Change Education in August (75 participants) and used as an example at outreach events throughout the fall. Outreach events include; Minneapolis Public School Elementary Science Institute, Minnesota Homeschoolers Alliance, Education Minnesota Professional Conference, Minnesota Naturalists Association, the University of Minnesota STEM Education Program, Humboldt High School, and The Green Schools National Conference. There were a total of 75 teachers involved with piloting potential activities for the curriculum this fall.

Development of the curricular content will continue through the spring with continued support from the project assistant, web team, and archive research. Meeting with the online classroom development team will be important to maintain a theme and consistency of the project.

Result 1 Final Report Summary
The Minnesota's Changing Climate curriculum framework was developed around four important ideas. Recognizing the importance of place in making issues and concepts relevant, the curriculum highlights Minnesota's four biomes and their unique biotic characteristics and encourages educators to take their students outside to explore their biome. Additionally, the curriculum's foundation is climate change science from peer reviewed journals, first person interviews with local scientists and state or federal resources. Knowing that stories and local heroes can inspire hope and change, Will Steger's adventures and lifelong journals are included with each lesson. Finally, climate change education needs to include opportunities for action and environmental stewardship. The final lesson of the curriculum gives students the opportunity to develop their own action projects related to climate change. Educators piloted lessons and were surveyed the first year of implementation and their feedback was used to

revise the curriculum for the second year of implementation. The final evaluation showed that almost all felt that the curriculum was “helpful” or “very helpful” for teaching about climate change and environmental stewardship. Five strengths and three challenges were revealed through the evaluation they were:
Strength 1: The local focus on Minnesota and connections to students’ experiences and the world
Strength 2: The active, hands-on, inquiry-based nature of the curriculum
Strength 3: The clarity of the lessons and teacher guide, including specific content and materials
Strength 4: The ability to adapt the lessons to fit their students and curriculum
Strength 5: There was a lot of support for implementing the curriculum
Challenge 1: Greater differentiation of the curriculum
Challenge 2: Lack of time and other resources

600 Grades 3-12 educators received a copy of and were trained in the Minnesota’s Changing Climate curriculum. Workshops ranged from an hour introduction to the resource to 2-day intensive institutes including activities from the curriculum and content specialists to provide in depth information about the concepts covered in the curriculum. Educators that received training were from each biome in Minnesota; work in urban, suburban and rural settings; are formal and informal educators; and work with students of all demographics. In addition to the curriculum itself, we were able to distribute 150 sets of curriculum kits that included the resources to successfully facilitate a number of the activities in the curriculum. During the 2011-2012 school year Will Steger and Will Steger Foundation education staff made visits to six schools located in all four biomes of Minnesota. Will did a presentation for each entire school and then visited the classroom of the teacher that had attended our Institute to see how they had been implementing the curriculum. 3000 students throughout Minnesota were reached through these school visits. Finally, a $25,000 grant from Weesner Family Foundation allowed us to distribute 100 biome kits to educators at our 2011 Institute. The kits contained field guides, cameras and other resources to explore outside. In addition to distribution of the kits, the Will Steger Foundation has 5 kits available for educators to borrow for three-week periods. The curriculum can be downloaded for free at http://classroom.willstegerfoundation.org. $25,000 was donated from foundations to support our work on this project and $39,000 of salary was donated through administrative and support of staff at the Will Steger Foundation.

RESULT/ACTIVITY 2: Institutes for Educators on Climate Change Education

Description: The Institutes for Educators on Climate Change Education are professional development opportunities for Minnesota educators. They are a vehicle for empowering educators by seeking to build their comfort and confidence with the topic of climate change and the lesson plans included in Minnesota’s Changing Climate. The Institutes are designed in collaboration with partners, including the Science Museum of Minnesota, Saint Paul Public Schools and academic institutions. Between 2010-2012, 300 Minnesota educators will be informed and/or trained in Minnesota’s Changing Climate.

Summary Budget Information for Result/Activity 2:

ENRTF Budget: $71,613.25

Amount Spent: $71,613.25

Balance: $0

Deliverable/Outcome	Completion Date	Budget
1. 2010 Summer Institute – Announce project opportunity	September 2010	$16,992.36
2. 2011 Institute Workshops– Unveil curriculum and program, train educators	September 2012	$30,382.75
3. 2012 Institute Workshops– Share successes and challenges, evaluation	June 2013	$24238.14

Result/Activity Completion Date: June 2013

Result 2 Status as of: August 31, 2012

Over 90 educators attended the 7th annual Summer Institute for Climate Change Education on August 7 and 8 at the School of Environmental Studies in Apple Valley, MN. This Summer Institute focused on climate science basics, introduced the second edition of the Minnesota's Changing Climate curriculum and provided training on many of the hands-on activities from the Minnesota's Changing Climate curriculum. Educators had the opportunity to hear from Dr. John Abraham, Dr. Eugenie Scott and Will Steger as well as a variety of excellent breakout speakers. The breakout speakers provided skills, resources and excellent information to enrich the use of the Minnesota's Changing Climate curriculum in the classroom. The evening before the Institute began, we co-hosted a public forum with Dr. Genie Scott of the National Center for Science Education at the Humphrey Institute. (250 attendees)

We were able to distribute to each teacher kits with materials needed to implement the curriculum. Evaluation results show increased confidence in teaching about climate change as a result of the Institute and increase climate literacy.

We were able to secure donations of food and teacher goodies from Aveda, General Mills, Valley Natural Foods, Common Roots, French Meadow Café, Kowalskis, The Wedge, Mississippi Market, Birchwood, Peace Coffee, The Jeffers Foundation and Chinook Book. We were also able to continue our partnership with the National Park Foundation , National Park Service and Mississippi River Fund by providing 12 of the metro area teachers with funds to visit the Mississippi with their students at Ft. Snelling State Park.

A recap of the Institute can be viewed at http://willstegerfoundation.org/summer-institute.

An institute workshop is scheduled for December with teachers that work at schools primarily serving American Indian youth. An Institute is tentatively planned for June, 2013 to be held at Ft. Snelling State Park.

Result 2 Status as of: April 30, 2012

Summer Institute 2012 outreach and registration began in January. As of May 23, 2012 we have 60 educators from around the state registered. A map showing location of participants can be viewed at: http://bit.ly/JI1U2s We have confirmed presentations for most of the eight breakout sessions and Dr. John Abraham and Will Steger will keynote the two days. The Institute will take place at the School of Environmental Studies in Apple Valley August 7-8.

We have also confirmed Dr. Eugenie Scott as the speaker for our public forum the evening of August 6, at the Humphrey School of Public Affairs (http://bit.ly/JV5rcD). Dr. Eugenie Scott is the Executive Director of the National Center for Science Education (NCSE). For the past 30 years NCSE has primarily focused on defending the teaching of evolution in the classroom. In 2012, in response to complaints from teachers that they were coming under fire for teaching global warming and other climate change concepts, NCSE decided to support the teaching of climate change in addition to evolution.

We were able to hire a Summer Institute intern that will begin June 4, 2012.

Additional curriculum trainings were offered at the Minnesota Science Teachers Association conference (40 participants), the Minnesota Phenology Conference (15 participants).

The rest of the spring and summer will be spent planning and implementing the Summer Institute. This will involve finalizing the agenda and speakers, asking for donations of food, and finalizing the plan for 2012-2013 to be shared with the teachers.

Result 2 Status as of: November 30, 2011
The dates of August 7-8, 2012 were set for Summer Institute 2012. Initial outreach began and registration will open late January 2012.

Result 2 Status as of: August 31, 2011
The 2011 Summer Institute for Climate Change Education was held at the School of Environmental Studies in Apple Valley, MN. Over 100 educators from across the state of Minnesota registered, which is the highest number of Summer Institute participants to date. Participants received training on our new Minnesota's Changing Climate curriculum and online classroom and attended a variety of breakout sessions that provided supporting information to enhance the use of the curriculum. Due to a grant from the Donald Weesner Trust we were able to distribute *Explore Minnesota's Biomes Kits*, which contain a digital camera, rain gauge, thermometer, field guides and other tools to help students explore the outdoors. 20 middle school metro teachers are eligible for $500 action project grants due to the Parks Climate Challenge, collaboration with the National Park Foundation, National Park Service and the Mississippi River Fund. At the conclusion of the Institute, 93% of participants were confident in their ability to implement the curriculum. All Summer Institute participants plan to implement Minnesota's Changing Climate curriculum this school year. We were able to secure donations of food, space and educator giveaways from; The School of Environmental Studies, common roots catering, French Meadow bakery, Kowalski's Markets, Linden Hills Coop, Prairie Restorations Inc, The Jeffers Foundation, Chinook Book, Peace Coffee, Seward Coop, Valley Natural Foods and the Freshwater Society.

A Summer Institute recap video, as well as more details of the Institute are available at: http://classroom.willstegerfoundation.org/about/summer-institute. A video that describes our collaboration with the National Park Foundation through the Parks Climate Challenge is available at: http://www.youtube.com/watch?v=_ge0lrl7Rhg.

A public forum, *Sense of Place in a Changing Climate*, was held the evening of August 11 and had over 200 attendees, including teachers from the Summer Institute. The panel consisted of Don Shelby, J. Drake Hamilton (Fresh Energy), and Will Steger and was moderated by MPR's Mid-morning host, Kerri Miller. The forum can we watched at: http://www.willstegerfoundation.org/climate-news/item/1292.

Result 2 Status as of: March 31, 2011
Outreach for the Summer Institute continued and as of June 7, 2011 we had 71 educators signed up from around the state. We will be focusing more on the Aspen Parkland (NW corner) of the state, as this is where we have the most limited involvement. We secured the School of Environmental Studies in Apple Valley, MN for small fee, as a location for our two-day Institute August 11-12, 2011 and began to develop an agenda and invite speakers.

An evening public forum will be included in the Summer Institute and we have finalized the speakers and theme of the forum. The forum will be a panel discussion called, *Sense of Place in a Changing Climate* and will be held at the Town and Country Club in St. Paul. The panel will consist of three Minnesotans discussing their connection to Minnesota, how climate change is impacting their sense of place, and why they are concerned or how this impacts their daily lives. The purpose of the event is to raise awareness about the impacts of climate change on our state's natural resources and what we as citizens can do through the personal stories and "testimony" of prominent Minnesotans. The panel will consist of Don Shelby, J. Drake Hamilton (Fresh Energy), and Will Steger and will be moderated by MPR's Mid-morning host, Kerri Miller.

As a result of a unique partnership with the National Park Foundation, Mississippi River Fund and the Mississippi National River and Recreation Area (National Park Service) we are able to offer $500 mini-grants to 20 metro middle school teachers that will be doing action projects that specifically mitigate the impacts of climate change on the Mississippi. These teachers will also receive additional training that highlights the national park and climate change.

The spring and summer will be spent planning and implementing the Summer Institute. This will involve finalizing the agenda and speakers, asking for donations of food, and finalizing the plan for 2011-2012 to be shared with the teachers.

Result 2 Status as of: October 31, 2010
An intern and the Education Program Manager put significant energy into planning our 2010 Summer Institute for Climate Change Education that was held on August 12, 2010 at the University of Minnesota, St. Paul Campus. We reached 75 educators in person and via moderated webinar and provided scholarships to 25 educators. Participants engaged with Minnesota's Changing Climate Curriculum through an activity using weather instruments. They also gained a deeper perspective on engaging students on the topic through our keynote speaker, Dr. Naomi Oreskes. The Institute was recorded

and videos are posted to our website (http://www.willstegerfoundation.org/summer-institute) for the educators to use in their classroom or further professional development. Outreach materials recruiting educators for the project and Summer Institute 2011 were developed, printed and distributed at the Summer Institute 2010. (See attached) Finally we were able to secure donations from; Aveda, Birchwood Café, Blue Sky Guide, Do It Green Guide, Eureka Recycling, French Meadow Bakery, Linden Hills Cooperative, Orion Magazine, Peace Coffee, Stonyfield Farm, Whole Foods, and Valley Natural Foods. The National Education Association and St. Paul Public Schools provided general support and outreach, and the University of Minnesota – Institute on the Environment & Office of International Programs supported with outreach and facility costs.

The Education Program Manager and Project Assistant will use the spring of 2011 to plan for the Summer Institute 2011 including securing a venue, speakers and recruitment of classrooms.

Result 2 Final Report Summary
Three Will Steger Foundation Institutes for Climate Change Education, three public forums and twenty workshops were conducted during this project. This resulted in the increased climate literacy and environmental stewardship of over 500 formal and informal educators representing over 10,000 students statewide, as well as the increased awareness of over 400 members of the general public through our public forums. Food and supply donations for breakfast, lunch and snacks was secured for 75 attendees in 2010, 100 attendees in 2011 and 100 attendees in 2012 for a value of $18,000. Speakers and volunteers additionally provided their services in kind in 2010, 2011 and 2012.

Public Forums were held 2010-2012 in conjunction with each Summer Institute to provide an evening option for educators and to raise awareness about Minnesota's changing climate. The Humphrey Institute donated their space for the forums and they featured Dr. Naomi Oreskes, a sense of place panel with Kerri Miller, Don Shelby, Will Steger and J. Drake Hamilton and Dr. Genie Scott. Approximately 250 members of the public and educators attended each forum. Overviews of each of the forums can found at http://www.willstegerfoundation.org/climate-news/item/1292, http://vimeo.com/14809445, and http://willstegerfoundation.org/media-room/video-gallery/viewvideo/243/education/summer-institute-2012-genie-scott-ncse.

Final evaluation of the Institutes showed overwhelming satisfaction with the experience and increased confidence and competence in teaching climate change. Reflecting back on the Summer Institute after implementing the curriculum, most teachers indicated that the Summer Institute had been helpful or very helpful. Approximately 1 in 5 teachers indicated that the institute was very unhelpful; open-ended responses indicate that these teachers would have liked more hands-on activities and more guidance in adapting the curriculum to meet particular instructional demands, such as integrating it into their existing instruction and modifying it for select grade levels and student groups. This feedback was taken into account when planning institutes held the summer of 2013. Returning teachers indicated that the value of the institute extended beyond the opportunities it provided for preparing to teach the MCC curriculum; it also was a place to share ideas and experiences and gain a sense of renewed purpose with like-minded educators. Recaps of the Institutes can be found at http://willstegerfoundation.org/summer-institute.

A partnership with the Mississippi River Fund and the Mississippi National River and Recreation Area and $20,000 in funding from the National Park Foundation made it possible to provide additional training, mini grants and field trips to a cohort of teachers attending the Institutes in 2011 and 2012. A video that describes our collaboration with the National Park Foundation through the Parks Climate Challenge is available at: http://www.youtube.com/watch?v=_ge0lrl7Rhg. This collaboration has continued and an Institute featuring the river and the curriculum is being held in August of 2013.

RESULT/ACTIVITY 3: Online-interactive Adventure Learning Classroom

Description: The online-interactive Adventure Learning Classroom will include multimedia resources linked to specific lesson plans in Minnesota's Changing Climate, including expedition videos, audio and video journals and an extensive image gallery. The curriculum will be available on the Will Steger Foundation web site for purchase (hard copy) and free PDF download in the online classroom. The online classroom will also include a social networking feature for educators and their classrooms to build a community of learners. The program will also reach an additional 25,000 visitors via the Will Steger Foundation Web site and through cross-promotion with partners and educational associations newsletters and websites

Summary Budget Information for Result/Activity 3:
ENRTF Budget: **$67,079.40**
Amount Spent: **$67,079.40**
Balance: **$0**

Deliverable/Outcome	Completion Date	Budget
1. Review Will Steger's archived journals and select up to 10 adventure stories including images, journals and videos	September 2011	$13,067.35
2. Develop and maintain interactive, online program in conjunction with the curriculum and evaluation tools and digitize archives	June 2013	$48,507.05
3. Monitor and support online classroom and social networking features	June 2013	$5,505

Result/Activity Completion Date: June 2013

Result 3 Status as of: August 31, 2012
The online classroom continues to be used by teachers and students. Over 100 observations have been posted during the month of September. They can be viewed at http://classroom.willstegerfoundation.org/get-social/view-student-submissions/view-observations-by-others.
We will continue to add to the classroom, and this fall will include a link to the Parks Climate Challenge work that is being done at Ft. Snelling State Park, including long

term weather data that is being collected. That information will be found at http://classroom.willstegerfoundation.org/about/parks-climate-challenge/parks-climate-challenge-2012.

Result 3 Status as of: April 30, 2012
The online classroom has continued to be used throughout the school year with over 800 submissions. A page was added for information about Summer Institute 2012 (http://classroom.willstegerfoundation.org/about/summer-institute/summer-institute-2012). Through the web portal, students have been able to share observations, photos and action projects, as well as view and comment on other student submissions from around the state. Teachers have used the classroom in a variety of ways, including as homework and a final assessment. One school has posted throughout the entire year and they are using it as a virtual place to reflect back on what they have observed. We will continue to maintain and support the classroom during the 2012-2013 school year.

Result 3 status as of: November 30, 2011
The online classroom's observation sharing section has been highly utilized by classrooms around the state with over 500 student submissions so far this school year. They can be seen at: http://classroom.willstegerfoundation.org/get-social/view-observations-by-others/. The curriculum has been downloaded from the website by over 60 educators.

Result 3 Status as of: August 31, 2011
The spring and summer were spent working collaboratively with Hamline's Center for Global Environmental Education to design the learning module portion of the online classroom and with the Technology director to create the social network and other content. The project assistant, Education Program Manager and videographer worked closely selecting and interviewing scientists and Will Steger to include in videos about Minnesota's biomes inserted in the learning module. The online classroom went live for the Summer Institute on August 11 and educators were trained in how to use it including where to download curriculum and how to teach students how to submit their observations of the natural world. It can be viewed at http://classroom.willstegerfoundation.org.

The 2011-2012 school year will be focused on outreach around the classroom, updating the classroom, supporting teachers and students that are using it and posting their observations.

Result 3 Status as of: March 31, 2011
After interviews with a number of candidates we selected Hamline's Center for Global Environmental Education to design the online classroom. We have had a number of meetings and planning sessions to finalize content. In collaboration with our videographer, we have been working on the creation of a number of videos that will be included in the classroom. These videos highlight Minnesota's biomes, climate change impacts and Minnesota sense of place. They include interviews with a number of Minnesota scientists and Will Steger. The online classroom will launch at the Summer Institute.

Result 3 Status as of: October 31, 2010
The Education Program Manager began review of the Will Steger archives to select journal entries to include on the site and for the future online classroom. In addition Will Steger was filmed and a few videos developed and posted on our site that give an overview of the project and preview of the content. (http://www.willstegerfoundation.org/new-minnesotas-changing-climate)

Throughout the winter of 2010 and spring of 2011 the Education Project Manager will develop and share a position description for an instructional design and web development team to develop the online classroom portion of this project. Interviews will be conducted in November with the assistance of the project assistant, web designer, and videographer.

Result 3 Final Report Summary
A Minnesota's Changing Climate online classroom (http://classroom.willstegerfoundation.org/) was developed by a Webmaster and a contract web design team at Hamline University's Center for Global Environmental Education. The classroom features an entire learning module that is referenced in the curriculum. The learning module introduces all four biomes through videos of scientists and Will Steger, historical journal entries and case studies of climate change impacts. The classroom also gave students from around the state the opportunity to share their observations and action projects. Over the two years this feature was available over 1,000 students posted to the site, http://classroom.willstegerfoundation.org/get-social/view-student-submissions/view-observations-by-others. In addition, educators may download the Minnesota's Changing Climate curriculum and worksheets from the site. Teachers used the classroom to help prepare their lessons, and they showed or asked students to look at the videos and still images. Most teachers thought the features they used, especially the image gallery and handouts, were "very helpful." Information about climate change basics and the ability for students to see what other students had posted in the Online Classroom received the lowest ratings, although almost all teachers rated them helpful. We had not anticipated the classroom being used by adults as well as students and this insight will be useful in development of future programming. Since the online classroom was launched in August of 2011 it has had over 9,000 unique visitors with over 16,000 visits.

RESULT/ACTIVITY 4: Evaluation:

Description: The overall evaluation will use both formative and summative approaches and will involve the use of an outside contract evaluator. We will solicit ongoing feedback from educators on the curriculum and Summer Institute; provide an online survey with curriculum download and in-person surveys at the Summer Institute. The overarching goal of the evaluation is to determine to what extent the curriculum empowered student leadership and action on climate change solutions. Evaluation will assess student motivation for learning, skill development and changes in stewardship behavior. We will include in the curriculum a final project that schools will select and share online; this will provide a concrete way for schools to demonstrate the impact of the curriculum on student learning.

Summary Budget Information for Result/Activity 4:
ENRTF Budget: $19,993.51
Amount Spent: $19,993.51
Balance: $0

Deliverable/Outcome	**Completion Date**	**Budget**
1. Curriculum Evaluation	May 2013	$10,409.79
2. Online Classroom Feedback and Evaluation	May 2013	$7,133.72
3. Site visits/Travel to schools	May 2013	$2,450

Result Completion Date: June 2013

Result 4 Status as of: August 31, 2012
Our evaluation team shared the evaluation results from the year-end survey with the teacher's at the Institute. A final report is being developed and will be available next month. Results were helpful in that they showed which lessons were being implemented and how the online classroom was being used. In general, results were positive and teachers that were trained in the curriculum were using at least some of it in their classroom.
Highlights of the initial results include:
- It gives a great picture of how climate change is happening here in Minnesota.
- This curriculum fills a niche that no other curriculum fills. It is relevant, brief, and engaging because it addresses the world around us in MN.
- The graphs and data that were available. I also thought the colored maps were wonderful.
- I valued the observation that was part of the journaling curriculum.

Result 4 Status as of: April 30, 2012
Our outside evaluation team has been contacting teachers and developing the final evaluation throughout the spring. They will present their findings at this Summer's Institute.

Result 4 Status as of: November 30, 2011
Our outside evaluators presented an initial report from the Institute in early September. Highlights from the report include:
- All respondents reported that they thought the curriculum would be "useful for teaching about climate change" and "useful for teaching about environmental stewardship."
- Most said it would be useful in their teaching (96% agree or strongly agree) and expected that their students will find it engaging
- Most said it matches their curricular goals (91% agree or strongly agree) and thought it is comprehensive (90% agree or strongly agree).
- All said that they would definitely (67%) or likely (33%) implement the curriculum next year. When asked what parts of the curriculum they would were most likely

to implement, each of the first five lessons was selected by 76% to 80% of the respondents. Lesson 6 ("What Can I Do?") was selected by 91%.

Result 4 Status as of: March 31, 2011
We have had a few meetings to discuss evaluation at the Summer Institute and the evaluators have worked on a plan for evaluating the project throughout the t2011-2012 school year.

Result Status as of: October 31, 2010
An evaluator position was posted and an evaluator team was hired. Initial meetings were conducted to create an evaluation plan and the evaluator team attended the Summer Institute.

Result 4 Final Report Summary
An outside evaluation team was able to provide and analyze evaluations from the Summer Institutes of 2011 and 2012, as well as follow up with teachers about their curriculum implementation. The feedback they provided proved invaluable in planning the 2012 Institute and in revision of the curriculum for a second education. The executive summary concluded that overall, "the Will Steger Foundation is on the right track for meeting their project goals. The MCC curriculum is a much-needed and much-appreciated resource for teaching about climate change and promoting environmental stewardship. The annual Summer Institutes provide valuable professional development for teachers, effectively prepares them for implementing the MCC curriculum, and is a supportive community that inspires and refreshes its participants. In general, WSF should keep doing what it's been doing: refining the MCC Curriculum, maintaining its Online Classroom, holding Summer Institutes, and providing teachers with personalized support. The Foundation's close contact and good relationship with its teachers allow it to understand and improve teachers' and students' experience, deepen their understanding of climate change, and promote environmental stewardship. As grant funding draws to a close, WSF should look for ways to sustain close contact with teachers, expand its reach, and codify some of the lessons learned. For example, WSF could take common areas of support and create webinars and other more permanent scaffolds for teachers. Although these resources would not wholly replace personalized just-in-time supports, they could provide support for a larger number of teachers."

V. TOTAL ENRTF PROJECT BUDGET:
Please note. We are requesting to make the budget amendments described below. Budgets in individual categories have been adjusted. Amendment Approved: June 14, 2012

Personnel: $79,522.76

The Education Program Manager (0.75 % of FTE) will be responsible for coordinating the entire LCCMR project over 3 years. This person will be responsible for the research and development of the grades 3-12 curricula; coordinating with contractors on program development, including the archives, evaluation and online classroom components and integration with the curriculum; Summer Institute program development and execution;

and finally collaborating with relevant partners. This person will reach out to and present at state-based professional education conferences and develop relationships with educators, school districts, and professional education associations. Finally, the Education Program Manager will be responsible for working with schools as they implement the curriculum and online tools and conducting the evaluation.

Education Program Manager Budget Amendment Request Approved October 12, 2011

- In Result 1, Curriculum we request to move $2240 to the Summer Institute Coordinator Contract line. The Education Program Manager works less than .75 FTE and relies on the Institute Coordinator position to support the revision and distribution of the curriculum for Institutes through the end of the project.
- In Result 2, Summer Institute we request to move $6260 to the Summer Institute Coordinator Line. The Education Program Manager works less than .75 FTE and relies on the Institute Coordinator position to plan and implement the majority of the Summer Institute 2012.
- In Result 3, Online Adventure Learning, we request to move $5000 to the Online/Web Support Line. The new online classroom requires technological support in order to implement the project throughout the 2011-2012 school year.
- In Result 3, Online Adventure Learning, we request to move $2000 to the Archive/Multimedia Support Line. The new online classroom requires the expertise of our videographer to create and add new content during the 2011-2012 school year.
- In Result 4, Evaluation, we request to move $9000 to the evaluator line. The Education Program Manager hired an outside evaluation team for the sake of objectivity, as well as a lack of time or expertise. This line item was included in the original workplan, but somehow was not included on the spreadsheet. We request to add that line.

Contracts: $99,560.00

Contracts include the following support services:
Online/Web support: The Will Steger Foundation's Technology Director will develop social networking tools to support the online classroom available on the Will Steger Foundation Web site. The Technology Director will also be responsible for creating new features of displaying the lessons and Will Steger's archives to harness the power and methodology of Adventure Learning.

Online/Web Support Amendment Request Approved October 12, 2011

- In Result 3, Online Adventure Learning, we request to add $5000 to the Online/Web Support Line from the Education Program Manager line. The new online classroom requires technological support in order to implement the project throughout the 2011-2012 school year.

Archive/Multimedia Support: The Will Steger Foundation's Media Development Director will be responsible for reviewing Will Steger's archives, working collaboratively with the project team (which includes WSF Exec. Director, Educ. Program Manager, Technology Director and Media Development Director) to integrate the archives into the curriculum and online classroom. The Media Director will also be responsible for producing video stories to support the program and documenting the Summer Institute for future use and dissemination.

Archive Multimedia Support Amendment Request Approved October 12, 2011

- In Result 3, Online Adventure Learning, we request to add $2000 to the Archive/Multimedia Support Line from the Education Program Manager line. The new online classroom requires the expertise of our videographer to create and add new content during the 2011-2012 school year.

Archive Multimedia Amendment Request Approved January 26, 2011

- Within the Archive/Multimedia Support line we request to decrease Result 1 (Curriculum) and increase Result 2(Summer Institute). We underestimated the amount of multimedia support we would need at the Summer Institute 2010 and consequently overspent in this result.

Digitalization: WSF will work with a third party digitalization service to transfer the archives into an appropriate digital format for use in the curriculum and online classroom.

Summer Institute Coordinator: This short-term contract position (May-August each year) will manage event logistics and on-site coordination, assist with recruiting participants and securing corporate support. This person will also handle communication with speakers and participants in the lead up to the Institute and handle registration. This person will plan Summer Institute committee meetings with relevant partners.

Summer Institute Coordinator Amendment Request Approved October 12, 2011

- In Result 1, Curriculum we request to move $2240 to the Summer Institute Coordinator Contract line from the Education Program Manager line. The Education Program Manager works less than .75 FTE and relies on the Institute Coordinator position to support the revision and distribution of the curriculum for Institutes through the end of the project.
- In Result 2, Summer Institute we request to move $6260 to the Summer Institute Coordinator Line from the Education Program Manager line. The Education Program Manager works less than .75 FTE and relies on the Institute Coordinator position to plan and implement the majority of the Summer Institute 2012.

Summer Institute Coordinator Budget Amendment Request Approved January 26, 2011

- We were able to hire one person that is filling the role of project assistant; encompassing both a school year intern and summer institute coordinator. This consolidation into one role has made it much easier for communication, consistency and quality of work. For this reason we request to decrease Result 2: Summer Institute Coordinator.

Graphic Design: This short-term contract position will be responsible for the design of the grades 3-5, 6-8 and 9-12 curriculum. This curriculum will match the look and feel of the Will Steger Foundation's existing climate change education resources.

Graphic Design For Curriculum Budget Amendment Request Approved January 26, 2011

- Within the Graphic Design for Curriculum line we request to decrease Result 1 and increase Results 2, 3, and 4. These costs were incurred from the printing of informational materials that were aligned to all of the results and consequently billed to all of them. The budget manager charged these using the Report Deliverables as a guide, rather than the Attachment A and consequently spent in areas where there was not money available.

Evaluator: This contract position will be responsible for designing and implementing an evaluation of the final curriculum.

Evaluator Budget Amendment Request Approved October 12, 2011

- In Result 4, Evaluation, we request to move $9000 to evaluator. The Education Program Manager hired an outside evaluation team for the sake of objectivity, as well as a lack of time or expertise. This line item was included in the original workplan, but somehow was not included on the spreadsheet. We request to add that line.

Interns: The Will Steger Foundation will recruit three interns to support the project. Two interns will be responsible for supporting the logistics and coordination of the Summer Institute (2011 and 2012) and will be supervised by the Education Program Manager. The third intern will collaborate with the project team and directly support the Media Development Director with reviewing and selecting the archives.

Interns Budget Amendment Request Approved January 26, 2011

- We were able to hire one person that is filling the role of project assistant; encompassing both a school year intern and summer institute coordinator. This consolidation into one role has made it much easier for communication, consistency and quality of work. For this reason we request to decrease Result 2: Interns.
- As mentioned in the earlier request, we have consolidated the intern and summer institute coordinator positions and therefore need less funds in the intern area and are requesting to decrease Result 3: Interns.

Equipment/Tools/Supplies: $15,277.23

Supplies include educator packets to be distributed to teachers at the Summer Institute, and web-based tools to support the online classroom and evaluation tools. Additionally, this includes using external webinar support for the Summer Institute to recruit educators that are not able to participate in the Institute in-person.

Travel: $28,225.00

A portion of the travel will allow the Education Program Manager to attend relevant education conferences in Minnesota to promote the program, to visit participating schools and to conduct the evaluation. This also includes travel reimbursement requests for educators that require it to attend the Institute, as well as Summer Institute speakers.

Travel Expenses in Minnesota Budget Amendment Request Approved January 26, 2011

- We are requesting to increase Result 1: Travel Expenses in Minnesota. This is based on a recognized need for travel funds for the Education Program Manager, Intern and Summer Institute Coordinator to recruit participating classrooms this year, and support classrooms next year statewide.
- Our largest amendment request is an increase of $10,000 to travel expenses in Result 2: Travel Expenses in Minnesota. We realize this is a large addition, but we significantly underestimated the cost of bringing approximately 50 educators from outstate Minnesota to our Summer Institute 2011 and 2012, paying their mileage and accommodations. We know that this is the only way most of these educators will be able to participate in the project, and statewide involvement is key to the project's success. Our estimates are based on .50 for mileage and $80 a night for accommodations for approximately 50 educators. (To view our applicants so far see our Google map: http://maps.google.com/maps/ms?ie=UTF8&hl=en&msa=0&msid=206495859425893573749.000496d4df90f7f9c714c&ll=46.286224,-93.955078&spn=7.592676,22.565918&z=6)

Additional Budget Items (printing): $27,415

Printing: WSF will provide every educator that attends the Institute with a hard-copy version of the curriculum that is relevant to the grade they teach. This will support the printing and dissemination of a minimum of 300 curricula.

Printing Budget Amendment Request Approved January 26, 2011

- We are requesting to decrease Result 1: Printing. Our printing costs for the curriculum were overestimated, and it is assumed we will not need as much money for printing and distribution.
- We are requesting to increase Result 2: Printing. In past years St. Paul Public Schools has been able to provide larger in kind support to offset printing costs and were not able to provide as large a sum this summer. Consequently we overspent in Result 2 on the Printing Line. We have factored printing costs for Summer Institute 2011 into this addition.

Summer Institute Facility Rental: WSF will cooperate with relevant facilities (Science Museum of Minnesota, University of Minnesota) to provide 100 educators with a one-day professional development opportunity. This covers the cost of the facility rental for the Summer Institute result.

Summer Institute Facility Rental Budget Amendment Request Approved January 26, 2011

- We are requesting to decrease Result 2: Summer Institute Facility Rental $10,500. This is a significant change in the budget, but we were able to secure free facility rental at last year's Institute and have done so again for this year's. Realizing the great need to bring teacher's to the Institute this summer, we request to move the majority of this surplus to Result 2: Travel expenses.

Educator Recruitment: The Education Program Manager will collaborate with education list-serves and associations to publicize the curriculum, online classroom and Summer Institute. This includes the production of flyers and materials to promote the program.

Outreach Educator Recruitment Budget Amendment Request Approved January 26, 2011

- We are requesting to increase Result 1: Outreach/Educator Recruitment. The cost for getting an exhibit table at Education Minnesota, was higher than anticipated, but a very effective tool for outreach and recruitment of teachers. We would like to be able to do this again next fall, as well as exhibit at another local conference, the Midwest Environmental Education Conference.

TOTAL ENRTF PROJECT BUDGET: $250,000

Explanation of Capital Expenditures Greater Than $3,500: None

VI. PROJECT STRATEGY:

A. Project Partners:

These partners may collaborate in the development, evaluation and implementation of the project through in-kind cooperation:

Curriculum Development: National Education Association/Education Minnesota, St. Paul Public Schools, Minnesota Historical Society True North: Mapping Minnesota's History, Science Museum of Minnesota, Union of Concerned Scientists

Professional Development: National Education Association/Education Minnesota, St. Paul Public Schools, University of Minnesota, Science Museum of Minnesota, Minnesota Alliance for Geographic Education, Minnesota Association of Secondary School Principals, and additional professional education associations.

Online interactive classroom: Minnesota Historical Society, Minnesota History Center, Science Museum of Minnesota

B. Project Impact and Long-term Strategy:

Minnesota's Changing Climate is part of a suite of climate change education programming the Will Steger Foundation has pioneered and will continue to develop as a core component of the organization's ten-year strategic plan. This program fills a critical need, while also adding value to existing resources, and will be featured in perpetuity on the Foundation's website. Future financial support from diverse revenue sources will sustain this program. To date, the Foundation has created four climate change curricula, endorsed by the National Education Association, Union of Concerned Scientists and National Geographic, reaching thousands of educators nationwide. The Will Steger Foundation is committed to delivering relevant and factual climate change content and tools for action to empower student leadership in the mainstream classroom.

C. Other Funds Proposed to be spent during the Project Period:

Will Steger Foundation earned revenue from private foundations, corporations and individuals (which will be support staff and office support of this project): $72,919.43

Saint Paul Public Schools (for Summer Institute program support): $15,000

National Education Association Education Program Support: $18,000

Summer Institute meals and snacks: $5,300

St. Paul Public Schools Technology Support (for Summer Institute): $6,000

Existing WSF climate change education resources/curricula: $15,000

Media Development/multi-media videos and images: $15,000

Total In-Kind: $147,219.43

D. Spending HIstory:

The Will Steger Foundation has executed three Summer Institues for Climate Change Education since 2006, supporting over 250 educators with 5-day, 3-day and 1-day professional development opportunities on climate change education. The Summer Institutes that will be developed to support the LCCMR project will be based on the lessons learned from hosting previous Institutes. WSF has collaborated with partner institutions and school districts to recruit and execute the Institute. WSF has also garnered significant in-kind resources to support the program, including food, snacks, keynote speakers such as Dr. James Hansen, New York Times' Andrew Revkin and author Bill McKibben. The costs associated with the development, graphic layout and printing of the curriculum are based on past curricula produced by WSF.

To develop existing climate change education resources, WSF has received funding from private individuals, foundations, and the National Education Association. The Summer Institute receives support from school districts, universities and corporations. Budgets have been determined based on past expenditures for similar programming.

VII. DISSEMINATION:

Educators will be recruited through educator list-serves, education associations (such as Education Minnesota, the MN Alliance for Geographic Education and the MN Association of Secondary School Principals, MSTA, etc), graduate programs in education, and at educator conferences. In addition, current educators engaged in WSF programs and those that attended previous Summer Institutes will be contacted to utilize this new program.

The entire project and all of its components will be available online at the Will Steger Foundation Web site: www.willstegerfoundation.org. Curriculum will be printed and distributed by project partners and through the Summer Institute for Educators for Climate Change Education beginning in August 2011. All project results will be archived on the Will Steger Foundation Web site and will be accessible after the project is completed. School-to-school engagement and evaluative feedback will be showcased on the Will Steger Foundation Web site, through education association outlets (Web site, newsletters) and local media.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than December 2010, May 2011, September 2011, December 2011, May 2012, and September 2012. A final work program report and associated products will be submitted by August 2013 as requested by the LCCMR.

Final Attachment A: Budget Detail for 2010 Projects

Project Title: Minnesota's Changing Climate: Engaging Students through Adventure Learning

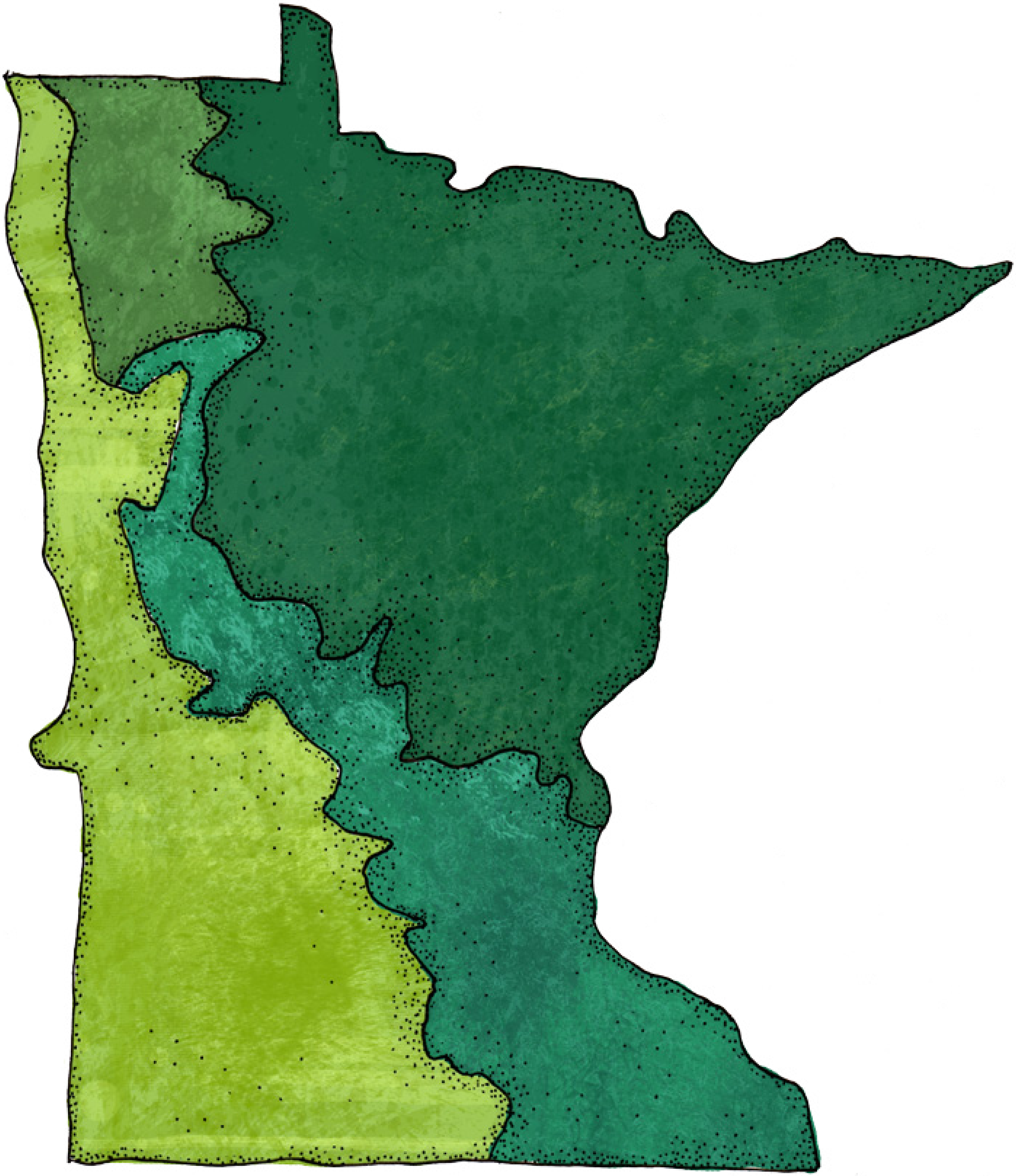
Project Manager Name: Nicole Rom

Trust Fund Appropriation: $ 250,000

Amendment approved - Mar 5, 2013

2010 Trust Fund Budget

Budget Item	Beginning Result 1 Budget - Approved 3/5/13	Current Balance Result 1	Amount Spent through 6/30/13	Beginning Result 2 Budget - Approved 3/5/13	Current Balance Result 2	Amount Spent through 6/30/13	Beginning Result 3 Budget - Approved 3/5/13	Current Balance Result 3	Amount Spent through 6/30/13	Beginning Result 4 Budget - Approved 3/5/13	Current Balance Result 4	Amount Spent through 6/30/13	Beginning Total Budget	Current Balance Total	Total Amount Spent through 6/30/13
	Result 1 - Curriculum			Result 2 - Summer Institute			Result 3 - Online Adventure Learning			Result 4 - Evaluation			Project Total		
Use information from Attachment A from Work Program															
Personnel Wages and Benefits															
Education Program Mgr .75 FTE	$ 49,771.38	$ -	$ 49,771.38	$ 14,544.55	$ -	$ 14,544.55	$ 13,804.55	$ -	$ 13,804.55	$ 1,402.28	$ -	$ 1,402.28	$ 79,522.76	$ -	$ 79,522.76
Contracts									$ -			$ -	$ -		$ -
Online/Web Support	$ 9,791.89	$ -	$ 9,791.89	$ 6,049.50	$ -	$ 6,049.50	$ 27,998.00	$ -	$ 27,998.00	$ 3,833.00	$ -	$ 3,833.00	$ 47,672.39	$ -	$ 47,672.39
Archive/Multimedia Support	$ 504.38	$ -	$ 504.38	$ 2,945.62	$ -	$ 2,945.62	$ 8,900.00	$ -	$ 8,900.00	$ 1,150.00	$ -	$ 1,150.00	$ 13,500.00	$ -	$ 13,500.00
Digitalizing Service	$ 934.50	$ -	$ 934.50	$ 934.50	$ -	$ 934.50	$ 3,738.00	$ -	$ 3,738.00	$ 623.00	$ -	$ 623.00	$ 6,230.00	$ -	$ 6,230.00
Summer Institute Coordinator	$ 2,240.00	$ -	$ 2,240.00	$ 18,260.00	$ -	$ 18,260.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 20,500.00	$ -	$ 20,500.00
Graphic Design for Curriculum	$ 2,947.50	$ -	$ 2,947.50	$ 22.50	$ -	$ 22.50	$ 22.50	$ -	$ 22.50	$ 7.50	$ -	$ 7.50	$ 3,000.00	$ -	$ 3,000.00
Evaluators			$ -			$ -			$ -	$ 9,000.00		$ 9,000.00	$ 9,000.00		$ 9,000.00
Interns	$ -	$ -	$ -	$ 3,000.00	$ -	$ 3,000.00	$ 1,000.00	$ -	$ 1,000.00	$ -	$ -	$ -	$ 4,000.00	$ -	$ 4,000.00
Printing (curriculum, educator packets)	$ 19,700.00	$ -	$ 19,700.00	$ 1,800.00	$ -	$ 1,800.00	$ 1,480.25	$ -	$ 1,480.25	$ 870.98	$ -	$ 870.98	$ 23,851.23	$ -	$ 23,851.23
Supplies (list specific categories)	$ 1,468.25	$ -	$ 1,468.25	$ 2,291.58	$ -	$ 2,291.58	$ 9,166.35	$ -	$ 9,166.35	$ 1,527.73	$ -	$ 1,527.73	$ 14,453.91	$ -	$ 14,453.91
Travel Expenses in Minnesota (reimbursement for keynote speaker travel, program travel, site visits, teacher travel)	$ 2,453.08	$ -	$ 2,453.08	$ 19,200.00	$ -	$ 19,200.00	$ 294.75	$ -	$ 294.75	$ 904.02	$ -	$ 904.02	$ 22,851.85	$ -	$ 22,851.85
Summer institute Facility Rental	$ -	$ -	$ -	$ 1,890.00	$ -	$ 1,890.00	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,890.00	$ -	$ 1,890.00
Outreach/Educator Recruitment	$ 1,502.86	$ -	$ 1,502.86	$ 675.00	$ -	$ 675.00	$ 675.00	$ -	$ 675.00	$ 675.00	$ -	$ 675.00	$ 3,527.86	$ -	$ 3,527.86
Column Total	**$ 91,313.84**	**$ -**	**$ 91,313.84**	**$ 71,613.25**		**$ 71,613.25**	**$ 67,079.40**		**$ 67,079.40**	**$ 19,993.51**	**$ -**	**$ 19,993.51**	**$ 250,000.00**		$ 250,000.00



Engaging Students in Environmental Stewardship through Adventure Learning: ENRTF Final Report Appendices

WILL STEGER FOUNDATION

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Engaging Students in Environmental Stewardship through Adventure Learning

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Total ENRTF Project Budget: ENRTF Appropriation $ 250,000.0
Legal Citation: M.L. 2010, Chp. 362, Sec. 2, Subd. 8b

PROJECT SUMMARY

The Will Steger Foundation developed Engaging Students in Environmental Stewardship through Adventure Learning (MCC) with the understanding that environmental stewardship begins with a local connection and sense of appreciation, or environmental sensitivity, towards the natural environment. This project's primary audience, educators, have the unique opportunity to lead their students through the environmental education continuum of knowledge, awareness, and skills that lead to an informed and active environmental citizenry.

Climate change is one of the most critical environmental issues of our time and educators have an important role to play in educating their students and providing them the skills to mitigate and adapt to climate change. In order to make the issue relevant and connected to the lives of those reached through our project, we focused specifically on the impacts of climate change on Minnesota's biomes. Additionally, we wove in stories from Will Steger's life and examples of his own early observations of the natural world and his curiosity of weather and climate. We also tapped into the expertise of many Minnesota scientists and educators in the development of our Grades 3-12 curriculum, online classroom and two public forums and three Summer Institutes for climate change education.

Over the three years of the project we were able to reach and increase the climate literacy of over 5000 educators, members of the public and students via our Summer Institutes for Climate Change Education, year round workshops, conference presentations, school visits, field trips, public forums and our online classroom (classroom.willstegerfoundation.org). The project also resulted in the development of a number of valuable, mutually beneficial, and long-term partnerships. The partnership with the Mississippi River Fund, National Park Foundation and Mississippi National River and Recreation Area resulted in the ability to support 20 student service projects and field trips for over 500 students to enhance their learning on Minnesota's changing climate. MCC was recognized in 2012 by Environmental Initiative in the area of environmental education in part due to these important partnerships. A final evaluation report showed overall success for the project in providing a curriculum and training that increased climate literacy, environmental stewardship and educator confidence in teaching about climate change.

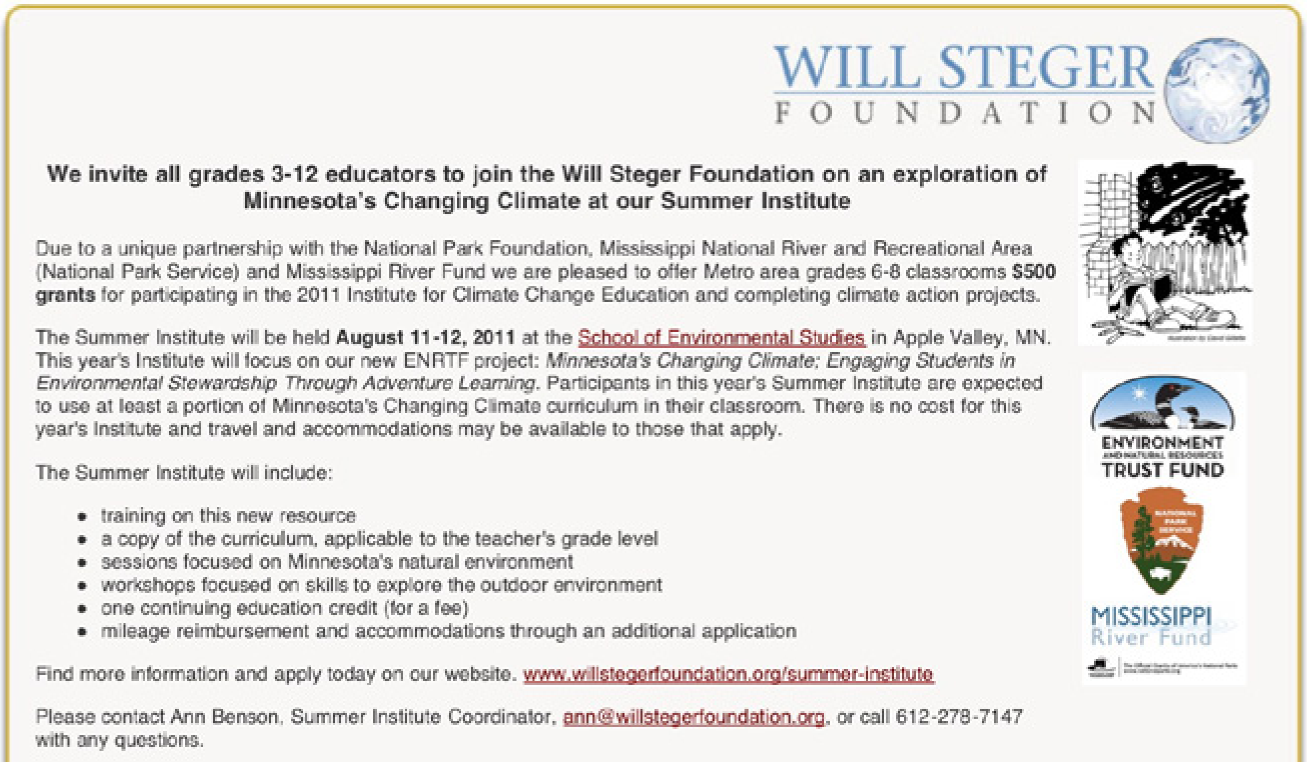
ENRTF Final Report Appendices Contents

1. Photo timeline of the project
2. Web links to videos and other important coverage of the project
3. Final Evaluation Report
4. Grades 3-8 Minnesota's Changing Climate Curriculum: 2012 edition
5. Grades 9-12 Minnesota's Changing Climate Curriculm: 2012 edition

Photographic Summary of the Project

Mark Seeley and other local experts spoke at our 2010 Summer Institute for Climate Change Education. 75 educators attended and received “teaser lessons” to introduce the ENRTF project.

Dr. Naomi Oreskes, a climate historian, and Will Steger spoke at a public forum co-sponsored with the Humphrey Institute. 250 members of the public and the educators attending the Summer Institute participated in the forum.



WILL STEGER FOUNDATION

We invite all grades 3-12 educators to join the Will Steger Foundation on an exploration of Minnesota's Changing Climate at our Summer Institute

Due to a unique partnership with the National Park Foundation, Mississippi National River and Recreational Area (National Park Service) and Mississippi River Fund we are pleased to offer Metro area grades 6-8 classrooms **$500 grants** for participating in the 2011 Institute for Climate Change Education and completing climate action projects.

The Summer Institute will be held **August 11-12, 2011** at the School of Environmental Studies in Apple Valley, MN. This year's Institute will focus on our new ENRTF project: *Minnesota's Changing Climate: Engaging Students in Environmental Stewardship Through Adventure Learning*. Participants in this year's Summer Institute are expected to use at least a portion of Minnesota's Changing Climate curriculum in their classroom. There is no cost for this year's Institute and travel and accommodations may be available to those that apply.

The Summer Institute will include:

- training on this new resource
- a copy of the curriculum, applicable to the teacher's grade level
- sessions focused on Minnesota's natural environment
- workshops focused on skills to explore the outdoor environment
- one continuing education credit (for a fee)
- mileage reimbursement and accommodations through an additional application

Find more information and apply today on our website. www.willstegerfoundation.org/summer-institute

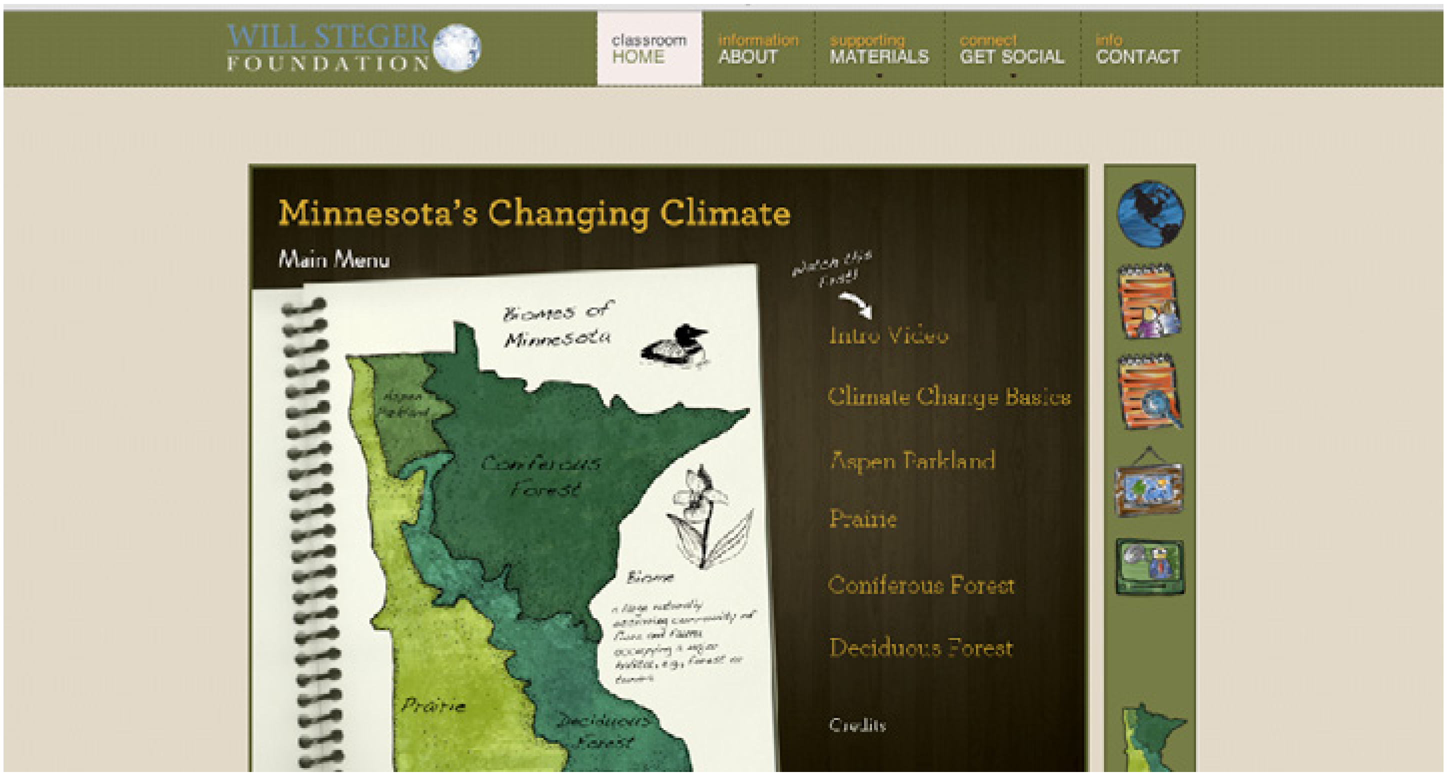
Please contact Ann Benson, Summer Institute Coordinator, ann@willstegerfoundation.org, or call 612-278-7147 with any questions.

Outreach for our 2011 Summer Institute for Climate Change Education began early. We received additional support from the National Park Foundation for a training that featured climate change impacts on the Mississippi National River and Recreation Area.

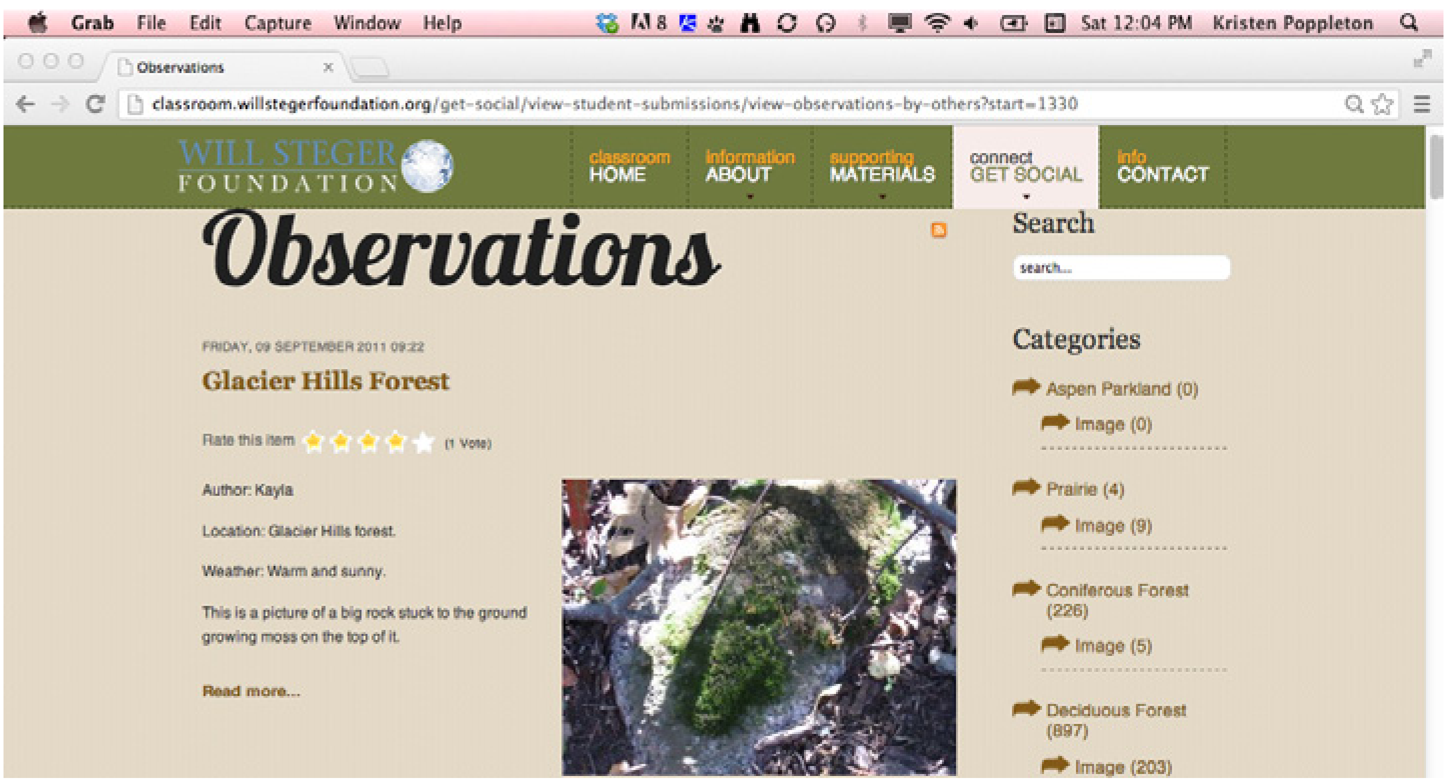
100 educators registered for our 2011 Summer Institute for Climate Change Education where our new Minnesota's Changing Climate Curriculum and online classroom were released.

Teachers received climate science content training at the 2011 Institute, as well as skills based training on taking students outside and journaling.

A public forum featuring climate change impacts on our sense of place was held at Town and Country during the 2011 Institute. MPR host Kerri Miller moderated and Will Steger, J. Drake Hamilton and Don Shelby spoke.



An online classroom featuring an entire learning module on Minnesota's biomes and climate change was introduced at the Summer Institute. The module was designed by Hamline's Center for Global Environmental Education.



During the 2011 and 2012 school year over 1000 students shared their observations and photos of their biomes in the online classroom.

Will Steger and Will Steger Foundation education staff visited with 6 schools around the state of Minnesota to see how they were implementing the *Minnesota's Changing Climate* curriculum.

Students showed off their observation skills and their special spots where they spent the year documenting the weather and natural world.

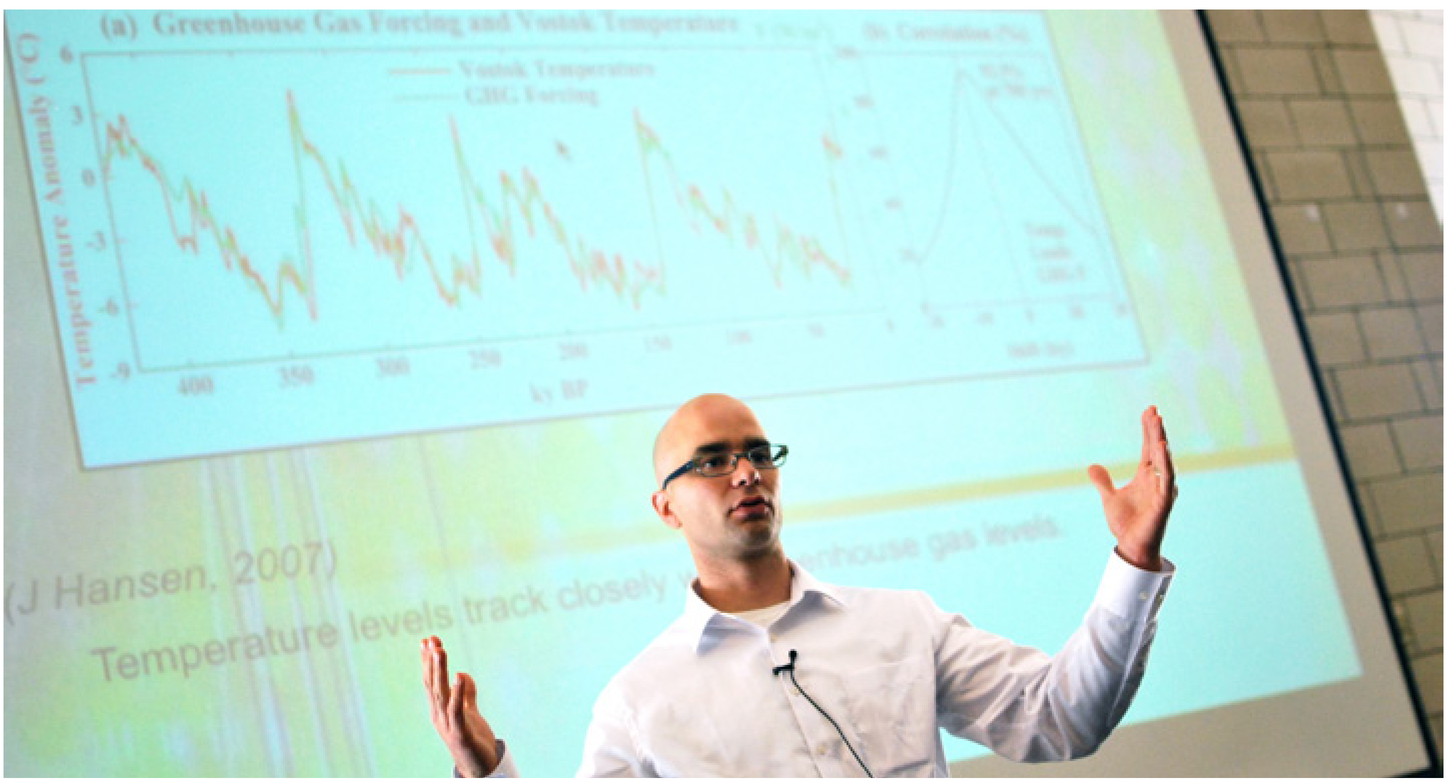
One school showed off what they learned through informational posters they hung in the hallways of their school.

Throughout the project we did outreach at local and regional conferences through exhibits and presentations.

In May of 2012 *Engaging Students in Environmental Stewardship Through Adventure Learning* received an Environmental Initiative Award in the area of Envrionmental Education.

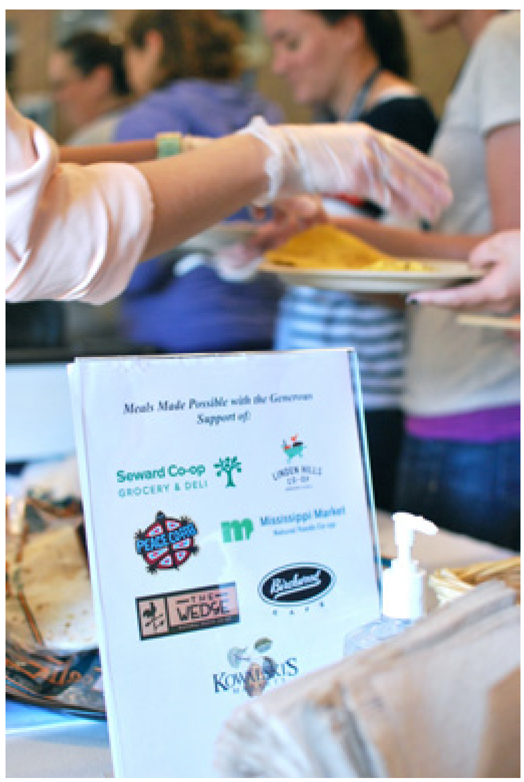
Educators and partners that supported the project were there to help us accept the award.

Our 2012 Summer Institute for Climate Change Education began with a public forum co-sponsoer by the Humphrey Institute. The speaker was Dr. Genie Scott, Director of the Naitonal Center for Science Education.



St. Thomas University professor, Dr. John Abraham provided the climate science keynote at the Institute.

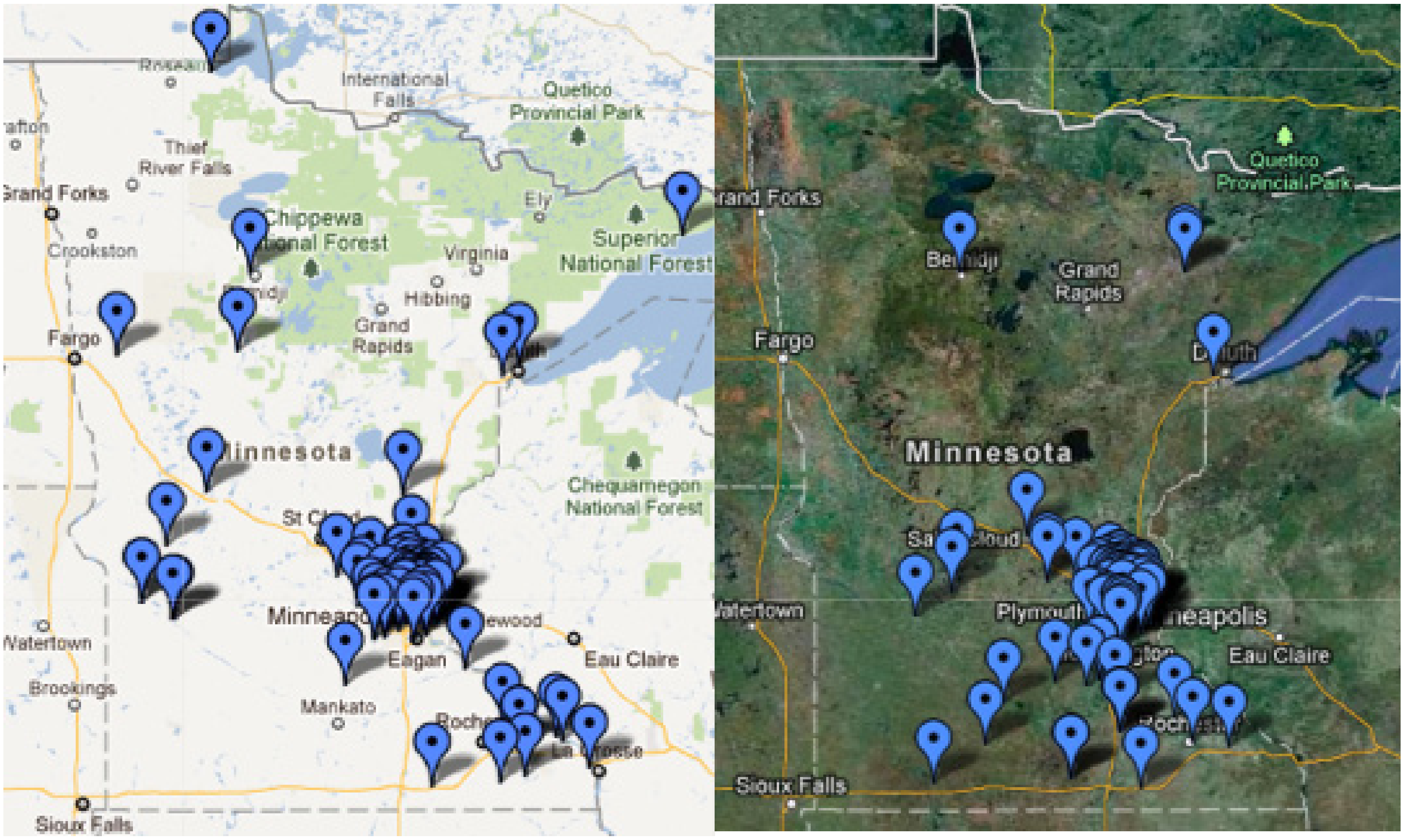
In evaluations from the Institute, educators noted that the time spent networking with other educators was an important part of their experience.



We were able to secure food donations for all meals and snacks during the 2011 and 2012 Institutes.

During the 2012-2013 school year we were able to provide field trips to students of teachers that attended the 2012 Summer Institute. Students learned about climate change impacts on the Mississippi River, weather, phenology and did a service project.

Students did service projects, such as buckthorn removal, during their field trip to Ft. Snelling State Park.



Over 10,000 students were reached through the 2010, 2011 and 2012 Summer Institutes for Climate Change Education, statewide school visits, conference presentations, field trips and the online classroom. These maps indicate cities that were visited or were represented by educators in 2011 and 2012.

Explore Minnesota's Biomes Kit

(Minnesota's Changing Climate, all lessons)

Use this kit for the *Take it Outside* components of Minnesota's Changing Climate.

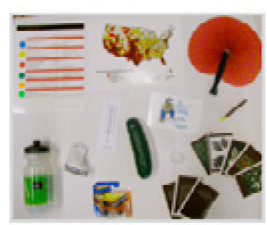
Kit contents:

- Insignia Digital Camera (with case, memory card, and 2-year warranty including incidental damages)
- (3) Field Guides (Prairies & Potholes; Big River, Big Woods; and North Woods, Great Lakes)
- (3) Magnifying Glasses (6X, 8X, 10X Power)
- Rain Gauge
- Thermometer
- (2) Rulers
- Cloud Chart
- Biome Meet and Greet Activity cards (laminated)

"What Does the Data Show?" Kit

(Minnesota's Changing Climate, Lesson 5)

This kit provides all the materials necessary to engage a typical classroom in the Minnesota's Changing Climate Lesson 5 activity: "What does the data show?"



Kit contents include all "objects" mentioned in the table, on Page 70 of MCC. Note: All of these are plastic and toy-sized and all paper cards are laminated:

Educators will continue to be able to check out two kits that extend learning with the Minnesota's Changing Climate Curriculum. Both were distributed to Institute attendees in 2011 and 2012.

Web links to videos and other important coverage of the project

The Minnesota's Changing Climate Online Classroom
http://classroom.willstegerfoundation.org/

Student Submitted Biome Observations
http://classroom.willstegerfoundation.org/get-social/view-student-submissions/view-observations-by-others

Will Steger Journaling Teaser Lesson Video
http://www.willstegerfoundation.org/media-room/video-gallery/viewvideo/191/education/will-steger-speaks-on-journaling

Minnesota's Changing Climate Introduction Video
http://www.willstegerfoundation.org/media-room/video-gallery/viewvideo/223/education/minnesotas-changing-climate-introduction

Summer Institute 2010 Overview and Recap
http://www.willstegerfoundation.org/summer-institute/summer-institute
http://www.willstegerfoundation.org/media-room/video-gallery/viewvideo/188/education/will-steger-foundation-summer-institute-2010-recap

Summer Institute 2011 Overview and Recap
http://classroom.willstegerfoundation.org/about/summer-institute/summer-institute-2011
http://www.willstegerfoundation.org/media-room/video-gallery/viewvideo/230/education/will-steger-foundation-2011-summer-institute-for-climate-change-education

2011 Sense of Place Public Forum Video
http://www.willstegerfoundation.org/media-room/video-gallery/viewvideo/229/education/sense-of-place-in-a-changing-climate

Summer Institute 2012 Overview
http://classroom.willstegerfoundation.org/about/summer-institute/summer-institute-2012
http://www.youtube.com/watch?v=wYey8w6LNdc

2012 MPR Interview with Dr. Genie Scott and Will Steger
http://minnesota.publicradio.org/display/web/2012/08/07/daily-circuit-eugenie-scott-climate-change

Parks Climate Challenge Overview
http://www.willstegerfoundation.org/media-room/video-gallery/viewvideo/231/education/parks-climate-challenge

CYCLES Workshop Overview
http://nasagcce.wordpress.com/2013/02/14/2nd-follow-up-workshop-will-steger-curriculum/

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Final Report
Evaluation Reports for the Will Steger Foundation's
Summer Institutes and Minnesota's Changing Climate Curriculum

By Molly Phipps and Steven R. Guberman

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND

Executive Summary

In 2010 the Will Steger Foundation received funding from Minnesota's Environmental and Natural Resources Trust Fund for the project, "Engaging Students in Environmental Stewardship through Adventure Learning." Key components of the project included developing curriculum, teacher professional development, and an online classroom about Minnesota's changing climate using Will Steger's journals, photos, audio, video, and skills as an environmentalist. The aim of the project is to increase educators' and students' understanding of climate change impacts in Minnesota and to provide them with the tools necessary for active and life-long stewardship. The resulting curriculum, Minnesota's Changing Climate (MCC), consists of 6 lessons presented in three bands—for grades 3 – 6, 6 - 9, and 9 – 12. The MCC curriculum was introduced to educators at the 2011 Summer Institute and implemented by teachers for the first time in the 2011-2012 academic year.

This document contains the reports of three evaluation studies: (1) an evaluation of the 2011 summer institute, (2) an evaluation of teachers' implementation of the curriculum in the 2011 – 2012 academic year, and (3) an evaluation of teachers who attended the 2011 summer institute and returned for the 2012 summer institute.

1. Evaluation of 2011 Summer Institute for Climate Change Education

The Minnesota's Changing Climate curriculum was introduced at the 2011 Summer Institute (August 12-13) at the Minnesota Zoo's School for Environmental Studies (Apple Valley, MN). Participants completed an online survey of open and closed-ended questions about four aspects of the institute: (a) pre-institute logistics, (b) the format and logistics of the SI program (c) the MCC curriculum, and (d) the speakers and breakout sessions. Participants' applications for the Summer Institute served as additional data points. Time was provided at the end of the institute for participants to complete the evaluation; 82 participants (92% of participants) completed the evaluation.

2. Evaluation of the Curriculum Implementation, 2011-2012

Educators who had attended the 2011 SI were sent an invitation to complete an online survey about their experiences implementing the MCC curriculum. The email provided links to two online surveys — one for participants who had implemented all or part of the MCC Curriculum in their classroom in the past year, and one for participants who had not implemented any of the MCC curriculum. Invitations were sent to 86 educators with active email addresses. The return included 26 completed surveys from participants who had implemented the curriculum and 8 from participants who had not.

3. Evaluation of Returning Educators at the 2012 Summer Institute

To better understand why some participants chose to attend more than one Summer Institute, six educators at the 2012 Summer Institute (also held at the Minnesota Zoo's School for Environmental Studies) who also attended the 2011 Summer Institute were interviewed. Interviews took place on the second day of the institute during lunch or the planning period; they were audio recorded and evaluators took notes during the conversations. There were two interview protocols—one for participants who had taught some of the curriculum and one for those who had not. All participants were asked their reason for attending the 2012 SI. Educators who had taught any part of the MCC curriculum were asked which lessons and grade levels they had taught, any modifications they had made, if they would use the modifications the next time they taught the lessons, and any recommendations they had for WSF to change the curriculum. Educators who did not teach any part of the curriculum were asked why not, what barriers they faced, if they would teach it during the next school year, and what else WSF could do to help them teach about environmental stewardship and climate change.

Primary Findings

The findings here are drawn from and combine the results of the three evaluation reports. See the individual reports that follow for detailed results of each study.

Summer Institute

The evaluation indicated that the Summer Institute was a success:

Pre-conference preparation: Most participants reported that prior to the institute they were provided with important information in a timely manner and the information they received was useful.

Institute logistics: Almost all participants were pleased with the logistics of the institute. They reported that onsite registration went smoothly, the meeting facility was comfortable, the lunches and snacks were adequate, and they valued the time to interact with other educators.

Schedule: Most participants indicated that the overall length of the Summer Institute (1.5 days for most participants), the length of each day of the institute, and the number and length of breaks were just right.

Mix of activities: Participants reported that they enjoyed the mix of activities—breakout sessions, hands-on activities, keynote presentations, and lectures—and that "just the right amount of time" was devoted to each format, although a sizeable minority would have liked more time devoted to hands-on activities.

Time allocation: A majority of participants reported that the amounts of time devoted to the curriculum and the science behind it were appropriate, although a sizeable minority indicated that more time should have been spent on it.

Full group and breakout sessions: Overall, educators gave high ratings—good or excellent—for each session's presentation, content, and relevance for their classroom although, as shown in the full results, there was some variation from session to session.

Impression of the MCC curriculum: Although most participants were introduced to the MCC curriculum for the first time at the Summer Institute and, therefore, did not have much time to review it, they gave the curriculum high marks. They indicated that it would be useful in their teaching, their students will find it engaging, it is clearly organized and easy to use, and it matches their curricular goals. They reported that the curriculum is comprehensive and meets need for which they had limited resources.

After teaching the curriculum, almost all of the respondents indicated that the curriculum was *helpful* (58-67%) or *very helpful* (29-33%) for teaching about climate change and environmental stewardship.

Preparation for curriculum implementation: Most educators at the Summer Institute indicated that the institute had provided them with good ideas about implementing the curriculum and were confident in their ability to teach it. All of the respondents agreed that the curriculum would be useful for teaching about climate change and would be useful for teaching about environmental stewardship, and almost all said that they were likely to include the curriculum in their teaching next year.

These findings were supported by teachers responses after they had implemented the curriculum: a majority said that they felt *confident* or *very confident* about implementing the curriculum; although some teachers reported feeling *a little unsure*, none indicated that they felt *totally unsure*.

Reflecting back on the Summer Institute after implementing the curriculum, most teachers indicated that the Summer Institute had been *helpful* or *very helpful*. But about 1 in 5 teachers indicated that the institute was *very unhelpful*; open-ended responses indicate that these teachers would have liked more hands-on activities and the Summer Institute and more guidance in adapting the curriculum to meet particular instructional demands, such as integrating it into their existing instruction and modifying it for select grade levels and student groups.

Community: Returning teachers indicated that the value of the institute extended beyond the opportunities it provided for preparing to teach the MCC curriculum; it also was a place to share ideas and experiences and gain a sense of renewed purpose with like-minded educators.

MCC Curriculum and Online Classroom

The evaluation indicates that the MCC curriculum and online classroom were very successful in the first year of implementation. Teachers reported that they used all or some of the curricular materials in their classroom, often with only minor modification; that students enjoyed the lessons and learned important concepts and skills in them; and that they were likely to teach the lessons again. (Responses varied somewhat by lesson; see the full results for these distinctions.) Almost all teachers indicated that the curriculum was “helpful” or “very helpful” for teaching about climate change and environmental stewardship.

The evaluation revealed five strengths and two challenges in implementing the MCC curriculum:

- **Strength 1:** The local focus on Minnesota and connections to students’ experiences and the world
- **Strength 2:** The active, hands-on, inquiry-based nature of the curriculum
- **Strength 3:** The clarity of the lessons and teacher guide, including specific content and materials
- **Strength 4:** The ability to adapt the lessons to fit their students and curriculum
- **Strength 5**: There was a lot of support for implementing the curriculum
- **Challenge 1:** Greater differentiation of the curriculum
- **Challenge 2:** Lack of time and other resources

Teachers used the Online Classroom to help prepare their lessons, and they showed or asked students to look at the videos and still images. Most teachers thought the features they used, especially the image gallery and handouts, were “very helpful.” Information about climate change basics and the ability for students to see what other students had posted in the Online Classroom received the lowest ratings, although almost all teachers rated them helpful.

Conclusion

Overall, the evaluation indicates that the Will Steger Foundation is on the right track for meeting its project goals. The MCC curriculum is a much-needed and much-appreciated resource for teaching about climate change and promoting environmental stewardship. The annual Summer Institutes provide valuable professional development for teachers, effectively prepares them for implementing the MCC curriculum, and is a supportive community that inspires and refreshes its participants. In general, WSF should keep doing what it's been doing: refining the MCC Curriculum, maintaining its Online Classroom, holding Summer Institutes, and providing teachers with personalized support. The Foundation's close contact and good relationship with its teachers allow it to understand and improve teachers' and students' experience, deepen their understanding of climate change, and promote environmental stewardship. As grant funding draws to a close, WSF should look for ways to sustain close contact with teachers, expand its reach, and codify some of the lessons learned. For example, WSF could take common areas of support and create webinars and other more permanent scaffolds for teachers. Although these resources would not wholly replace personalized just-in-time supports, they could provide support for a larger number of teachers.

Will Steger Foundation
2011 Summer Institute Evaluation

On August 11-12, 2011, the Will Steger Foundation (WSF) held its annual Summer Institute (SI) for Climate Change Education at the School of Environmental Studies at the Minnesota Zoo in Apple Valley, MN. WSF debuted its Minnesota's Changing Climate (MCC) curriculum and accompanying online classroom. The two-day SI included keynote presentations, breakout sessions, networking opportunities, and planning time. Eighty-nine teachers from formal and informal classrooms around the state of Minnesota attended the institute. Twenty of the teachers also participated in the Parks Climate Challenge, a program through the National Parks Service for middle school teachers in the Twin Cities Metro Area.

Methods

Evaluators attended the workshop and took notes at each session they attended. Participants completed a computer-based survey of open and closed-ended questions about four primary aspects of the workshop: (a) pre-institute logistics, (b) the SI program (the format and its logistics), (c) the MCC curriculum, and (d) the speakers and breakout sessions. Participants' applications for the SI served as additional data points. Time was provided at the end of the SI for participants to complete the evaluation; 82 participants completed the evaluation at a completion rate of 92%.

Results

Results are presented as percentages of respondents for each question.

Part 1: Participant Characteristics

We gathered information about participants from their online applications to participate in the Summer Institute. Participants heard about the institute from a variety of sources (see Table 1). The most common source of information was colleagues or friends, followed by the Foundation's newsletter and website. Other sources include conferences (e.g., MnSTA, MNA, MN Naturalists Association, Green Schools, Home School Conference) and email announcements (from the Foundation, school administrators, and colleagues).

Table 1: How Did Applicants Hear About the Summer Institute?

Source of Information	%
WSF newsletter	20
WSF website	16
Colleagues or friends	38
Other newsletters	10
Other	35

Participants selected more than one option, so percentages total more than 100.

Applicants teach a variety of grade levels, spanning elementary, middle, and high school (see Table 2). Applicants also represent a range of educational institutions: In addition to public and private schools, applicants came from nature centers, environmental centers, and post-secondary institutions (e.g., Metropolitan State, University of Minnesota). They were mostly classroom teachers, but also included consultants, administrators, home school parents, and informal educators.

Table 2: Teacher Grade Levels (n=89)

Grade Level	**%**
Elementary	13
Middle	38
High School	29
Other	19

Most of the applicants had not attended a previous WSF Summer Institute (see Table 3), nor had they previously used and WSF curricula (see Table 4)

Table 3: Have Teachers Participated in a Summer Institute Before? (n=82)

	%
Yes	24
No	76

Table 4: Have Teachers Used WSF Curriculum Before? (n=84)

	%
Yes	29
No	71

Part 2: Pre-Institute Logistics

The majority of participants reported that the pre-institute information was useful and that they were kept well informed of important information on a timely basis (see Figure 1).

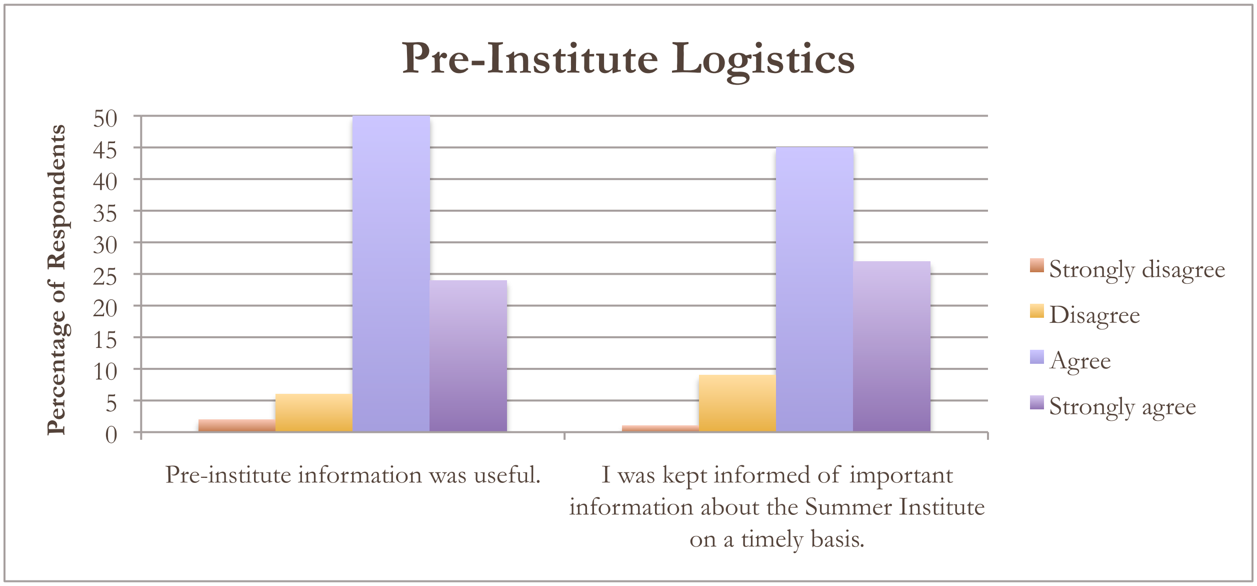


Figure 1: Pre-Institute Logistics

Almost all participants found the online registration process easy (91%) or a little easy (7%). Only one participant thought the online registration process was difficult.

Part 3: The Summer Institute Program

We asked participants to consider several aspects of the SI's format: the mix of session types (breakout sessions, hands-on activities, keynote presentations, and lectures), the length of the institute (each day and overall), the number and length of scheduled breaks, and the time devoted to the new curriculum and the science behind it. For each aspect, we asked participants to rate whether the amount of time devoted to it was "not enough," "too much," or "just right."

Most participants found the mix of activities to be appropriate (see Figure 2). When asked about the mix of session types, over 80% of the respondents indicated that there was "just the right amount" of time devoted to keynote presentations, lectures, and breakout sessions. In contrast, a sizable minority of participants (38%) indicated there were not enough hands-on activities.

- The desire for more hands-on, active sessions came through in participants' comments. When asked what was missing from the institute, participants responded:

  Hands on, engaging activities. The first day I was lectured at for 9 hours! That is way to long for anyone to sit and listen. Also, based on the prior information of the institute it led me to believe that we would be exploring the outdoors, and I only went outside for a breakout session once for about 15 minutes. I was very disappointed.

  Time outside. I know some sessions went outside but it would have been nice to have more opportunities for exploring the area as a way to demonstrate how we would do this with kids. Especially because this spot is set up for this!

Most participants (83%) indicated that the length of the institute (2 days) was "just right." Most respondents also indicated that the length of each day of the institute was "just right"; 15% indicated that the daily schedule was too long, and 6% that it was too short.

There were three primary reasons that participants thought the institute should be longer: (a) to be able to attend more of the breakout sessions, (b) to be able to go into the material more thoroughly, and (c) to have more time for social networking.

- To attend more breakout sessions:

  I wish there was more time (meaning more days) so I could participate in more of the break out sessions. I really wanted to take the photography course but being required to do both of them (photo 1 and 2) limited the other possibilities for sessions.

  I would have liked to attend all breakout sessions. That is why I stated that length of institute was not enough.

- To go into the material more thoroughly:

  Perhaps the break out sessions could be longer in length, so as to go deeper. I felt a little like I was just getting the tip of the iceberg in all of these areas. I love the choice idea, as we are all at different places.

  Because the workshops were rushed, they were lecture focused. With more time the workshops could have been much better.

  Nothing was missing, but often to get to everything, things felt rushed and information was glossed over, especially at the one-hour breakout sessions. I think add a third day and one more break out session, and make each session longer so all the information can be presented.

  Although I really like the fact that it isn't a week long, 5 day, drawn out institute, I also feel like this is a lot of information jammed into 2 days. Maybe even 3 days, or 2 full days and 1 half day would be better to give us more time to soak up the information and think about the application of everything we have learned.

- To have more time for social networking:

  Time to meet formally with other educators was the main thing that I thought was missing. It's a great opportunity (missed in this case) when we have so many people working throughout the state and with many different age groups/populations. Creating interest groups/areas ahead of time and giving some time (1 breakout session?) for educators to choose to meet to see how we can learn from and support each other in the coming year would be valuable in the future.

  There was not enough time for people who participated for the first time to connect with other people.

Several members of the PCC cohort commented that, because they had several required sessions, they felt limited in the breakout sessions they could attend.

The schedule included several breaks each day, approximately 15 minutes between sessions. Most participants (> 80%) indicated that the number of breaks and their length was "just right," although some thought there were not enough breaks (11%) and that they were not long enough (12%).

Table 5: Participants' Ratings About the Mix of Sessions, Breaks, and Length of the Institute (n=89)

Session Type	Not Enough	Just the Right Amount	Too Much
Breakout Sessions	12	69	1
Hands-on Activities	31	50	1
Keynote Presentations	4	73	5
Lectures	2	68	12
Length of Institute (2 days)	11	71	0
Length of Each Day	5	65	12
Number of Breaks	9	71	2

A majority of participants thought that the time devoted to the new curriculum and the science behind it was "just right," although about one third responded that not enough time was spent on them (Table 5).

The desire for more time devoted to learning about the curriculum and the science of climate change was reflected in participants' comments when asked if anything was missing from the institute. In particular, participants would have liked (a) more information about the curriculum and how to implement it, and (b) more information about the science of climate change.

- More information about the curriculum and how to implement it:

  More time spent "practicing" some of the activities and concepts in the new curriculum.

  There was not enough training the trainer for the lessons. Skip the overview and do the lessons.

  I would have liked to have hands on experience going through the activities in the workbook. Only doing one small activity from one lesson was not enough exposure.

- Participants were especially eager to have more information about implementing the curriculum in particular grade levels:

  Would like to do more with specific grade level cohorts—having that intentionally built it would be great. For example, partner/level people with specific grade levels and varying biomes so we could do collaboration throughout the year.

  I liked the breakout sessions but I wish they were more focused on grade level. I found myself with many elementary teachers wanting to learn different content and methods of teaching than myself as a secondary teacher. I think the institute should make these divisions so that we as teachers can get more age appropriate training.

  I suppose I just wish there were more elementary teachers. It would have also been helpful to have more specific ideas about how to address teaching the youngers about climate change since the foundational years are so important to how they will receive this kind of information in the future. We want them to feel empowered with information and be problem solvers.

- More information about the science of climate change:
  A little more of the science explained to support teachers, especially those with less background (elementary school teachers, for example) would be good.

  I also did not feel like I got data or stories that would help me present the case of climate change to the deniers.

  The institute assumes everyone knows and has some knowledge of climate change in which I do not. I was hoping to get some education on it, before I could teach any of it to my students. Now, I have to teach myself and then apply that knowledge to my classroom. I feel the information on climate change was so vague.

  As an elementary teacher attending with science teachers, I feel inadequate and a bit intimidated. I would love to attend an institute that would make me more scientifically savvy.

Many participants commented on their own lack of knowledge about climate change and thought that learning more of the underlying science during the institute would strengthen their ability to teach the topic and to address colleagues, students, and parents who are skeptical about climate change. In contrast, participants did not indicate that the MCC curriculum itself needed to include more underlying science.

Over time, the location of the institute has varied. The first institute was held at the School of Environmental Studies, the same location as the 2011 institute. Other institutes were held at the University of Minnesota's Conference Center at the Saint Paul Campus. Additionally, institutes have varied in length, ranging from a full week to a single day. This year's SI was one and a half days for all participants and an additional half-day for the middle school teachers participating in the Parks Climate Challenge. Almost all participants (87%) thought the length of the institute was "just right"; a few participants (13%) thought the institute should be longer and none responded that the institute was too long.

Almost all teachers found the meeting logistics acceptable (Figure 2). Over 90% of respondents agreed or strongly agreed that onsite registration went smoothly, the meeting facility was comfortable, the lunches and snacks were adequate, and that they valued the time to interact with other educators. Teachers were least enthusiastic about the new meeting location in Apple Valley, MN, and the built-in planning time, although most agreed or strongly agreed that the location was convenient (89%) and thought the planning time was helpful (87%).

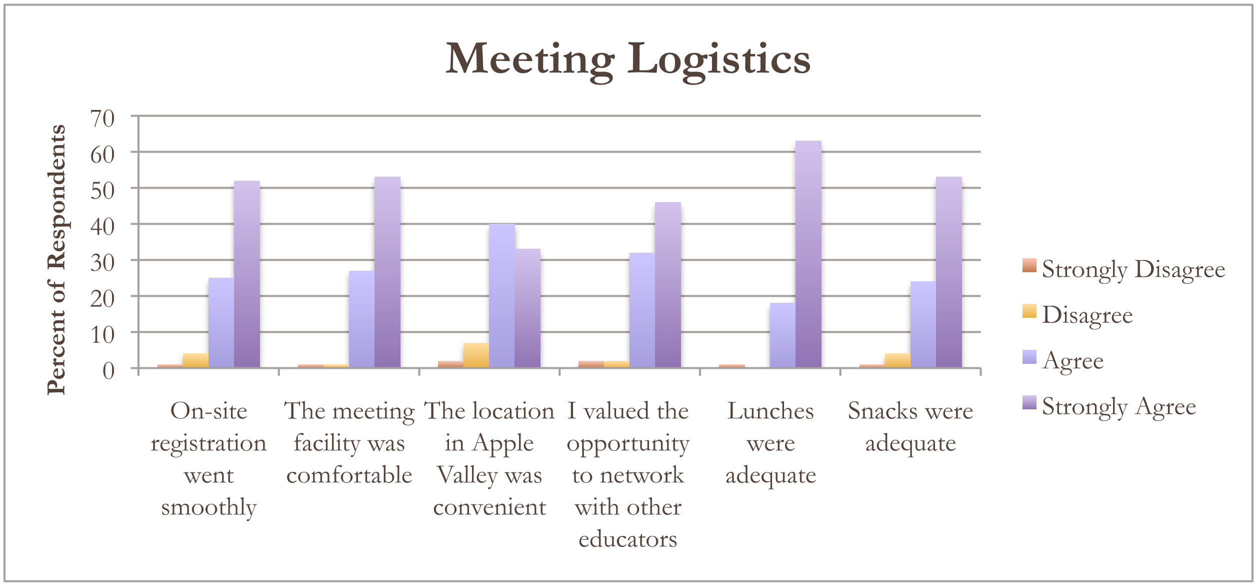


Figure 2: Meeting Logistics

Part 4: Minnesota's Changing Climate Curriculum

Teachers gave Minnesota's Changing Climate Curriculum high marks. More than three fourths of the respondents *agreed* or *strongly agreed* that the curriculum will be useful in their teaching, their students will fond it engaging, that it is clearly organized and easy to use, and it matches their curricular goals (Figure 3).

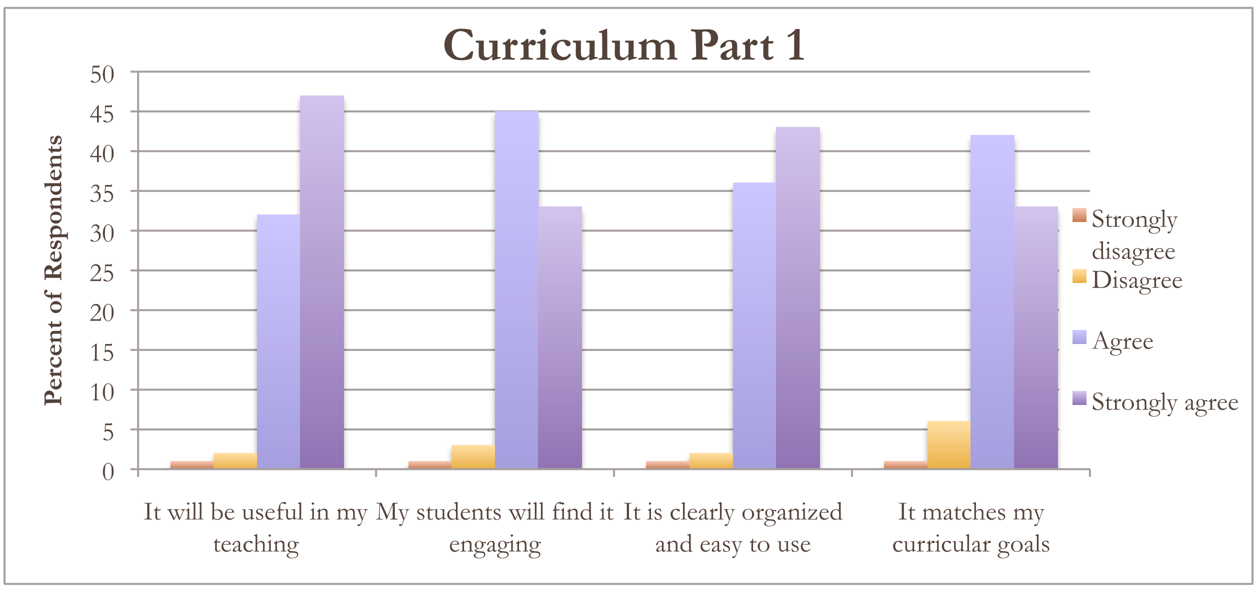


Figure 3: Minnesota's Changing Climate Curriculum (part 1)

Most teachers also *agreed* or *strongly agreed* that the curriculum is comprehensive (74%) and meets a need for which they had inadequate resources (76%) (Figure 4). Most participants also agreed or strongly agreed that the Summer Institute had provided them with h good ideas about implementing the curriculum (72%) and were confident in their ability to teach the curriculum

(76%). All teachers (100%) agreed or strongly agreed that the curriculum would be useful for teaching about climate change and would be useful for teaching about environmental stewardship.

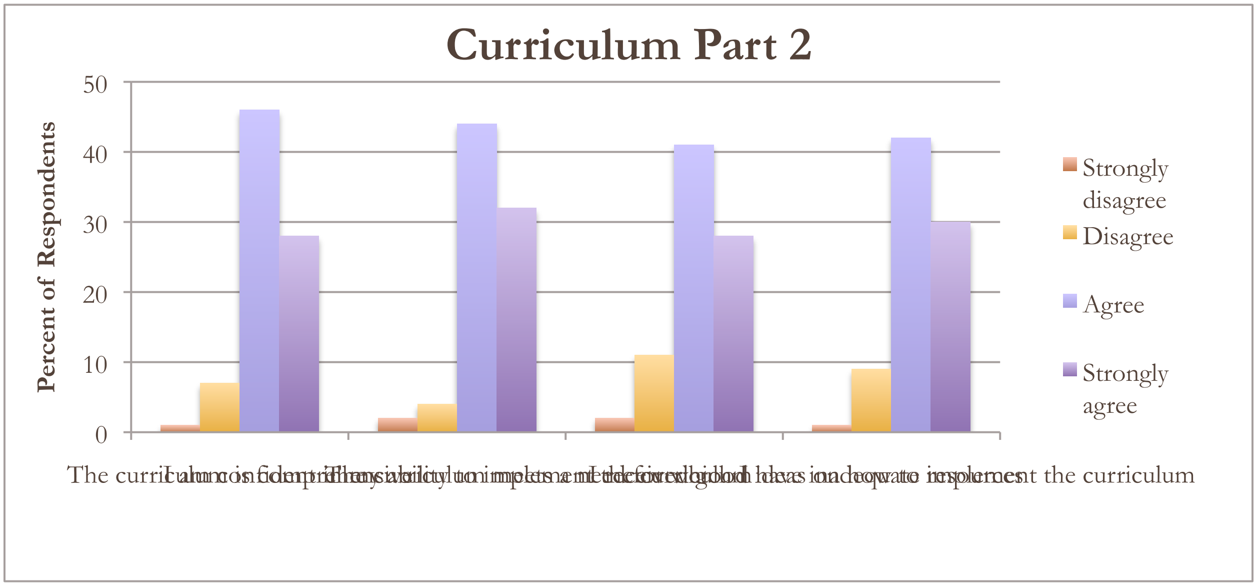


Figure 4: Minnesota's Changing Climate Curriculum (part 2)

Even though they had not spent a lot of time reviewing the curriculum, when asked at the end of the institute to describe its strengths and weaknesses, participants mentioned a variety of characteristics.

Strengths of the Curriculum

Several participants appreciated having a curriculum that addressed climate change, a topic for which they flacked resources and found difficult to teach.

> *The strengths are the fact that it teaches climate change which, to this point, I have not encountered a good curriculum that does so. In addition, it is short and sweet so that I am not overwhelmed by the length of it to the point where I can't fit it into an already busy school year.*
>
> *It is easy to use and very engaging. It made a topic that is scary and complex more manageable. It helped me see correlations with many of the topics I need to teach. It convinced me that teaching climate is an integral part of teaching what I already teach about populations & ecosystems, diversity of life, outdoor science and energy transfer.*
>
> *I love that all the research is done for me and all I have to do is read and learn the material to create a knowledge base and then impart it to my students as they navigate the material themselves.*

Several participants noted that a strength of the curriculum is that it is based in the Minnesota academic standards, and that the links to the standards are explicit. This is especially important since teachers often have little time for lessons that are not directly tied to the standards.

> *I am absolutely thrilled that the curriculum references the state standards and that the curriculum is cross disciplinary.*

[A strength of the curriculum is] linkage to the state standards. The depth of the biology standards leaves no time for any extras.

So far, I am impressed with the inclusion of the MN academic standards. I think using this curriculum will meet some standards not yet addressed by my school district.

Participants also noted that the curriculum was adaptable and could easily be integrated with their existing lesson plans or to meet a variety of goals.

Very easily and quickly can be implemented into my existing curriculum.

Each activity is a very manageable size and length, especially for those of us in nature centers who have limited amounts of time with individual groups of children.

The journaling/notebook aspect of this is the part that seems the best for what I teach. Interdisciplinary!! Meeting more than just science standards is the only way I'll be able to get other teachers on my team on board with this. THANK YOU!

Participants like that the curriculum is focused locally, in Minnesota, but could be adapted to their needs.

I like the unique focus on climate science as applied to Minnesota, to our place and space here, which connects with students' personal observation and experience of changes to plant communities, weather and climate, ice and water, etc. The connection of the fundamental science to what students are able to personally observe in their own communities makes the curriculum stronger, in terms of pedagogy.

For me it has what I've been looking for. In the past I've taught GW using WSF curriculum from the 2007 Institute, with success. But I've always felt I needed to bring the issue closer to home. I have been able to come up with limited resources on my own, mainly form the MN DNR website and articles from the MN Volunteer magazine. This new curriculum is just what I was looking for!

It can be applied anywhere—integrated curriculum that is place-based to MN, but can be modified to wherever you are located. It is student-centered.

Teachers replied that a strength of the curriculum is that it uses a variety of approaches to engage students in active learning and in putting their learning to use.

Curriculum follows a clear process which begins with student observations and builds to a call to action. It involves students in service learning. It gets students outside. It provides a framework for my environmental class.

Great data for students to interpret and analyze. Video, interactive and applicable to the 21st Century kid.

The journaling piece of each activity is an exciting way to engage students in critical thinking and giving them opportunities to express themselves.

I love that the focus is also on action and not just learning. I have always told students that learning and knowing is not nearly enough. "Doing" is even more important.

In addition to commenting on the content of the curriculum, participants also pointed to several aspects of its presentation as strengths; they appreciated the layout of the curriculum, its ease of use, and that it is comprehensive.

> *I am really pleased that the curriculum is laid out in the format that it is and that is aligned with the standards. The introduction explaining how the lessons are laid out is helpful and direct. I liked the inclusion of Will Steger's journal entries and that there are interactive and extension activities. The web site as a companion with all of the online interaction and support that was offered with the curriculum is a really unique aspect to the whole experience. Receiving the generous resources and being offered help from all of the instructors and experts was very impressive.*
>
> *Well laid out and easy to use. It contains the videos and other parts necessary to implement easily. I like the fact that there is a hard copy and an online version of things. Since my students are young, there are sometimes a few slow readers, so having the reading material with an auditory option is great. I love the panorama and other interactive aspects of the curriculum.*
>
> *I think its brevity is a strength. I was anticipating something like Project Wild, which is a wonderful resource, however I like how this is different.*
>
> *That it encompasses all subject areas and is applicable to all age levels.*
>
> *Very well laid out—easy to read, easy to understand and visualize how the activity is supposed to be done. I think it's broken down nicely with sections—take it outside, etc. Great pictures.*
>
> *Clear instructions—can use right away in my curriculum.*
>
> *You provided the resources (curriculum, biome kit, online classroom with videos, etc.). The "experts" at WSF are available and want to help.*

Several participants mentioned the online classroom as a strength of the curriculum.

> *I love the on-line classroom. I think students need a venue to share, work like "real" scientists, and interact with their peers. I gained new insights for the journal and believe it will help my students feel like they are doing the work of a real scientist.*
>
> *I love the opportunity for students to put their observations online. I plan on using this for my students as a means to share information and grade them on their quality. I hope they will find it interesting and enjoyable.*
>
> *Finally, I have the on-line curriculum which my students will find engaging and more geared to their level. My students are very visual and I can't wait to use the on-line resources - videos and pictures!*

Weaknesses of the Curriculum

Several participants indicated that they could not see any weaknesses in the curriculum although, as some noted, they had not had much time to become familiar with it. Other participants, though, pointed to several concerns of the when asked if the curriculum had any weaknesses.

The concern that participants noted most often is the perception that the curriculum needs to be better integrated with their existing instruction. As noted above (under strengths), teachers often feel pressure to cover the topics they are required to teach and, therefore, introducing new topics is often problematic. Several participants wanted the curriculum to have more connections to other topics within and outside of science.

> *[The curriculum is] focused on life science. I teach earth science and will look for ways to integrate it more efficiently. Makes it seem like global warming is only a life science issue.*

> *I feel that geology could be addressed a little more as it is a part of a system that interacts to create an ecology, climate, system. I will be able to use a lot of the program very easily so it's not a significant problem, but I will write lessons to supplement this area. However, there are many projects that could fit well with climate change issues that could be considered for this program.*

> *Basic chemistry behind it. It might be as simple as adding a video or webquest to the online classroom at a kids level. Middle school students have not [have had] chemistry, so even basic formulas and molecules will confuse them.*

> *Maybe music and the arts? Every revolution in thought needs music. But I realize you can't do everything at once. You can only do so much at once.*

> *Embed this into strategies that schools are already using: AVID interactive science notebooks; speak openly to culturally relevant teaching; time to fit it all in.*

Participants also suggested several additions to the curriculum.

> *Six lessons are not enough keep the idea of climate change sprinkled though out the year.*

> *Wish there were 6 lessons per grade level.... I think that would be reasonable to have each grade level complete throughout year. If [grades] 3-6 do these this year.... then what should we do next year?*

> *Not enough data to give to students. I would like many sources to divide up amongst the students so we can have a comprehensive view of climate change from many different indicators so students can come to their own conclusions.*

> *More data and more ideas for higher order thinking ways to engage the students in this data.*

Several participants suggested changes to the curriculum that would help them teach particular groups of students.

> *More advanced lessons for upper level high schools. Journal articles, case studies, scenarios, etc.*

> *Adaption and modification for students with disabilities. That's always the case with curriculum geared for the regular classroom. I do feel however, that this curriculum will be less difficult to adapt and modify for my students.*

I teach grade 6 and it only meets two grade 6 standards. Unfortunately, the two standards it meets are the two standards which are already implemented in everything I do in science already (measurement). I will use the journaling/notebook aspect all year in my classroom, but the other lessons may or may not get done (depending on time constraints and how well I can integrate them into my science standards).

I would have liked more specific lesson plans for 8th grade, instead of a general 3-8 but understand why it was done that way.

The need to match it to my grade level is both an opportunity and a burden. I will look at it is as an opportunity as I learn the subject better by making it work for 4th graders.

Depending on the grade level they taught, some participants thought the curriculum was too complex for their students, and others thought it was not complex enough.

Some of it will take some pre-teaching and may be over the heads of students.

Teaching 8th grade, I will have to beef up some of the material or look more at the 9-12 version to bring it to more of an academic level on par with my students.

For my curriculum, portions of it lack the scientific "rigor" that I need in my everyday lessons. The one that would fit is the lesson that looks at the data/graphs/charts. Also, with a sophisticated group of students, the level might not be challenging enough and I might have to beef it up a bit.

Two thirds of the participants said they would definitely implement the curriculum; the remaining third of teachers would likely implement the curriculum in the coming academic year. Teachers were slightly less enthusiastic about using the online curriculum, 90% were either likely or definitely going to implement (Table 6).

Table 6: How Likely Participants Are to Use the Minnesota's Changing Climate Curriculum in the Next Academic Year

	%
Not at all likely	1
A little likely	9
Likely	45
Definitely	45

When asked which lessons in the curriculum they were most likely to implement, about four fifths of the participants selected each of the first five lessons (Table 7). Over 90% of participants indicated that they would be likely to implement Lesson 6, about taking action in response to what students have learned about climate change.

Table 7: Parts of Curriculum Participants Thought They Would Implement

	%
Lesson 1: What is journaling for?	79
Lesson 2: What defines Minnesota's biomes?	76
Lesson 3: What defines Minnesota's climate?	77
Lesson 4: What is climate change and what does it mean for Minnesota?	80
Lesson 5: What does the data show?	77
Lesson 6: What can I do?	91

Barriers to Implementing the Curriculum

Although most participants indicated their intention to use the curriculum in their classroom, several participants noted barriers to implementation. The two most common barriers are the lack of time and the politics of climate change.

As mentioned previously, finding time to cover everything that they need to teach is a primary concern of many teachers. Several participants saw time as a barrier to teaching the curriculum. Connecting to the standards and integrating with other content areas are two ways to overcome the time barrier.

> *I have good intentions [but] I worry about the time aspect.*
>
> *Time if it doesn't satisfy a standard.*
>
> *One barrier may be finding time in an already loaded curriculum. 4th grade has a rather heavy science load, and we find it difficult sometimes to cover the standards thoroughly. We are trying to be more creative in ways that we teach some of these things through integration. It requires the other teachers at the grade level to be on board.*
>
> *Time.... emphasis is on reading and math curriculum (NCLB) leaves little time for science and social studies...sad, but true. Administration agrees but its difficult for them to turn backs on test scores and opt for doing what's best for kids. I appreciate your emphasis on integrating resources into cross-curriculum.*

Several participants noted that the politically-charged atmosphere around the science of climate change might be a barrier to teaching the curriculum, especially if parents objected.

> *Parental prickling should they hear the words climate change, global warming, etc. I have already had issues in the past with introducing students to fairly basic concepts regarding this issue. Time, time, time and testing...the barrier to all classrooms.*
>
> *I may face some resistance from administration and from parents. There are skeptics within my school community.*
>
> *I'm able to use pretty much what I'd like, but the barrier will come from the very conservative (politically and religiously) students and parents that live in my district.*

I think it would have been nice to have suggestions for interacting with parents who are skeptical of climate change. Additionally I would appreciate if there was a suggestion of how to present the unit in a letter to send home explaining the unit and what students would be studying.

Other possible barriers mentioned by participants include teaching in settings other than classrooms, and their own lack of knowledge about climate change.

As an environmental educator at a nature center, I do not have the ability to do many long-range lessons since we do not see many of the students/schools more than one time in a school year.

As an informal educator, I am not in the classroom very often or very long. So the trick will be pulling out items to use in the time slot I have available.

The lack of knowledge on climate change. How can I do a [Public Service Announcement] if I don't know anything about basic climate change?

Only a few participants mentioned that access to the outdoors, money to buy journals, or accommodating all learners (including students with limited English proficiency) would be a barrier to implementing the curriculum.

I do not have access within walking distance to a nature area and our grounds are devoid of most living plants. The neighborhood is not the safest to walk in, though we do at times. It would be helpful for inner city schools to have the opportunity to go to Fort Snelling or other nature area a few times during the year. Bus cost is difficult at this time due to budget cuts.

What is Missing from the Curriculum?

When asked to describe what is missing from the curriculum, most participants responded either that nothing was missing or they did not have enough time to know. Several participants offered suggestions. Some of the suggestions mirror earlier comments, such as a request for information about dealing with parents who are skeptical of climate change.

I know that the previous curriculum materials did address more of the scientific aspects of climate change, and this curriculum was designed to have a slightly different focus, but I would like to see a little more of the science included.

Would like to have an area on online classroom where you could share data in the form of data tables and graphs.

I think it would have been nice to have suggestions for interacting with parents who are skeptical of climate change. Additionally I would appreciate if there was a suggestion of how to present the unit in a letter to send home explaining the unit and what students would be studying.

I would like more on the economics of climate change.

Information on how [climate change] impacts people who rely on the weather , [such as] farmers, Ojibwa people who do seasonal activities.

The only thing that I noticed was an absence of differentiation ideas and not much that recognized the different learning styles or the applications for multiple intelligences in teaching, but that happens in the lesson planning details and creation of units. It could be a good appendix or supplement though.

I don't feel I can speak to this until I have had the opportunity to really look at the curriculum and implement components in my classroom. Check back in a year. :) :)

Several participants continued to express concern about their own understanding of the science of climate change.

As an elementary teacher attending with science teachers, I feel inadequate and a bit intimidated. I would love to attend an institute that would make me more scientifically savvy.

I still have a hole in my understanding about why climate change can cause droughts in one area of the world/country/state, while another part is flooding. I was hoping to understand that better but it always seems that it is assumed we understand it. Maybe it is something simple and obvious but I just have not understood that. I haven't looked at the entire curriculum but if there is not specific data for addressing the common misconceptions and common false explanations for climate change I think there should include that information.

I am hoping the 6 lessons will be enlightening for me. You are talking to a real beginner in climate change understanding.

Part 5: Participant Ratings of Keynote Presentations and Breakout Sessions

Full Group Presentations

There were four full group presentations at the 2011 Summer Institute: Will Steger, Karen Campbell, and Kristen Poppleton, and Abby Fenton. Teachers rated each presentation for overall presentation (interesting, engaging, clear, and understandable), content, and relevance to their classrooms (Figures 5, 6, 7, & 8).

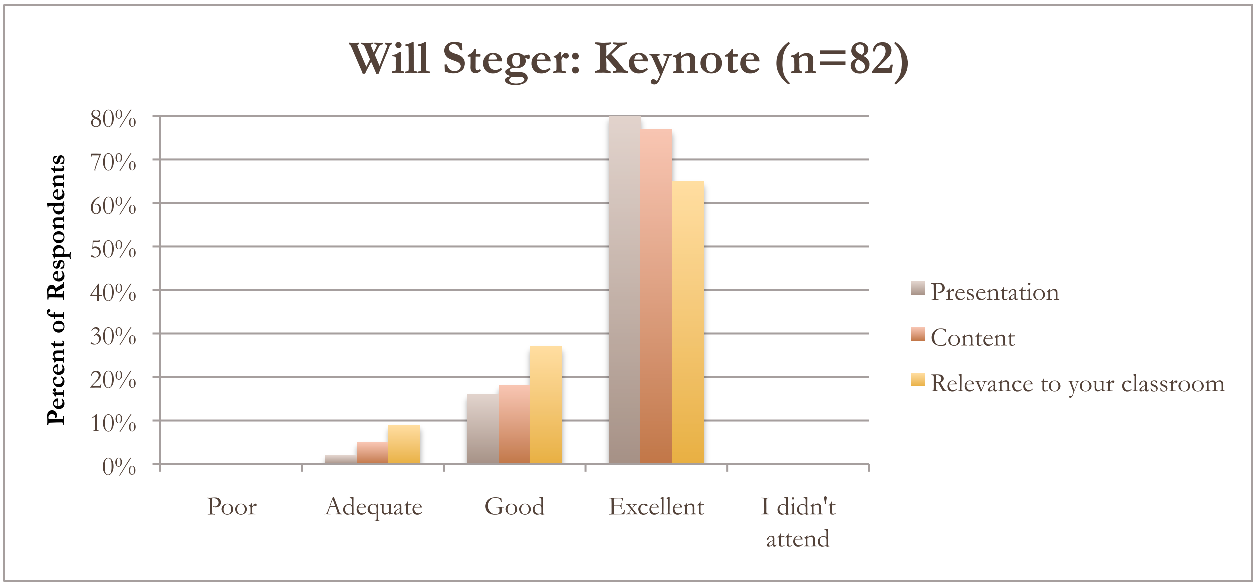


Figure 5: Will Steger Keynote Presentation

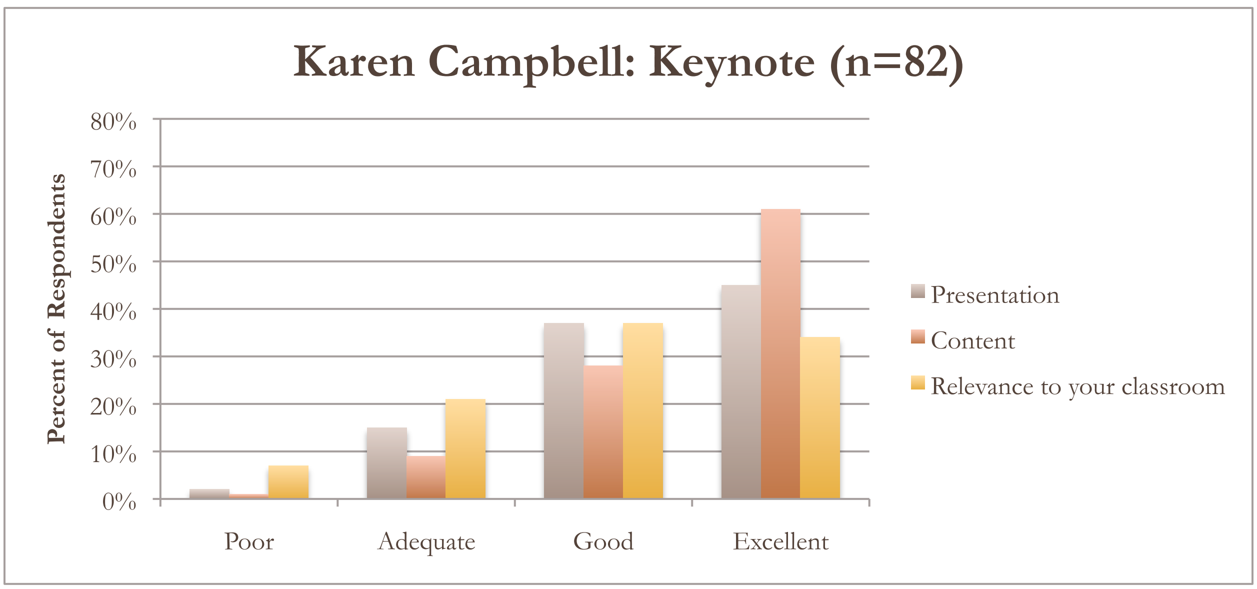


Figure 6: Karen Campbell Keynote Presentation

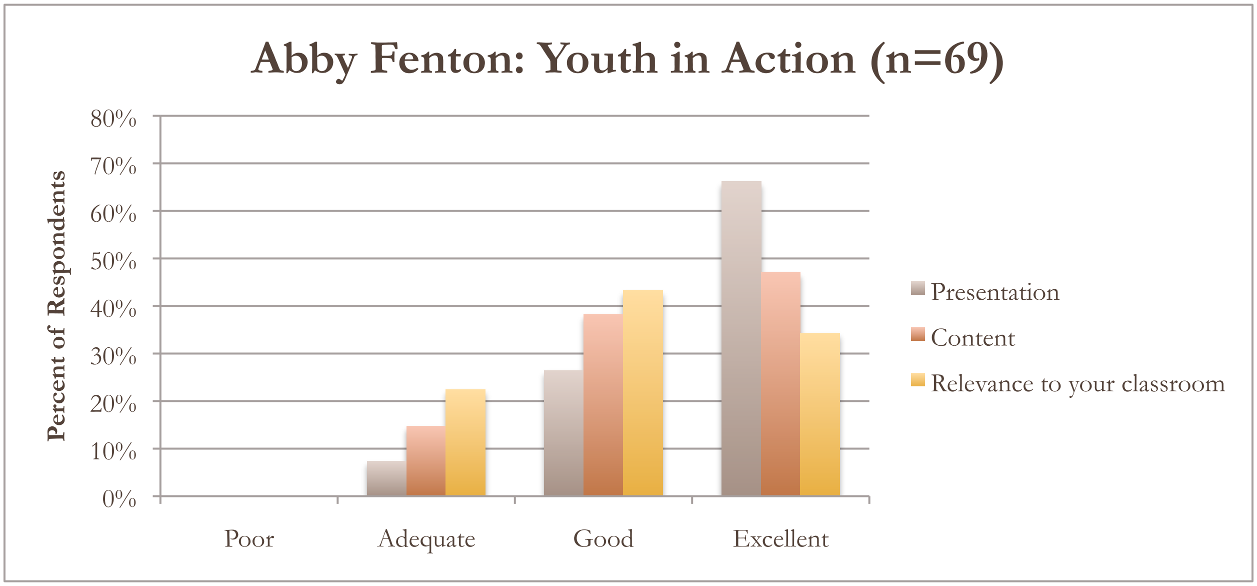


Figure 7: Abby Fenton Youth in Action Presentation

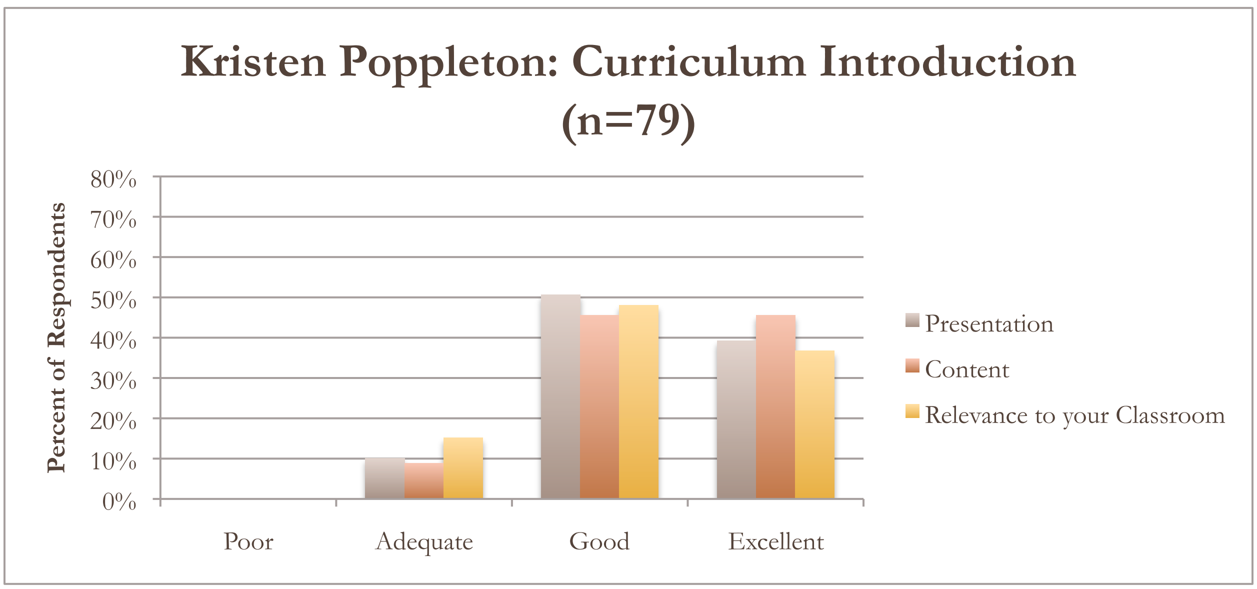


Figure 8: Kirsten Poppleton Curriculum Introduction Presentation

Breakout Sessions

Will Steger Foundation offered a number of breakout sessions to introduce the new curriculum and to support teachers' ability to successfully implement the curriculum. Breakout sessions were a mix of indoor hands-on activities, outdoor hands-on activities, and lectures. Sessions on using the new curriculum and the on-line classroom were required; all other sessions were optional for participants except those participating in the Parks Climate Challenge also had to participate in particular sessions. Participants rated breakout sessions along the same metrics as the full group sessions.

Thursday Afternoon breakout sessions

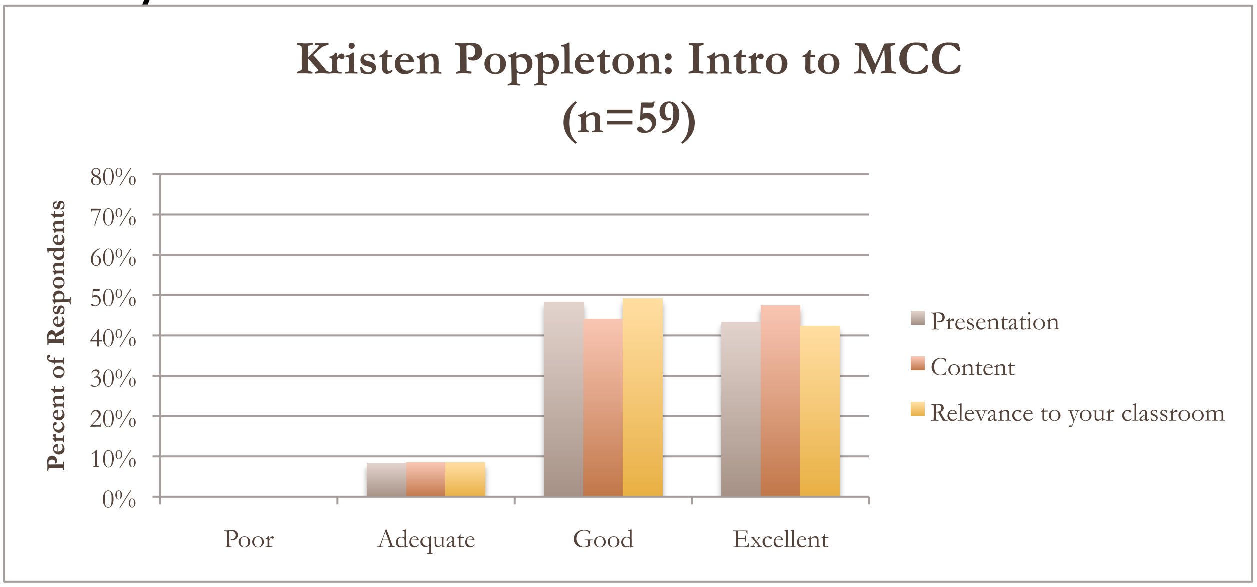


Figure 9: Kristen Poppleton's Introduction to Minnesota's Changing Climate Curriculum Breakout Session

Kristen Poppleton's sessions introducing Minnesota's Changing Climate Curriculum were well attended and well received almost-equally across all three measures (Figure 9).

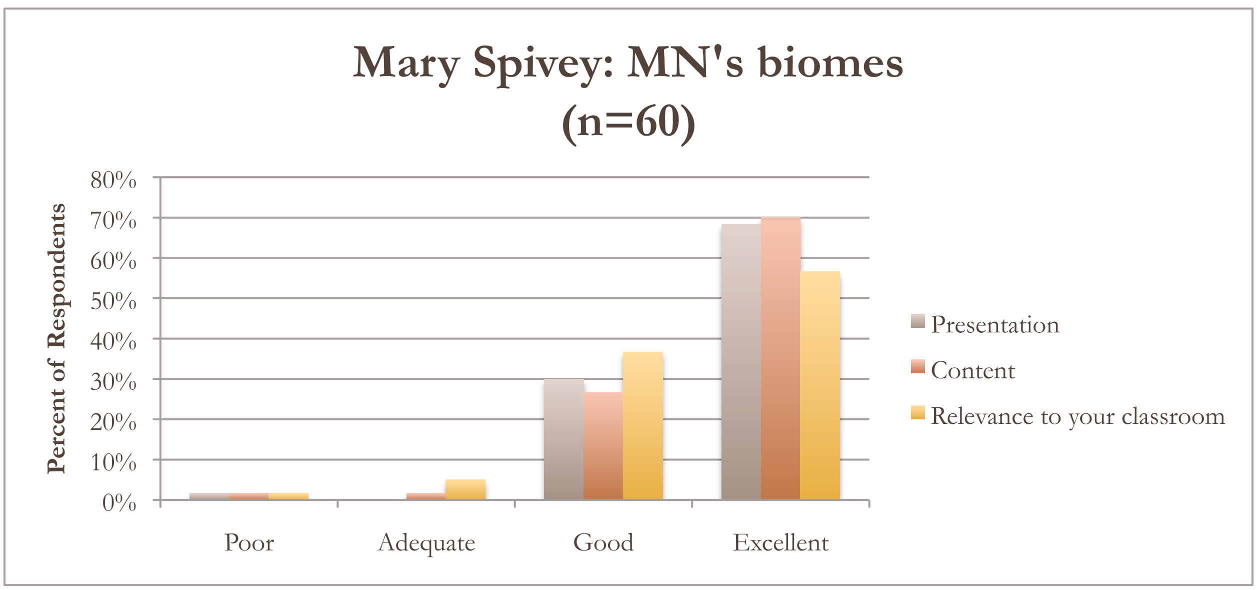


Figure 10: Mary Spivey's Minnesota's Biomes Breakout Session

Mary Spivey's sessions on Minnesota's biomes were well attended and highly rated. Mary's presentation and content were rated higher than the relevance to teachers' classrooms (Figure 10).

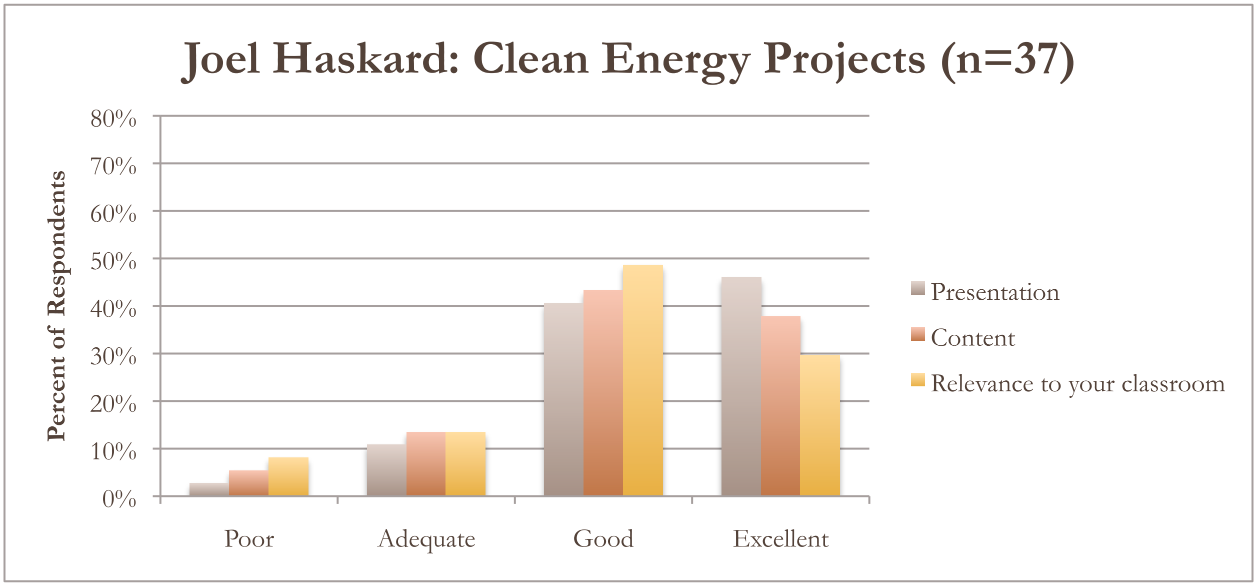


Figure 11: Joel Haskard's Clean Energy Projects Breakout Session

The majority of participants who attended Joel Haskard's presentations on clean energy projects found it either good or excellent on all measures, but Joel's presentations received the most 'poor' ratings (Figure 11).

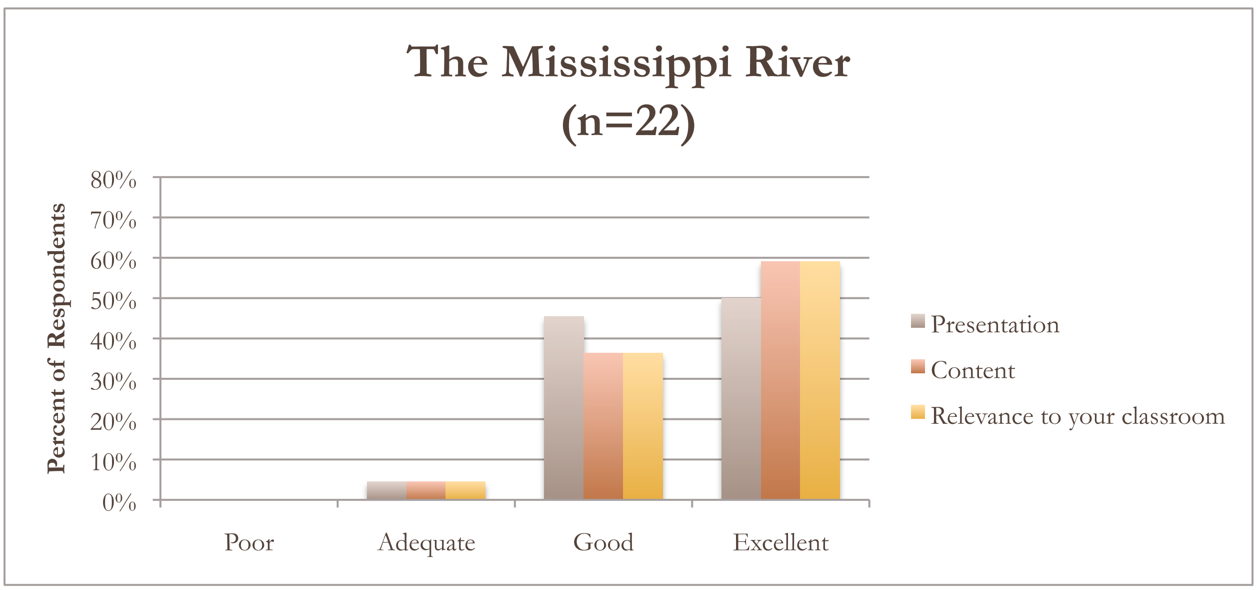


Figure 12: Mississippi River Breakout Session

The Mississippi River session was well received by the 22 teachers who attended the session (Figure 12).

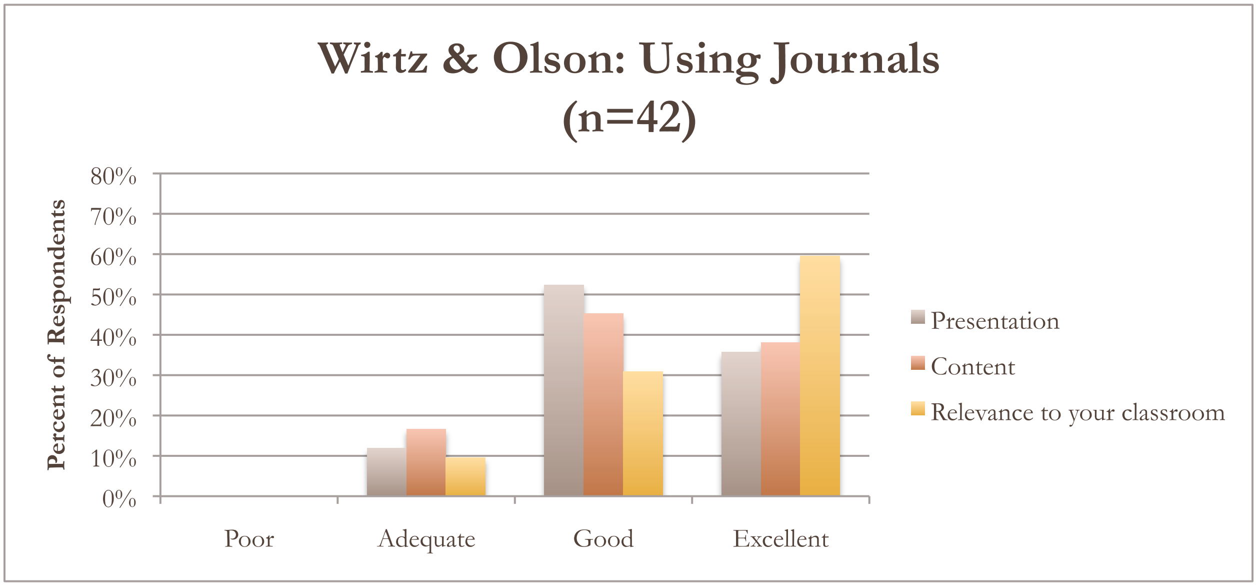


Figure 13: Mick Wirtz and John Olson's Extending Learning Using Journals Breakout Session

Most participants found Wirtz and Olson's workshop on journaling highly relevant to their classrooms, but 10-15% of participants found each aspect of their presentation to be only adequate (Figure 13).

Friday Morning Breakout Sessions

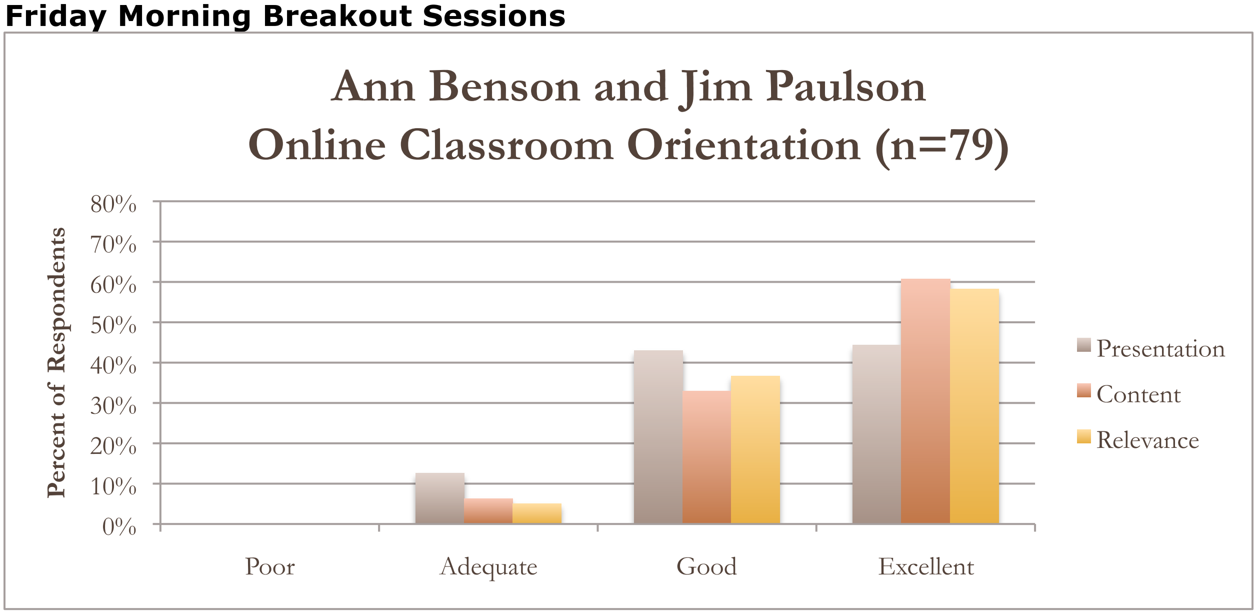


Figure 14: Ann Benson and Jim Paulson's Orientation to the Online Classroom Breakout session. This session was required of all Summer Institute Participants

Ann Benson and Jim Paulson's sessions on the online classroom was a mandatory session for participants. The sessions were stronger in content and classroom relevance than they were on the presentation itself.

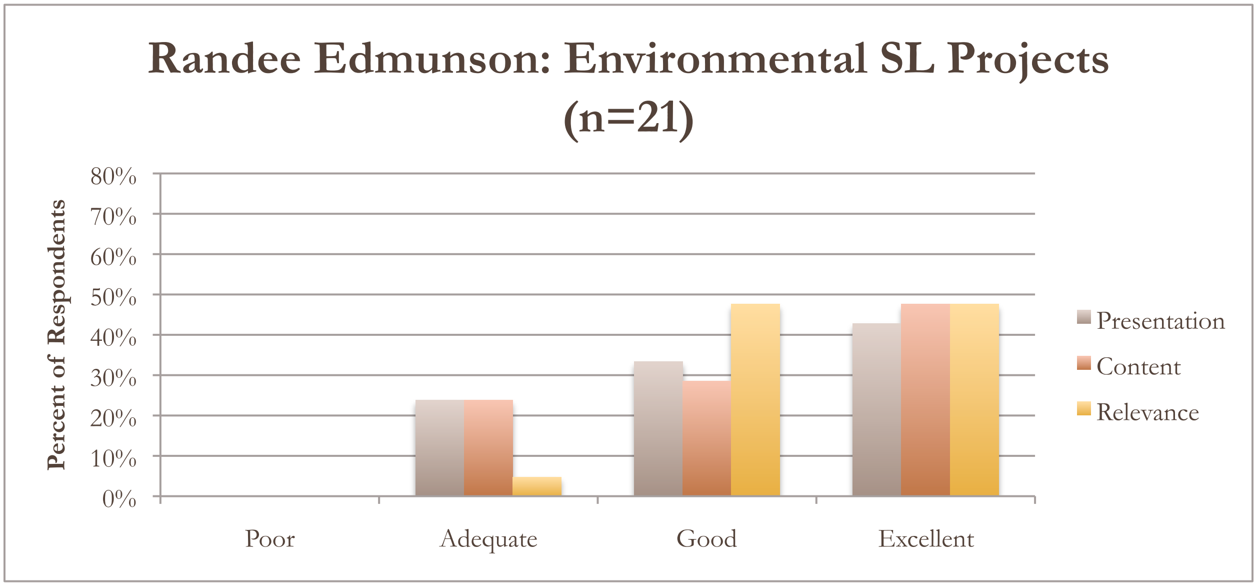


Figure 15: Randee Edmonson's Environmental Service Learning Projects Breakout Session

Randee Edmunson's session on environmental service learning projects was attended by 21 participants. She received excellent marks by a plurality of teachers, but about one fifth of teachers found the presentation and content only adequate (Figure 15).

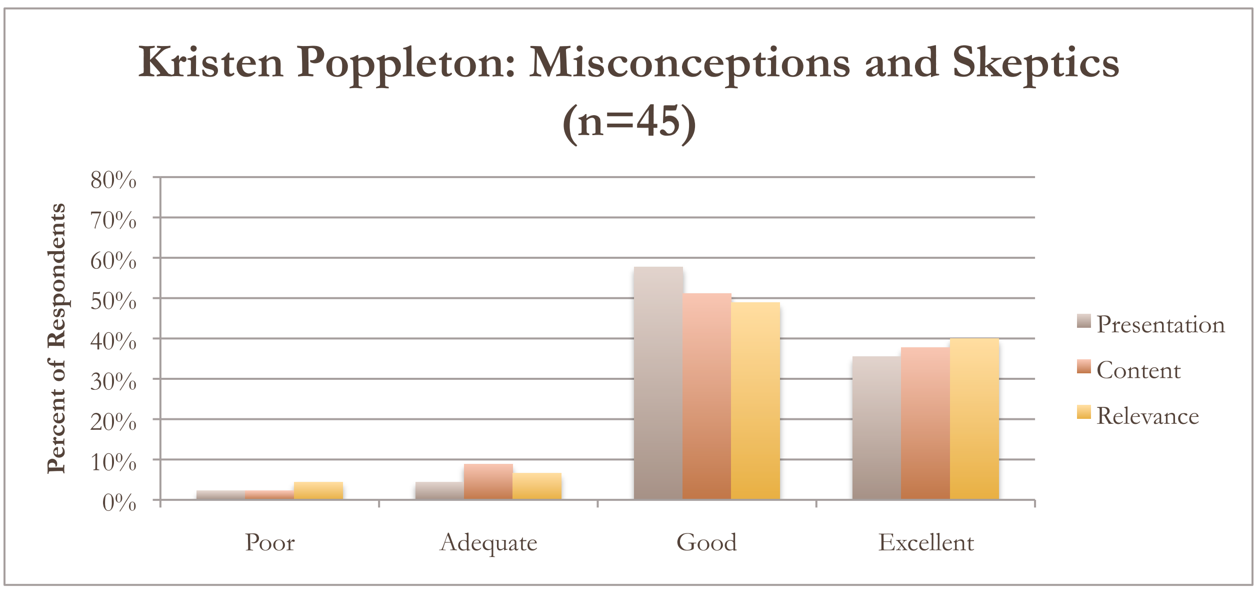


Figure 16: Kristen Poppleton's Misconceptions and Skeptics Breakout Session

Forty-five participants attended Kristen Poppleton's breakout session on dealing with climate change misconceptions and skeptics; the vast majority of participants thought the session was either good or excellent on all three measures (Figure 16).

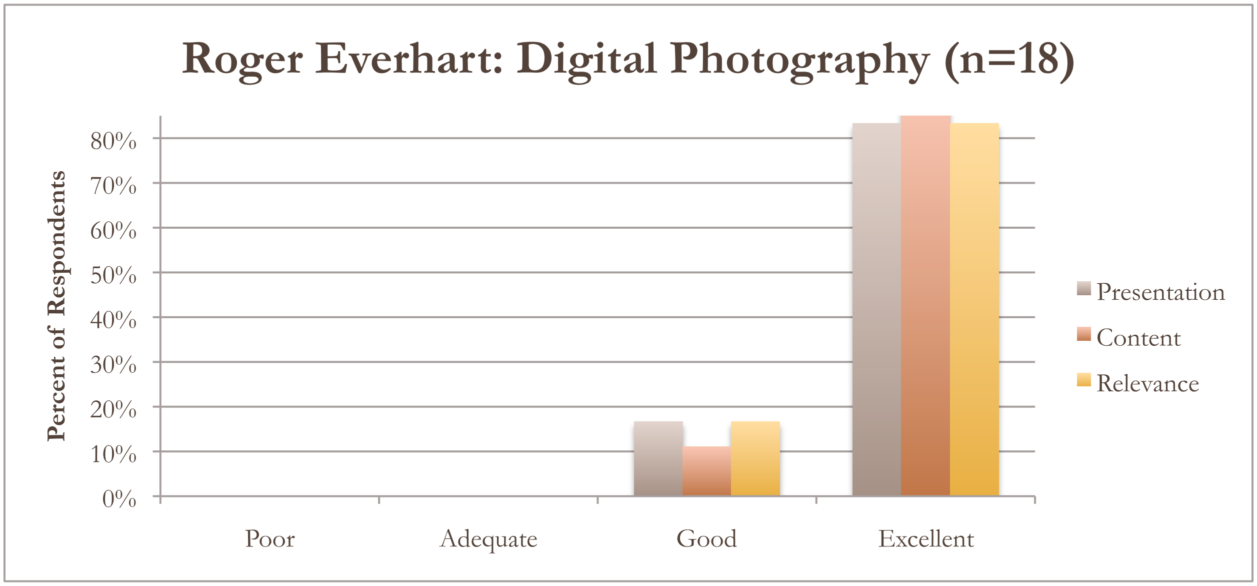


Figure 17: Roger Everhart's Sessions on Digital Photography: Bridge to Nature Breakout Session. (This breakout session was offered as one or two sessions.)

Roger Everhart presented "Digital Photography: Bridge to Nature" in a one or two session format. Eighteen participants attended the workshop and 83% of attendees attended both sessions. This session was sparsely attended, but very well received by those who did attend with the greatest number of excellent responses (Figure 17).

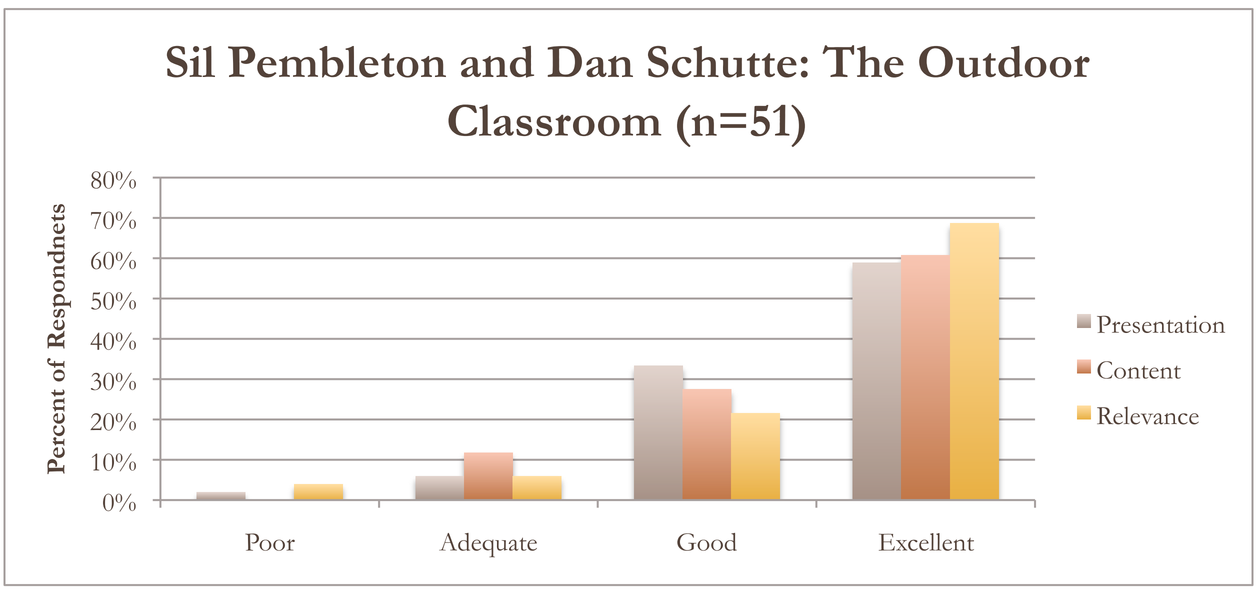


Figure 18: Sil Pembleton and Dan Schutte's The Outdoor Classroom: Team Teaching with Mother Nature Breakout Session. (This session was offered in a two-session version and a one-session version.

Sil Pemberton and Dan Schutte, from the Jeffers Foundation, presented on the outdoor classroom offering a one and two-session format. Pemberton and Schutte distributed materials from the Jeffers Foundation (notebook, pencil, hand lens, and measuring tape) to participants.

Most participants gave their workshop high marks (Figure 18), and most participants attended the abbreviated session (Table 8).

Table 8: Which Outdoor Classroom Sessions Participants Attended

	%
I attended Part 1 ONLY	8%
I attended Part 2 ONLY	4%
I attended both Parts 1&2	24%
I attended the abbreviated session	65%

Thursday Evening Session

In addition to the workshop in Apple Valley, Summer Institute participants had the opportunity to attend an off-site evening lecture Thursday evening called Sense of Place in Minnesota's Climate. Will Steger, J. Drake Hamilton, and Don Shelby were panelists at this open-to-the-public event in Saint Paul, MN; teachers attending the Summer Institute for graduate credit were required to attend this event. About half (55%) of the participants attended the panel discussion; most rated the event highly on all measures (Figure 19).

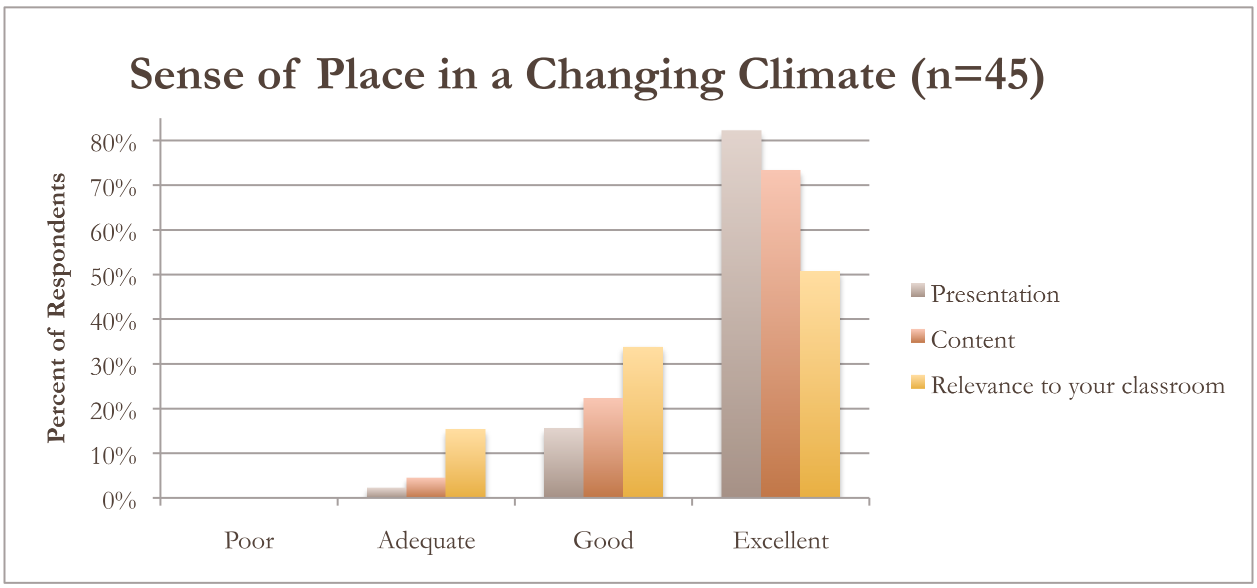


Figure 19: Sense of Place in Minnesota's Changing Climate Off-Site Evening Event

Recommendations

Incorporate more hands-on activities into the next Summer Institute. Perhaps ensuring each breakout session time slot has a hands-on activity would be advisable at the next institute or including a nature hike for all participants where Summer Institute leaders could model strategies for teaching in nature. A post-lunch walk could serve as an invigorating break for participants just as a nature walk is beneficial for students in the classroom.

There were several issues that could be addressed by making relatively small changes to the institute or supplemental information for the curriculum. Participants expressed interest in having information tailored for particular grade levels in both the institute and the curriculum. Several suggested ways that participants could be grouped by grade levels (and, perhaps, different biomes) to work together at the institute and to provide support for each other throughout the year. Although providing distinct curricula for each grade level is not feasible, it may be possible to address this concern and support teachers by providing a few guidelines about adapting the curriculum for different grades and ability levels. Teachers of younger children expressed concerns that they might need to prepare their students to deal with the curriculum issues, and teachers of older students were concerned about making the curriculum challenging. Teachers from all grade levels wanted help fitting the curriculum into their existing program, and guidelines about connecting the MCC curriculum to standards within and outside of science, and to other disciplines, would go a long way to alleviating these concerns.

Appendix: 2011 Summer Institute Evaluation

PCC Results

	Not Enough	Just Right	Too much
Mix of session types - Breakout	25%	75%	0%
Mix of session types - Keynote Presentations	5%	95%	0%
Mix of session types - Lecture	0%	75%	25%
Length of Institute (2 days)	5%	95%	0%
Number of breaks	15%	75%	10%
Length of breaks	25%	65%	10%
Time devoted to new curriculum	30%	70%	0%
Time devoted to science	50%	50%	0%

	Strongly disagree	Disagree	Agree	Strongly agree
On-line registration was smooth	5%	5%	25%	65%
The meeting facility was comfortable	5%	0	25%	70%
The location in Apple Valley was convenient	5%	15%	35%	45%
I valued the networking opportunity	5%	5%	35%	55%
Lunches were adequate	5%	0%	20%	75%
Snacks were adequate	5%	5%	30%	60%
Planning time was helpful	5%	15%	35%	45%

	Strongly disagree	**Disagree**	**Agree**	**Strongly agree**
My students will find the curriculum engaging	5%	0%	55%	40%
It is clearly organized and easy to use	5%	5%	35%	55%
The curriculum will be useful in my teaching	5%	0%	40%	55%
It matches my curricular goals	5%	10%	55%	35%

The curriculum is comprehensive	5%	10%	50%	35%
I am confident in my ability to implement the curriculum	10%	0%	50%	40%
The curriculum meets a need for which I have inadequate resources	5%	15%	35%	45%
I received good ideas on how to implement the curriculum	5%	10%	45%	40%
I know how to get additional info and questions answered	0%	5%	55%	40%

	Not at all likely	Not too likely	Likely	Definitely
How likely are you to use the curriculum	0	0	25%	75%
How likely are you to use the on-line classroom	0	5%	45%	50%

100% think curriculum will be useful for teaching about climate change and environmental stewardship

	Poor	Adequate	Good	Excellent
Full Group Speakers				
Kristen Poppleton (n=12)				
Presentation	0	8%	33%	58%
Content	0	8%	33%	58%
Relevance	0	8%	58%	33%
Will Steger (n=20)				
Presentation* (n=19)	0	5%	16%	79%
Content	0	5%	20%	75%
Relevance	0	10%	20%	75%
Abby Fenton (n=12)				
Presentation	0	0	42%	58%
Content	0	0	33%	67%
Relevance	0	8%	33%	58%
Sense of Place in a Changing Climate (n=12)				
Presentation	0	0	0	100%
Content	0	0	0	100%

Relevance	0	17%	33%	50%
Karen Campbell (n=19)				
Presentation	0	5%	32%	68%
Content	0	5%	16%	84%
Relevance	0	16%	42%	47%

Breakout Sessions	Poor	Adequate	Good	Excellent
Thursday				
Intro to MN's Changing Climate (KP) (n=19)				
Presentation	0	5%	47%	47%
Content	0	11%	42%	47%
Relevance	0	11%	42%	47%
Climate Change and MN's Biomes (MS) (n=0)				
Clean Energy Projects (JH) (n=6)				
Presentation	1	1	1	3
Content	2	0	2	3
Relevance	2	0	1	3
The Mississippi River (n=19)				
Presentation	0	0	53%	47%
Content	0	0	42%	58%
Relevance	0	0	42%	58%
Journals (MW & JO) (n=6)				
Presentation	0	0	50%	50%
Content	0	0	67%	33%
Relevance	0	0	50%	50%

Friday Morning	Poor	Adequate	Good	Excellent
Online Classroom (AB & JP) (n=19)				

Presentation	0	16%	42%	42%
Content	0	0	47%	53%
Relevance	0	0	47%	53%
Env't Service Learning (RE) (n=18)				
Presentation	0	22%	28%	50%
Content	0	22%	22%	56%
Relevance	0	6%	39%	56%
Misconceptions and Skeptics (KP) (n=9)				
Presentation	0	0	67%	33%
Content	0	11	67%	22%
Relevance	0	0	22%	78%
Digital Photography (RE) (n=3)				
Presentation	0	0	0	2
Content	0	0	1	2
Relevance	0	0	1	2
The Outdoor Classroom Abbrev. Sess. (SP&DS) (8)				
Presentation	0	0	38%	63%
Content	0	0	13%	88%
Relevance	0	0	0	100%

1 parks climate challenge teacher attended part 1 of Roger Everhart's workshop and 2 teachers took parts one and two.

Minnesota’s Changing Climate Curriculum Implementation Evaluation

Background

The Will Steger Foundation (WSF) launched its *Minnesota’s Changing Climate Curriculum (MCCC)* in the 2011-2012 school year. The MCCC was funded by an Environment and Natural Resources Trust Fund (ENRTF) 2010 Work Program from the State of Minnesota. Comprised of six units, the MCCC was created to incorporate reflective writing and phenology into a learning unit on climate change and environmental stewardship for students in grades 3-12. MCCC includes yearly professional development workshops, a grade band specific curriculum manual, and an online classroom; this report details teachers’ feedback on the curriculum manual and the online classroom in the first year of implementation (see Guberman & Phipps, 2011 for an overview of the 2011 professional development workshop.)

Method

We sent an invitation to complete an online survey to 91 email addresses representing the teachers who had registered for, and attended, the WSF 2011 Summer Institute (the professional development workshop). Of these 91 email addresses, five were invalid addresses, so the effective sample was 86 teachers. In the email we provided two links to online surveys — one for participants who had implemented all or part of the MCC Curriculum in their classroom in the past year, and one for participants who had not implemented any of the MCC Curriculum. We received 26 completed surveys from participants who had implemented the curriculum and 8 from participants who had not. Our return rate was 40%, high for an internet survey.

Results

PART I: LESSONS TAUGHT AND COMMENTS ABOUT THEM

We present results about teachers’ use of the six lessons that comprise the curriculum in two ways. First, we present the results for each lesson looking across survey questions. This provides a snapshot of each lesson. Next, we present results for all six lessons by survey questions. This format facilitates comparisons between lessons. The distribution of teachers’ responses for these questions is presented in Table 1.

Results By Lesson

Table 1:Teachers’ Responses About the Six Curriculum Lessons

Survey Item	Lesson					
	1	2	3	4	5	6
Lesson Implementation (%)						
Taught as is or with minor modifications	73	58	50	38	35	23

Taught with major modifications	15	23	8	31	27	31
Did not teach	12	19	42	31	38	46
Student Enjoyment (%)						
Enjoyed a lot	25	19	33	17	20	36
Enjoyed	63	71	67	67	73	64
Didn't enjoy it much	13	10	0	17	7	0
Disliked	0	0	0	0	0	0
Number of Concepts Learned (%)						
Many	33	33	40	33	20	43
One or Two	58	67	60	67	73	57
None	2	0	0	0	7	0
Number of Skills Learned (%)						
Many	17	33	36	11	19	43
One or Two	79	48	64	89	69	57
None	4	19	0	0	13	0
Likelihood of Teaching the Lesson Again (%)						
Definitely will	58	62	73	47	29	67
Probably will	38	29	20	42	59	27
Probably not	0	5	0	5	6	0
Definitely not	4	5	0	5	6	7

Lesson 1: What Is Journaling For?

Of the 26 respondents, almost all (n=24; 88%) reported that they had taught lesson 1, with most indicating that they taught it "as is or with minor modifications." Of those who taught the lesson, almost two thirds of the teachers responded that their students had "enjoyed" it, and one fourth indicated that their students had "enjoyed it a lot." Only a few teachers indicated that their students "didn't enjoy the lesson much" and no teachers reported that students "disliked" the lesson. Almost all teachers reported that their students had learned at least one or two important concepts and skills, with several teachers indicating that students had learned "many" important concepts and skills. (Teachers were twice as likely to report that students learned "many" important concepts compared to "many" important skills.) All but one teacher indicated that they would "definitely" or "probably" teach Lesson 1 again.

Lesson 2: What Defines Minnesota's Biomes

Of the 26 respondents, 21 (81%) reported having taught lesson 2, with a majority indicating that they had taught the lesson "as is or with minor modifications." Almost three fourths of the teachers reported that their students "enjoyed" the lesson, and one fifth indicated that their students had "enjoyed it a lot." Only a few teachers indicated that their students "didn't enjoy it much" and no teachers reported that students "disliked" the lesson. All teachers reported that their students learned at least one or two important concepts, with one third reporting that their students had learned “many” important concepts. Almost all teachers also reported that their students had learned important skills from Lesson 2: Almost half reported that students learned “one or two” important skills, and one third indicated that students learned “many” important skills. In contrast, a few teachers reported that their students had learned no important skills from the lesson. Almost two thirds of the teachers indicated that they would “definitely” teach Lesson 2 again, and another one-third would “probably” teach it again. Only one teacher reported “probably” not teaching the lesson again, and one reported “definitely” not teaching it again.

Lesson 3: Defining Minnesota’s Climate

Of the 26 respondents, 15 (58%) reported having taught lesson 3, and almost all of them had taught it “as is or with minor modifications.” All reported that their students either “enjoyed it” (two thirds of respondents) or “enjoyed it a lot” (one third). All reported that their students had learned at least “one or two” important concepts and skills, with slightly more than one third indicating that students had learned “many” important concepts and skills. Almost three fourths of the teachers indicated that they would definitely” teach Lesson 3 again, and all but one of the other teachers indicated that they would “probably” teach it again.

Lesson 4: What Is Climate Change and What Does It Mean for Minnesota?

Of the 26 respondents, 18 (69%) reported having taught Lesson 4, with about half of them indicating that they had taught the lesson “as is” or with minor modifications” and half indicating they had taught it with “major modifications.” Two thirds of the teachers responded that their students “enjoyed” the lesson with the remainder of responses evenly split between “enjoyed it a lot” and “didn’t enjoy it much.” All teachers responded that their students learned at least “one or two” concepts and skills, with the rest of the teachers indicating that students had learned “many” concepts and skills. (Three times as many teachers chose “many” for concepts compared to “skills.”) Almost all of the teachers reported that they would likely teach Lesson 4 again, with almost half indicating they would “definitely” teach the lesson again and almost half indicating they would “probably” do so.

Lesson 5: What Does the Data Show?

Of the 26 respondents, 16 (62%) indicated that they had taught Lesson 5, with a little more than half of them teaching it “as is or with minor modifications” and a little less than half teaching it with “major modifications.” Of those who taught the lesson, half reported that their students “enjoyed it” with the other half evenly split between “enjoyed it a lot” and “didn’t enjoy it much.” None reported that their students “disliked” the lesson. A majority of teachers also reported that their students learned “one or two” important concepts and skills; several teachers reported that students learned “many” important concepts and skills, and a few teachers reported that students learned no important concepts and skills. A majority of teachers reported that they would “probably” teach Lesson 5 again, and one third said they would “definitely” do so. One teacher “probably” will not and one teacher “definitely” will not teach the lesson again.

Lesson 6: What Can I Do?

Of the 26 respondents, 14 (54%) indicated that they had taught Lesson 6, and a majority of them had made “major modifications” when doing so. All teachers reported that students had wither “enjoyed” the lesson (two thirds of teachers) or “enjoyed it a lot” (one third). All teachers also reported that their students had learned important concepts and skills from the lesson, with more than two fifths of them indicating that students had learned “many” important concepts and skills. Two thirds of the teachers who taught this lesson would “definitely” teach it again, and almost all of the other teachers would “probably” do so. One teacher reported that he or she will not teach the Lesson 6 again.

Overall Curriculum

Overall, these results indicate that teachers had good things to say about their experiences teaching each of the MCC lessons. Most were able to use the lessons in their classes as is or with only minor modifications. They reported that their students overwhelmingly enjoyed the lessons and learned several important concepts and skills from them. Almost all teachers reported that they will teach the lesson again. In light of these very positive results, it is worth noting that there is room for improvement. For instance, although a majority of teachers reported that their students "enjoyed" each of the lessons and almost none indicated that students "disliked" any of the lessons, relatively few teachers indicated that their students enjoyed the lessons "a lot." Similarly, whereas most teachers indicated that students learned "one or two" concepts and skills from each of the lessons, relatively few indicated that students learned "many" concepts or skills. It is an ambitious, but not unreasonable goal, to move teachers from providing very good to excellent responses. The results reported here, including the responses to open-ended questions, provide information to facilitate that transition.[1]

B. Results By Question Type

Lesson Implementation

We asked teachers which of the six lessons they had taught. As shown in Table 2, respondents were most likely to teach the first lesson, and the number of respondents teaching each of the subsequent lessons steadily decreased. This does not indicate that all teachers started with the first lesson and progressed lesson-by-lesson until they completed using the curriculum. Rather, some teachers reported skipping lessons or selecting just one or two lessons. For instance, more teachers taught Lesson 4 than taught Lessons 3, 5, or 6.

Table 2:Percent of All Respondents Teaching Each Lesson (N = 26)

Lesson	I taught this lesson as is or with minor modifications	I taught with major modifications	I did not teach this lesson
Lesson 1: What Is Journaling For?	73	15	12
Lesson 2: What Defines Minnesota's Biomes	58	23	19
Lesson 3: Defining Minnesota's Climate	50	8	42
Lesson 4: What Is Climate Change and What Does It Mean for Minnesota?	38	31	31
Lesson 5: What Does the Data Show?	35	27	38
Lesson 6: What Can I Do?	23	31	46

[1] Of course, each teachers' presentation of the lessons has an influence on students' enjoyment and learning, and presentations are likely to improve as teachers become more familiar with the lessons and ways to adapt them to meet curriculum goals for particular groups of students.

For each lesson, we also asked teachers who taught the lesson to indicate whether they had done so "as is or with minor modifications" or "with major modifications." As shown in Table 3, how much modification teachers did varied by lesson. Most of the teachers reported that when they taught the lower numbered-lessons — Lessons 1, 2, and 3 — they taught them as is or with only minor modifications. In contrast, teachers were more likely to report that they made major modifications to the lessons later in the unit. Close to half of the teachers indicated that they made major modifications to Lessons 4 and 5 was modified, and a majority reported making major modifications to Lesson 6 (WSF had already made major modifications to Lesson 5 in response to personal feedback).

Table 3: Of the Teachers Who Taught Each Lesson, Percent Who Taught It "As Is or With Minor Modification" and "With Major Modifications"

Lesson	No. Who Taught The Lesson	Teacher Responses (%)	
		Taught as is or with minor modifications	Taught with major modifications
Lesson 1: What Is Journaling For?	23	83	17
Lesson 2: What Defines Minnesota's Biomes	21	71	29
Lesson 3: Defining Minnesota's Climate	15	87	13
Lesson 4: What Is Climate Change and What Does It Mean for Minnesota?	18	56	44
Lesson 5: What Does the Data Show?	16	56	44
Lesson 6: What Can I Do?	14	43	57

Student Enjoyment

We asked teachers to rate how much their students enjoyed each lesson. As shown in Table 4, teachers rated student enjoyment high for each lesson, with three fourths of teachers indicating that their students "enjoyed" it or "enjoyed it a lot." Lessons 3 and 6 received especially high ratings, with one third or more of the teachers responding that their students liked those lessons "a lot" and no teachers indicating that their students didn't enjoy the lessons. Lesson 5 was rated the lowest of the six lessons, although 75% of the teachers reported that students "enjoyed it" or "enjoyed it a lot."

Table 4: Teacher Ratings of How Much Students Enjoyed or Disliked Each Lesson

Lesson	*n*	Teacher Ratings (%)			
		Enjoyed it a lot	Enjoyed it	Didn't enjoy it much	Disliked it
Lesson 1: What Is Journaling For?	24	25	63	13	0
Lesson 2: What Defines Minnesota's Biomes	21	19	71	10	0
Lesson 3: Defining Minnesota's Climate	15	33	67	0	0
Lesson 4: What Is Climate Change and What Does It Mean for Minnesota?	18	17	67	17	0
Lesson 5: What Does the Data Show?	16	25	50	25	0
Lesson 6: What Can I Do?	14	36	64	0	0

Learning Important Concepts and Skills

For each less that they taught, we asked teachers if students learned important concepts and important skills and, if so, we asked if students learned "one or two" or "many" important concepts and skills. As shown in Table 5, almost all teachers responded that students learned "one or two" important concepts and skills in each lesson, and many teachers indicated that students learned "many" important concepts and skills. More teachers rated Lessons 3 and 6 as teaching "many" concepts compared to other lessons, and Lesson 5 received relatively few "many" ratings for concepts. Teachers were less likely to indicate that students learned "many" skills than "many" concepts, although overall learning (one or more concepts or skills) was similar.

Table 5: Teachers Ratings of the Degree to Which Students Learned Important Concepts and Skills in Each Lesson

Lesson	*n*	Teacher Ratings (%)					
		Concepts			Skills		
		Many	One or two	None	Many	One or two	None
Lesson 1: What Is Journaling For?	24	33	58	2	17	79	4
Lesson 2: What Defines Minnesota's Biomes	21	33	67	0	33	48	19
Lesson 3: Defining Minnesota's Climate	15/14	40	60	0	36	64	0
Lesson 4: What Is Climate Change and What Does It Mean for Minnesota?	18	33	67	0	11	89	0

Lesson 5: What Does the Data Show?	15/16	20	73	7	19	69	13
Lesson 6: What Can I Do?	14	43	57	0	43	57	0

Likelihood That Teachers Will Teach Each Lesson Again

For each lesson that teachers taught, we asked them to rate how likely they were to teach it again. As shown in Table 6, almost all teachers (88-96%) reported that they would “definitely” or “probably” teach each lesson again. Lesson 5, and to a lesser extent Lesson 4, stand out as receiving relatively low ratings of “definite.” Nonetheless, very few teachers (4-12%) reported that they were unlikely to teach any of the lessons again.

Table 6: Teacher Ratings of How Likely or Unlikely They Are to Teach Each Lesson Again in the Future

Lesson	*n*	Teacher Ratings (%)			
		Definitely will	Probably will	Probably will not	Will not
Lesson 1: What Is Journaling For?	24	58	38	0	4
Lesson 2: What Defines Minnesota’s Biomes	21	62	29	5	5
Lesson 3: Defining Minnesota’s Climate	15	73	20	0	7
Lesson 4: What Is Climate Change and What Does It Mean for Minnesota?	19	47	42	5	5
Lesson 5: What Does the Data Show?	17	29	59	6	6
Lesson 6: What Can I Do?	15	67	27	0	7

Strengths and Weaknesses of the Curriculum

We asked teachers to tell us what they thought were the strengths and weaknesses of the lessons they had taught. These were open-ended questions and teachers could write as much as they liked in response. Several themes emerged from the results. We present the primary themes and excerpts to illustrate them here. The complete list of response is provided in the Appendix.

Strengths of the curriculum.

Based on teachers’ responses, we identified five primary strengths of the curriculum:

Strength 1*: The local focus on Minnesota and connections to students’ experiences and the world*

> *The curriculum focused on Minnesota rather than more global concerns. I felt that it was very easy to connect climate change to the students because of this relationship.*

I especially liked how the lessons used Minnesota data. I felt that this made a much bigger impact on my students - they could see that it is happening here in Minnesota

I loved that they were able to make some type of connections throughout all the lessons.

Strength 2*: The active, hands-on, inquiry-based nature of the curriculum*

There [were] plenty of hands-on activities to keep [students'] interest. It was based on good science.

They loved taking action and making posters.

Strength 3*: The clarity of the lessons and teacher guide, including specific content and materials*

Each lesson was easy to follow and clear.

Did not have to do a lot of research to teach this curriculum.

The online features are engaging for students.

The graphs and data that were available. I also thought the colored maps were wonderful.

Strength 4*: The ability to adapt the lessons to fit their students and curriculum*

The curriculum gives me a framework to develop my lesson plans from. The lesson plans are tied to the state standards!

Basically, I took the overall concepts and adapted them by using additional videos, texts and websites that were a bit more relevant to my high school students.

My students keep science journals anyway, so nature journals were a good supplement to those. Lesson 6 fits right into my Earth Day curriculum nicely.

Strength 5*: There was a lot of support for implementing the curriculum*

I also appreciated the fact that I could email the staff and could get a response. That support is something that is not often found.

Weaknesses of the curriculum.

Unlike when they were asked for the strengths of the curriculum, when asked about its weaknesses few common themes emerged. Mostly, teachers would like the curriculum to address their particular concerns, such as activities for older students, greater focus on social justice, and adaptations for students with disabilities. Others suggested minor improvements to the curriculum. (See the full set of responses in the Appendix.) Based on teachers' responses, we identified two concerns that were shared by several of the respondents. Although they present teachers with challenges to implement the curriculum, they are not weaknesses per se:

Challenge 1: *Greater differentiation of the curriculum*

I understand that the curriculum is 3-8 grades, which is a very, very large developmental span. Some of the lessons for the 8th graders (biome cards) needed to be *modified. So, specifically, I'd like to see a curriculum that is more developmentally appropriate. Perhaps something along the lines of 3-5 and 6-8 (or something along these lines).*

The biggest weakness for me was that most of the curriculum does not meet grade 6 science standards, so I was unable to use most of it.

Challenge 2: *Lack of time and other resources*

Because we are in Frogtown and a low-income school getting to nature was difficult. There are very few green spaces here by school. We went to one place by bus, but then just stayed on our school grounds which did not excite the students for the journaling part. I tried my best, but without a better immersion in nature, the journaling part does not go as well as it should.

Computers are VERY limited in my school so my students never had a chance to post on the website.

I was not able to continue teaching the curriculum because time consuming and my principal directed me not to spend time teaching this curriculum.

Part II: The Curriculum As A Whole And Teachers' Preparation To Implement It

A set of survey questions asked teachers to provide information about the curriculum as a whole, rather than about particular lessons. We asked teachers to rate their confidence in their ability to implement the lesson and how helpful the curriculum was for teaching about climate change and environmental stewardship.

Teachers' Confidence for Teaching the Curriculum

As shown in Table 7, a majority of teachers reported feeling "confident" about their ability to teach the curriculum, and about one fifth reported feeling "very confident." A little more than one fifth of the teachers responded that they felt "a little unsure," and no teachers reported feeling "totally unsure."

Table 7: Teachers' Ratings of How Confident or Unsure They Were In Their Ability to Implement the Curriculum (N = 26)

Teacher Ratings (%)			
Very confident	Confident	A little unsure	Totally unsure
19	58	23	0

Teaching About Climate Change and Environmental Stewardship

Almost all teachers indicated that the curriculum was "helpful" (58-67%) or "very helpful" (29-33%) for teaching about climate change and environmental stewardship (see Table 8). Ratings were a bit higher for environmental stewardship than for climate change.

Table 8: Teachers' Ratings of How Helpful or Unhelpful the Curriculum Was for Teaching About Climate Change and Environmental Stewardship (N = 24)

Topic	Teacher Ratings (%)			
	Very helpful	Helpful	A bit helpful	Very unhelpful
Climate Change	29	67	0	4
Environmental stewardship	33	58	8	0

Reflecting on the 2011 Summer Institute

We were also interested in gathering information that would be helpful for preparing the next Summer Institute. Although we had gathered evaluation data at the end of the 2011 Summer Institute — which participants indicated was very helpful — we thought that after they had taught the lessons they may be able to provide additional information, such as things that should be added to the institute to prevent problems that arose in their implementation. Therefore, we asked teachers to rate how well the institute prepared them to teach the curriculum, and provided an opportunity for them suggest how the institute could have better prepared them.

As shown in Table 9, although almost three fourths of the teachers indicated that the institute was "helpful" or "very helpful," one fifth reported that the institute was "very unhelpful." In light of the very positive results from the Summer Institute and about the curriculum implementation (above), this result warrants concern and is addressed by respondents open-ended comments.[2]

Table 9: Teachers' Ratings of How Helpful the 2011 Summer Institute Was in Preparing Participants to Teach the Curriculum (N = 25)

Teacher Ratings (%)			
Very helpful	Helpful	A bit helpful	Very unhelpful
44	28	8	20

When asked how the 2011 Summer Institute could have better prepared them for implementing the curriculum, several teachers replied that they had no suggestions:

> *I can't think of any [suggestions]. It was a great experience.*
>
> *No real suggestions. It met my needs.*
>
> *I thought the Summer Institute was very helpful. It gave me ideas on what would work for my students, and many things that I did not think of.*

Several teachers asked for more hands-on instruction in how to implement the curriculum and to adapt for their instructional needs:

[2] We are aware that, in response to evaluation results and informal feedback, the 2012 Summer Institute has implemented several changes.

Maybe time where someone could lead us into implementing parts or all of the curriculum into our classes. We did get time ourselves, but it was hard for me to make the connections of where it could fit into my existing curriculum as well as the standards.

How to bridge the gap between different grades.

I know it was the first year, but having teachers that have taught it leading some small group classes on implementation. Also, showing instructors how and when to implement the biomes kit even above and beyond the MCC curriculum.

The complete set of teachers' responses is in the Appendix.

PART III: QUESTIONS ABOUT THE ONLINE CLASSROOM (*N* = 26)

As part of the evaluation, we included survey questions about whether and how teachers used the Online Classroom. Teachers who used the Online Classroom were asked to rate how helpful various aspects of it were and how it could be improved.

How Teachers Used the On Line Classroom

Of the 26 survey respondents, 21 (81%) replied that they had used the Online Classroom. As shown in Table 10, all teachers who used the Online Classroom used it to help prepare their lessons. Most of these teachers also showed or asked students to look at the videos available in the Online Classroom and two thirds of them made use of the still images with students. Relatively fewer teachers had students view observations that other students had posted or asked their students to post their own observation.

Table 10: How Teachers Used the Online Classroom (N = 21)*

Ways of Using the Online Classroom	%
I used it myself when preparing lessons	100
I showed or asked my students to look at some of the videos	81
I showed or asked my students to look at some of the images	66
My students viewed observations that others had posted	33
My students shared their observations	24

*Five additional respondents reported not using any aspect of the online classroom.

We also asked teachers if they had used the Online Classroom in a way we had not anticipated. Two teachers described their use:

I showed some of the videos, images, and virtual tour of biomes to the whole class.

To give the students more resources in identifying the different biomes and what kinds of plants and animals were unique or common in them.

Two teachers responded that they planned to use it more the next time they taught the curriculum:

I will use it more this coming school year!

I hope to use the on line classroom more this coming year.

Teachers' Ratings of Features of the Online Classroom

Table 11 contains teachers' ratings of how helpful teachers found various features of the Online Classroom. Teachers who used a feature tended to find it "very helpful." Teachers indicated that the image gallery and handouts were especially helpful. Information about climate change basics and the ability for students to see what other students had posted in the Online Classroom received the lowest ratings, although almost all teachers rated them helpful.

Table 11: Teachers' Ratings of How Helpful Features of the Online Classroom Were

	n	Teacher Ratings (%)		
		Very helpful	Somewhat helpful	Unhelpful
The curriculum	20	75	25	0
The video gallery	19	74	21	5
The image gallery	18	83	17	0
Information about climate change basics	18	67	22	11
The handouts	17	88	12	0
The students could see what the other students had posted there	12	50	50	0
The students could post their observations	9	78	22	0

Improving the Online Classroom

Several of the teachers who had used the Online Classroom offered suggestions about how to improve it.

Some teachers responded that there was no need for any improvements:

I thought that it was great. No changes needed.

Teachers' most common concern with the Online Classroom concerned their lack of access to computers and related issues:

One of our biggest issues was access to the Internet. The kids were testing online so much this year that when I wanted to use computers they were in use for testing. We hope to get more iPads this next year.

It was a little slow to load at times.

It was hard to search for some observations.

Other teachers suggested that aspects of the Online Classroom needed improvement:

The videos are somewhat long and dry. They are not really usable in the classroom due to the lack of attention getting material in them. In order to inspire kids to start nature journals there needs to be a reason for them to do so that is age appropriate and somewhat attention grabbing - make it relate to kids, not adults. Short and sweet videos would be great. The image gallery is useful - kids enjoy it.

I chose not to use the class time for students to post observations. My understanding of the potential value of that aspect of the program may be incomplete. I did not expect that my students would build knowledge and skills that way. And students showed no interest when I offered the activity as an option.

The complete set of teachers' responses is in the Appendix.

PART IV: QUESTIONS ABOUT SUPPORT FOR IMPLEMENTING THE CURRICULUM

As noted above, teachers indicated that one of the strengths of the curriculum is the support provided for implementing it, including the ability to call WSF staff members when needed. When asked if they had sought support for implementing the MCC curriculum, 15% (4) of the teachers said that they had. (Eighteen teachers replied that they did not seek support and four did not respond.)

Five teachers described the support they received. Several mentioned that they sought help from people to write a mini-grant application, worked with the National Park Service, and contacted WSF staff for assistance. The full set of responses is in the Appendix.

PART V: ADDITIONAL COMMENTS

Near the end of the survey, we provided the opportunity for respondents to include any other comments they wanted to share about their experience implementing the curriculum.

Most of the respondents used the opportunity to praise the curriculum and its developers:

The MN CC curriculum is a great way to start off the year and I plan to do so again this coming school year.

In implementing this curriculum into my classroom, I could tell that a lot of time, effort and energy went into developing the curriculum. Thank you for all of your hard work. I was so happy to have the curriculum to teach.

Thank you for a wonderful curriculum. My students learned so much and are tuned in to the climate change issue, ready to make a difference.

That it was regarding Minnesota was perfect for my high school students who care more about things that seem pertinent to their lives.

The full set of responses is in the Appendix.

PART VI: PARTICIPANTS WHO DID NOT IMPLEMENT THE CURRICULUM

Eight teachers responded to the survey for teachers who did not implement the MCC Curriculum in the 2011-2012 academic year. All indicated that they had planned to. Because there were fewer than 10 participants, all responses will be included in the body of the text.

Reasons Teachers Did Not Implement the Curriculum

Teachers provided a variety of idiosyncratic explanations for why they had not implemented the curriculum:

> *Another teacher borrowed the binder; he used it and never returned it.*
>
> *This year brought me the challenges of a new school, grade, team, and curriculum. I had every intention of using the curriculum but could barely keep up with the basic standards and expectations of my grade level. I have used portions in my grad school planning and intend on using aspects of the curriculum next year. I did use examples of Will's Journal to introduce my students to their science journals.*
>
> *After getting home and really studying the material, I believe the curriculum is just too advanced for 3 - 5 graders. Since the size and number of the classes increased for me this year, I didn't have time to really break the coursework down. I incorporated what I could from Lesson 2 and Lesson 3 into the sessions I already do with the students.*
>
> *Due to the school's state test scores, we changed the schedule to give the students more practice before the tests. Because of this, our schedules changed and I ran out of time to teach with the curriculum.*
>
> *Too busy.*
>
> *In 2011-2012, I was not teaching the course (Environmental Science) where using the MCC curriculum would have been a natural fit. I do plan to implement the curriculum the next time I teach Environmental Science, hopefully in 2012-2013 (during the second semester).*
>
> *Didn't have a full time teaching position this last school year. I'm still looking!!*
>
> *I did not teach environmental science last year as I had planned.*

What Can WSF Do To Help Teachers Implement the Curriculum?

We asked the teachers who had not implemented the curriculum if there was anything the Will Steger Foundation could do to help them implement it in the future. With one exception — to provide another copy of the curriculum — teachers responded that the issues that kept them from implementing it in 2011-2012 were not solvable by the Foundation:

> *I will need another copy of curriculum or if you put it on your website and gave us an access code or something.*

There is nothing that you could have done to help out this year. It was just part of the challenges I faced as a "new teacher" even though I have been teaching for about 10 years.

There is nothing the foundation could do. Hopefully there won't be any surprise schedule changes next year.

Find me a teaching position?

Nothing. I plan to implement some of the lessons I planned this year as I am teaching environmental science this year.

Finally, we provided teachers who did not implement the curriculum with an opportunity to tell us anything else they wanted to share about the curriculum. Three teachers responded:

I meant to have my students log while at service week. I will still try to get some of them to do it.

I love it and look forward to implementing it.

I like it and I'm anxious to implement it!

Conclusions and Recommendations

The Will Steger Foundation's Minnesota's Changing Climate Curriculum and Online Classroom were successful in its first year of implementation. Participants reported using all or some of the curricular materials in their classroom, students having positive experiences, and finding the support system excellent. Teachers expressed their views on the strengths and challenges of the MCCC and the Online Classroom. Survey results indicated five strengths and two challenges in implementing the MCCC:

Strength 1: The local focus on Minnesota and connections to students' experiences and the world

Strength 2: The active, hands-on, inquiry-based nature of the curriculum

Strength 3: The clarity of the lessons and teacher guide, including specific content and materials

Strength 4: The ability to adapt the lessons to fit their students and curriculum

Strength 5: There was a lot of support for implementing the curriculum

Challenge 1: Greater differentiation of the curriculum

Challenge 2: Lack of time and other resources

These strengths show that teachers' perception of the strengths of MCCC align with the WSF's goals for the project – strengths 1, 2, and 5 directly tie to the project's goals. The first challenge has been recognized by the WSF and they now recommend the MCCC for a narrower range of grade levels; the second challenge is a perennial issue for teachers. Similarly, the Online

Classroom was well received by teachers and their students. Teachers used the Online Classroom in a variety of ways and most felt nothing should change; the major complaint was about lack of computer access (beyond the control of the WSF).

In the evaluation of the 2011 Summer Institute, Guberman and Phipps (2011) asked teachers which lessons they planned on implementing. We compared these values to the pattern of which lessons teachers reported actually implementing in Table 12.

Table 12: Teachers' Intent to Teach MCCC Compared to Teachers' Actual Implementation*

Lesson	% intended	% actual
Lesson 1: What is journaling for?	79	88
Lesson 2: What defines Minnesota's biomes?	76	81
Lesson 3: What defines Minnesota's climate?	77	58
Lesson 4: What is climate change and what does it mean for Minnesota?	80	69
Lesson 5: What does the data show?	77	62
Lesson 6: What can I do?	91	54

*Implementation includes teachers who reported teaching the lesson as is or with minor modification, and those who reported teaching the lesson with major modifications.

More teachers implemented the first two lessons than they intended and fewer teachers implemented the remaining lessons; the biggest disparity was for Lesson 6. Lesson 6 is arguably the most involved of the lessons to plan for and to implement, it was also the lesson the staff at the WSF 2011 Summer Institute emphasized heavily in the 2011 Summer Institute. We believe these factors lead to this great discrepancy between intention and action with this lesson. To combat this challenge, the WSF asked teachers who had completed Lesson 6 share their experiences at the 2012 Summer Institute.

Overall, the WSF should keep doing what it's doing: maintaining its Online Classroom, making its Minnesota's Changing Climate Curriculum, holding Summer Institutes, and supporting its teachers with personalized support. The Foundation's close contact and good relationship with its teachers allows it to understand on and improve teachers' and students' experience with the MCCC. As grant funding draws to a close, the WSF should look for ways to sustain close contact with teachers and codify some of the lessons learned. For example, the WSF could take common areas of support and create webinars and other more permanent scaffolds for teachers. Although these resources would not wholly replace personalized just in time supports, they could provide support for a larger number of teachers.

Interview with Returning Teachers to Will Steger Foundation's 2012 Summer Institute

By Molly Phipps and Steven Guberman

The Will Steger Foundation (WSF) was interested in understanding more about the motivations of the 17 teachers who participated in the 2011 Summer Institute (SI) and chose to attend the 2012 SI. The 2012 Summer Institute (SI) was very similar to the SI from 2011 (same content, same curriculum), and the WSF staff wanted to get insight on why these 17 teachers chose to attend both SIs. Evaluators Steven Guberman and Molly Phipps interviewed a sample of these participants to better understand their reasons for attending the 2012 SI. Six participants were interviewed; five who implemented the curriculum in the 2011 school year and one who did not.

Methods

Guberman and Phipps interviewed participants during the lunch hour and planning period of the second day of the 2012 SI. Interviews were audio recorded and evaluators took notes during the conversations. None of the participants were part of the Parks Climate Challenge group since that group had a session planned during the planning period. The remaining 11 repeat attendees were part of the Parks Climate Challenge who were required to attend the 2012 SI.

We developed two separate interview protocols one for participants who had taught some of the curriculum and one for those who had not. All participants were asked their reason for attending the 2012 SI. For those who had taught any part of the (Minnesota's Changing Climate)MCC curriculum, we asked which lessons they taught, what grade levels, about any modifications they made, if they would keep the changes next time they taught the lessons, and any recommendations they had for WSF to change the curriculum. For those who did not teach any part of the curriculum, we asked why not, what barriers they faced, if they would teach it during the next school year, and what else the WSF could do to help them teach about environmental stewardship and climate change.

Results

Due to the small sample size, overall results are summarized and then a brief description of each participant follows.

Implementers

Participants who implemented all or part of the MCC returned for a number of reasons including to learn more about MCC, to network and collaborate with like-minded teachers, to learn more about how to deal with skeptics, to get ideas, and to attend breakout sessions. One teacher noted that she always attended the WSF SI, so she did this year. One participant reported feeling overwhelmed after the 2011 SI, so she came back to feel more comfortable with the MCC. Another teacher was looking for ideas and advice on starting a school garden and felt the teachers who attend WSF SIs would be a good resource. These teachers see the SI as a place to collaborate with and learn from like-minded colleagues, to renew old connections and to forge new ones. Participants from schools or areas where there are many climate change deniers see it as a 'support group' for those who recognize the importance of climate change.

Participants' ability to teach the MCC lessons varied from taking bits and pieces as possible to teaching the majority of the lessons. Two teachers taught Lessons One through Four, one teacher taught Lessons One and Two, and two teachers incorporated bits and pieces of the MCC Curriculum into existing lessons as they could. Teachers who could only use pieces of the lessons cited external pressures (i.e., state testing priorities), and courses taught (i.e., economics) as barriers to implementing the MCC. Both teachers planned on implementing larger parts of the MCC next year. The participant who taught Lessons One and Two worked at a nature center where students came for field trips. She used the tree identification, biome game, and weather observations. One of the teachers who taught the first four lessons teaches 10th through 12th grade biology and environmental sciences and did not make modifications to the curriculum. The other teacher who taught the first four lessons teaches 7-12th grade special education; most of her minor modifications were to make the lessons developmentally appropriate for her students.

At the nature center, the participant developed a successful one-hour lesson on phenology, climate, and weather based on materials from the MCC Curriculum. She felt this was a successful modification and will continue to use it. She hopes to add more lessons to her repertoire in the coming year. She suggested adding modifications to the curriculum focused on nature centers.

The 10th-12th grade biology and environmental science teacher appreciated the review of Lesson Five (What does the data show?) at the SI because she felt that lesson was a bit overwhelming the first time she learned about it. Some barriers she sees to fully implementing the MCC are state standards and testing. She sees science as more important than test preparation, but is forced to do test preparation.

The special education teacher also appreciated the review of Lesson Five (What does the data show?). She feels that her students would need much more direction on the group project than they were given.

The 7th and 8th grade teacher was planning to teach the lesson around state testing time, but was told to focus more on math and reading and lost six weeks of science teaching to test preparation. She plans to teach the MCC earlier in the school year to avoid conflicts with test preparation. She teaches mainly ESL students and was successful using a modified version of the journaling lesson.

Non-implementer

The one participant who did not implement any part of the curriculum attended the SI because he feels that climate change is the biggest concern right now and wants to be able to share this kind of information with his students. He sees climate change as a serious problem that can be addressed if people were better educated. He also expressed his admiration of Will Steger and wants to support the work of the WSF. He did not teach the curriculum because he teaches ESL to adults, but uses articles about climate change in his classroom when possible. His main barrier was time, but thought he might be able to teach some of the MCC lessons in the coming school year.

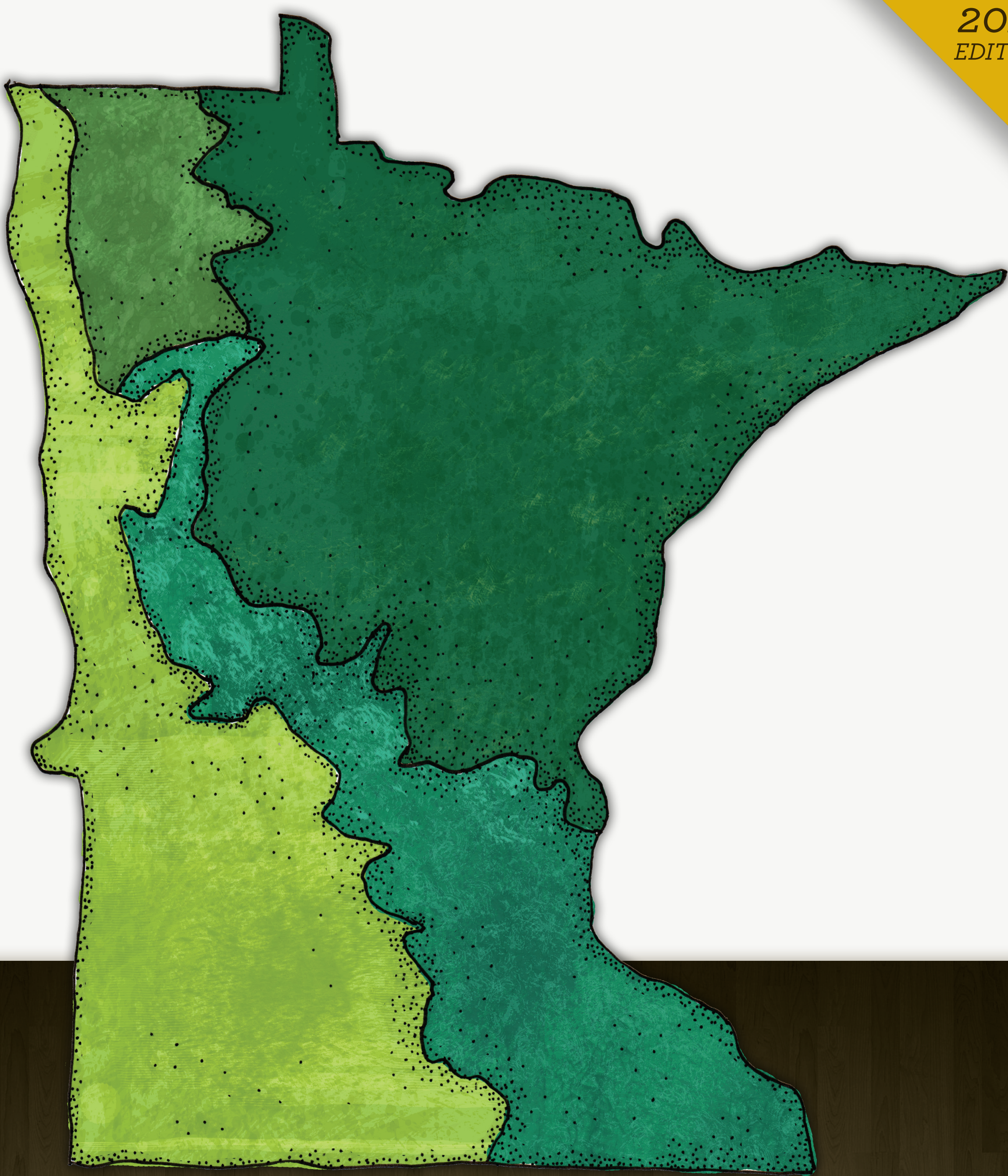
Discussion

The six returning teachers chose to return to the 2012 SI, after having attended the 2011 SI, for a number of reasons. Some of these teachers look forward to the WSF SI every year and attend each institute regardless of topic. They cited social reasons as in camaraderie with like-minded teachers as reasons to attend as well as intellectual reason as in the breakout sessions and getting a review of the curriculum.

The teachers implemented the curriculum in a range of ways from not at all to most lessons as well as from heavily modified to mostly intact. Teachers who modified lessons worked in nature centers, in special education classrooms, and had limited time to implement the curriculum.

Teachers also appreciated learning more about the MCC and the lessons, especially Lesson Five (What does the data show?). Lesson Five was significantly modified from 2011 to 2012 based on teacher feedback, so it is not surprising that teachers mentioned this lesson most frequently.

2012 EDITION



Minnesota's Changing Climate

Grades 3–8

WILL STEGER FOUNDATION

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Grades 3–8

Acknowledgements

August 2012

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For additional information on the Will Steger Foundation please visit:
http://www.willstegerfoundation.org

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Minnesota's Changing Climate - Curriculum Introduction

Dear Educator:

The Will Steger Foundation created *Minnesota's Changing Climate* because we believe that environmental stewardship and action begins with a local connection and sense of appreciation, or *environmental sensitivity*, towards the natural environment. As educators, you have the unique opportunity to lead your students through the environmental education continuum of knowledge, awareness, and skills that lead to an informed and active environmental citizenry. *Minnesota's Changing Climate is a* great place to start because it follows this model of inspiring an appreciation and understanding of Minnesota's natural environment and empowering action.

Climate change is one of the most critical issues of our time. The overwhelming consensus of the scientific community for the past two decades has been that the planetary warming we are now experiencing, and the resulting climate change, is largely a human-induced phenomenon. This was reconfirmed with overwhelming consensus in 2007 with the release of the fourth report by the Intergovernmental Panel on Climate Change (IPCC). Climate change is largely driven by human activities, primarily the burning of fossil fuels to produce electricity and drive our cars, which in turn emit gases—principally carbon dioxide—that blanket the planet and trap heat, raising the earth's surface temperature.

Minnesota is at risk from climate change. From the Boundary Waters Canoe Area Wilderness and the great northern boreal forests, to the northern tall grass prairie, water is a critical element of Minnesota's rich ecological character. Lake Superior borders the state to the northeast, the Mississippi and Red Rivers define large portions of the eastern and western borders respectively, and there are thousands of inland lakes throughout the state. Minnesotans benefit from the many recreational, inspirational, and economic opportunities provided by this diversity of biomes. It is precisely these ecological and natural resources that are at risk from climate change.

Will Steger 's compelling life story of adventure has motivated thousands of Minnesotan's to care about our state and has generated real concern over the threat of climate change to our economy, natural resources, and way of life. Using Will's archives, starting when he was a young boy growing up in the suburbs of Minneapolis, to his Mississippi River adventures, to his homestead on the edge of the Boundary Waters wilderness, and the inspiration these experiences gave him to explore the Arctic, we share his story to inspire others. It was Will's early observation of the natural world and his curiosity of weather and climate that eventually enabled him to explore and survive in the Arctic. It is these critical skills that we focus on in *Minnesota's Changing Climate.*

In this set of lessons, we explore and learn about Minnesota's unique biomes and what a changing climate will mean for the state. Specifically, we examine how Minnesota's climate has already changed and how it is projected to change; how these changes may impact agriculture, forests and wildlife, aquatic ecosystems, our economy, and tourism and recreation; and how you can help reduce these potential impacts and help your biome adapt to a changing climate.

The following section gives suggestions of how to integrate this curriculum into your educational setting. We welcome and appreciate feedback and stories from all of you. Please share them with us at education@willstegerfoundation.org and don't forget to visit our online classroom developed in conjunction with this written curriculum http://classroom.willstegerfoundation.org

Thank you for your commitment to climate change education!

Kristen Poppleton

Kristen Iverson Poppleton
Director of Education
Will Steger Foundation

Will Steger Foundation Education Program

Will Steger Foundation

Established in January 2006 by polar explorer Will Steger, the Will Steger Foundation (WSF), located in Minneapolis, Minn, is dedicated to creating programs that foster international cooperation and leadership through environmental education and policy. The Will Steger Foundation has seen firsthand the dramatic effects of climate change on both the environment and the human condition through the efforts of its founder, Will Steger, who has explored the polar regions for 45 years. With that knowledge, WSF is leading humanity to slow the pace of climate change.

The Will Steger Foundation educates, inspires and empowers people to engage in solutions to climate change. The strategic goal of our education program is:

> To support educators, students and the public with science-based interdisciplinary educational resources on climate change, its implications and solutions to achieve climate literacy.

K-12 Education Program Overview

WSF's education program offers thought-provoking and practical solutions for educators and students by developing, supporting and connecting them with:

- Climate Change Curriculum
- Professional Development Opportunities
- Online Resources

Climate Change Curriculum

WSF offers a suite of curriculum resources via our two online learning portals, as well as our Educator Resources Binder and *Minnesota's Changing Climate* lesson plans. All lesson plans are available for free online and include lessons appropriate for grades 3-12. Aligned with the national and Minnesota state standards, the curriculum has been reviewed by the National Education Association, and the Union of Concerned Scientists. It can be purchased or downloaded for free at http://www.willstegerfoundation.org.

Educator Resources Binder

The Educator Resource binder was developed to support educators looking for innovative and engaging ways to integrate climate change into their classroom. In addition to the three sets of lesson plans for Grades 3-12 in the binder, each lesson is linked to archived video and audio footage of past expeditions, as well as other online resources.

Minnesota's Changing Climate Curriculum

WSF created *Minnesota's Changing Climate* because we believe that environmental stewardship and action begins with a local connection and sense of appreciation, or *environmental sensitivity*, towards the natural environment. This set of lesson plans for Grades 3-8 and 9-12 explores Minnesota's unique biomes and what a changing climate will mean for the state.

Online Curriculum

- Arctic Community Online Curriculum: This curriculum features the Arctic community as seen by animals, native peoples, explorers and scientists; all with diverse perspectives and ways of knowing, and all contributing to knowledge and action to slow climate change. The focus is on solutions and positive messages of hope and action.
- *Minnesota's Changing Climate* Online Classroom: This online classroom was developed in conjunction with the *Minnesota's Changing Climate* lessons. Through the classroom, students have the opportunity to learn about Minnesota's unique biomes and the impacts of climate change. Students also have the opportunity to contribute their own observations and action projects, in photo or written format, and see what other students from around the state have observed.

Professional Development Opportunities

Summer Institute for Climate Change Education: WSF has provided professional development to educators for six years through annual summer institutes. The institutes provide educators with tools to communicate climate change in the classroom. Past keynote speakers have included Bill McKibben, Dr. James Hansen, Andrew Revkin, and Dr. Naomi Oreskes.

Graduate Course on Communicating Climate Change in the Classroom (2 credits): WSF staff teach an annual graduate level course in the fall at Hamline University on "Teaching Climate Change in the Classroom."

Online Resources

Climate Lessons Blog for Educators: WSF maintains a weekly blog dedicated to providing tools and references for educators and communicators of climate change.

Video Gallery: WSF's video gallery contains 100s of videos featuring past expedition footage in the polar regions, as well as presentations by leading climate scientists and other climate educators.

Adventure Learning: WSF is a leader in adventure learning, a hybrid distance education approach that provides students with opportunities to explore real-world issues through authentic learning experiences. WSF harnesses the power of adventure learning by providing the organization's website and its virtual library of multi-media resources, classroom visits, and real-time web conferences to classrooms during WSF expeditions.

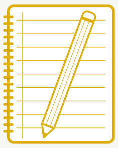
Using Minnesota's Changing Climate in your educational setting

Minnesota's Changing Climate was created with the following goals in mind:

1. To build awareness and interest in
   • Minnesota's natural environment
   • The impact of climate change
2. To provide educators and students with the tools necessary for active and lifelong stewardship.

Recognizing the time constraints and standards-based school environment that exists today, WSF developed these six lessons to make them as useful as possible to educators. They are aligned to Minnesota State Science and Literacy Standards, as well as the Climate Literacy Principles. It is not meant to provide students with an in-depth introduction to the science of climate change, but rather as a review if they have studied it before, or an introduction if it is a new issue. For educators interested in providing students with a more in-depth study of climate change, our Grades 3-5 and Grades 6-12 Global Warming 101 Lessons provide this opportunity and can be downloaded for free at http://www.willstegerfoundation.org.

This set of lessons will be most effective when used in their entirety, including the "Journal Connection" and "Take It Outside-Connecting With Your Place" sections, in conjunction with the online classroom. That said, these lessons could be used in a variety of educational settings. It can also follow a variety of different timelines such as over an intense week of study or once a week over the course of a month and a half. The following suggestions might be helpful when developing your plan of implementation for *Minnesota's Changing Climate*, but we also trust that as an educator you are the experts and will change and adapt lessons best for your situation. We would love to hear how you are using the curriculum in your classroom or school. Please share your stories and photos or videos with us at education@willstegerfoundation.org or upload them to our online classroom at http://classroom.willstegerfoundation.org



Document, document, document

The first lesson of this curriculum is about starting a journal and includes examples of different ways of documenting and reflecting. This lesson was deliberately developed with the idea that a journal, science notebook or blog can provide students with an excellent means to practice reflection, observation and synthesis of information. In addition, if used throughout the implementation of this curriculum, the final product can provide educators with a great assessment of student learning.

Teach Across the Curriculum

Some schools work in team settings with different educators taking on different subject areas. While this is the norm in middle and high school, it can occur in elementary classrooms as well. If possible, break apart the lessons between educators or subject area teaching time, and emphasize the relevant content.

For example:

Lesson 1: What is a journal for?
This lesson is obviously well aligned with any English/language arts course; however, many science classes have begun using science notebooks, and an art class could work on creating the stylistic/graphic design. In addition, it could be possible to set up a blog for each or your students, putting an emphasis on technology skills.

Lesson 2: What defines Minnesota's biomes?
This lesson could fit well with life science, environmental science, earth science and physical geography, depending on what content you wanted to emphasize.

Lesson 3: What defines Minnesota's climate?
Earth science, life science and math could address this lesson.

Lesson 4: What is climate change and what does it mean for Minnesota?
Although this lesson presents students with climate science information, there is a big emphasis on communicating the information that would work well in any English or public speaking course or unit.

Lesson 5: What does the data show?
This lesson is very data- and graph-focused and therefore would work well with any earth science or life science unit focused on interpretation of information. It could also be used and extended in a math course.

Lesson 6: What can I do?
Some schools have volunteer or service learning staff that might be able or interested in facilitating this lesson. Bringing together all the staff that participated, and making this the assessment for students that have completed this unit would also be an exciting possibility. Finally, students may be able to take on this part in an after-school setting through an environmental club.

Using Minnesota's Changing Climate in your educational setting

We really mean it when we say "Take It Outside!"

The "Take It Outside—Connecting with Your Place" section of each lesson is not meant to be an extension, but rather an integral part of each lesson. Connecting students with the biome in which they live and providing them with the skills to be eyewitnesses to the changing climate we live in is an important goal of this project. Not only do we think this is important, but research shows that getting students outside daily is beneficial not only to their health, but their ability to perform in school. (See http://www.childrenandnature.org/research/) Suggestions of how to "Take it Outside" with your classroom include:

- Make an outing to your schoolyard once a week throughout the entire year to observe the same area and record changes in a journal or science notebook.
- Select a weather reporter each day that records the temperature, precipitation, etc. as well as researches weather history via the Internet or an almanac. Record in the classroom and use data for different graphing exercises and compare year to year.
- Ask students to select an area to observe near their home and make weekly observations in a journal or science notebook.

Use the Online Classroom

The Online Classroom designed in conjunction with this curriculum is a fantastic way to bring some of the content alive in the classroom or in an educator-facilitated setting. Ideally, students will be introduced to the classroom and given time to explore it at school. Additional opportunities for assessment are available through the classroom, and if your students have the Internet available at home, exploring pieces of the classroom could be integrated as homework. We highly encourage educators and students to share what they have learned through this curriculum, and the online classroom is a place where students and educators can upload photos of their biome, journal entries and other observations, as well as see what other schools around the state are doing.

Do an Action Project

Climate change can be overwhelming and frightening. Students should understand the consequences and impacts of climate change in Minnesota, but then be offered the opportunity to discuss and learn about potential solutions. Facilitating a discussion of possible action projects, rather than selecting one for students to do, will make students feel more involved and empowered, as well as provide educators with a good assessment of what the students have learned and how much they have connected the causes of climate change with possible actions.

Science

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Grade - 3 Strand - 1. The Nature of Science and Substrand - 1. The Practice of Science Standard - 1. Scientists work as individuals and in groups; emphasizing evidence, open communication and skepticism.							
3.1.1.1.1	Provide evidence to support claims, other than saying "Everyone knows that," or "I just know," and question such reasons when given by others.			•	•	•	•
Grade - 3 Strand - 1. The Nature of Science and Engineering Substrand - 3. Interactions Among Science, Engineering, Technology and Society Standard - 2. Scientific inquiry is a set of interrelated processes incorporating multiple approaches that are used to pose questions about the natural world and investigate phenomena.							
3.1.1.2.1	Generate questions that can be answered when scientific knowledge is combined with knowledge gained from one's own observations or investigations. For example: Investigate the sounds produced by striking various objects.		•		•	•	•
3.1.1.2.3	Maintain a record of observations, procedures and explanations, being careful to distinguish between actual observations and ideas about what was observed. For example: Make a chart comparing observations about the structures of plants and animals.		•	•	•		
3.1.1.2.4	Construct reasonable explanations based on evidence collected from observations or experiments.		•	•	•	•	•
Grade - 3 Strand - 1. The Nature of Science and Engineering Substrand - 1. The Practice of Science Standard - 2. Men and women throughout the history of all cultures, including Minnesota American Indian tribes and communities, have been involved in engineering design and scientific inquiry.							
3.1.3.2.1	Understand that everybody can use evidence to learn about the natural world, identify patterns in nature, and develop tools. For example: Ojibwe and Dakota knowledge and use of patterns in the stars to predict and plan.	•	•	•	•	•	•
3.1.3.2.2	Recognize that the practice of science and/or engineering involves many different kinds of work and engages men and women of all ages and backgrounds.		•	•	•	•	•
Grade - 3 Strand - 1. The Nature of Science and Engineering Substrand - 1. The Practice of Science Standard - 4. Tools and mathematics help scientists and engineers see more, measure more accurately, and do things that they could not otherwise accomplish.							
3.1.3.4.1	Use tools, including rulers, thermometers, magnifiers and simple balance, to improve observations and keep a record of the observations made.			•			
Grade - 3 Strand - 4. Life Science Substrand - 3. Evolution in Living Systems Standard - 2. Offspring are generally similar to their parents, but may have variations that can be advantageous or disadvantageous in a particular environment.							
3.4.3.2.2	Identify common groups of plants and animals using observable physical characteristics, structures and behaviors. For example: Sort animals into groups such as mammals and amphibians based on physical characteristics. Another example: Sort and identify common Minnesota trees based on leaf/needle characteristics.		•				

Science (continued)

Grade - 4
Strand - 1. The Nature of Science and Engineering
Substrand - 2. The Practice of Engineering
Standard - 1. Engineers design, create, and develop structures, processes, and systems that are intended to improve society and may make humans more productive

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
4.1.2.1.1	Describe the positive and negative impacts that the designed world has on the natural world as more and more engineered products and services are created and used.				•		•

Grade - 4
Strand - 2. Physical Science
Substrand - 1. Matter
Standard - 1. Objects have observable properties that can be measured.

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
4.2.1.1.1	Measure temperature, volume, weight and length using appropriate tools and units.			•			

Grade - 4
Strand - 3. Earth Science
Substrand - 2. Interdependence within the Earth system
Standard - 3. Water circulates through the Earth's crust, oceans and atmosphere in what is known as the water cycle.

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
4.3.2.3.1	Identify where water collects on Earth, including atmosphere, ground, and surface water, and describe how water moves through the Earth system using the processes of evaporation, condensation and precipitation.			•			

Grade - 5
Strand - 1. The Nature of Science and Engineering
Substrand - 1. The Practice of Science
Standard - 1. Science is a way of knowing about the natural world, is done by individuals and groups, and is characterized by empirical criteria, logical argument and skeptical review.

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
5.1.1.1.1	Explain why evidence, clear communication, accurate record keeping, replication by others, and openness to scrutiny are essential parts of doing science.	•			•		
5.1.1.1.4	Understand that different models can be used to represent natural phenomena and these models have limitations about what they can explain. For example: Different kinds of maps of a region provide different information about the land surface.		•			•	

Grade - 5
Strand - 1. The Nature of Science and Engineering
Substrand - 1. The Practice of Science
Standard - 2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
5.1.1.2.1	Generate a scientific question and plan an appropriate scientific investigation, such as systematic observations, field studies, open-ended exploration or controlled experiments to answer the question.	•	•			•	
5.1.1.2.2	Identify and collect relevant evidence, make systematic observations and accurate measurements, and identify variables in a scientific investigation.			•			

Grade - 5
Strand - 1. The Nature of Science and Engineering
Substrand - 3. Interactions Among Science, Engineering, Technology and Society
Standard - 4. Tools and mathematics help scientists and engineers see more, measure more accurately, and do things that they could not otherwise accomplish

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
5.1.3.4.1	Use appropriate tools and techniques in gathering, analyzing and interpreting data. For example: Spring scale, metric measurements, tables, mean/median/range, spreadsheets, and appropriate graphs			•		•	

Science (continued)							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
5.1.3.4.2	Create and analyze different kinds of maps of the student's community and of Minnesota. For example: Weather maps, city maps, aerial photos, regional maps, or online map resources.		•	•		•	
Grade - 5 Strand - 3. Earth Science Substrand - 4. Human Interactions with Earth Systems Standard - 1. In order to maintain and improve their existence, humans interact with and influence Earth systems.							
5.3.4.1.1	Identify renewable and nonrenewable energy and material resources that are found in Minnesota and describe how they are used. For example: Water, iron ore, granite, sand and gravel, wind, and forests.				•		
5.3.4.1.3	Compare the impact of individual decisions on natural systems. For example: Choosing paper or plastic bags impacts landfills as well as ocean life cycles.						•
Grade - 5 Strand - 4. Life Science Substrand - 1. Structure and Function of Living Systems Standard - 1. Living things are diverse with many different characteristics that enable them to grow, reproduce and survive.							
5.4.1.1.1	Describe how plant and animal structures and their functions provide an advantage for survival in a given natural system. For example: Compare the physical characteristics of plants or animals from widely different environments, such as desert versus tropical, and explore how each has adapted to its environment.		•				
Grade - 5 Strand - 4. Life Science Substrand - 2. Interdependence Among Living Systems Standard - 1. Natural systems have many components that interact to maintain the living system							
5.4.2.1.1	Describe a natural system in Minnesota, such as a wetland, prairie, or garden, in terms of the relationships among its living and nonliving parts, as well as inputs and outputs. For example: Design and construct a habitat for a living organism that meets its need for food, air and water.		•				
5.4.2.1.2	Explain what would happen to a system such as a wetland, prairie or garden if one of its parts were changed. For example: Investigate how road salt runoff affects plants, insects and other parts of an ecosystem. Another example: Investigate how an invasive species changes an ecosystem.			•	•	•	
Grade - 5 Strand - 4. Life Science Substrand - 4. Human Interactions with Living Systems Standard - 1. Humans change environments in ways that can be either beneficial or harmful to themselves and other organisms.							
5.4.4.1.1	Give examples of beneficial and harmful human interaction with natural systems. For example: Recreation, pollution, wildlife management.				•		•

<table>
<tr><td colspan="8">Scivence (continued)</td></tr>
<tr><td colspan="8">Grade - 6
Strand - 1. The Nature of Science and Engineering
Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics and Society
Standard - 4. Current and emerging technologies have enabled humans to develop and use models to understand and communicate how natural and designed systems work and interact.</td></tr>
<tr><td>Code</td><td>Benchmark</td><td>Lesson 1</td><td>Lesson 2</td><td>Lesson 3</td><td>Lesson 4</td><td>Lesson 5</td><td>Lesson 6</td></tr>
<tr><td>6.1.3.4.1</td><td>Determine and use appropriate safe procedures, tools, measurements, graphs, and mathematical analyses to describe and investigate natural and designed systems in a physical science context.</td><td></td><td></td><td></td><td></td><td>•</td><td></td></tr>
<tr><td>6.1.3.4.2</td><td>Demonstrate the conversion of units within the International System of Units (SI, or metric) and estimate the magnitude of common objects and quantities using metric units.</td><td></td><td>•</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Grade - 7
Strand - 1. The Nature of Science and Engineering
Substrand - 1. The Practice of Science
Standard - 2. Scientific inquiry uses multiple interrelated processes to investigate questions and propose explanations about the natural world.</td></tr>
<tr><td>7.1.1.2.1</td><td>Generate and refine a variety of scientific questions and match them with appropriate methods of investigation, such as field studies, controlled experiments, review of existing work, and development of models.</td><td></td><td>•</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7.1.1.2.3</td><td>Generate a scientific conclusion from an investigation, clearly distinguishing between results (evidence) and conclusions (explanation).</td><td></td><td></td><td>•</td><td>•</td><td>•</td><td></td></tr>
<tr><td colspan="8">Grade - 7
Strand - 1. The Nature of Science and Engineering
Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics and Society
Standard - 3. Current and emerging technologies have enabled humans to develop and use models to understand and communicate how natural and designed systems work and interact.</td></tr>
<tr><td>7.1.3.4.1</td><td>Use maps, satellite images and other data sets to describe patterns and make predictions about natural systems in a life science context. For example: Use online data sets to compare wildlife populations or water quality in regions of Minnesota.</td><td></td><td>•</td><td>•</td><td></td><td>•</td><td></td></tr>
<tr><td>7.1.3.4.2</td><td>Determine and use appropriate safety procedures, tools, measurements, graphs and mathematical analyses to describe and investigate natural and designed systems in a life science context.</td><td></td><td>•</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Grade - 7
Strand - 4. Life Science
Substrand - 2. Interdependence Among Living Systems
Standard - 1. Natural systems include a variety of organisms that interact with one another in several ways.</td></tr>
<tr><td>7.4.2.1.1</td><td>Identify a variety of populations and communities in an ecosystem and describe the relationships among the populations and communities in a stable ecosystem.</td><td></td><td>•</td><td></td><td></td><td></td><td></td></tr>
<tr><td>7.4.2.1.3</td><td>Explain how the number of populations an ecosystem can support depends on the biotic resources available as well as abiotic factors such as amount of light and water, temperature range and soil composition.</td><td></td><td>•</td><td>•</td><td></td><td></td><td></td></tr>
</table>

Science (continued)							
Grade - 7 Strand - 4. Life Science Substrand - 3. Evolution in Living Systems Standard - 2. Individual organisms with certain traits in particular environments are more likely than others to survive and have offspring.							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
7.4.3.2.4	Recognize that extinction is a common event and it can occur when the environment changes and a population's ability to adapt is insufficient to allow its survival.		•		•		
Grade - 7 Strand - 4. Life Science Substrand - 4. Human Interactions with Living Systems Standard - 1. Human ativity can change living organisms and ecosystems.							
7.4.4.1.2	Describe ways that human activities can change the populations and communities in an ecosystem.		•		•	•	•
Grade - 8 Strand - 1. The Nature of Science and Engineering Substrand - 1. The Practice of Science Standard - 2. Scientific inquiry is a set of interrelated processes incorporating multiple approaches that are used to pose questions about the natural and engineered world and investigate phenomena.							
8.1.1.2.1	Use logical reasoning and imagination to develop descriptions, explanations, predictions and models based on evidence.					•	
Grade - 8 Strand - 1. The Nature of Science and Engineering Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics and Society Standard - 3. Science and engineering operate in the context of society and both influence and are influenced by this context.							
8.1.3.3.3	Provide examples of how advances in technology have impacted how people live, work and interact.			•	•	•	
Grade - 8 Strand - 1. The Nature of Science and Engineering Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics and Society Standard - 4. Current and emerging technologies have enabled humans to develop and use models to understand and communicate how natural and designed systems work and interact.							
8.1.3.4.1	Use maps, satellite images and other data sets to describe patterns and make predictions about local and global systems in earth science contexts. For example: Use data or satellite images to identify locations of earthquakes and volcanoes, ocean surface temperatures, or weather patterns.			•	•	•	
8.1.3.4.2	Determine and use appropriate safety procedures, tools, measurements, graphs and mathematical analyses to describe and investigate natural and designed systems in earth and physical science contexts.		•				

Science (continued)							
Grade - 8 Strand - 3. Earth Science Substrand - 2. Interdependence Within the Earth system Standard - 2. Patterns of atmospheric movement influence global climate and local weather.							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
8.3.2.2.1	Describe how the composition and structure of the Earth's atmosphere affects energy absorption, climate, and the distribution of particulates and gases. For example: Certain gases contribute to the greenhouse effect.				•	•	
8.3.2.2.3	Relate global weather patterns to patterns in regional and local weather.				•	•	
Grade - 8 Strand - 3. Earth Science Substrand - 4. Human Interactions with Earth Systems Standard - 1. In order to maintain and improve their existence humans interact with and influence Earth systems.							
8.3.4.1.2	Recognize that land and water use practices affect natural processes and that natural processes interfere and interact with human systems. For example: Levees change the natural flooding process of a river. Another example: Agricultural runoff influences natural systems far from the source.						•
Social Studies - Geography							
Grades - K-3 Substrand - B. Maps and Globes Standard - The student will use and create maps and globes to locate people, places and things.							
	1. Students will locate places by using simple maps, and understand that maps are drawings of locations and places as viewed from above. 2. Students will recognize and locate the outline shape of the state of Minnesota on a map/globe. 3. Students will create and interpret simple maps using the map elements of title, direction, symbols, and a map key or legend.		•				
Grades - K-3 Substrand - C. Physical Features and Processes Standard - The student will distinguish between physical and human-made features of places on the Earth's surface.							
	1. Students will name and locate physical features of the United States, including places about which they have read. 2. Students will name and locate major human-made features of the United States, including features about which they have read.		•				
Grades - 4-8 Substrand - A. Concepts of Location Standard - The student will identify and locate major physical and cultural features that played an important role in the history of Minnesota.							
	1. Students will locate major Minnesota ecosystems, topographic features, continental divides, river valleys, and cities.		•				
Grades - 4-8 Substrand - A. Concepts of Location Standard - The student will use maps and globes to demonstrate specific and increasingly complex geographic knowledge.							
	1. Students will use political and thematic maps to locate major physical and cultural regions of the world and ancient civilizations studied. 4. Students will distinguish differences among uses of, and limitations of, different kinds of thematic maps to describe the development of Minnesota.		•				

Geography (continued)							
Grades - 4-8 Substrand - A. Concepts of Location Standard - The student will make and use maps to acquire, process, and report on the spatial organization of people and places on earth.							
	1. Students will create a variety of maps to scale. 2. Students will compare and contrast the differences among a variety of maps and explain the appropriate use of projections, symbols, coloring and shading, and select maps appropriate for answering questions they have.		•				
Grades - 4-8 Substrand - A. Concepts of Location Standard - The student will use basic terminology describing basic physical and cultural features of continents studied.							
	1. Students will locate and describe major physical features and analyze how they influenced cultures/civilizations studied. 2. Students will describe and locate major physical features in their local community and analyze their impact on the community.		•				
Grades - 4-8 Substrand - C. Physical Features and Processes Standard - The student will identify and locate geographic features associated with the development of Minnesota.							
	1. Students will identify and compare and contrast the landforms, natural vegetation, climate, and systems of rivers and lakes of Minnesota with those of other parts of the United States. 2. Students will identify physical features that shaped settlement and life-ways of the Dakota and the Ojibwe and analyze their impact. 3. Students will identify physical features that either hindered or promoted the development of the fur trade and the rapid settlement in the early 19th Century. 4. Students will identify physical features that either hindered or promoted the industrialization of the state.		•				
Grades - 4-8 Substrand - D. Interconnections Standard - The student will give examples that demonstrate how people are connected to each other and the environment.							
	2. Students will analyze how the physical environment influences human activities.		•	•	•	•	
Grades - 4-8 Substrand - D. Interconnections Standard - The student will identify examples of the changing relationships between the patterns of settlement and land use in Minnesota.							
	1. Students will give examples of how changes in technology made some locations in Minnesota more suitable for urbanization than others. 7. Students will use regions to analyze modern agriculture in MN.		•	•	•	•	
Grades - 4-8 Substrand - E. Essential Skills Standard - The student will use maps, globes, geographic information systems and other sources of information to analyze the natures of places at a variety of scales.							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
	1. Students will demonstrate the ability to obtain geographic information from a variety of print and electronic sources. 2. Students will make inferences and draw conclusions about the character of places based on analysis and comparison of maps, aerial photos, and other images.		•				

English Language Arts - K–12

Please note: Due to the extensive number of standards aligned there is not as much detail provided below. More information on Minnesota Language Arts Standards can be found at:
http://education.state.mn.us/MDE/EdExc/StanCurri/K-12AcademicStandards/index.htm

English Language Arts							
Grade - 3 READING Informational Text							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
		3.2.1.1 3.2.4.4 3.2.9.9 3.6.6.6 3.6.7.7	3.2.1.1 3.2.4.4 3.2.5.5 3.2.7.7 3.2.8.8 3.2.9.9	3.2.1.1 3.2.3.3 3.2.4.4 3.2.5.5 3.2.7.7 3.2.8.8 3.2.9.9	3.2.1.1 3.2.3.3 3.2.4.4 3.2.5.5 3.2.7.7 3.2.8.8 3.2.9.9	3.2.1.1 3.2.3.3 3.2.4.4 3.2.5.5 3.2.7.7 3.2.8.8 3.2.9.9	3.2.4.4 3.2.8.8
Grade - 3 WRITING							
		3.6.6.6 3.6.10.10	3.6.6.6 3.6.7.7 3.6.8.8 3.6.9.9 3.6.10.10	3.6.6.6 3.6.8.8 3.6.9.9 3.6.10.10	3.6.6.6 3.6.8.8 3.6.9.9 3.6.10.10	3.6.6.6 3.6.8.8 3.6.9.9 3.6.10.10	3.6.1.1 3.6.4.4 3.6.6.6 3.6.9.9 3.6.10.10 3.6.10.10
Grade - 3 SPEAKING, VIEWING, LISTENING, AND MEDIA LITERACY							
		3.8.2.2	3.8.1.1 3.8.2.2 3.8.4.4	3.8.1.1 3.8.2.2	3.8.1.1 3.8.2.2	3.8.1.1 3.8.2.2	3.8.1.1 3.8.5.5 3.8.8.8
Grade - 4 READING Informational Text							
		4.2.5.5	4.2.5.5 4.2.7.7	4.2.5.5 4.2.7.7	4.2.5.5 4.2.7.7	4.2.5.5 4.2.7.7 4.2.9.9	
Grade - 4 WRITING							
		4.6.2.2 4.6.10.10	4.6.2.2 4.6.6.6 4.6.7.7 4.6.8.8 4.6.10.10	4.6.2.2 4.6.6.6 4.6.8.8 4.6.10.10	4.6.2.2 4.6.6.6 4.6.8.8 4.6.10.10	4.6.2.2 4.6.6.6 4.6.8.8 4.6.10.10	4.6.1.1 4.6.10.10
		5.6.6.6 5.6.10.10	5.6.2.2 5.6.6.6 5.6.7.7 5.6.10.10	5.6.2.2 5.6.6.6 5.6.10.10	5.6.2.2 5.6.6.6 5.6.10.10	5.6.2.2 5.6.6.6 5.6.10.10	5.6.10.10

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Grade - 4 SPEAKING, VIEWING, LISTENING, AND MEDIA LITERACY							
		4.8.1.1	4.8.1.1 4.8.2.2	4.8.1.1 4.8.2.2	4.8.1.1 4.8.2.2	4.8.1.1 4.8.2.2	4.8.1.1 4.8.8.8
Grade - 5 READING Informational Text							
		5.2.1.1	5.2.1.1 5.2.3.3 5.2.7.7 5.2.9.9	5.2.1.1 5.2.3.3 5.2.7.7 5.2.9.9	5.2.1.1 5.2.3.3 5.2.7.7 5.2.9.9	5.2.1.1 5.2.3.3 5.2.5.5 5.2.7.7 5.2.9.9	
Grade - 5 WRITING							
		5.6.6.6 5.6.10.10	5.6.2.2 5.6.6.6 5.6.7.7 5.6.10.10	5.6.2.2 5.6.6.6 5.6.10.10	5.6.2.2 5.6.6.6 5.6.10.10	5.6.2.2 5.6.6.6 5.6.10.10	5.6.10.10
Grade - 5 SPEAKING, VIEWING, LISTENING, AND MEDIA LITERACY							
			5.8.2.2	5.8.2.2	5.8.2.2	5.8.2.2	5.8.5.5 5.8.5.5 5.8.8.8

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
English Language Arts Grades - 6–8 READING in Science and Technical Subjects							
		12.1.1 12.2.2 13.6.6		12.1.1 12.2.2 13.4.4 13.6.6 13.7.7 13.10.10	12.1.1 12.2.2 13.6.6 13.7.7 13.8.8 13.10.10	12.1.1 12.2.2 13.3.3 13.4.4 13.6.6 13.7.7 13.8.8 13.9.9 13.10.10	12.1.1 12.2.2 13.3.3
Grades - 6–8 WRITING in History/Social Studies, Science and Technical Subjects							
		14.3.3 14.4.4 14.10.10	14.2.2 14.3.3 14.4.4 14.7.7 14.8.8 14.10.10	14.2.2 14.3.3 14.4.4 14.6.6 14.8.8 14.10.10	14.2.2 14.3.3 14.4.4 14.6.6 14.8.8 14.10.10	14.1.1 14.2.2 14.3.3 14.4.4 14.6.6 14.8.8 14.10.10	14.2.2 14.3.3 14.4.4 14.5.5 14.6.6 14.10.10

Minnesota Environmental Literacy Scope and Sequence Benchmarks							
Grades - 3–5							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
	In social and natural systems that consist of many parts, the parts usually influence one another.		•	•	•	•	
	Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected.		•	•	•	•	
Grades - 6–8							
	Social and natural systems can include processes as well as things.		•	•	•	•	
	The output from a social or natural system can become the input to other parts of social and natural systems.		•	•	•	•	
	Social and natural systems are connected to each other and to other larger or smaller systems.		•	•	•	•	•

The Essential Principles of Climate Literacy

Developed through a cooperative effort of numerous US federal agency scientists, formal and informal educators, interested individuals, and representatives from nongovernmental organizations and other institutions involved in climate research, education, and outreach, the Essential Principles of Climate Science summarizes the most important principles and concepts of climate science. It presents important information for individuals and communities to understand Earth's climate, impacts of climate change, and approaches for adapting and mitigating change. Principles can serve as discussion starters or launching points for scientific inquiry. They can also serve educators who teach climate science as part of their science curricula. More information can be found at: http://cleanet.org/cln/climateliteracy.html

A climate literate person will

- understand the essential principles of Earth's climate system;
- knows how to assess scientifically credible information about climate;
- communicates about climate and climate change in a meaningful way;
- is able to make informed and responsible decisions with regard to actions that may affect climate.

The Essential Principles of Climate Literacy

The Guiding Principle for Informed Climate Decisions
Principle: Humans can take actions to reduce climate change and its impacts.

	Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
	A. Climate information can be used to reduce vulnerabilities or enhance the resilience of communities and ecosystems affected by climate change. Continuing to improve scientific understanding of the climate system and the quality of reports to policy and decision makers is crucial.				•	•	•
	B. Reducing human vulnerability to the impacts of climate change depends not only upon our ability to understand climate science, but also upon our ability to integrate that knowledge into human society. Decisions that involve Earth's climate must be made with an understanding of the complex interconnections among the physical and biological components of the Earth system as well as the consequences of such decisions on social, economic, and cultural systems.				•	•	•
	C. The impacts of climate change may affect the security of nations. Reduced availability of water, food, and land can lead to competition and conflict among humans, potentially resulting in large groups of climate refugees.						
	D. Humans may be able to mitigate climate change or lessen its severity by reducing greenhouse gas concentrations through processes that move carbon out of the atmosphere or reduce greenhouse gas emissions.						•
	E. A combination of strategies is needed to reduce greenhouse gas emissions. The most immediate strategy is conservation of oil, gas, and coal, which we rely on as fuels for most of our transportation, heating, cooling, agriculture, and electricity. Short-term strategies involve switching from carbon-intensive to renewable energy sources, which also requires building new infrastructure for alternative energy sources. Long-term strategies involve innovative research and a fundamental change in the way humans use energy.						•
	F. Humans can adapt to climate change by reducing their vulnerability to its impacts. Actions such as moving to higher ground to avoid rising sea levels, planting new crops that will thrive under new climate conditions, or using new building technologies represent adaptation strategies. Adaptation often requires financial investment in new or enhanced research, technology, and infrastructure.						•
	G. Actions taken by individuals, communities, states, and countries all influence climate. Practices and policies followed in homes, schools, businesses, and governments can affect climate. Climate-related decisions made by one generation can provide opportunities as well as limit the range of possibilities open to the next generation. Steps toward reducing the impact of climate change may influence the present generation by providing other benefits such as improved public health infrastructure and sustainable built environments.						•

The Essential Principles of Climate Literacy (continued)							
The Essential Principles of Climate Science 1. The sun is the primary source of energy for Earth's climate system.							
	Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
	Sunlight reaching the Earth can heat the land, ocean, and atmosphere. Some of that sunlight is reflected back to space by the surface, clouds, or ice. Much of the sunlight that reaches Earth is absorbed and warms the planet.						
	When Earth emits the same amount of energy as it absorbs, its energy budget is in balance, and its average temperature remains stable.						
	The tilt of Earth's axis relative to its orbit around the sun results in predictable changes in the duration of daylight and the amount of sunlight received at any latitude throughout a year. These changes cause the annual cycle of seasons and associated temperature changes.						
	Gradual changes in Earth's rotation and orbit around the sun change the intensity of sunlight received in our planet's polar and equatorial regions. For at least the last 1 million years, these changes occurred in 100,000-year cycles that produced ice ages and the shorter warm periods between them.						
	A significant increase or decrease in the sun's energy output would cause Earth to warm or cool. Satellite measurements taken over the past 30 years show that the sun's energy output has changed only slightly and in both directions. These changes in the sun's energy are thought to be too small to be the cause of the recent warming observed on Earth.						
The Essential Principles of Climate Science 2. Climate is regulated by complex interactions among components of the Earth system.							
	Earth's climate is influenced by interactions involving the sun, ocean, atmosphere, clouds, ice, land, and life. Climate varies by region as a result of local differences in these interactions.			•			
	Covering 70% of Earth's surface, the ocean exerts a major control on climate by dominating Earth's energy and water cycles. It has the capacity to absorb large amounts of solar energy. Heat and water vapor are redistributed globally through density-driven ocean currents and atmospheric circulation. Changes in ocean circulation caused by tectonic movements or large influxes of fresh water from melting polar ice can lead to significant and even abrupt changes in climate, both locally and on global scales.						
	The amount of solar energy absorbed or radiated by Earth is modulated by the atmosphere and depends on its composition. Greenhouse gases—such as water vapor, carbon dioxide, and methane—occur naturally in small amounts and absorb and release heat energy more efficiently than abundant atmospheric gases like nitrogen and oxygen. Small increases in carbon dioxide concentration have a large effect on the climate system.				•		
	The abundance of greenhouse gases in the atmosphere is controlled by biogeochemical cycles that continually move these components between their ocean, land, life, and atmosphere reservoirs. The abundance of carbon in the atmosphere is reduced through seafloor accumulation of marine sediments and accumulation of plant biomass, and is increased through deforestation and the burning of fossil fuels as well as through other processes.						
	Airborne particulates, called "aerosols," have a complex effect on Earth's energy balance: they can cause both cooling, by reflecting incoming sunlight back out to space, and warming, by absorbing and releasing heat energy in the atmosphere. Small solid and liquid particles can be lofted into the atmosphere through a variety of natural and manmade processes, including volcanic eruptions, sea spray, forest fires, and emissions generated through human activities.						
	The interconnectedness of Earth's systems means that a significant change in any one component of the climate system can influence the equilibrium of the entire Earth system. Positive feedback loops can amplify these effects and trigger abrupt changes in the climate system. These complex interactions may result in climate change that is more rapid and on a larger scale than projected by current climate models.				•	•	

The Essential Principles of Climate Literacy (continued)							
The Essential Principles of Climate Science 3. Life on Earth depends on, is shaped by, and affects climate.							
	Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
	Individual organisms survive within specific ranges of temperature, precipitation, humidity, and sunlight. Organisms exposed to climate conditions outside their normal range must adapt or migrate, or they will perish.		•	•			
	The presence of small amounts of heat-trapping greenhouse gases in the atmosphere warms Earth's surface, resulting in a planet that sustains liquid water and life.				•		
	Changes in climate conditions can affect the health and function of ecosystems and the survival of entire species. The distribution patterns of fossils show evidence of gradual as well as abrupt extinctions related to climate change in the past.						
	A range of natural records shows that the last 10,000 years have been an unusually stable period in Earth's climate history. Modern human societies developed during this time. The agricultural, economic, and transportation systems we rely upon are vulnerable if the climate changes significantly.						
	Life—including microbes, plants, and animals and humans—is a major driver of the global carbon cycle and can influence global climate by modifying the chemical makeup of the atmosphere. The geologic record shows that life has significantly altered the atmosphere during Earth's history.						
The Essential Principles of Climate Science 4. Climate varies over space and time through both natural and man-made processes.							
	Climate is determined by the long-term pattern of temperature and precipitation averages and extremes at a location. Climate descriptions can refer to areas that are local, regional, or global in extent. Climate can be described for different time intervals, such as decades, years, seasons, months, or specific dates of the year.			•	•	•	
	Climate is not the same thing as weather. Weather is the minute-by-minute variable condition of the atmosphere on a local scale. Climate is a conceptual description of an area's average weather conditions and the extent to which those conditions vary over long time intervals.			•			
	Climate change is a significant and persistent change in an area's average climate conditions or their extremes. Seasonal variations and multi-year cycles (for example, the El Niño southern oscillation) that produce warm, cool, wet, or dry periods across different regions are a natural part of climate variability. They do not represent climate change.			•	•		
	Scientific observations indicate that global climate has changed in the past, is changing now, and will change in the future. The magnitude and direction of this change is not the same at all locations on Earth.				•	•	
	Based on evidence from tree rings, other natural records, and scientific observations made around the world, Earth's average temperature is now warmer than it has been for at least the past 1,300 years. Average temperatures have increased markedly in the past 50 years, especially in the North Polar region.				•	•	
	Natural processes driving Earth's long-term climate variability do not explain the rapid climate change observed in recent decades. The only explanation that is consistent with all available evidence is that human activity is playing an increasing role in climate change. Future changes in climate may be rapid compared to historical changes.				•	•	
	Natural processes that remove carbon dioxide from the atmosphere operate slowly when compared to the processes that are now adding it to the atmosphere. Thus, carbon dioxide introduced into the atmosphere today may remain there for a century or more. Other greenhouse gases, including some created by humans, may remain in the atmosphere for thousands of years.						

The Essential Principles of Climate Literacy (continued)							
The Essential Principles of Climate Science 5. Our understanding of the climate system is improved through observations, theoretical studies, and modeling.							
	Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
	The components and processes of Earth's climate system are subject to the same physical laws as the rest of the Universe. Therefore, the behavior of the climate system can be understood and predicted through careful, systematic study.					•	
	Environmental observations are the foundation for understanding the climate system. From the bottom of the ocean to the surface of the sun, instruments on weather stations, buoys, satellites, and other platforms collect climate data. To learn about past climates, scientists use natural records, such as tree rings, ice cores, and sedimentary layers. Historical observations, such as native knowledge and personal journals, also document past climate change.	•	•	•	•	•	
	Observations, experiments, and theory are used to construct and refine computer models that represent the climate system and make predictions about its future behavior. Results from these models lead to better understanding of the linkages between the atmosphere-ocean system and climate conditions and inspire more observations and experiments. Over time, this iterative process will result in more reliable projections of future climate conditions.					•	
	Our understanding of climate differs in important ways from our understanding of weather. Climate scientists' ability to predict climate patterns months, years, or decades into the future is constrained by different limitations than those faced by meteorologists in forecasting weather days to weeks into the future.			•			
	Scientists have conducted extensive research on the fundamental characteristics of the climate system and their understanding will continue to improve. Current climate change projections are reliable enough to help humans evaluate potential decisions and actions in response to climate change.				•	•	
The Essential Principles of Climate Science 6. Human activities are impacting the climate system.							
	The overwhelming consensus of scientific studies on climate indicates that most of the observed increase in global average temperatures since the latter part of the 20th century is very likely due to human activities, primarily from increases in greenhouse gas concentrations resulting from the burning of fossil fuels.				•	•	
	Emissions from the widespread burning of fossil fuels since the start of the Industrial Revolution have increased the concentration of greenhouse gases in the atmosphere. Because these gases can remain in the atmosphere for hundreds of years before being removed by natural processes, their warming influence is projected to persist into the next century.				•	•	
	Human activities have affected the land, oceans, and atmosphere, and these changes have altered global climate patterns. Burning fossil fuels, releasing chemicals into the atmosphere, reducing the amount of forest cover, and rapid expansion of farming, development, and industrial activities are releasing carbon dioxide into the atmosphere and changing the balance of the climate system.				•	•	
	Growing evidence shows that changes in many physical and biological systems are linked to human-caused global warming. Some changes resulting from human activities have decreased the capacity of the environment to support various species and have substantially reduced ecosystem biodiversity and ecological resilience.			•	•	•	
	Scientists and economists predict that there will be both positive and negative impacts from global climate change. If warming exceeds 2–3°C (3.6–5.4°F) over the next century, the consequences of the negative impacts are likely to be much greater than the consequences of the positive impacts.				•		

The Essential Principles of Climate Literacy (continued)							
The Essential Principles of Climate Science 7. Climate change will have consequences for the Earth system and human lives.							
	Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
	Melting of ice sheets and glaciers, combined with the thermal expansion of seawater as the oceans warm, is causing sea levels to rise. Seawater is beginning to move onto low-lying land and to contaminate coastal fresh water sources, and beginning to submerge coastal facilities and barrier islands. Sea-level rise increases the risk of damage to homes and buildings from storm surges such as those that accompany hurricanes.						
	Climate plays an important role in the global distribution of freshwater resources. Changing precipitation patterns and temperature conditions will alter the distribution and availability of freshwater resources, reducing reliable access to water for many people and their crops. Winter snowpack and mountain glaciers that provide water for human use are declining as a result of global warming.				•	•	
	Incidents of extreme weather are projected to increase as a result of climate change. Many locations will see a substantial increase in the number of heat waves they experience per year and a likely decrease in episodes of severe cold. Precipitation events are expected to become less frequent but more intense in many areas, and droughts will be more frequent and severe in areas where average precipitation is projected to decrease.				•	•	
	The chemistry of ocean water is changed by absorption of carbon dioxide from the atmosphere. Increasing carbon dioxide levels in the atmosphere is causing ocean water to become more acidic, threatening the survival of shell-building marine species and the entire food web of which they are a part.						
	Ecosystems on land and in the ocean have been and will continue to be disturbed by climate change. Animals, plants, bacteria, and viruses will migrate to new areas with favorable climate conditions. Infectious diseases and certain species will be able to invade areas that they did not previously inhabit.				•		
	Human health and mortality rates will be affected to different degrees in specific regions of the world as a result of climate change. Although cold-related deaths are predicted to decrease, other risks are predicted to rise. The incidence and geographical range of climate-sensitive infectious diseases—such as malaria, dengue fever, and tick-borne diseases—will increase. Drought-reduced crop yields, degraded air and water quality, and increased hazards in coastal and low-lying areas will contribute to unhealthy conditions, particularly for the most vulnerable populations.				•	•	

Grades 3–8 Lesson Organizer

Lesson Outcomes	*Lesson Materials*
Lesson 1: What is a journal for?	
• Students will identify key features of a journal • Students will identify journal entry themes • Students will compare journal entries from different time periods and in different styles • Students will create their own journal to be used for outdoor observation and documenting their exploration of *Minnesota's Changing Climate*	Three Will Steger Journal Entries Three Excerpts from *Eden Summer Collages* (David Coggins) Four Historical Biome Journal Exerpts
Lesson 2: What defines Minnesota's biomes?	
• Students will identify Minnesota's four main biomes. • Students will identify characteristic vegetation and animals found in each biome. • Students will describe and compare factors that define each biome.	Will Steger Journal Entry Handout 1: Biome Cards Handout 2: Minnesota Biomes Table Handout 3: Minnesota Biomes Map
Lesson 3: What defines Minnesota's Climate?	
• Students will define climate and weather • Students will define climate change • Students will define phenology • Students will gather their own weather data from their school site and record it in their journal • Students will graphically represent authentic data from Minnesota's Climatology site • Students will make three predictions of how a change in climate might affect Minnesota's biomes	Three Will Steger Journal Entries Handout 1: Normal Mean Temperature Annual Map Handout 2: Normal Annual Precipitation Map Handout 3: What Defines Minnesota's climate? Student Worksheet
Lesson 4: What is climate change and what does it mean for Minnesota?	
• Students will explain the causes of climate change • Students will explain the implications of climate change • Students will predict how climate change might impact or is impacting the area where they live • Students will describe five key climate change implications for Minnesotans	Will Steger Journal Entry Handout 1: Key Implications for Minnesotans Facing Climate Change Cards Handout 2: Climate Change Fact Cards
Lesson 5: What does the data show?	
• Students will make their own interpretations of figures of data that represent different impacts of climate change on Minnesota. • Students will make the connection between 3-D objects and what the data represents. • Students will divide 3 statements about each graph into true or false categories. • Students will share their results. • Students will brainstorm how climate change could affect their biome.	Will Steger Journal Handout 1: Twelve Activity Sheets Handout 2: Full Size Figures Handout 3: Activity Sheet Template/Gameboard
Lesson 6: What can I do?	
• Students will brainstorm appropriate solutions and select one for their group, class or school. • Students will develop a climate action plan and begin to implement it.	Handout 1: Climate Action Template Handout 2: Climate Action Plan Worksheet

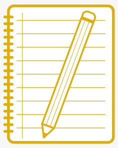
Lesson 1: Minnesota's Changing Climate

What is a journal for?

Age Level:	Grades 3-12
Time Needed:	50 minutes
Materials:	Journal/notebook for each student Access to the Internet (to watch videos and view journal examples) Projector or handouts of journal examples
Student Learning Outcomes:	• Students will identify key features of a journal. • Students will identify journal entry themes. • Students will compare journal entries from different time periods and in different styles. • Students will create their own journal to be used for documenting their outdoor observations and exploration of *Minnesota's Changing Climate*.

Background Information

Journals are a tool for exploring the natural world and can be used to develop many different skills. In this lesson, students will have the opportunity to look at journal excerpts written at different points in Will Steger's life. They show different styles of journaling and ways of observing and documenting the natural world. In addition to excerpts from Will's journals, there are examples from individuals who have kept journals about Minnesota's natural world throughout history. Finally, David Coggins, a Minnesota writer and artist, provided us with beautiful examples of art/collage journals. Journal excerpts are found on pages 6-13.



Journal Assignment

Each lesson in *Minnesota's Changing Climate* includes journaling activities, and assessments that should be kept together in a journal or notebook. Students will conclude this lesson by designing their own journal. Students should paste their work from this lesson in the journal to look back on in later lessons.

> There is something to journaling that is extremely important. It's a way of learning where you absorb yourself... you put your mind and your attention and your focus on one observation. It's a mechanism of where you are going through your curiosity and your thought, and you're documenting and you're writing it down....It's a learning process. The idea [is] to see [nature] in a different way.
>
> —Will Steger, Interview, July, 2010

Activity Description

Introduction

Click on the "Journal Basics" category of the "Journals" section in any biome in the learning module of the online classroom at http://classroom.willstegerfoundation.org. Afterwards, have a short discussion about journaling and journals.

There are many different types of journals. Nature journals, personal journals, travel journals, scrapbooks, sketchbooks and blogs are just a few examples. Will shows examples of some of his journal entries in the video and talks about why he thinks it is important.

1. What has Will used his journals for and why were they important?
2. What does he mean when he says the point of journaling is "to see nature in a different way?"
3. Has anyone used a journal before or does anyone have a journal, or a diary?
4. What do you use it for?
5. What sorts of things do you put in it?
6. Is it just writing or do you sketch or put other objects (newspaper clippings, programs, stickers, pressed flowers, etc.)?
7. Why do you think journals might be useful?

Activity: Explore different styles of journals

1. Hand out copies of the different journal excerpts found on pages 6-13, or access them online at http://classroom.willstegerfoundation.org/handouts. If you have Internet access, also show the examples listed below under Internet Journal Examples. These journal examples show a number of different styles of journals focused on nature observation, and provide a broad array of examples from the early exploration of Minnesota's natural resources to more contemporary and artistic enjoyment of nature.

Journal excerpts include:

- Weather Journal, 1956, Will Steger (12 years old)
- Astronomy Journal-when Sputnik was launched, 1957, Will Steger (13 years old)
- Phenology Journal, 1978, Will Steger
- Art/Collage Journal, 2004, David Coggins (3 entries)
- Historical Minnesota Biome Journal Excerpts (4 entries)

Internet Journal Examples

- Botany Journal, 1836, Charles Geyer found at: http://www.stolaf.edu/academics/nicollet/geyerjournalintro.html
- Selection of Natural History blogs found at: http://neurophilosophy.wordpress.com/2007/03/03/natural-history-blogs/

2. Ask the students to answer the following questions independently on a sheet of paper:
   1. What journal entry did you think was the most interesting? Why?
   2. What journal entry do you think was the most useful? Why?
   3. How were the journal entries similar?
   4. How were the journal entries different?
   5. What topics were covered in the journal entries?
   6. If you were to start a journal what would you use it to record? What would be important to include in each entry? Ask them to answer the questions.
3. Bring the students back together as a class. On the board make a list of
   - Things they found interesting;
   - Things that were common between the examples;
   - Things that are different between the examples;
   - Topics or themes that the different journal entries covered.
4. Ask the students to choose one of the journal entries. Hand out pieces of paper and ask them to write their own journal entry in the same style as the journal entry they chose. Before they start they should identify key elements that define the journal entry. This could include date, sketches, observations of weather, or lists of birds or plants seen.

Concluding Activity

The students will have investigated different styles of journaling through the excerpts provided. Students should now create or be provided with a notebook that will be their own journal to use during their exploration of *Minnesota's Changing Climate*. Students should personalize their journal and integrate the exploration of Minnesota's biomes, the impacts of climate change, and solutions that can happen at schools and be led by students.

Descriptions of different styles of journals are provided in the following pages. If you have time, take a few class periods or portions of class periods to explore the different styles of journaling described in the following pages. Discuss when each type of journal might be used and how most journals don't just use one style, but depending on the person's mood or what information they would like to record, may have many different styles.

Science Notebooks

Materials:

- Notebook
- Colored pencils
- Graphing paper
- Items for investigations

Klentschy writes, "A science notebook is a central place where language, data, and experience work together to form meaning for the student."(2005) Creating and using a science notebook helps develop skills such as student organization, data recording and interpretation, question development, reasonable predictions, and reflection.

Each entry in a science notebook should begin with a question that is investigable. Developing good questions that don't have yes or no answers can be difficult. Taking the students outside a few times observing and exploring will often elicit curiosity around a particular subject. Developing a question about something that is real and tangible and interesting to them will lead to a much richer project.

Once the student has developed a question, they should also come up with a prediction of what they will discover through their investigation.

After the student develops the question, they will need to determine how they can go about answering it through an investigation. Planning for their investigation should include the steps involved, material needs and how they will organize the data they collect. It will be important to have a discussion about charts, tables, graphs, Venn diagrams, and labeled sketches or diagrams as possible data organizers.

Once students have determined their question, prediction, and how they will organize their observations they may begin their investigation. Investigations can last an hour to an entire school year depending on the questions they ask.

Once students have finished their investigation they will need to review their science notebook and data. Their observations should help them develop some sort of claims related to their question and help them develop a statement of what they learned. This step of interpreting and explaining what they learned is an important skill in science and can involve oral presentations, PowerPoints, graphing and other multimedia. The science notebook will be integral to development of any presentation.

Finally, the students should be asked to think about what new questions they have as a result of their investigation. If they could do another investigation, what would they do?

Art or Collage Journals

Materials:

- Notebook
- Colored pencils
- Flower/plant press
- Glue
- Photos

Some students may be interested in making their observations through sketching, poetry or creative writing, or collages of objects associated with their observations. Pressed flowers, photos, maps are just a few examples of what can go into this type of journal.

Blogging

Materials:

- Internet access
- Digital camera
- Computer

If you are interested in sharing and collaborating with students or others anywhere in the world, a blog is an easy and fun way to do this. A blog, or web log, is an online shared journal. In addition to written material, it is possible to embed videos, photos and audio in a blog. Blogs can generally be made as publicly accessible as you want them to be and after each blog post it is possible to leave comments for the writer. This function makes it possible for peer interaction around a particular topic both locally and globally. Some good places to start a blog include posterous.com or blogspot.com.

Take it Outside—Connecting With Your Place

Phenology Journals

Materials:

- Notebook
- Colored pencils
- Thermometer
- Rain gauge
- Barometer
- Cloud charts
- Historic weather data
- Camera

Phenology is the study of the cyclical nature of biological events as they relate to climate and season. Phenology journals often include observations of the natural world, sketches, photographs and other data that relate. Because phenology is the study of how the natural world responds to climate and season, there are a few elements that are important to include in a journal entry. Date, time, location, temperature, and precipitation type or amount are basic things that should be included. Barometric readings, cloud cover and type, as well as historic highs and lows of temperature can also be included.

Phenology journals are ideally done outside, but can be done looking out the window of a classroom as well. Spending five minutes at the start of every day asking students to record certain weather elements and what observations they made of the natural world on their way to school is another method. Observations might include what color the trees were turning, if they saw birds flying south or north, what birds or other animals they saw and what the observed animals were doing. Asking the students good questions about what they saw will help them remember to look more closely the next day.

Observations of the natural world can be made in writing, sketches or photos. It can be interesting for students to choose a spot that they follow throughout the school year, observing and recording the changes with the seasons.

Temperatures and other numeric data recorded over time can be used to make graphs directly in the student journals, or on graph paper and then pasted in. Consider keeping your own phenology journals year to year, and making them available for students to view, to use for comparing the timing of seasonal events.

Extensions
Take time to try out the different styles of journaling as described above.

Online Classroom Connection
Visit http://classroom.willstegerfoundation.org

1. There are a variety of journal examples provided for each biome. Read through each journal entry and discuss them as a class, or ask students to try and write their own journal entry in the style of one of those shared.
2. Upload journal entries from your classroom! Upload them at: http://classroom.willstegerfoundation.org/get-social/share-your-observations
   Read and comment on entries from other students.

Monday October 8 1956
Partly cloudy
temperature 58 degrees
high 58
Low 49
Humidity at 6:30 p.m 38 per cent
Precipitation 24 hours ending at 6:30 p.m.: none. Total since Jan. 1 to date 23.27 inches.
Sun rises 6:21 a.m., set 5:39 p.m.
Moon phase new, Rises 12:06 p.m., sets 9:22 p.m
Wind at 4:05 p.m 15 miles per hour and at 4:30 p.m. miles per hour coming from the North west
Year ago high 67 Low 38
All-time record high for the date 80, in 1905,
All-time record Low for this date 28, in 1917

Seattle, cloudy
San Francisco, clear
Los Angeles, clear
Billings, Partly cloudy

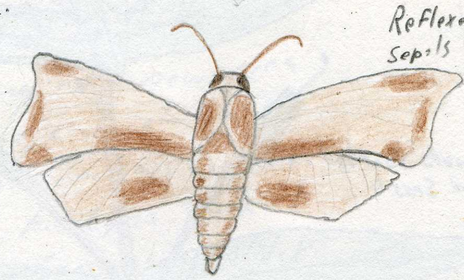
Weather Journal, 1956, Will Steger (12 years old)

-diation fog this morning. Last night clear with
-roaching full. I'm told by the locals that on
moon nights we get our early frosts. If the
-er system sits over us for several more days
-a frost by full moon. The fog from the lake
-ill keep the frost away from the garden somewhat.
last night. It's been a long time since we have
like that.

-s now a misty yellow just a little ways above the
-uetted trees on the other side of the lake. This is
early fall morning. All the animals are quite except
-sional red squirrel who insists on voicing his
-f the world. Last night and almost every night this
-have heard the white throated sparrows who
-ep at night.

-morning, the first morning or a quite, clear high pressure
-ometer 29.92, rising. Dead Calm.

-Note
-ept. 4th Southern and
-innesota had the
-ly killing frost.
Ely, but as expected
-'s lake with the
-l keep the frost
-m the garden



Sphinx Moth
Adults powerful fliers,
often have a long proboscis with
which they suck nectar. Some are called
hawkmoths for their swooping flights
others hummingbird moths because they
hover while feeding.

-ed and walked to Halbuckle field this morning. The hazy
-lhouetted the many cobwebs hanging in ~~those~~ trees
-t much of a walk because of the wet, wet waist
-ss.

-rly talked with Dave Furthmiller from Cedar. He skin
the area. Dave said the thermocline (division of cool and
-ter) was only 20 feet deep in cedar as compared with
30 feet. Cool summer he said. A cold May and June but a
-and warm August. It got so cold in Mid-June that
-atoe plants turned purple.

Just got back from a paddle on Cedar and a visit with
who lives on the lake where the stream flows out. On Cedar
from a large white pine near shore, I got the ~~closest~~ close look
-rican Bald Eagle - Beautiful bird. When he swooped down from
trees, the seagulls altered their flight route 180° and the parent loons
babies dive. ~~It's~~ cracked their house foundation in 20 places from the
blasting on Sunday. Also the blasting
made the lake so rough that
their nephew had to come in
from fishing. ~~Others~~ They

writing and drawing table
← 30" →

Common Evening Primrose*
Evening - Primrose Family*
* Largely showy flowers which close after m-
Flower parts of four. 4-branched stigma for-

Phenology Journal, 1978, Will Steger

at 4:00 a.m.

October 4 1957

Russia launched the first Earth Satellite today. The Satellite can be picked up by a ham radio at 20.005 and 40.002 megacycles. It is estimated to be 23 inches in diameter, 187 pounds, going at 18,000 miles per hour, altitude 560 miles, circles the earth once every one hour and 31 minutes and estimated life not more than three weeks.

October 5 1957

Russia misplaced the decimal place. It Weighs 18.7 pounds and goes around the earth every 93 minutes

October 20 1957

The Orionide meteor shower will reach it peak at the 21st at 20 meteor per hour. 2:20-4:00 I saw 15 meteors. The Orionids are swift in flight.

2:15-400

1 2:31, swift, Red, Magnitude 3d
2 2:34, ~~swift~~, Red, long, Magnitude 1st
3 2:40, swift, Red, Magnitude 2d
4 2:42, swift, Red, train leaving meteor, Magnitude 1st
5 2:48, swift, Red, short, Magnitude 2d
6 2:51, swift, Red, long, train, Magnitude 2d
7 2:57, swift, Red, the only one going toward Orion, Magnitude 2d
8 3:01, swift, Red, long, train leaving meteor, Magnitude 1st
9 3:20, swift, Red, long, Magnitude
10 3:25, swift, Red, very faint, magnitude 4th
11 3:28, swift, Red, short, faint, Magnitude 3d
12 3:32, swift, Red, train lasting 3 seconds, Magnitude 2d
13 3:46, swift, Red, magnitude 3d

Astronomy Journal-when Sputnik was launched, 1957, Will Steger (13 years old)

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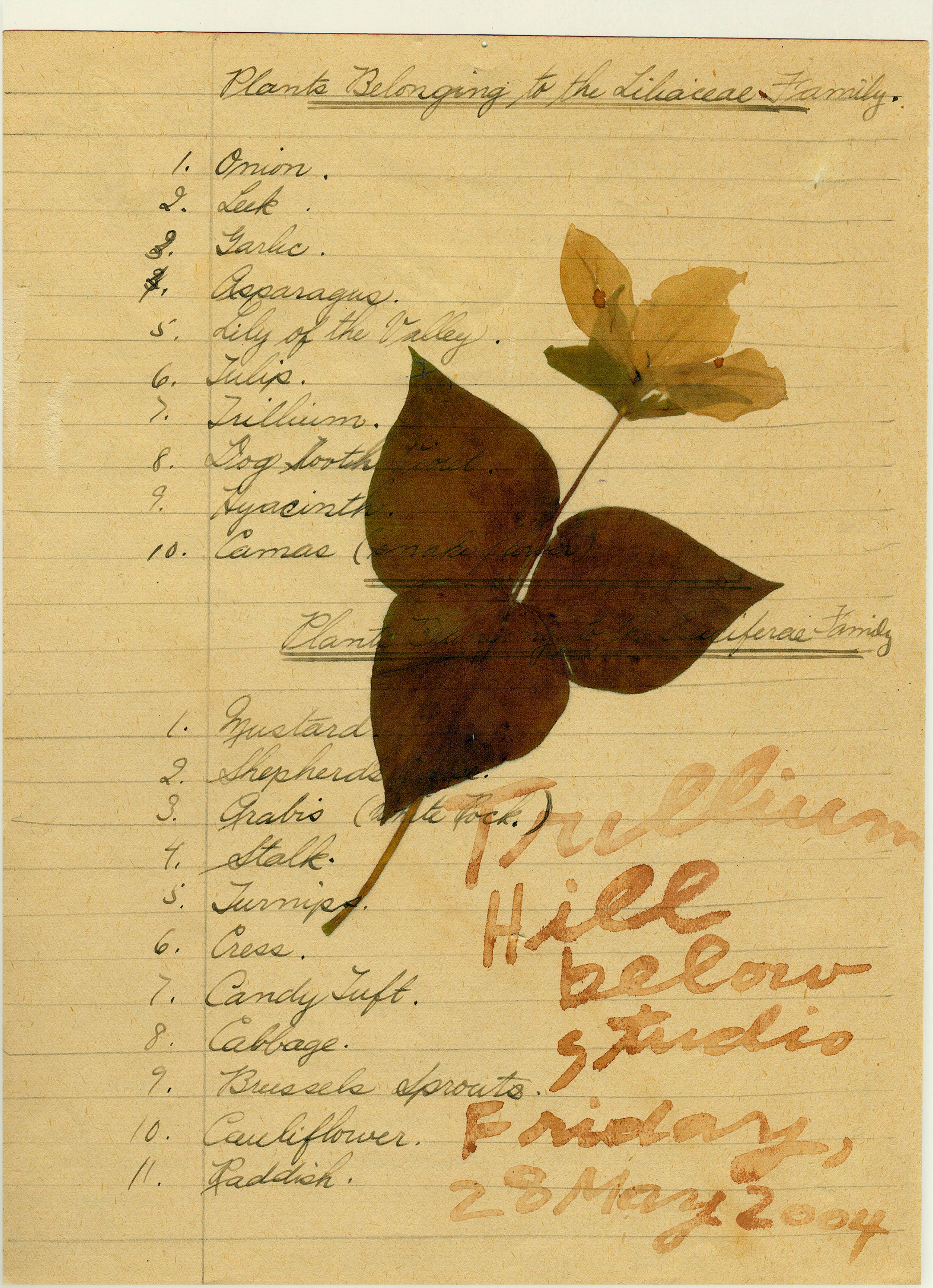

Plants Belonging to the Liliaceae Family.

1. Onion.
2. Leek.
3. Garlic.
4. Asparagus.
5. Lily of the Valley.
6. Tulip.
7. Trillium.
8. Dog Tooth Violet.
9. Hyacinth.
10. Camas (Snake Flower).

Plants Belonging to the Cruciferae Family

1. Mustard.
2. Shepherds Purse.
3. Arabis (White Rock.)
4. Stalk.
5. Turnips.
6. Cress.
7. Candy Tuft.
8. Cabbage.
9. Brussels Sprouts.
10. Cauliflower.
11. Raddish.

Trillium Hill below studio Friday, 28 May 2004

Historical Journal Excerpt Describing Minnesota's Tallgrass Aspen Parkland Biome, from Henry Hind (1823-1908)

The ancient Lake Ridge...extends in an unbroken line, except where the river from the higher level in the rear has cut channels through it, from near Lake Winnipeg, far beyond the international boundary. At the crossing-place on the Roseau, about forty-six miles from the Red River, its height is estimated to be the same as at the Middle Settlement; it forms a beautiful dry gravel road wherever traversed, and suffers only from the drawback of being the favorite haunt of numerous badgers, whose holes in the flank, and sometimes also on the summit, are dangerous to horses; it is, apparently, perfectly level for a hundred miles, and everywhere, as far as my observation enabled me to judge, shows the same even rounded summit; it may yet form an admirable means of communication through the country, and it marks the limit of the good land on the east of Red River. This ridge is a favourite resort of the prairie hen (Tetro cupido), when they perform their curious dances in the early spring months.

from: Narrative of the Canadian Red River Exploring Expedition of 1857 and Reports of Progress on the Assiniboine and Saskatchewan Exploring Expedition

Historical Journal Excerpt Describing Minnesota's Prairie Grassland, from Joseph Nicollet (1786-1843)

Thursday, June 28, 1838
We enter the Great Oasis, which offers the only direction to take without going into water several feet deep. This beautiful grove is surrounded by large lakes [Crooked, Great Oasis, Rush, and Bear] ornamented with aquatic plants, in which live innumerable families of muskrats and water birds. These lakes are from 7 to 12 feet deep, and the soil that surrounds them is suitable for potatoes and other vegetables. The distance through the grove is about 1½ miles. The growth of the various species forming it is as beautiful as any which can be seen in the basin of the lower Missouri. I will list the principle ones: 1. The linden [basswood] - 30 to 40 feet; the white birch - 20 to 30; swamp white oak- 20 to 30; swamp ash - 20 to 30; beaver wood [aspen] - 15 to 20; prickly ash - to 15 feet. As this oasis is protected from the spring and fall fires by the lakes which surround it, one can understand why the climate has been able to develop such a richness here. It is good testimony in favor of my opinion that all the prairies watered by the Mississippi and the Missouri are the work of the Indians who destroyed by fire the rich vegetation to assure themselves of animal food. Let the vast and shorn prairies that we cross remain untouched and the forests, with time will reappear.

from: 1838 Minnesota River and Blue Earth River Expeditions, Published 1843, Joseph N. Nicollet: On the Plains and Prairies, Pages 54-55, 66-67

Historical Journal Excerpt Describing Minnesota's Coniferous Foreset, from William Keating (1799-1844)

We entered Rainy-Lake River on the morning of the 28th of August, and reached its head early on the 31st. The length of this stream is about one hundred miles. Its breadth at its mouth is about four hundred yards; it becomes narrower above; its average breadth is three hundred yards; its current is rapid and uniform; there are very few obstructions to the navigation, there being but two places at which canoes are lightened and towed up. The longest of these is about one mile.

At its mouth the banks of this stream are low and marshy; beyond this they rise somewhat, but present few hills; the river runs in many places over a pebbly bed. The country assumes a more smiling appearance, which led us to anticipate the meeting with limestone rocks; we saw none along the river, but some precipices, seen at a distrance, were supposed from their horizontal stratification to be composed of limestone. On the river the rocks seldom appear in place; where we saw them they were principally mica-slate, sometimes, however, sienite. Dr. Bigsby found staurotide in the slate of this river.

from: Narrative of an expedition to the source of St. Peter's River, Lake Winnepeck, Lake of the Woods performed in the year 1823, by order of the Hon. J.C. Calhoun, Secretary of war, under the command of Stephen H. Long, Major U.S.T.E. Volume 1. Published: 1824

Historical Journal Excerpt from Minnesota's Deciduous Forest, from Jonathon Carver (1710-1780)

June 4, 1767
Came to the great meadows or plains. Here I found excellent good land and very pleasant country. [This is the area near Lake Pepin on the Wisconsin-Minneesota border.] One might travel all day and only see now and then a small pleasant grove of oak and walnut. This country is covered with grass that affords excellent pasturage for the buffeloe which here are very plenty. Could see them at a distance under the shady oaks like cattle in a pasture and sometimes a drove of an hundred or more shading themselves in these groves at noon day which afforded a very pleasant prospect for an uninhabited countyr.

We killed several of these buffaloes, one of which we all judged would weigh fifteen hundred weight and if the same could be fed as is common to fatten our tame cattle undoubtedly would weigh three thousand, they being by far the largest creatures in bulk that I ever saw...

from: Travels through the Interior Parts of North America in the Years 1766, 1767, and 1768. Published: 1778

Find more on each of these writers and hear more of their excerpts read outloud in the Will Steger Foundation online classroom within each biome's featured journal section.

Lesson 2: Minnesota's Changing Climate

What defines Minnesota's biomes?

Age Level:	Grades 3-8
Time Needed:	50 minutes
Materials:	Animal and plant biome cards (1 for each student) Map (1 for each student to paste in journal) Biomes table (1 for each student to paste in journal)
Student Learning Outcomes:	• Students will identify Minnesota's four main biomes. • Students will identify characteristic vegetation and animals found in each biome. • Students will describe and compare factors that define each biome.

Educator Prep:

- Cut out the animal and vegetation biome cards. Laminate for longevity. Make a classroom set that has equal numbers of plants and animals from each biome. Hole punch each card and put enough string through it so that it can hang around the student's neck.
- Using masking tape, make the shape of the map of Minnesota on the floor of your classroom large enough so that all of the students in your class would fit. Using chalk outside would work as well.
- Make copies of the Minnesota Biomes Table for each student
- Make copies of the Minnesota map of biome boundaries for each student (Note: color pdfs of the biome cards can be downloaded from the website at http://classroom.willstegerfoundation.org

Background Information

The Minnesota DNR uses the word "biome" to describe a biological community. Usually, biomes occur over large areas and include many similar plant communities and the animals that live in them. (MN DNR-Biomes Sheet)

Journal Assignment

At the end of this lesson, student journals should include the names of all four biomes, what defines them, a map of Minnesota that shows approximately where each biome is, and something unique about the biome where they live.

Activity Description

Introduction

1. Read out loud a journal excerpt from the biome where your school is located. These can be found in the Journals section of each biome in the online classroom at http://classroom.willstegerfoundation.org/. Ask the students to write an excerpt in their own journal that describes the plants and animals they see every day. Compare and contrast journal excerpts, discussing why there may or may not be similarities.
2. If there is time, read an excerpt from another biome and discuss.

I have spent much time alone on the porch this summer, reading and writing and other quiet things. The local animals have taken me as just another piece of furniture for they don't pay me any attention.

—Will Steger, August 17, 1974

The key is to be comfortable in order to relax and take in actually what is happening, the raw nature that is experienced: the sting of the wind on hands and nose, the freshness of the air, the beauty of the sky and land forms in such weather.

—Will Steger, Ely Homestead, January 25-27, 1977

Activity: Biome Meet and Greet

1. Ask each student to sit with their eyes shut. Hang a card around each of their necks with it hanging on their back. Explain that they will have to figure out what kind of animal or plant is on their back using yes or no questions, one per person in the class. Allow them to walk around the room asking other students.
2. Once they determine their animal or plant, they should still participate, helping other students out.
3. Ask students to take a seat. Explain that they are all wearing a plant or animal that is native to Minnesota. Show or draw a map of Minnesota on your blackboard, wipe board or smart board. Ask them to read silently about their animal or plant on the back of the card. In what biome are they found?
4. Ask students to stand up and walk over to the map you have made on the floor. They should go and stand in the part of the state where they are found. When they get there, ask them to introduce themselves to the other plants and animals nearby. Ask them to come up with ways they think they are related. This could be that they share a habitat, eat the same thing, eat each other, etc.
5. Ask the students to share some of the connections that they made on the map.

Concluding Activity: Explore the Biomes

1. Students can return to their seats. Using the panoramic view available on the online classroom (http://classroom.willstegerfoundation.org) show examples of each biome. Ask students to raise their hands when the biome their animal or plant is found in is being shown. Ask a few of them to share information about their animal or plant and how they fit into this particular biome.
2. Hand out the Minnesota biomes table and map and ask the students to paste it in their journal. Have them mark on the map where their animal or plant is found.
3. Discuss the biome where your school is found, ask if any of the students are familiar with the plants and animals described. Why or why not? Would they describe the area they live as being uniquely different from another biome in the state? How?
4. What else defines the different biomes of Minnesota besides its plants, animals and climate? For example where is agriculture common? Winter tourism? Forestry? Urban centers? If there is time, ask students to do the extension activity about how you might split up the state based on something other than biomes.

Journaling Connection

1. In their journal, the students should paste the photo of their animal or plant.
2. Ask the students to write a story about their plant or animal including what they know about the biome where the animal or plant lives.

Take It Outside—Connecting With Your Place

Materials
Field guides for your region
Journal

1. Ask students to turn to a page in their journal and make a line down the middle of the page to make two columns, label one plants and one animals (please remind them that insects are animals).
2. Take students out into the schoolyard, or to a nearby nature area if possible. Ask them to choose a place where they are comfortable to sit and are able to look all around them. Ask them to make a list of what they see. If they don't know the name of the animal ask them to sketch it. If you have digital cameras they could also take a photo, or if they have guidebooks they could use it to identify whatever they are observing.
3. Return inside and make a list on the board of what was seen. Look back at the list of common animals and plants found in your biome. Were any of these seen? Discuss why or why not you may have seen them.

Extensions

1. Ask students to research the animal or plant they were in the biome meet and greet game. Create a classroom encyclopedia of Minnesota plants and animals.
2. Ask students to write a story from the perspective of the animal or plant they were in their biome meet and greet.
3. Use the outline map of Minnesota and ask students to create a map that shows how they might divide the state based on tourism, economy, etc.

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org

1. Explore each biome virtually. Watch the intro video for each biome.
2. Connect with another classroom in another biome and use Skype (web conference) to discuss the different or similar animals and plants they see outside their window.
3. Upload photos and journal entries to http://classroom.willstegerfoundation.org/get-social/share-your-observations. Look through other photos uploaded by students around the state.

Resources

Minnesota DNR. *Biomes of Minnesota.*
http://www.dnr.state.mn.us/biomes/index.html

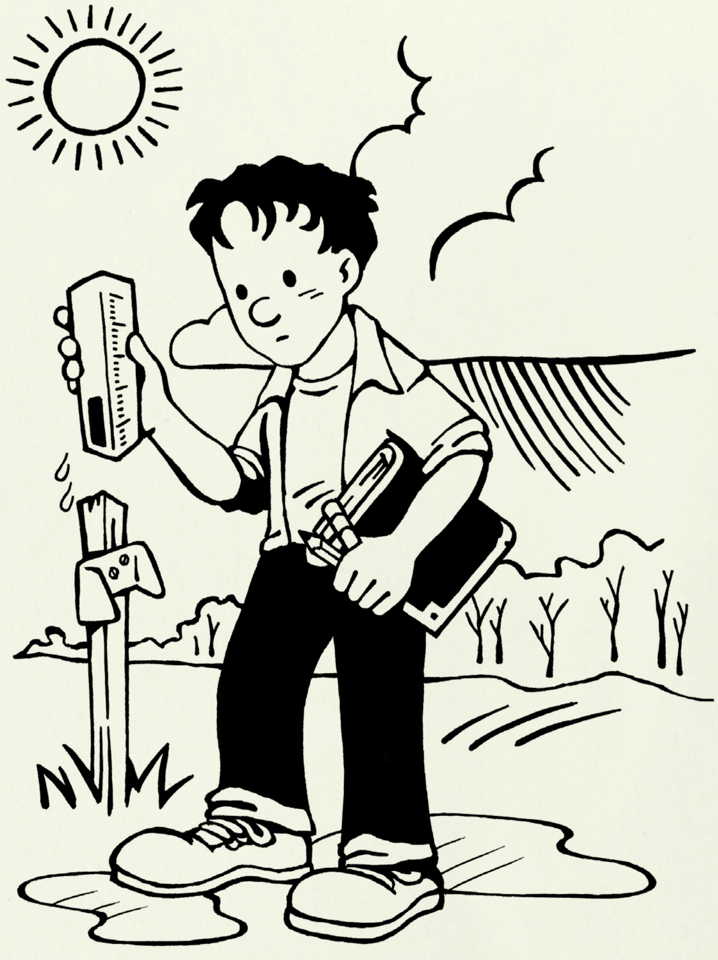
Enature (online field guide)
http://www.enature.com/home/

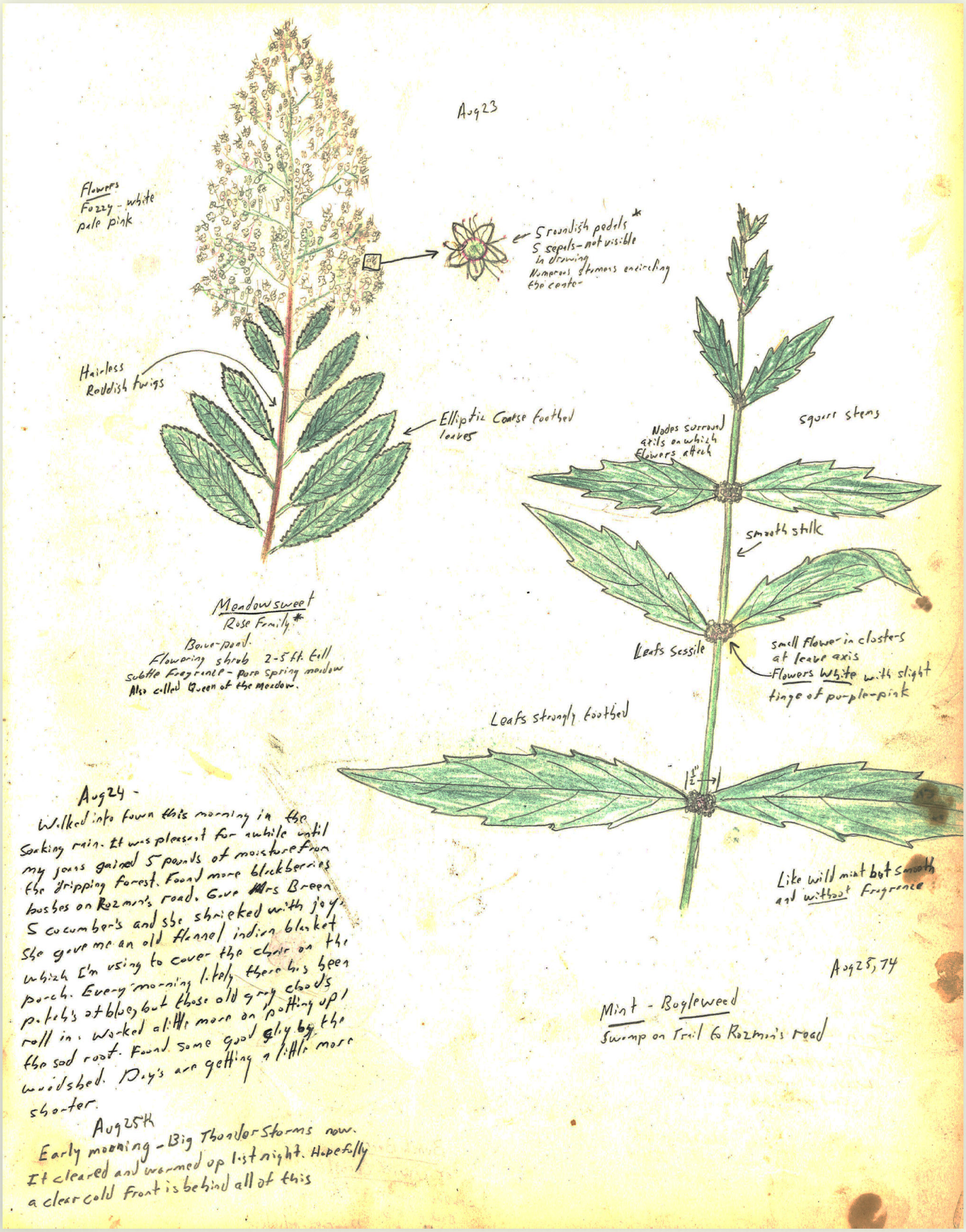
Feather Atlas
http://www.lab.fws.gov/featheratlas/

Ely Homestead
Aug 17th, 1974

Another clear day. It's 8:00am, 57° and barometer steady. There are also a few small patches of altocumulus and fracto-cumulus clouds. The fracto-cumulus are a sign of later thundershowers. There is a squirrel perched by the railing in his usual spot eating balsam pine cones. He is watching me and eating at the same time. Last night he sat on my lap when I was reading. I have spent much time alone on the porch this summer, reading and writing and other quiet things. The local animals have taken me as just another piece of furniture for they don't pay me any attention. I have watched a white throated sparrow family grow. Soon the young will be on their own.

Quiet morning, the sound of a few August flies, a noisy blue jay family down the lake, pine cones falling and hitting branches as the squirrels begin to harvest and stock up for the winter, peep-peep-peep of the white throated sparrow and the wind in the poplars across the lake. A ruby-throated hummingbird was hovering around the trees this morning in front of the porch. I have seen him a score of times this summer near the cabin.





Aug23

Flowers
Fuzzy - white
pale pink

5 roundish pedals *
5 sepals - not visible
in drawing
Numerous stamens encircling
the center

Hairless
Reddish twigs

Elliptic Coarse toothed
leaves

Meadowsweet
Rose Family *
Beaver pond.
Flowering shrub 2-5 ft. tall
subtle Fragrance - pure spring meadow
Also called Queen of the meadow.

Nodes surround
axils on which
Flowers attach

square stems

smooth stalk

Leafs Sessile

small Flower in clusters
at leave axis
Flowers White with slight
tinge of purple-pink

Leafs strongly toothed

$1\frac{1}{2}$"

Like wild mint but smooth
and without Fragrance

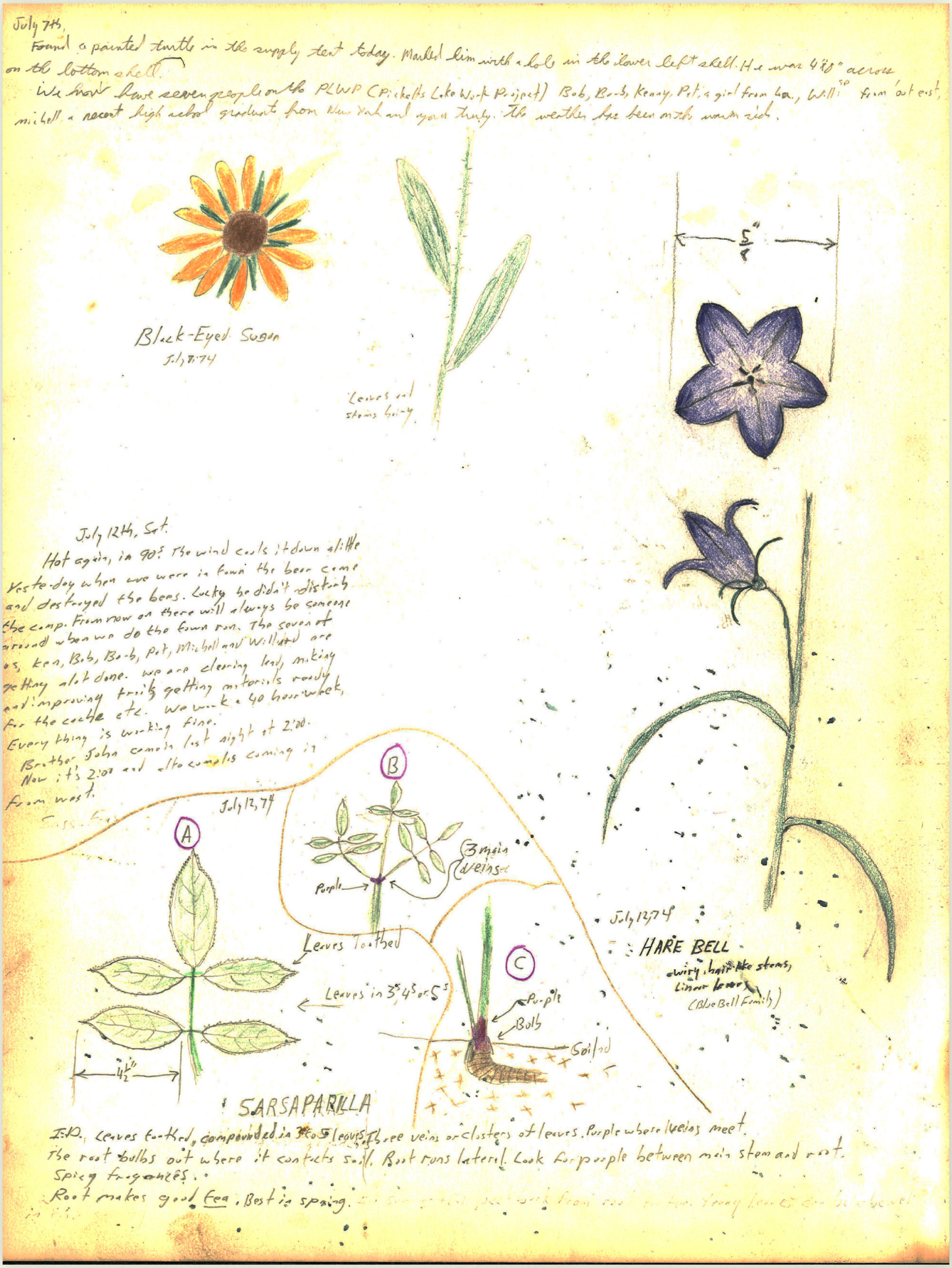
Aug25, 74

Mint - Bugleweed
Swamp on Trail to Rozman's road

Aug24 -
Walked into town this morning in the soaking rain. It was pleasant for awhile until my jeans gained 5 pounds of moisture from the dripping forest. Found more blackberries bushes on Rozman's road. Gave Mrs Breen 5 cucumber's and she shrieked with joy. She gave me an old flannel indian blanket which I'm using to cover the chair on the porch. Every morning lately there has been patch's of blue, but those old gray clouds roll in. Worked a little more on "potting up" the sod roof. Found some good clay by the woodshed. Day's are getting a little more shorter.

Aug25th
Early morning - Big Thunder Storms now. It cleared and warmed up last night. Hopefully a clear cold Front is behind all of this

Phenology Journal, Will Steger, 1978

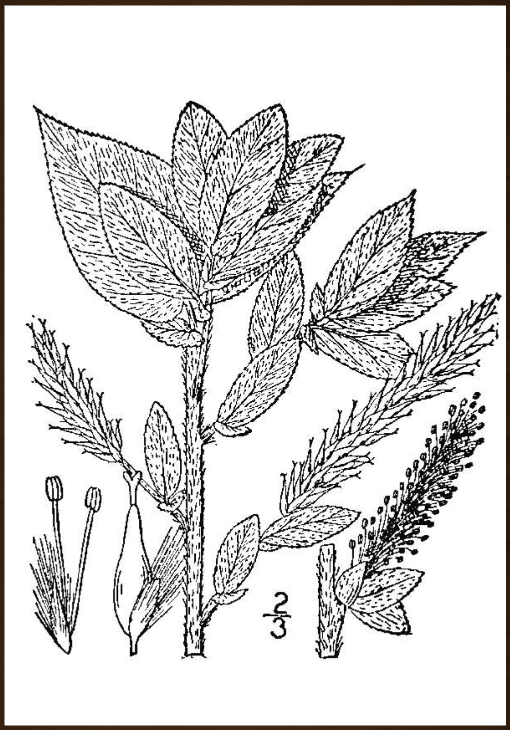

July 7th,
Found a painted turtle in the supply tent today. Marked him with a hole in the lower left shell. He was 4 1/8" across on the bottom shell.
We now have seven people on the PLWP (Pickett's Lake Work Project) Bob, Barb, Kenny, Pat, a girl from Iowa, Willard from out east, Michell a recent high school graduate from New York and yours truly. The weather has been on the warm side.

July 12th, Sat.
Hot again, in 90s. The wind cools it down a little. Yesterday when we were in town the bear came and destroyed the bees. Lucky he didn't disturb the camp. From now on there will always be someone around when we do the town run. The seven of us, Ken, Bob, Barb, Pat, Michell and Willard are getting alot done. We are clearing land, making and improving trails, getting materials ready for the cache etc. We work a 40 hour week. Every thing is working fine.
Brother John came in last night at 2:00. Now it's 2:00 and also camels coming in from west.

I.D. Leaves toothed, compounded in 3 to 5 leaves, three veins or clusters of leaves. Purple where veins meet.
The root bulbs out where it contacts soil. Root runs lateral. Look for purple between main stem and root.
Spicy fragrances.
Root makes good tea. Best in spring.

Phenology Journal, Will Steger, 1978

Phenology Journal, Will Steger, 1978



Heart-Leaved Willow

Salix cordata

Biome: Tallgrass Aspen Parkland

Heart-leaved willow is a perennial plant that is found in sandy soils, often on the shores of a lake.

Aspen

Populus tremuloides

Biome: Tallgrass Aspen Parkland

Aspen leaves are 1 to 4 inches long with a broad oval shape and finely toothed edges. They become yellow in the fall. Aspen trees have a white to grey-green bark that is thin and smooth. Aspen grows quickly and grows in space left by a fire or harvest. Aspen can grow well on sandy soil but grows best on a more nutrient-rich soil.

Small White Lady's Slipper

Cypripedium candidum

Biome: Tallgrass Aspen Parkland

Habitat: Prairies and grasslands

Threats: Loss of habitat, listed as Minnesota State Special Concern Species

The small white lady's slipper is a perennial plant that blooms in the spring—usually by early June. It can be 4 to 13 inches tall. The small white lady's slipper has one flower per stem that is white and shaped like a pouch, and this can have some purple spots or streaks. The flower column in the middle of the pouch is yellow. There are also two twisted side petals that are a greenish shade. This wildflower is threatened by loss of habitat due to land use change from prairie to agriculture or an urban environment, and invasion of weeds or more woody forest species.

Wiregrass Sedge

Carex lasiocarpa

Biome: Tallgrass Aspen Parkland

Wiregrass sedge is a perennial herb that grows in bogs and marshes, often in shallow water. It has very thin leaves and stems that can grow to about 3 feet. Wiregrass sedge has the characteristics that allow it to form a floating mat structure in a bog.

Sharp-Tailed Grouse

Tympanuchus phasianellus

Biome: Tallgrass Aspen Parkland

Diet: Seeds in the summer and fall; buds and twigs in the winter

Threats: Loss of open brushland and grassland, the suitable sharp-tailed grouse habitat

The range of sharp-tailed grouse in Minnesota has declined significantly due to the decline in their habitat. This brown and grey grouse is 15 to 20 inches long and weighs from 2 to 3 pounds. Its predators include great horned owls, foxes, skunks and raccoons.

Little Bluestem

Schizachyrium scoparium

Biome: Tallgrass Aspen Parkland

Little bluestem begins to grow in August with the appearance of its thin blue or blue-green stems. In can grow to be about 3 feet tall and becomes a deep red color in the fall. In the winter, little bluestem produces fuzzy white seeds that attract birds. The deep, dense root system of little bluestem allows it to be less susceptible to droughts and grow successfully in the drier prairie soils. Little bluestem also serves as habitat for many animals.

American Bittern

Botaurus lentiginosus

Biome: Tallgrass Aspen Parkland

Diet: Fish, insects, amphibians, crayfish, small mammals, snakes

Habitat: Freshwater wetlands

Threats: Habitat loss, Minnesota Species of Greatest Conservation Need

The American bittern is 23 to 34 inches long. It is well camouflaged in its wetland habitat and feeds by slowly following its prey or waiting for it to approach.

Sandhill Crane

Grus Canadensis

Biome: Tallgrass Aspen Parkland

Diet: Omnivore—grains, plants, insects, worms, mice, snakes

Habitat: Wetlands

Threats: Loss of wetland habitat

Sandhill cranes find most of their food in shallow wetlands and wetland soil, but they are also able to find seeds, such as corn, that have been planted in agricultural land. This can damage crops and cause conflicts with farmers. Sandhill cranes have a red crown on their heads and are grey, however, they often appear brown because they groom themselves with mud from their wetland area.


Family Cervidae
Cervus elaphus canadensis
E. C. Oaks
ASM - MIL


© Smithsonian Institution

American Elk

Cervus elaphus

Biome: Tallgrass Aspen Parkland

Habitat: Forests and open areas

Diet: Plants such as grasses and woody plants, including parts of aspen trees

Threats: Winter habitat loss, forests are needed and can be lost due to land use change

The American elk requires both forested habitat as well as open areas since forest offers the cover and protection while open areas offer the grasses and other plants that American elk eats. The American elk eats a wide variety of plants, so they will eat what is available. The American elk also has different summer and winter coats that have different appearances.

Canadian Toad

Bufo hemiophrys

Biome: Tallgrass Aspen Parkland

Diet: Insects, worms

Habitat: Woodlands, near water

The Canadian toad is 2 to 3.5 inches and is active at night. It digs burrows and its habitat includes more water than the habitats of other toads in Minnesota. Its main predator is the hognose snake as well as raccoons and skunks.

Northern White Cedar

Thuja occidentalis

Biome: Coniferous Forest

Threats: Structures that restrict movement of water through soil, such as roads, pipelines or beaver dams

Northern white cedar requires an area where water moves well through the soil in order to grow successfully. They can grow to be 50 to 60 feet tall. Northern white cedar will grow near black spruce on wetter soils and aspen on drier soils. This is a shade-tolerant tree. White-tailed deer and snowshoe hares feed on the seedlings, and this can damage a young, growing population.

Black Spruce

Picea mariana

Biome: Coniferous Forest

Threats: Eastern dwarf-mistletoe

Black spruce trees often grow in areas after fires have occurred, and produce cones to reproduce. They grow on wet soils and can live for 200 years. Black spruce trees are harvested primarily for pulp as well as Christmas trees and lumber. The spruce grouse relies on black spruce trees for its habitat.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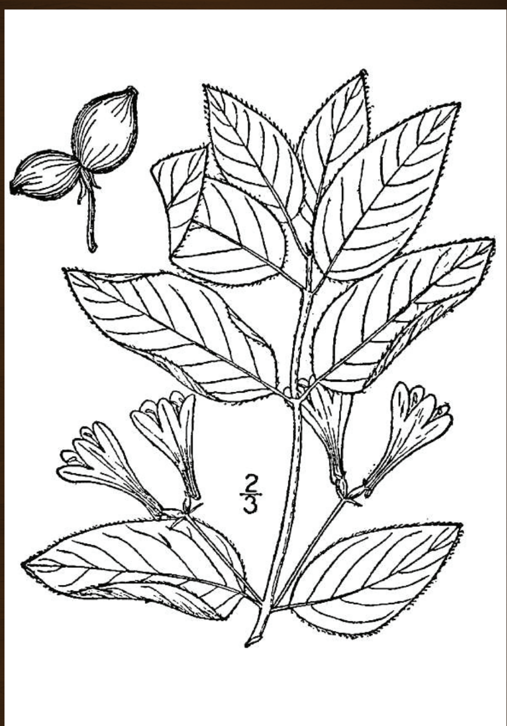
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Red Pine

Pinus resinosa

Biome: Coniferous Forest

Red pine's bark is red-brown plates, the leaves are dark green needles and it produces light brown cones. It often grows in areas after fires and can grow to be 60 to 80 feet high. Red pine grows on dry soils, does not tolerate shade and grows well in cold environments. Red pine is a habitat for many animals as well as food for deer and snowshoe hares. Birds, mice and chipmunks eat red pine seeds. Red pine is grown for a variety of uses including pulp and lumber.

Balsam Fir

Abies balsamea

Biome: Coniferous Forest

Threats: Spruce budworm insect; needle rust and root rot disease; easily killed by fires

Balsam fir grows well in cool, damp environments. It has smooth, gray bark, narrow leaves that are ½ to 1 inch long and purple cones. It can be 60 feet high and live for 100 years. It can also grow in shady conditions, so it can grow under forests under other trees. Balsam fir serves as food and habitat for a variety of species such as moose, white-tailed deer, snowshoe hare, red squirrel and grouse. Balsam fir is also used for pulp, Christmas trees and lumber.

Wood Frog

Rana sylvatica

Biome: Coniferous Forest

Diet: Small invertebrates

Habitat: Forests, bogs

The wood frog has a dark band over its eyes that appears to be a mask. It is 2 to 2.75 inches long. The wood frog breeds in bodies of water and then often moves far from these areas, into the forest. It lives well in cold climates.

Fly Honeysuckle

Lonicera canadensis

Biome: Coniferous Forest

Fly honeysuckle is perennial shrub that is about 7.5 feet high. It has yellow and white flowers that are in bloom April to July. This plant is beneficial to hummingbirds and butterflies.


Family Canidae
Canus lupus
L. L. Master
ASM - MIL


Family Cervidae
Alces americanus
J. O. Wolff
ASM - MIL

Compton's Tortoise Shell Butterfly

Nymphalis vaualbum

Biome: Coniferous Forest

The Compton's tortoise shell caterpillars depend on aspen, cottonwood, willow, gray birch and paper birch trees. The butterfly emerges as an adult in July and has a wing span of 2.5 to 3 inches.

Boreal Chickadee

Poecile hudsonicus

Biome: Coniferous Forest

Diet: Seeds and insects

Habitat: Spruce and fir forests

Threats: Destruction of spruce and fir forests due to industry and climate change

Boreal chickadees are often omnivores that eat seeds and insects. They store seeds and insect larvae for the winter. They find food in groups, except during breeding. They construct their nests in holes in trees and do not migrate during the winter.

Moose

Alces alces

Biome: Coniferous Forest

Diet: Aspen, maple and cherry trees and aquatic plants

Habitat: Forests

Threats: Warmer climate

Moose weigh 950 to 1,000 pounds, making them Minnesota's largest wild animal. They have strong senses of smell and hearing. Moose are very stressed by warmer temperatures, which makes them more susceptible to diseases. Wolves and bears are moose predators.

Gray Wolf

Canis lupus

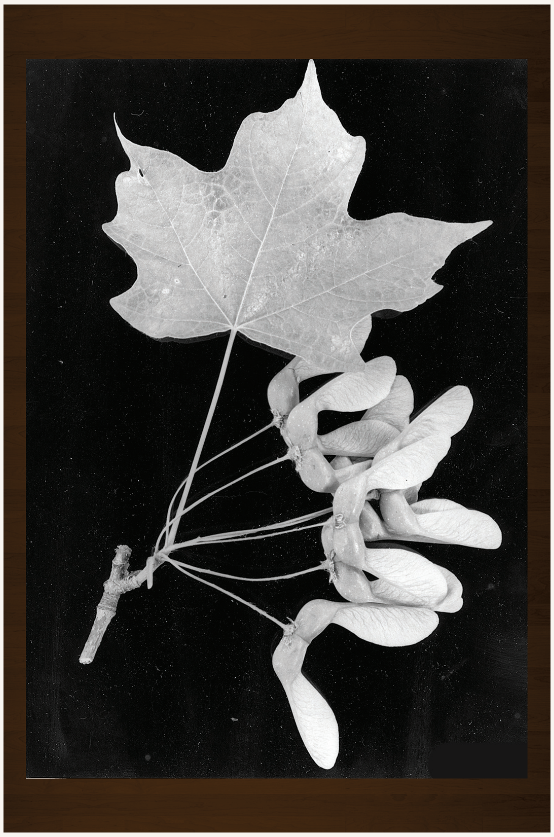
Biome: Coniferous Forest

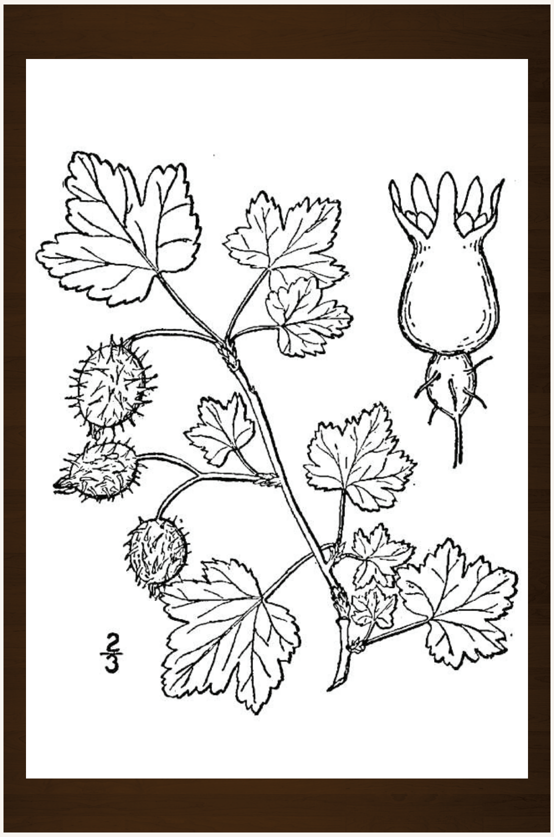
Diet: Small mammals and deer, moose and beavers

Habitat: Forests

Threats: Endangered Species

Gray wolves live in packs that are made up of 5 to 12 wolves. The pack hunts together, which allows them to catch the larger animals. Gray wolves weigh 60 to 120 pounds and their sense of smell is 100 times stronger than humans.

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American Basswood
Tilia americana

Biome: Deciduous Forest

The American basswood tree has white-yellow flowers that bloom around June and are fragrant. It grows in forests with sugar maple trees as well as northern red oaks. American basswood can be 60 to 80 feet high with gray bark. Its leaves are 3 to 6 inches long and heart-shaped.

Northern Red Oak
Quercus rubra

Biome: Deciduous Forest

Threats: Oak wilt fungus and gypsy moths

Northern red oak grows quickly and can be 55 to 80 feet tall. Its leaves are 5 to 9 inches long and they turn bright red in the fall. It provides a good habitat for many animals. The northern red oak also produces acorns. These, as well as leaves and seedlings, are food for deer, elk, moose and rabbits. Northern red oak is harvested for lumber and grows well in urban areas. Oak wilt fungus has become a serious threat to northern red oak trees in Minnesota.

Prickly Gooseberry
Ribes cynosbati

Biome: Deciduous Forest

Prickly gooseberry is a perennial shrub that is about 36 inches tall. Its flowers are a green-yellow color and bloom in May or June. It also has a bristly, purple berry that birds often eat.

Sugar Maple
Acer saccharum

Biome: Deciduous Forest

Threats: Asian long-horned beetle

Sugar maple grows to a height of 80 feet or more. It grows slowly and can grow well in shady conditions. Its leaves are 3 to 5 inches long with 3 to 5 points. Sugar maple is used for lumber and it also produces maple syrup.

Eastern Hognose Snake

Heterodon platyrhinos

Biome: Deciduous Forest

Diet: Toads primarily and small mammals

Habitat: Edge of forests, on sandy soil

The eastern hognose snake is not venomous and its predators are hawks and other mammals. This snake is usually 24 to 46 inches long and can be a variety of colors: yellow, gray, brown or black

Rue Anemone

Anemonella thalictroides

Biome: Deciduous Forest

Rue anemone is a perennial flower that often grows in shady areas. Its flowers can be white or light purple and it blooms in April or May. This flower grows in areas of healthy soil.

Eastern Pipistrelle Bat

Perimyotis subflavus

Biome: Deciduous Forest

Diet: Insects such as moths, flies, beetles, ants

Habitat: Caves, primarily

Threats: Minnesota Species of Special Concern, disturbance during hibernation

The eastern pipistrelle bat is the smallest bat species in Minnesota. It is known as a tricolored bat because of the variation in color of its individual hairs. This bat hibernates from October to April in caves or tunnels.

Cerulean Warbler

Dendroica cerulean

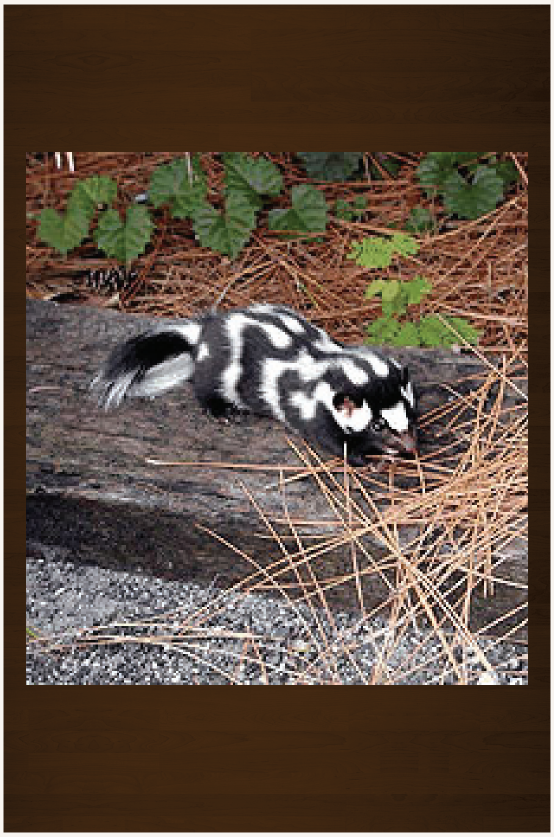
Biome: Deciduous Forest

Diet: Insects

Habitat: Large areas of deciduous forest

Threats: Loss of forest habitat

The cerulean warbler migrates a long distance to South America for the winter, and it arrives in Minnesota around May each year. The cerulean warbler lives in forests with oak, maple and basswood trees. It lives in forest areas with older, mature trees.



Eastern Spotted Skunk

Spilogale putorius

Biome: Deciduous Forest

Diet: Insects and small rodents

Habitat: Woodlands, thickets, brush

Threats: Minnesota Threatened Species

The eastern spotted skunk is 18-22 inches long and its tail usually has a white tip. This skunk lives in dens during the winter and is an extremely rare species. They eat primarily insects and small rodents but will eat almost anything they can find.

Gray Fox

Urocyon cinereoargenteus

Biome: Deciduous Forest

Diet: Small mammals such as rabbits

Habitat: Forest

The gray fox can be identified by the dark stripe along its back and bushy tail. It is 35 to 40 inches long. The gray fox can climb trees, which is a unique characteristic for this type of animal. Its main predator is the coyote.

Blazing Star

Liatris spicata

Biome: Prairie Grassland

Blazing star is a perennial that can be 18 inches tall. Its pink-purple spike blooms in August.

Big Bluestem

Andropogon gerardii

Biome: Prairie Grassland

Big bluestem is a perennial grass that grows in moist soil. It has a blue tint and there is a purple flower cluster at the top of this grass. Big bluestem provides nesting habitat for birds and insects. Songbirds and prairie chickens also eat its seeds while white-tailed deer and bison eat the grass itself. This grass can also be grazed by livestock.

Prairie Dropseed

Sporobolus heterolepis

Biome: Prairie Grassland

Prairie dropseed is a grass that grows to about 2 feet tall and has orange flowers. These flowers are in bloom beginning in late summer.

Purple Prairie Clover

Petalostemum purpureum

Biome: Prairie Grassland

Purple prairie clover is a perennial that is 1 to 3 feet tall. Its purple flowers are in bloom from July to September. This plant attracts many butterfly species.

Great Plains Toad

Bufo cognatus

Biome: Prairie Grassland

Diet: Insects and earthworms

Habitat: Damp areas in prairies, farm fields

The great plains toad is 2 to 3.5 inches long, making it Minnesota's largest toad. They breed in bodies of water, so this habitat must also be nearby. This toad burrows into the ground for shelter.

Leadplant

Amorpha canescens

Biome: Prairie Grassland

Leadplant is a perennial that has blue or purple flowers. It is from 1 to 3 feet tall and its flowers are in bloom from late spring to summer.

Upland Sandpiper

Bartramia longicauda

Biome: Prairie Grassland

Diet: Insects

Habitat: Prairies

Threats: Species of Greatest Conservation Need, loss of habitat

The upland sandpiper is about 1 foot tall. Other sandpiper species live near water, but the upland sandpiper lives in a prairie habitat. Upland sandpipers migrate to South America for the winter and arrive in Minnesota in April or May.

Greater Prairie Chicken

Tympanuchus cupido

Biome: Prairie Grassland

Diet: Plants and insects

Habitat: Open prairies

Threats: Minnesota Species of Special Concern, loss of habitat

The greater prairie chicken nests in tall grass and is well known for its displays during the mating season. Its predators are red-tailed hawks and great-horned owls. The greater prairie chicken's habitat is threatened as it is being lost to agriculture or forest.

Badger

Taxidea taxus

Biome: Prairie Grassland

Diet: Insects and small mammals such as mice and gophers

Habitat: Prairies

The badger is 20 to 35 inches long and lives primarily underground. It can be identified by the white stripe from its nose to the base of its neck. The badger is a nocturnal animal.

Plains Pocket Gopher

Geomys bursarius

Biome: Prairie Grassland

Diet: Plants

Habitat: Prairies

The plains pocket gopher is about 1 foot long and its tail has a white tip. It digs underground tunnels in the spring and fall and lives mostly underground. The plains pocket gopher lives in areas with sandy soil.

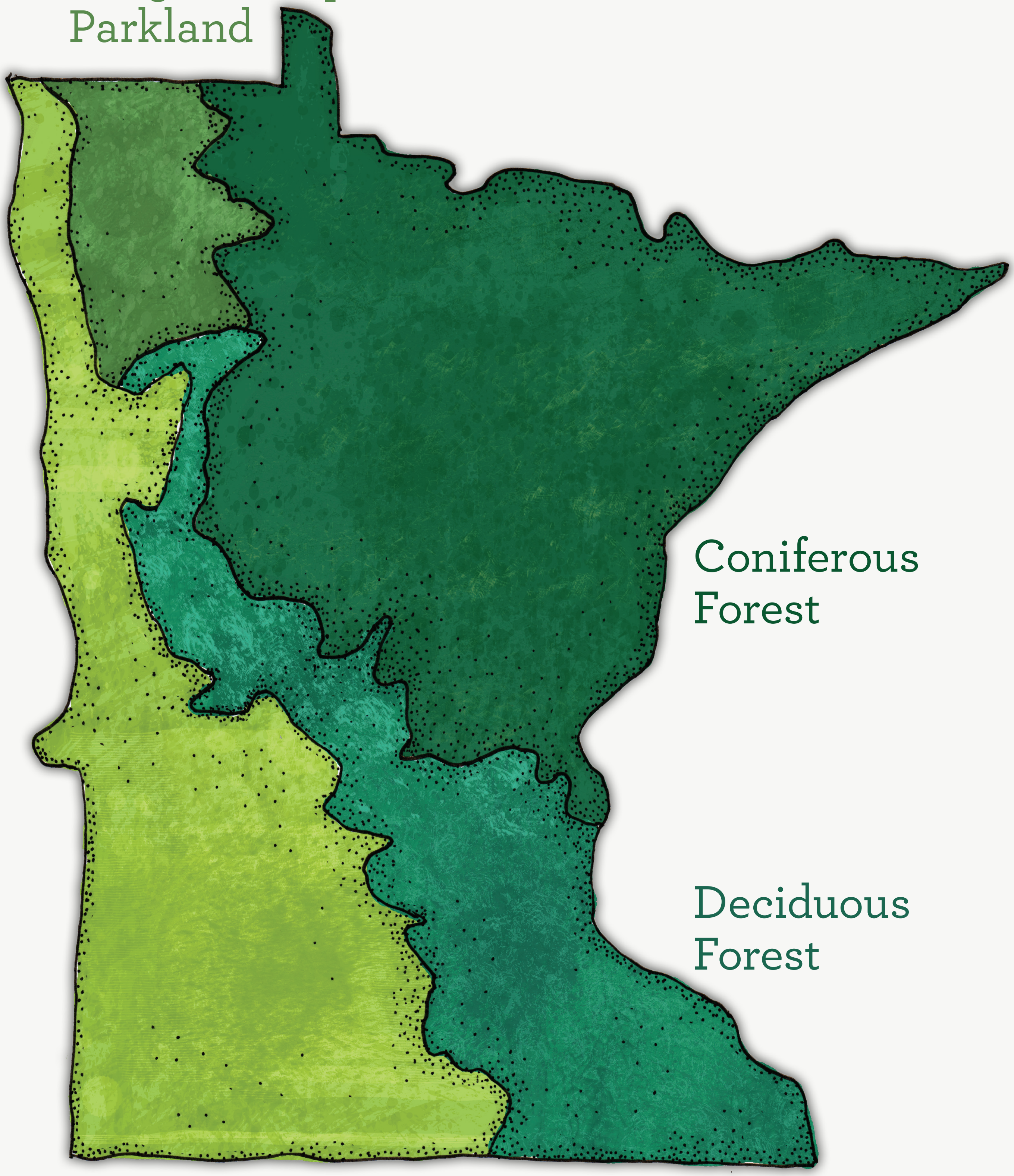
Minnesota Biomes Table

"Biome" is a term used to describe a biological community. Usually, biomes occur over large areas and include many similar plant communities and the animals that live in them. The table below shows examples of conditions within Minnesota's biomes.

	Average Annual Precipitation	*Average Annual Temperature*	*Vegetation Examples*	*Animal Examples*	*Average Growing Season Length*
Tallgrass Aspen Parkland Biome	20" – 22"	35° – 44° F	-Aspen -Heart-leaved Willow -Winegrass Sedge -Small White Lady's Slipper -Little Bluestem	-Sharp-tailed Grouse -Sandhill Crane -American Bittern -Canadian Toad -American Elk	90-130 days
Coniferous Forest Biome	21" – 32"	36° – 41° F	-Black Spruce -Northern White Cedar -Balsam Fir -Red Pine -Fly Honeysuckle	-Wood Frog -Boreal Chickadee -Compton's Tortoise Shell Butterfly -Gray Wolf -Moose	90 – 100 days
Deciduous Forest Biome	24" – 35"	39° – 45° F	-Northern Red Oak -American Basswood -Sugar Maple -Prickly Gooseberry -Rue Anemone	-Eastern Hognose Snake -Cerulean Warbler -Eastern Pipistrelle Bat -Gray Fox -Eastern Spotted Skunk	100 – 130 days
Prairie Grassland Biome	18" – 33"	37° – 45° F	-Big Bluestem -Blazing Star -Purple Prairie Clover -Prairie Dropseed -Leadplant	-Great Plains Toad -Greater Prairie Chicken -Upland Sandpiper -Pocket Gopher -Badger	130 – 180 days

For a fun way to learn about Minnesota's biomes, plants, and animals, check out the Junior Park Naturalist Program at a state park near you, or call the DNR's Information Center at (651) 296-6157 (metro area) or 1-999-646-6367 (toll free).

Tallgrass Aspen
Parkland



Coniferous
Forest

Deciduous
Forest

Prairie Grassland

Lesson 3: Minnesota's Changing Climate

What defines Minnesota's Climate?

Age Level:	Grades 3-8
Time Needed:	50-75 minutes
Materials:	Normal Annual Precipitation handout (1 per student or projection) Normal Annual Mean Temperature handout (1 per student or projection) Graphing paper Colored pencils for graphing
Student Learning Outcomes:	• Students will define climate and weather. • Students will define climate change. • Students will define phenology. • Students will gather their own weather data from their school site and record it in their journals. • Students will graphically represent authentic data from Minnesota's Climatology site. • Students will make three predictions of how a change in climate might affect Minnesota's biomes.

Background Information

This lesson will introduce the terms weather, climate and phenology. These terms are essential to understanding climate change and how it is impacting and will impact biomes. As discussed in lesson 2, climate is an important and defining characteristic of the biomes of Minnesota.

The difference between weather and climate is an essential concept to understand when learning about climate change. Minnesota climatologist Mark Seeley defines climate as the "quantitative description of historical weather for a given place over a given interval of time ... [climate descriptions] include the physical and biological features of Earth's surface, their interactions and atmospheric feedbacks." In other words, climate is not just one instance of snow or rain or heat, but the many weather events over long periods of time (multiple years) that define a particular geographical area as hot and dry, cold and wet, etc.

Weather, on the other hand is "... the recent, current, and near-future state of the atmosphere. The most common elements include temperature, humidity, precipitation, cloudiness, visibility and wind." Weather is what is going on outside your window right now and one instance of weather does not define a particular area or a particular climate.

According to the USA National Phenology Network; "Phenology refers to recurring plant and animal life cycle stages ... such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. Many of these events are sensitive to climatic variation and change. ..." (http://www.usanpn.org/) Keeping track of the phenology outside your school can be a fun way for students to make connections between the physical factors related to climate and the biotic reactions by flora and fauna. Regardless of where your school is located, students will be able to observe phenology, and it is an excellent way to draw connections between climate and living things.

I always had an incredible interest in weather. I wanted to be able to predict the weather, understand where the weather came from.

—Will Steger. Interview, August 2010

In pre-spring the weather systems really come and go. The constant sound of wind seems like continual music.

—Will Steger, Ely Homestead, March 4, 1972

As usual, the weather dictated the mood of the day.

—Will Steger, Ely Homestead, September 28, 1971

Journal Assignment

At the end of this lesson, student journals should contain a definition for weather, climate and phenology, two graphs that show average temperature and precipitation for each of the four biomes, and three predictions of possible impacts on Minnesota biomes from changes in temperature and precipitation.

Activity Description

Introduction

1. Pre-write...
   A. If you were going to describe to someone who has never been to Minnesota, what the climate of Minnesota is like, how would you describe it? Would you compare or contrast it with somewhere else so that they would be able to picture it? Where?
   B. If you were going to describe to someone what the weather is like today, how would you describe it?
   C. What is the weather like today for the animal or plant you "met" in lesson 2? Look on the map and describe what you think of when you think of the climate of the biome where that animal or plant is found.
2. Share with your neighbor what you wrote. Did you write similar things for A and B?

Activity: What are climate, weather and phenology?

1. Tell the students that climate, weather, and how climate affects living things (phenology) will be the topics of the day. Use the background information to explain weather, climate and phenology. Make sure students conclude the discussion with clear definitions of all three written in their journal.
2. On the board make four bubbles and write Fall, Winter, Spring, Summer in each bubble. Draw two lines from each bubble with a bubble on the end (see diagram below). In one bubble write weather and in one bubble write phenology. Repeat for each season. Ask the students to describe each season to them in terms of the common weather they might observe and make a concept map off of the weather bubble.
3. Explain to the students the concept of phenology, and ask them to help make a concept map of common phenology of the season you are working on as a group. See the example below.

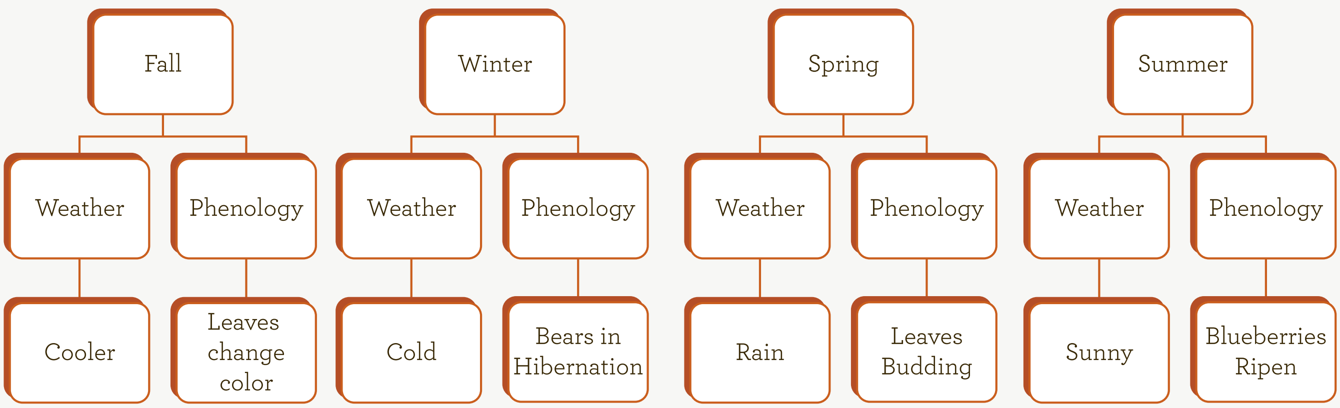


Figure 1: Common Minnesota Seasonal Weather and Phenology

4. In their journals and individually, ask the students to repeat for the other three seasons. If there is time, ask them to share.
5. At this point the students could be led outdoors to do the weather report and phenology activity in the Take It Outside section, or continue to the interpretation of data activity.

Activity: Interpretation and Representation of Data

1. Hand out or project the Minnesota map of *Normal Annual Mean Temperature* and *Normal Annual Precipitation*. Ask the students what the maps show. Point out the different colors and ask what they represent.
2. Hand out the worksheets found on page 53. You may need to guide them through the worksheet together as a group, or if your students are comfortable with graphing you could ask them to make a graph on their own without the graph "blanks." An example graph is provided below.

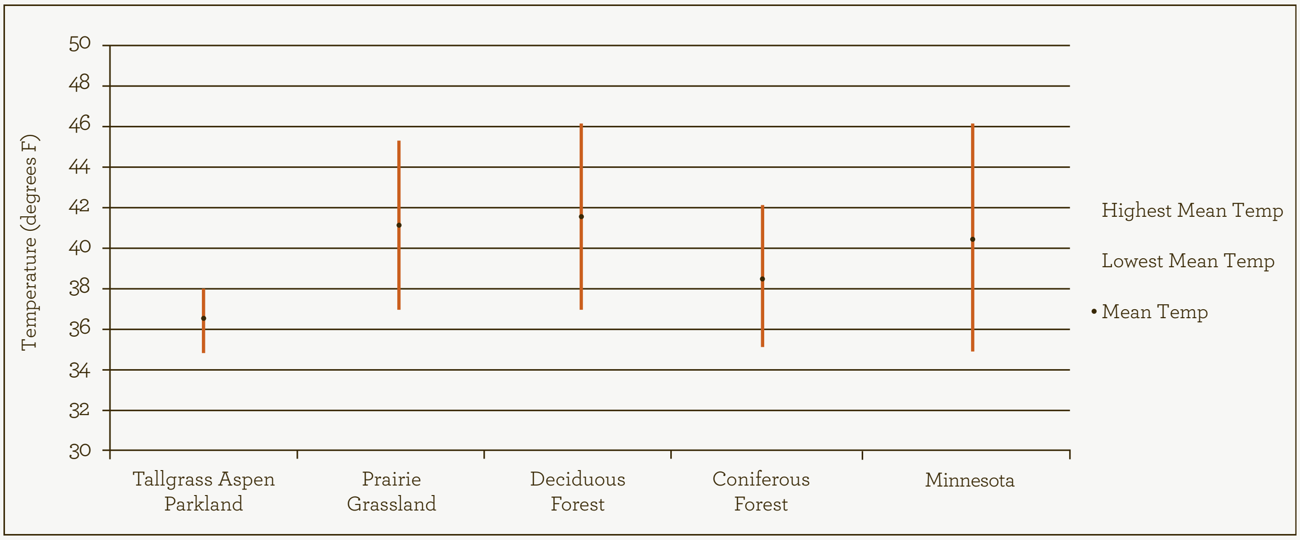


Figure 2: Mean Temperature Range of Minnesota Biomes

Concluding Activity: Climate and Biomes

1. Discuss in small groups or as a class what the graphs tell us about Minnesota's biomes and climate, individually and also when combined. Do the students prefer the maps or the graphs as ways of showing the date?
2. Is there a mean temperature and/or precipitation where all biomes could exist? If temperatures and precipitation were to change in each biome, what could that mean for the plants and animals commonly found there? Refer back to the table describing biomes (page 41).
3. Emphasize the importance of climate in defining each of the biomes. Discuss how a change in temperature or precipitation might affect the animals and plants of a biome and/or the phenology of a particular species.
4. Ask the students to make three predictions of how either more or less precipitation, warmer or colder weather or a combination of factors might affect specific plants or animals in a biome. Write the predicitons in their journal and paste in their worksheets and graphs.

Journaling Connection

Students will use their journals to record weather observations. Ask the students what information they think would be important to record every day and make a table for students to paste or create in their journal. Include research on historical weather events for the day and common phenology as a part of this.

Take It Outside—Connecting With Your Place

Materials:
Journal and writing utensil
Thermometer
Rain gauge
Anemometer

1. Based on weather reports they look at online or that are clipped from the paper, brainstorm with your students a list of things that would be important to include in a weather report. This list could include precipitation, temperature, wind speed and direction, historical highs and lows, historical average and important historical events.
2. Take your students outside and ask them to make their own weather reports in their journal. Provide thermometers, rain gauge and the Beaufort scale if you do not have an anemometer to measure wind speed. Also ask them to take a photo or draw an image that they might include to represent that day's weather.
3. After students have recorded their weather data, ask them to make a phenological observation. Can they see any birds or insects? Are there leaves on the trees? What color are they?

Extensions

Continue to make weather observations and phenology every morning with your class. Keep a weather log or journal for the class and maintain it over time so that the data can be used for graphing or, if kept over a period of years, compared to past years.

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org

1. In the learning module of the online classroom click on "Climate Change Basics" and then "From Ice Age to Today," to learn more about how Minnesota's climate has changed over time and to play the game.
2. Submit your weather observations and data to the online classroom via the share button.

Weather Resources

Watch Dr. Mark Seeley's talk on weather vs. climate at:
http://vimeo.com/15885303

National Weather Service Weather and Climate Data
http://www.weather.gov

Minnesota Historical Climate Data
http://climate.umn.edu/doc/historical.htm

Hey-How's the weather?
http://www.dnr.state.mn.us/young_naturalists/weather/index.html

Climate-Minnesota DNR
http://www.dnr.state.mn.us/climate/index.html

Current Conditions
http://www.dnr.state.mn.us/current_conditions/index.html

Minnesota Weather Guide Calendar. Freshwater Society

Paul Douglas Weather Column
http://pauldouglasweather.blogspot.com/

Phenology Resources

Gilbert, Jim. *Jim Gilbert's Minnesota Nature Notes*. Minneapolis: Nodin Press, 2008.

Minnesota Phenology Network
http://phenology.cfans.umn.edu/index.htm

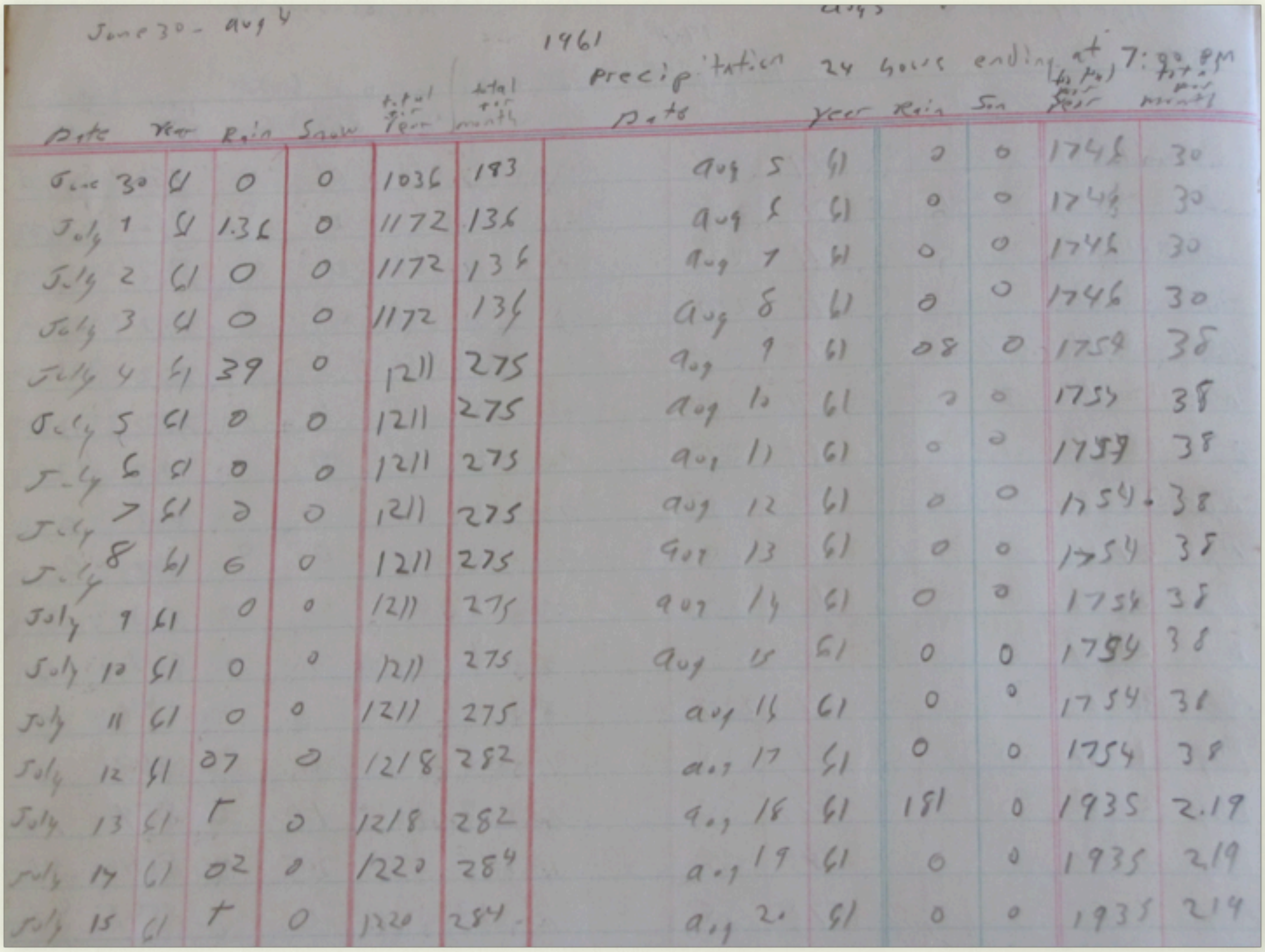
National Phenology Network
http://www.usanpn.org/

Twin Cities Naturalist Blog
http://www.twincitiesnaturalist.com

Weber, Larry. *The Backyard Almanac: A 365-day guide to the plants and critters that live in your backyard*. Pfeifer-Hamilton Publisher, 1995.

Youth:

When Will Steger was young, he kept detailed charts recording his observations. The chart seen here shows observations of clouds, precipitation and temperatures.



June 30 - aug 4

1961

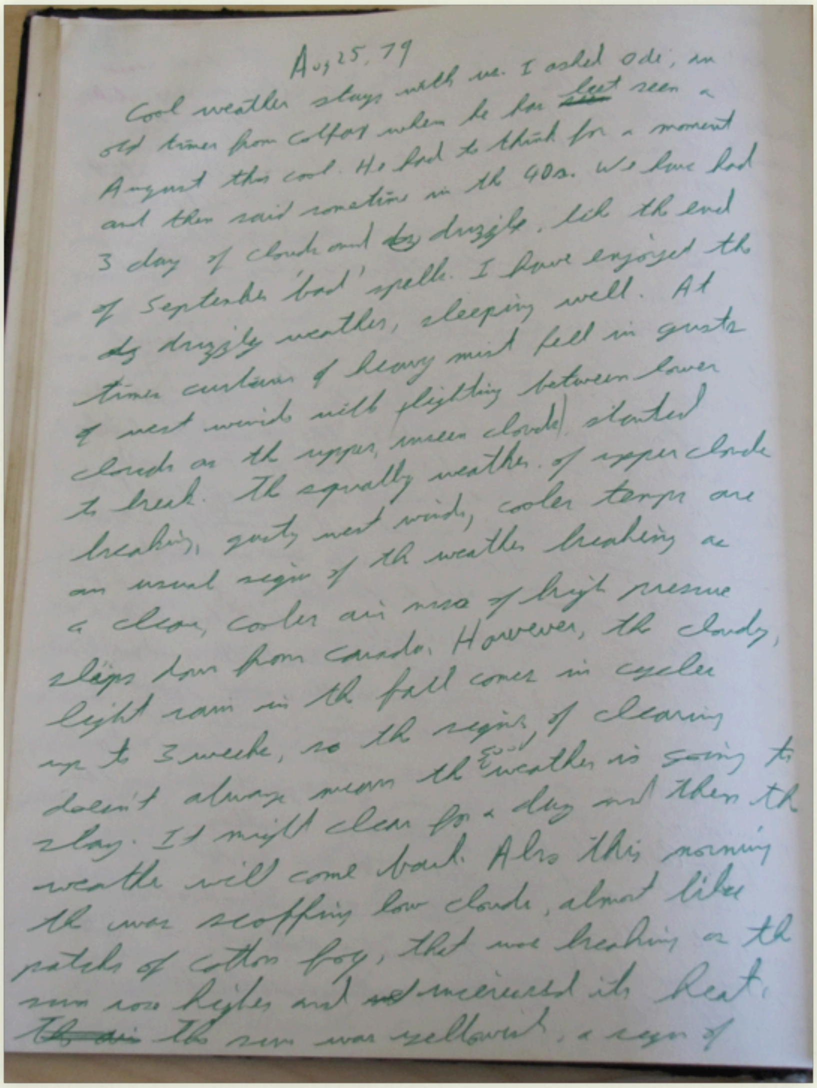
precipitation 24 hours ending at 7:00 PM

Date	Year	Rain	Snow	total for year	total for month
June 30	61	0	0	1036	183
July 1	61	1.36	0	1172	136
July 2	61	0	0	1172	136
July 3	61	0	0	1172	136
July 4	61	39	0	1211	275
July 5	61	0	0	1211	275
July 6	61	0	0	1211	275
July 7	61	0	0	1211	275
July 8	61	0	0	1211	275
July 9	61	0	0	1211	275
July 10	61	0	0	1211	275
July 11	61	0	0	1211	275
July 12	61	07	0	1218	282
July 13	61	T	0	1218	282
July 14	61	02	0	1220	284
July 15	61	T	0	1220	284

Date	Year	Rain	Snow	total for year	total for month
aug 5	61	0	0	1746	30
aug 6	61	0	0	1746	30
aug 7	61	0	0	1746	30
aug 8	61	0	0	1746	30
aug 9	61	08	0	1754	38
aug 10	61	0	0	1754	38
aug 11	61	0	0	1754	38
aug 12	61	0	0	1754	38
aug 13	61	0	0	1754	38
aug 14	61	0	0	1754	38
aug 15	61	0	0	1754	38
aug 16	61	0	0	1754	38
aug 17	61	0	0	1754	38
aug 18	61	181	0	1935	2.19
aug 19	61	0	0	1935	219
aug 20	61	0	0	1935	219

Ely Homestead:
August 25, 1979

Cool weather stays with us. I asked Ode, an old timer from Colfax when he had last seen an August this cool. He had to think for a moment and then said sometime in the 40s. We have had 3 days of clouds and drizzle, like the end of September bad spells...The squally weather of upper clouds breaking, gusty west winds and cooler temperatures are a typical sign of the weather breaking as a clear, cooler air mass of high pressure slips down from Canada. However, the cloudy, light rain in the fall comes in cycles of up to 3 weeks, so the clearing doesn't always mean that the good weather is going to stay. It might clear for a day and then the weather will come back. Also this morning, there were low clouds, almost like patches of cotton. They were breaking as the sun rose higher and increased its heat. The sun was yellowish, a sign of water vapor. After a period of moisture when the sun comes out, like today, the sun's heat will evaporate the moisture to form clouds and even more rain.



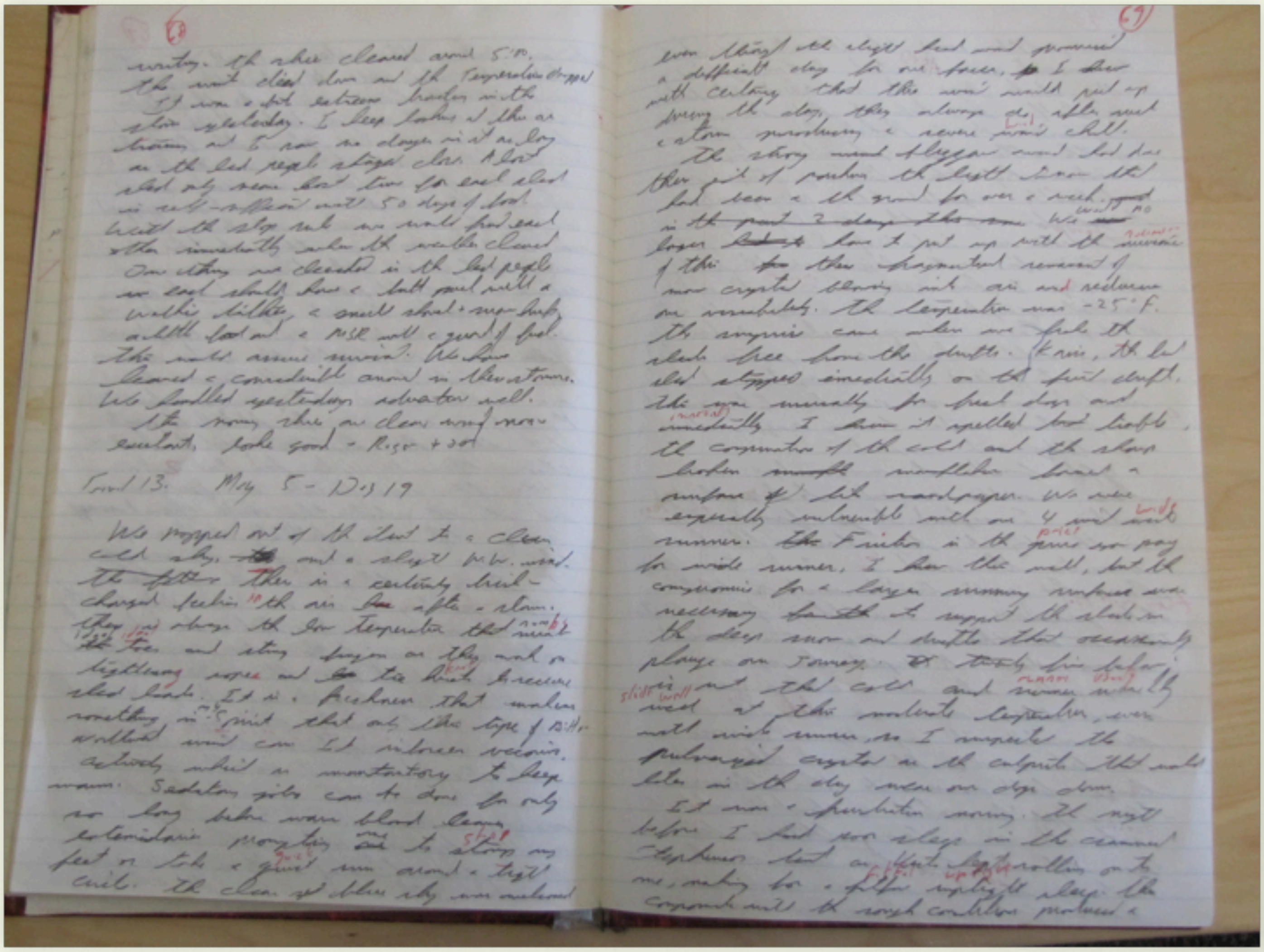
Aug 25, 79

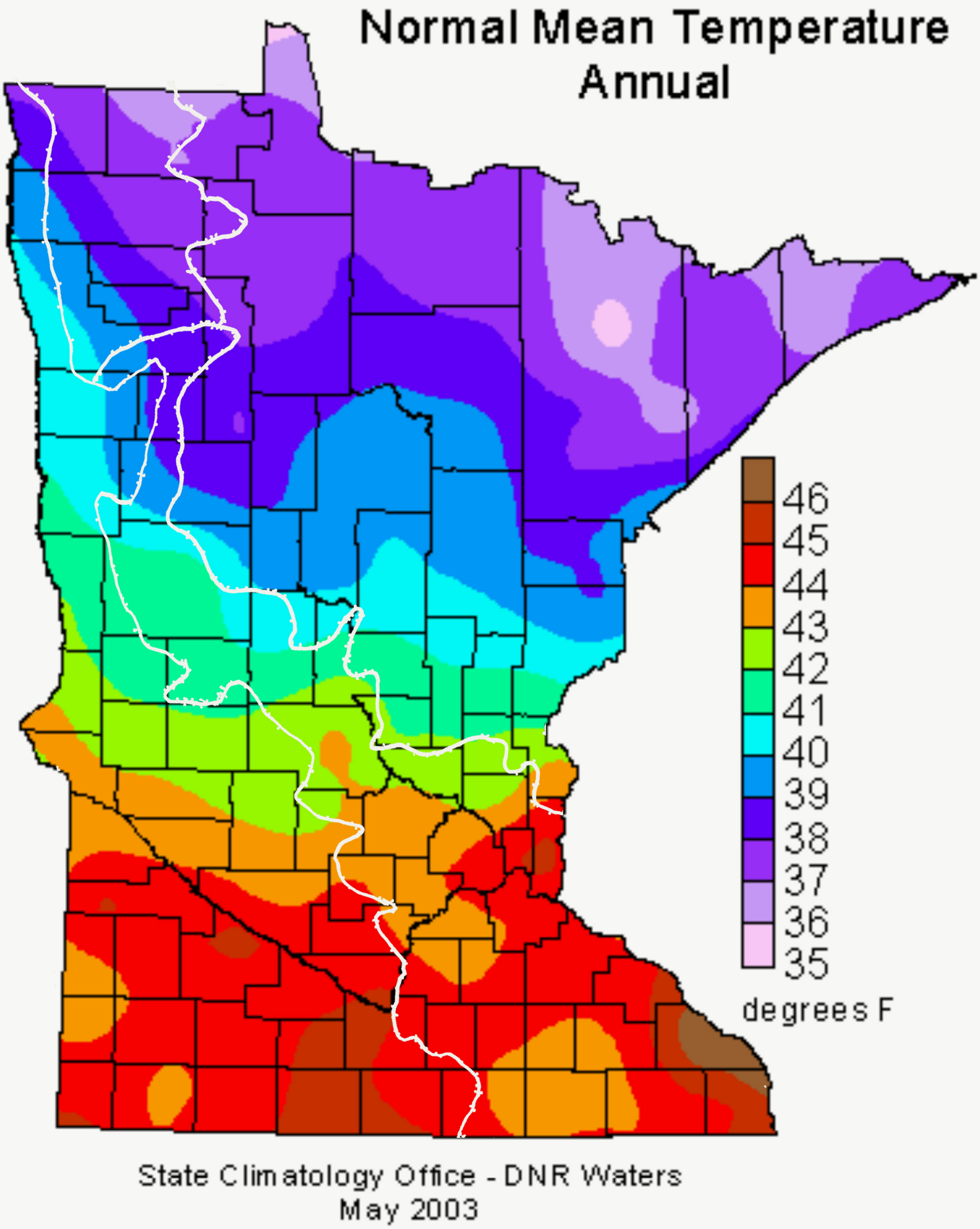
Cool weather stays with us. I asked Ode, an old timer from Colfax when he had last seen an August this cool. He had to think for a moment and then said sometime in the 40s. We have had 3 days of clouds and ~~dry~~ drizzle, like the end of September 'bad' spells. I have enjoyed the dry drizzly weather, sleeping well. At times curtains of heavy mist fell in gusts of west winds with flighting between lower clouds as the upper, unseen clouds started to break. The squally weather of upper clouds breaking, gusty west winds, cooler temps are an usual sign of the weather breaking as a clear, cooler air mass of high pressure slips down from Canada. However, the cloudy, light rain in the fall comes in cycles up to 3 weeks, so the signs of clearing doesn't always mean the good weather is going to stay. It might clear for a day and then the weather will come back. Also this morning there was scuffing low clouds, almost like patches of cotton fog; that was breaking as the sun rose higher and ~~and~~ increased its heat. ~~The air~~ The sun was yellowish, a sign of

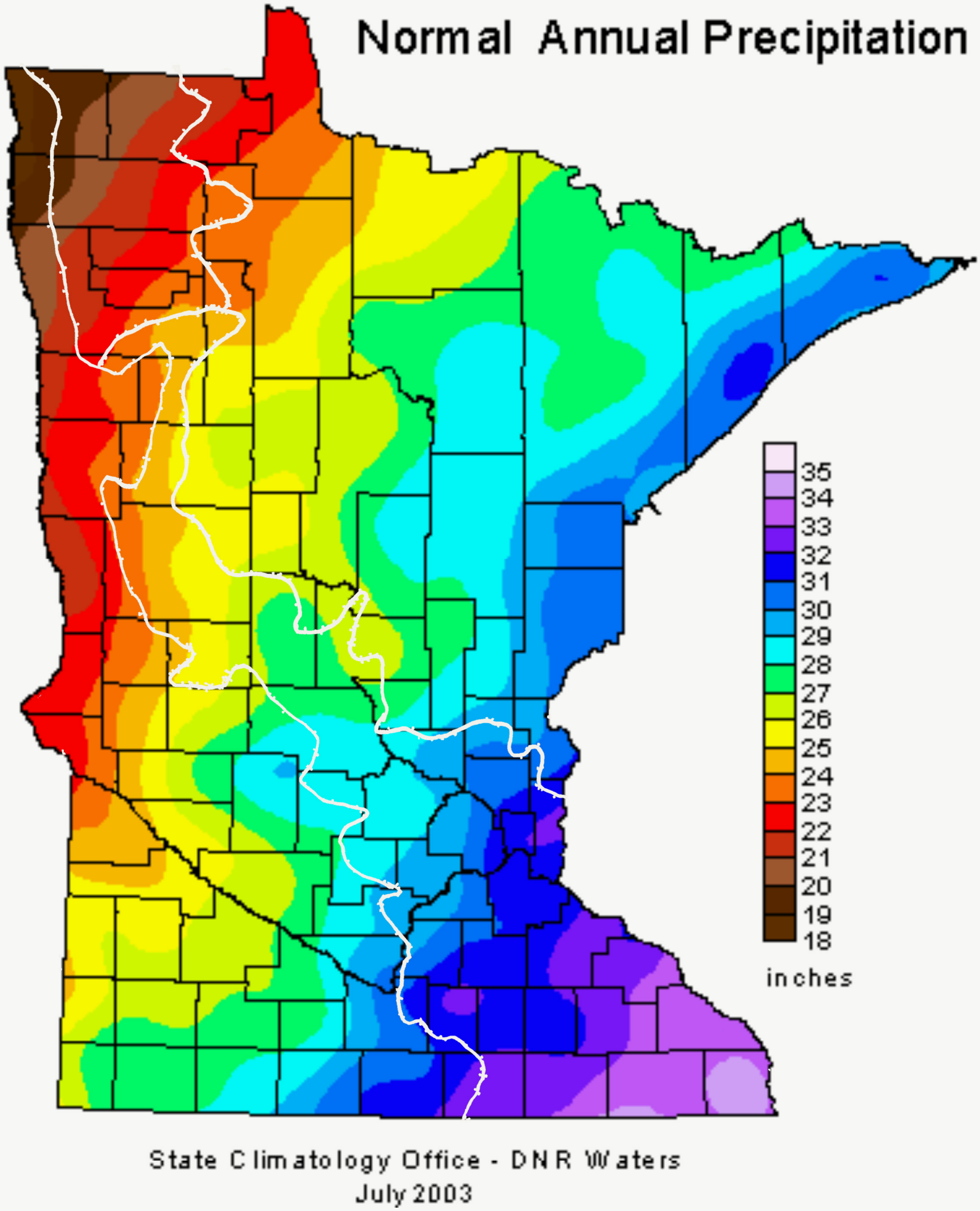
Expedition:

May 5, 1988

The clear, blue sky was welcome, even though I knew with certainty that these winds would pick up during the day; they always do after such a storm, producing a severe windchill. The strong blizzard winds had done their job in packing the light snow that had been on the ground for over a week. We would no longer have to put up with the nuisance of these fragmented remains of snow crystals blowing into the air and reducing our visibility. The temperature was -25F.




Normal Mean Temperature
Annual
46
45
44
43
42
41
40
39
38
37
36
35
degrees F
State Climatology Office - DNR Waters
May 2003


Normal Annual Precipitation
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
inches
State Climatology Office - DNR Waters
July 2003

Name ____________________________

Date ____________________________

1. Look at the Normal Annual Mean Temperature Map.What does each color represent?

2. Fill in the following table with the higest and lowest mean temperatures, and mean temperature for each biome and the state as a whole.

Biome	*Highest Mean Temperature*	*Lowest Mean Temperature*	*Mean Temperature*
Tallgrass Aspen Parkland			
Coniferous Forest			
Deciduous Forest			
Prairie Grassland			
Minnesota			

3. Turn your temperature data into a graph that shows the range of mean temperatures for each biome, the mean temperature and compares the range between biomes and the state of Minnesota.
(see attached)

Explain your graph by answering the following questions:

4. What does it show?

5. What conclusions can be drawn?

6. In what ways is this type of graph useful?

7. What can be said about each biome?
   a. Tallgrass Aspen Parkland

   b. Coniferous Forest

   c. Deciduous Forest

   d. Prairie Grassland

8. Look at the Normal Annual Precipitation Map. What does each color represent?

9. Fill in the following table with the highest, lowest and mean annual precipitation for each biome and state as a whole.

Biome	*Highest Annual Precipitation*	*Lowest Annual Precipitation*	*Mean Annual Precipitation*
Tallgrass Aspen Parkland			
Coniferous Forest			
Deciduous Forest			
Prairie Grassland			
Minnesota			

10. Turn your precipitation data into a graph that shows the range of annual precipitation for each biome and compares the range between biomes and the state of Minnesota.
Explain your graph by answering the following questions:

1. What does it show?

2. What conclusions can be drawn?

3. In what ways is this type of graph useful?

4. What can be said about each biome?
    a. Tallgrass Aspen Parkland

    b. Coniferous Forest

    c. Deciduous Forest

    d. Prairie Grassland

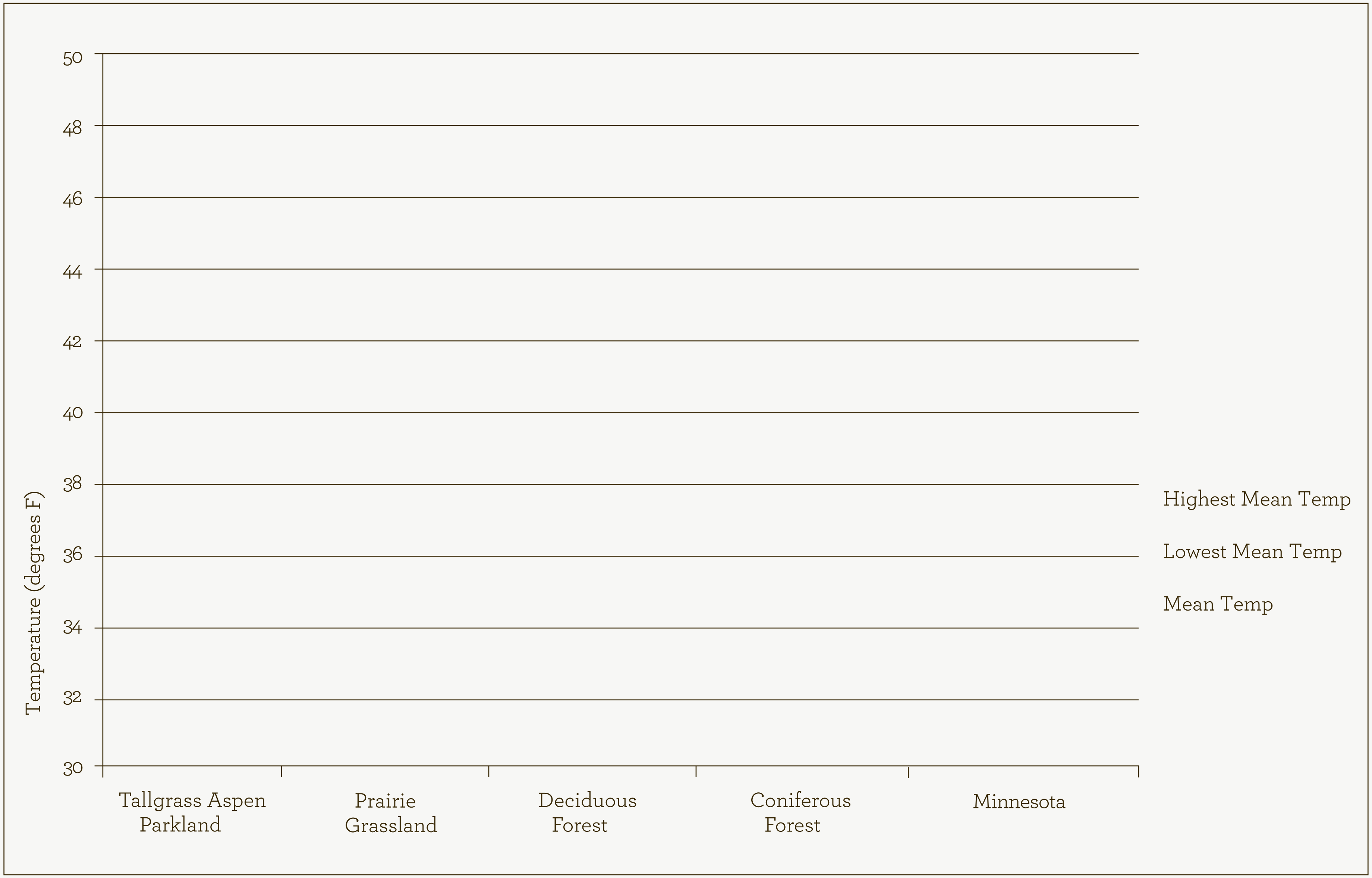
Look at both graphs side by side.
5. What can be said about each biome?
    a. Tallgrass Aspen Parkland

    b. Coniferous Forest

    c. Deciduous Forest

    d. Prairie Grassland

Title____



Temperature (degrees F)
50
48
46
44
42
40
38
36
34
32
30
Tallgrass Aspen Parkland
Prairie Grassland
Deciduous Forest
Coniferous Forest
Minnesota
Highest Mean Temp
Lowest Mean Temp
Mean Temp

Title____


40
35
30
25
20
15
Inches
Tallgrass Aspen Parkland
Prairie Grassland
Deciduous Forest
Coniferous Forest
Minnesota
Highest Ave Precip
Lowest Ave Precip
Mean Precip

Lesson 4: Minnesota's Changing Climate

What is climate change and what does it mean for Minnesota?

Age Level:	Grades 3-8
Time Needed:	Two 50-minute lessons
Materials:	Enough sets of climate change fact worksheets (8/set) that each student receives two sets Implications of Climate Change for Minnesotans handout Journals Pencils Drawing utensils
Student Learning Outcomes:	• Students will explain the causes of climate change. • Students will explain the implications of climate change. • Students will predict how climate change might impact or is impacting the area where they live. • Students will describe five key climate change implications for Minnesotans.

Background Information

In this lesson, students will be introduced to the basics of climate change.

Important points to communicate include:

1. The earth's atmosphere that surrounds our planet is made up of gases called greenhouse gases. Greenhouse gases include carbon dioxide, methane, nitrous oxide and water vapor.
2. Greenhouse gases act like a blanket around the planet. They allow heat from the sun to enter the atmosphere. Some of this heat is absorbed and some of it is reflected back. Some of the heat is reflected into space, and greenhouse gases hold some of it in. A simple example of the greenhouse effect is when heat enters a car through its windshield and gets trapped inside, causing the car to heat up.
3. The greenhouse effect is a natural process that makes the earth habitable.
4. The greenhouse gas carbon dioxide (CO_2) has increased from 280 parts per million before 1870 and the industrial revolution, to over 390 parts per million today (2012). This information was determined by researchers by taking ice cores from Antarctica. The researchers measured the amounts of carbon dioxide trapped in air bubbles at different heights on the core which corresponded to periods of time. Since 1958, carbon dioxide measurements have been taken from on top of Mauna Loa, a Hawaiian volcano.
5. The burning of fossil fuels, as well as land use changes from deforestation and land clearing, releases carbon dioxide into the atmosphere. Fossil fuels are burned in the process of electricity production, industrial processes and the driving of vehicles. Fossil fuels include natural gas, oil and coal.
6. Throughout the history of the planet Earth, there have been increases and decreases in global average temperature. Although there have been periods of natural warming in the past, scientists are especially concerned about what is happening today because there is a change in temperature that has been rapid within the last 100 years, rather than over hundreds or thousands of years.

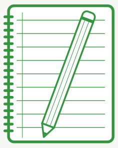
The melting and freezing of the ice cap has been a natural cycle for millions of years that drastically changed the weather and topography of our landforms. It is a very delicate balance that recently accounted for the past ice ages. The major problem mankind now faces is that through pollution of the atmosphere and destruction of the natural environment, the atmosphere is warming at an alarming rate.

—Will Steger, Greenland Training Expedition for Trans-Antarctic Expedition; June 12, 1988

7. This increase in temperature has an effect on Minnesota's climate as a whole, and has enormous implications for Minnesota. The results have been and continue to be experienced across Minnesota's biomes in all living communities of organisms, including humans.
8. There are climate change solutions and students can be part of the solution. Later in this unit students will have the opportunity to learn about and develop their own solutions.

There are some important implications of climate change for the Midwest and for Minnesotans, as described below and found in the report, *Global Climate Change Impacts in the United States* (United States Global Change Research Program).

1. During the summer, public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and increasing occurrence of insect-transmitted and waterborne diseases.
2. Significant reductions in Great Lakes water level, which are projected under higher emission scenarios, lead to impacts on shipping, infrastructure, beaches and ecosystems.
3. The likely increase in precipitation in winter and spring, more heavy downpours, and greater evaporation in summer would lead to more periods of both floods and water deficits.
4. While the longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects and weeds will present increasing challenges to managing crops, livestock and forests.
5. Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.



Journal Assignment

At the end of this lesson, student journals should contain notes on what climate change is and the list of key implications for the Midwest and Minnesotans.

Activity Description

Introduction

1. Ask students to look back in their journals at the definition they wrote of climate. Thinking about their definition of climate, ask students to write or draw what comes to mind when they hear "climate change."
2. Discuss as a class what they wrote or drew.

Activity: What is climate change?

1. Share the key points included in the introduction by handing out climate change fact cards included with this lesson to groups of four. Give each group member two cards to read in sets of 1 and 2, 3 and 4, 5 and 6, etc.
2. Ask each group member to read their cards and then to create a visual they think would be helpful to explain the information on the two cards. Alternatively, ask the students to find visuals through an Internet search to share.
3. Ask them to read aloud their cards and share their visual with their group in their numbered order.
4. Groups should discuss what the cards mean and make a list of any questions they might have in their journals.
5. Discuss as a class each card and questions that came up. Show the visuals created or found for each set of cards as you discuss them.

Concluding Activity: What are the implications of climate change for Minnesotans?

1. Think back to "*What defines Minnesota's biomes?*" lesson 2. Review what is unique about the biome where your school is located as far as climate, flora and fauna and other defining factors. Students can look back in their journals to review.
2. Share the five climate change implications for Minnesotans, either by projecting them (see included handout), reading them out loud, or handing them out to the class. Discuss which issues might impact the biome where you live the most and why.
3. Think about what you know about the other biomes. What issues may be most impactful in them?
4. If you haven't already, hand out the list of implications and ask students to paste it in their journal. Ask them to choose one issue that concerns them the most and to write in their journal about how they think it could affect their lives.

Journaling Connection

Ask students to think about the implications of climate that were discussed. Ask them to write a journal entry that discusses how climate change may affect them directly, or ask them to choose one issue that is of particular concern to them and explain why.

Take It Outside—Connecting With Your Place

Materials
  Journals
  Colored pencils

1. Take the students outside with their journals. Make sure that they remember or have listed in their journal the key implications described.
2. Ask them to look around and draw a picture of what they see.
3. Ask them to label different parts of their picture where they predict climate change impacts will be seen or are already being seen as they relate to the key issues described. For example, if you can see agricultural fields, they may label them and write that the growing season may be longer or there may be more flooding; or any plant life seen may be labeled "will bloom earlier."

Extensions

The Will Steger Foundation's Global Warming 101 Lessons provide an opportunity to explore climate change causes and impacts more deeply. Download lessons at:
http://www.willstegerfoundation.org/educator-resource-binder

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org

1. Scan journal entries and pictures the students have drawn and upload them to the online classroom.
2. Click on "Climate Change Basics" and then "Climate Closeup: Temperature" in the learning module of the online classroom to play a game to extend learning on climate change.

Resources

Minnesota Department of Natural Resources. Accessed 2011-2-17 at http://www.dnr.state.mn.us/

Dispatch from 2007 Baffin Island Expedition:

From what I've seen personally, from all the interviews that we did tenting and living with the Inuit people as we've traveled, basically what's happening in the Arctic regions is that global warming is being played out on the sea ice. As the extra energy is absorbed into the ocean from human induced global warming, this is warming the ocean. 80% of the excess energy goes into the ocean and that, in turn, starts melting the ice. We're seeing later freeze-ups and earlier break-ups. In other words, what we're seeing is the winter season, the ice season, which is so important for hunting and traveling, is starting to diminish. What used to be about an 8 month season in Baffin now is, in some areas, reduced to around 6 months...Also we could tell on the glaciers that we saw and the mountains and mountain passes that we've crossed, the glaciers have definitely receded.

Fact #1

The earth's atmosphere that surrounds our planet is made up of gases called greenhouse gases. Greenhouse gases include carbon dioxide, methane, nitrous oxide and water vapor.

Fact #2

Greenhouse gases act like a blanket around the planet. They allow heat from the sun to enter the atmosphere. Some of this heat is absorbed and some of it is reflected back. Some of the heat is reflected into space, and some of it is held in by greenhouse gases. A simple example of the greenhouse effect is when heat enters a car through its windshield and gets trapped inside, causing the car to heat up.

Fact #3

The greenhouse effect is a natural process that makes the earth habitable.

Fact #4

The Greenhouse Gas carbon dioxide (CO_2) has increased from 280 parts per million before 1870 and the industrial revolution, to over 390 parts per million today. This information was determined by researchers by taking ice cores from Antarctica and measuring the amounts of carbon dioxide trapped in air bubbles at different heights on the core that correspond to periods of time. Since 1958, carbon dioxide measurements have been taken from on top of Mauna Loa, a volcano in Hawaii.

Fact #5

The burning of fossil fuels releases carbon dioxide into the atmosphere, as well as land use changes from deforestation and land-clearing. Fossil fuels are burned in the process of electricity production, industrial processes and the driving of vehicles. Fossil fuels include natural gas, oil and coal.

Fact #6

Throughout the history of the planet Earth, there have been increases and decreases in global average temperature. Although there have been periods of natural warming in the past, scientists are especially concerned about what is happening today because there is a change in temperature that has been rapid in the last 100 years, rather than over hundreds or thousands of years.

Fact #7

This increase in temperature has an effect on Minnesota's climate as a whole, and has enormous implications for Minnesota. The results have been and continue to be experienced across Minnesota's biomes in all living communities of organisms, including humans.

Fact #8

There are climate change solutions and students can be part of the solution. Later in this unit students will have the opportunity to learn about and develop their own solutions.

Implications of Climate Change for Minnesotans

1. During the summer, public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and increasing insect and waterborne diseases.

2. Significant reductions in Great Lakes water level, which are projected under higher emission scenarios, lead to impacts on shipping, infrastructure, beaches and ecosystems.

3. The likely increase in precipitation in winter and spring, more heavy downpours, and greater evaporation in summer would lead to more periods of both floods and water deficits.

4. While the longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects and weeds will present increasing challenges to managing crops, livestock and forests.

5. Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases and invasive species moving in from warmer regions.

Lesson 5: Minnesota's Changing Climate

What does the data show?

Age Level:	Grades 3-8
Time Needed:	50-75 minutes
Materials:	Six sets of materials related to climate change in Minnesota (details in table on p. 74) A container to hold each set of materials
Student Learning Outcomes:	• Students will make their own interpretations of graph images of data that represent different impacts of climate change on Minnesota. • Students will make the connection between 3-D objects and what the data represents. • Students will divide three statements about each graph into true or false categories. • Students will share their results. • Students will brainstorm how climate change could affect their biome.

Background Information

In this activity groups of 4 students will be given a set of materials in a box. Each set should contain two 3-D objects (or photos if no objects available), two figures, and two sets of three true/false statements that correspond to each figure. There are six sets of materials; each set is related to a common theme. The table above shows the themes of each set of materials and the level of difficulty for explaining the figure. Depending on the number of students in your class and group size, you may need to replicate sets between groups. The figures will introduce students to different ways that data is represented and will demonstrate different influences climate change may have on the state of Minnesota.

> Sometimes when you explore, you find things that you know and then sometimes you find other things that you can figure out and sometimes there's a total unknown. When you don't know something, what I usually do when I go back is go to a library and look it up in a book or ask somebody a question.
>
> —Will Steger in field trip with elementary students, 1995

Educator Prep:

It is important that the materials for this activity are sorted and organized correctly and together. Beginning on page 77 there are 12 figures with corresponding explanations and true/false statements and a template to be copied. These materials are also available online at: http://classroom.willstegerfoundation.org/handouts, if you would like to print them out in color. Each set of materials needs to be separated into: figures, individual true/false statements, and figure explanations. The true/false statements for a given set of three materials can be put in an envelope and set of figure explanations in another envelope. These envelopes, along with the corresponding two figures and two 3-D objects, should be put in a box of Ziploc. There are six sets of two figures that are in some way related. The following table shows which figures should be clustered together, their common theme, the grade level the figure may be most appropriate for, a suggested 3-D object or photo, and one possible connection to an implication of climate change for Minnesotans as discussed in Lesson 4. All of the materials may be laminated for long-term usage.

Journal Assignment

At the end of this lesson, student journals should contain a list of key messages determined through an exploration and discussion of the figures shared.

Figure and Theme	*Level of Difficulty*	*3-D Object/Photo*	*Possible Connected Implication*
Climate Change and Ice			
Minnesota Average Ice Out Date (p. 73)	Elementary/Middle School	Ice cube	5: more heat-tolerant aquatic species could move in
ICE OUT day of year (p. 75)	Middle School/High School	Ice Fishing Postcard	See above
Climate Change and Seasons			
Fewer Days of Snow Falling (p. 77)	Elementary	Snowflake	2: fewer days of snowfall could mean lower lake levels in the spring
Extreme Heat Becomes More Frequent (p. 79)	Elementary/Middle School	Fan	1: dangerous heat waves could affect public health
Climate Change and Temperature			
Side by side comparison of Average Temperature Increase Since 1895 (p. 81)	Elementary	MN in Winter Postcard	All
Temperature Increase in Northern vs. Southern Minnesota (p. 83)	Middle School/High School	Thermometer	5: species may move north with warming temperatures
Climate Change and Water			
Water Supply Sustainability Index (p. 85)	Elementary/Middle School	Water bottle	3: more floods and water deficits
Regional air temperature and average ice cover of Lake Superior (p. 87)	Middle School/High School	Ice Skates	2: impacts beaches, ecosystems, great lakes shipping, etc.
Climate Change and Fossil Fuels			
The Midwest Burns More Fossil Fuels (p.89)	Elementary	Power plant photo	The cause for all
Greenhouse Gas Emissions from Minnesota (p. 91)	Elementary/Middle School	Car/Bus	See above
Climate Change and Plant Life			
Observed and Projected Changes in Plant Hardiness Zones (p. 93)	Elementary/Middle School	Vegetable	4
Interactions between global warming and other drivers (p. 95)	Middle School/High School	Plastic worm	5: native species threatened by invasives

Activity Description

Introduction

1. Ask the students to name the five implications of climate change for Minnesotans. They can look back in their journals to review this.
2. Ask the students to write in their journals for five minutes about what issue they might be interested in studying if they were a scientist. Ask them to describe where and how they might do their research and what questions they might have based on what they've learned so far.

Activity: Data exploration

Note: This activity can be simplified by using one set of materials per box instead of two. The table above shows which figures may be most appropriate for certain grade levels. The template included with this lesson can also help younger students organize the information provided, but may not be needed with older groups.

1. Hand out a box that contains a set of materials to each group of three to five students. Make sure the data sets are face down and only the 3-D objects, or photos if objects are not available, are visible.
2. Students should begin by taking out the 3-D objects without looking at the other papers in the box. In their group, they should brainstorm a list of how each of the objects might relate to climate change in Minnesota and write the list in their journals.
3. After the students have finished brainstorming their lists, they should remove the papers that are left in the box. Each student or pair of students should take a figure out and spend some time looking over it. They should think about what 3-D object the figure might be connected to and they should prepare to explain what the figures mean to the other members of their group.
4. Each student will explain their figure to their group and how the object is connected.
5. Students should look in the envelope labeled "figure explanations." Read each explanation and as a group decide which explanation fits with each figure.
6. Ask students to remove the envelope of true/false statements and take turns reading a statement and aligning it with the graph where they think it belongs. Explain that they don't need to worry if it is true or false yet.
7. Once they have lined up the statements as a group, read through them again and decide if they are true or false.
8. Ask the groups to look at their completed sets, discuss what they think are common themes, and create a poster that summarizes the information.

Concluding Activity: Collect the Evidence

1. Ask each group to share their poster and what they learned.
2. Summarize each set as a class and make a list of key messages.
3. As a class, decide how each set of figures might be related to one of the five key issues for Minnesotans facing climate change they learned about in lesson 4.

Journaling Connection

Ask the students to create a concept map that shows the connections between the five implications of climate change for Minnesotans and the figures they looked at in their group and/or the other groups.

Take It Outside—Connecting With Your Place

Ask the students to think about the research that went into the figures they studied. Is there a particular experiment they could design and do in the schoolyard, their backyard or nearby nature area?

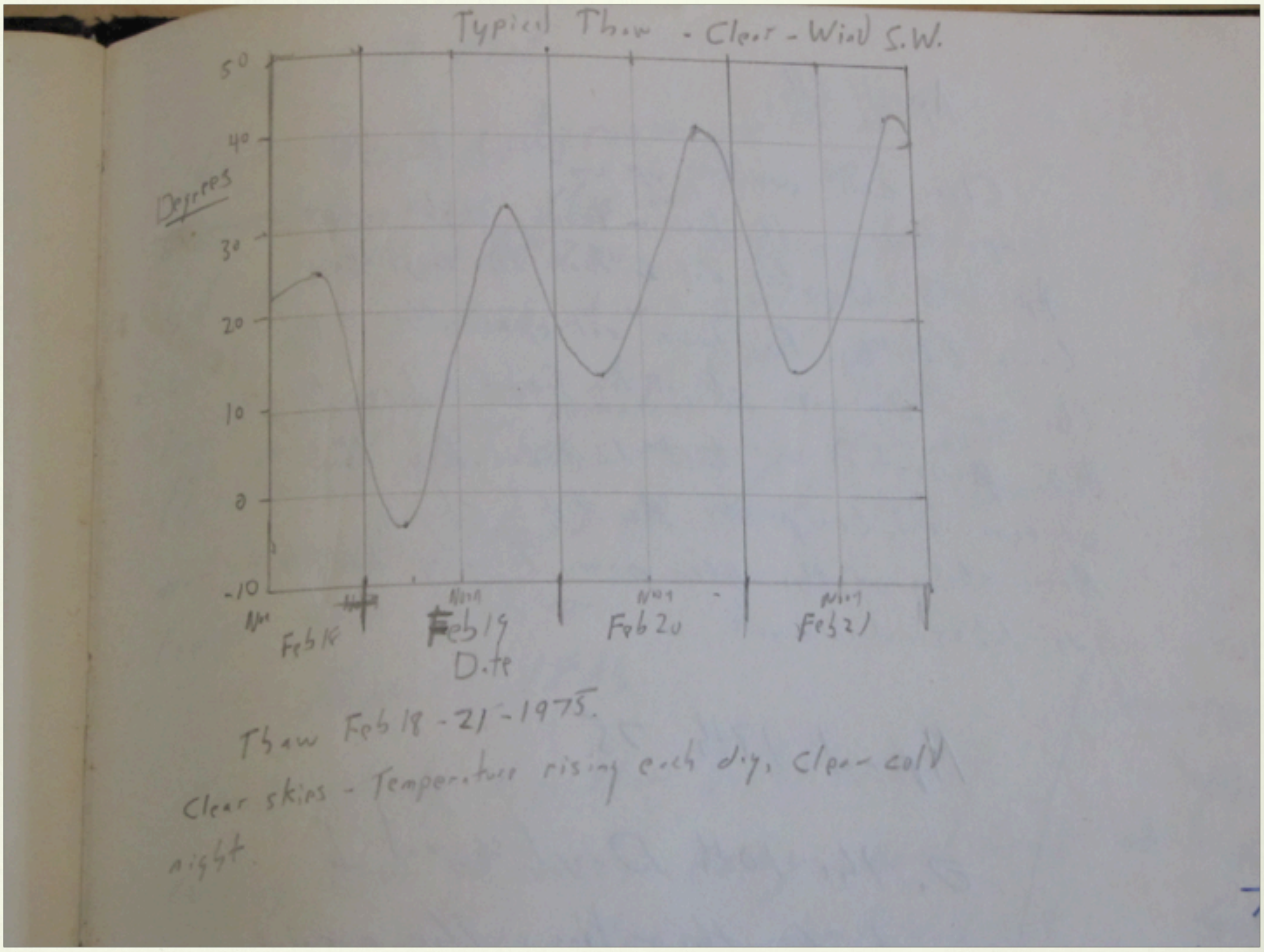
Extensions

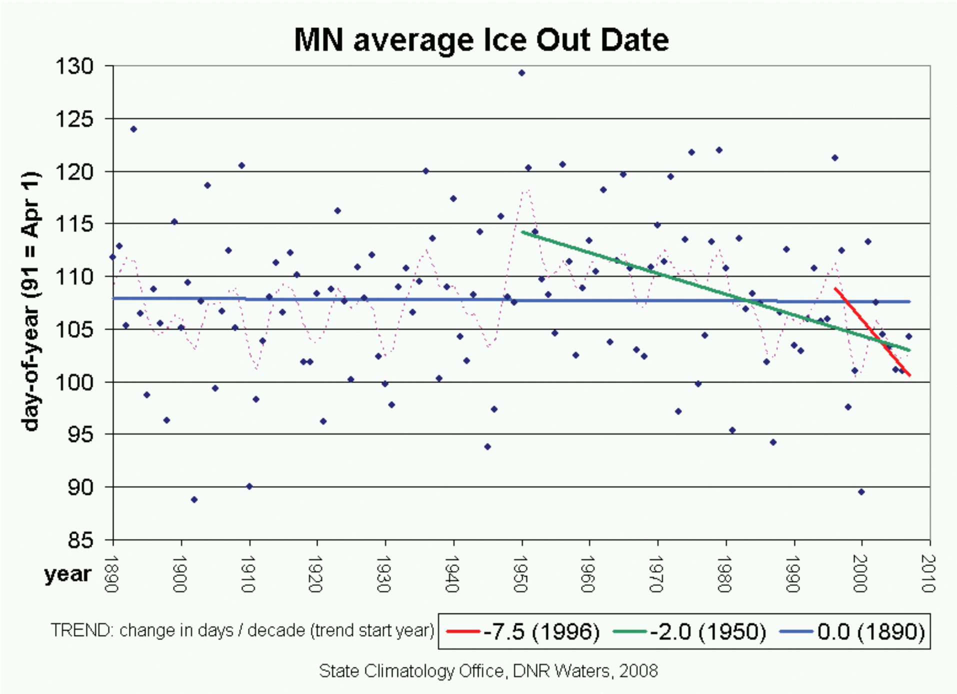
1. Ask students to develop a report based on the key messages that can be drawn from each set.
2. Ask students to develop their own sets of figures and true/false statements. Exchange with other classmates.

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org
Visit the Climate Change Basics section and interact with some of the graphs.

Will Steger used graphs to interpret the data he gathered from his observations. In this example, he records the changes in temperature over the course of a February thaw in 1975.

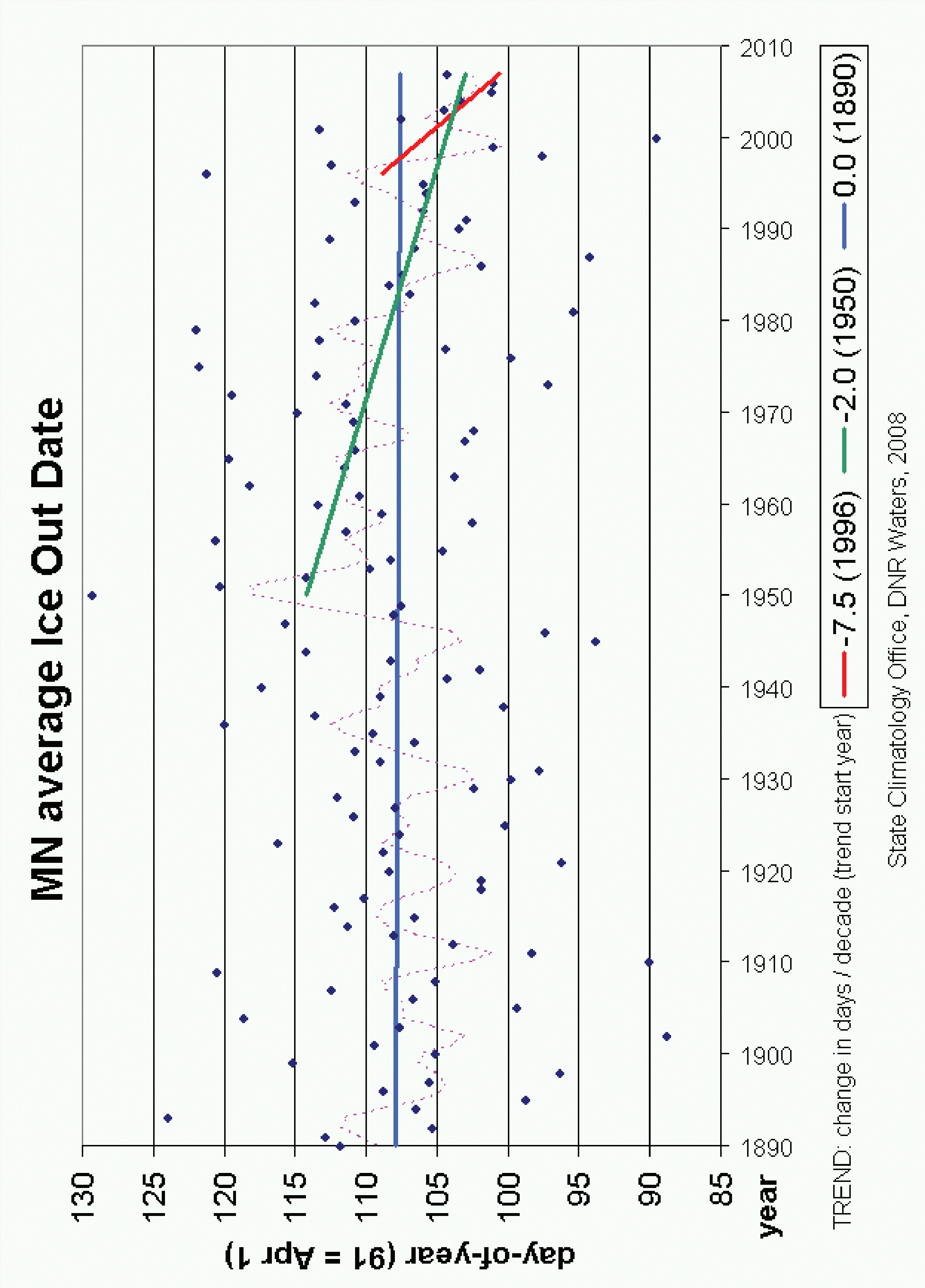


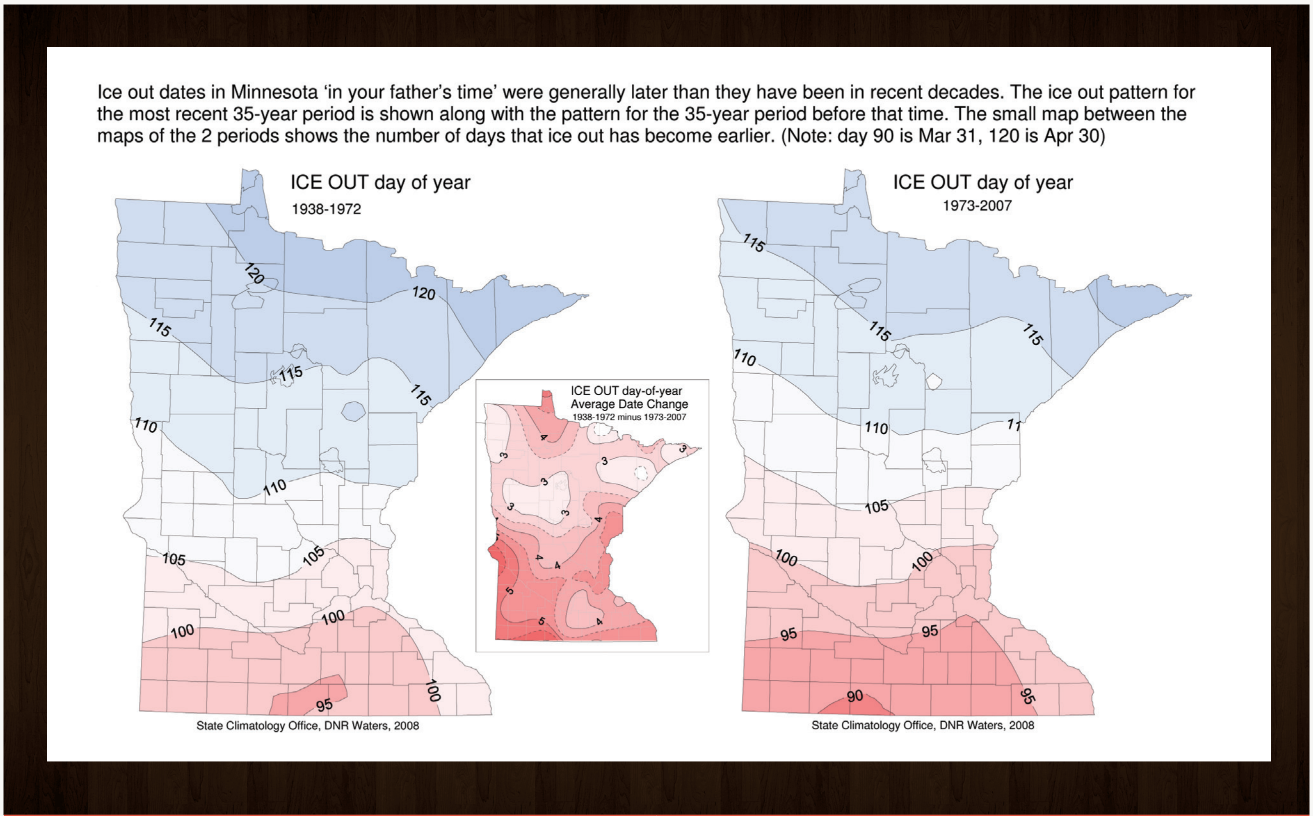


Ice out, like snow, is one of the many results of both temperature changes and humidity changes since both represent heat changes. Lake ice out has been getting earlier in the last few decades. The rate at which it has been getting earlier is greater in recent record than for longer periods.

Zandlo, Jim. (last modified 2008) Climate Change and the Minnesota State Climatology Office: Observing the Climate. Retrieved from http://climate.umn.edu/climateChange/climateChangeObservedNu.htm

TRUE STATEMENTS	FALSE STATEMENTS
The latest day the ice was recorded to go out was in 1950.	On the y-axis, 91 is the same as May 1.


MN average Ice Out Date
day-of-year (91 = Apr 1)
130
125
120
115
110
105
100
95
90
85
year
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
-7.5 (1996)
-2.0 (1950)
0.0 (1890)
TREND: change in days / decade (trend start year)
State Climatology Office, DNR Waters, 2008

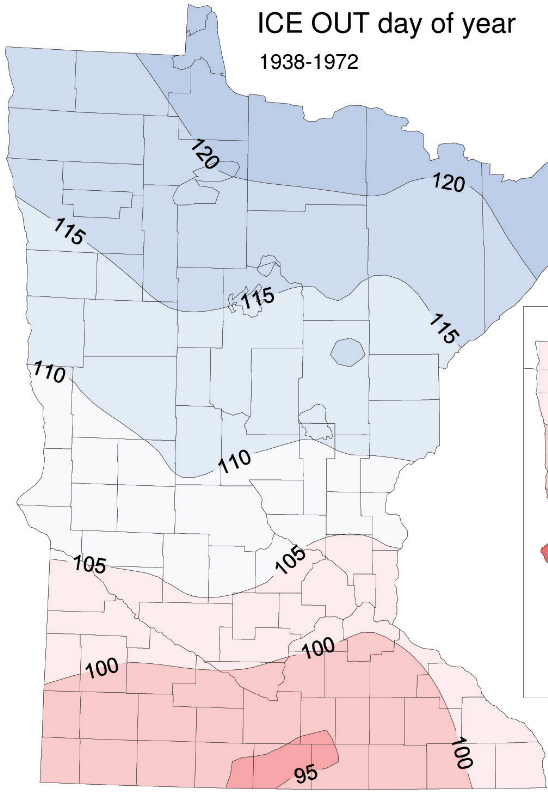


A comparison of ice-out dates in Minnesota between 1938-1972 and 1973-2007.
(Note: Day 90 is March 31, 120 is April 30)

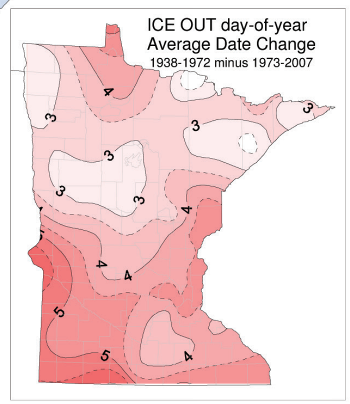
Zandlo, Jim. (last modified 2008) Climate Change and the Minnesota State Climatology Office: Observing the Climate. Retrieved from http://climate.umn.edu/climateChange/climateChangeObservedNu.htm

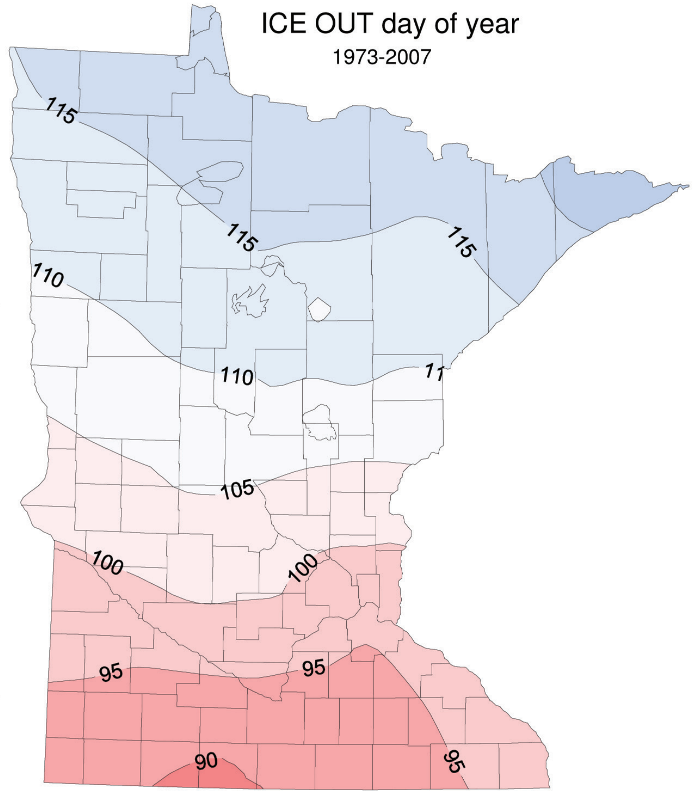
TRUE STATEMENTS	FALSE STATEMENTS
Ice out in the southwest corner of the state has been about 5 days earlier in recent decades.	The northern part of the state has seen 115 days of ice in recent decades.

Ice out dates in Minnesota ‘in your father’s time’ were generally later than they have been in recent decades. The ice out pattern for the most recent 35-year period is shown along with the pattern for the 35-year period before that time. The small map between the maps of the 2 periods shows the number of days that ice out has become earlier. (Note: day 90 is Mar 31, 120 is Apr 30)

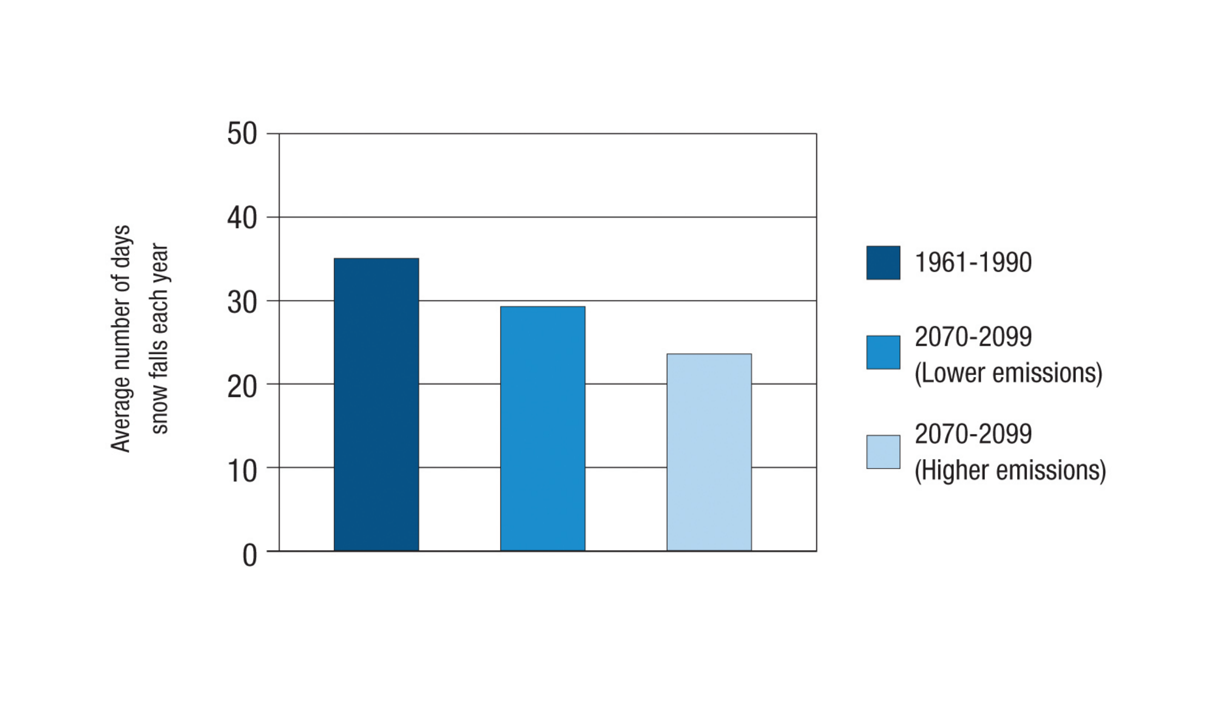


State Climatology Office, DNR Waters, 2008





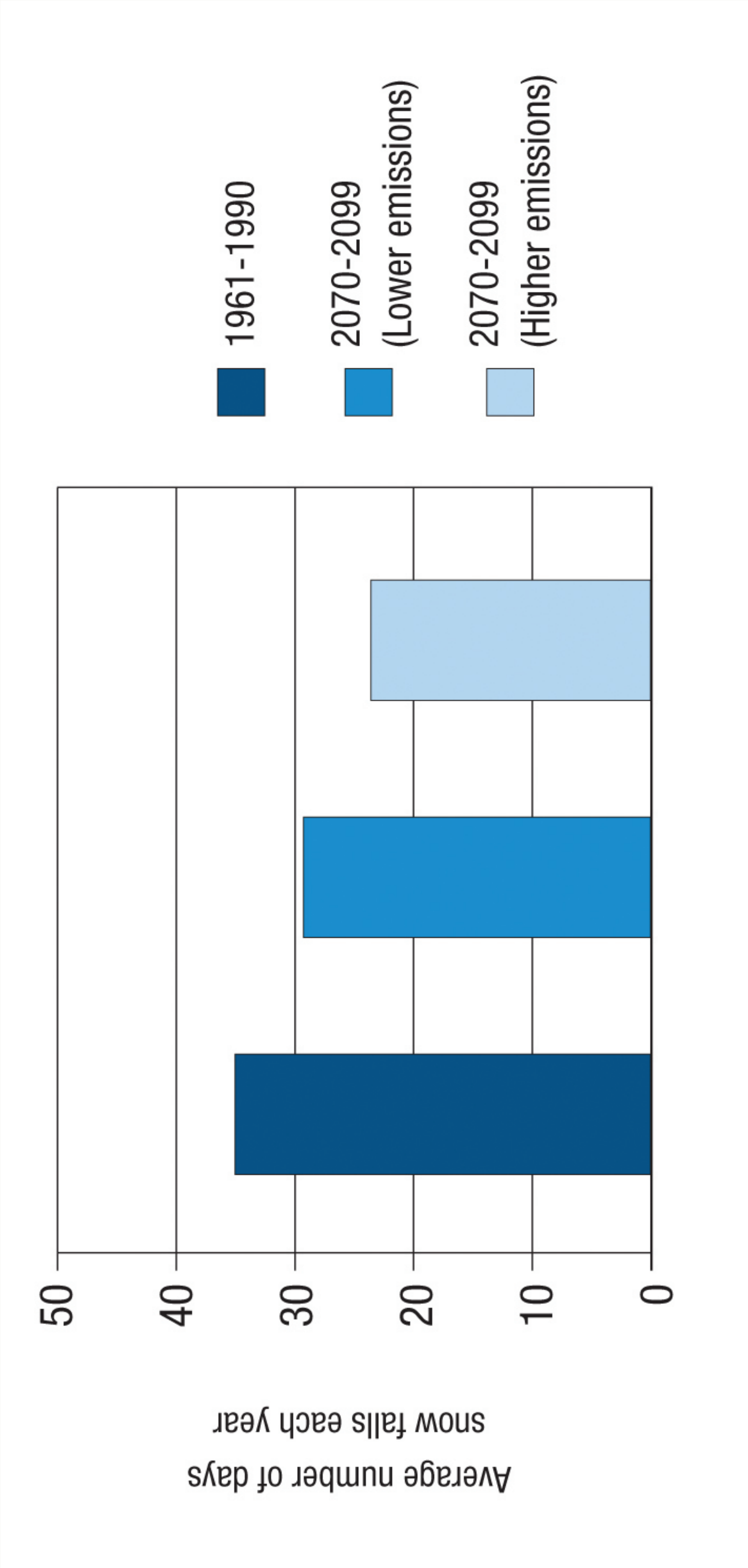
State Climatology Office, DNR Waters, 2008

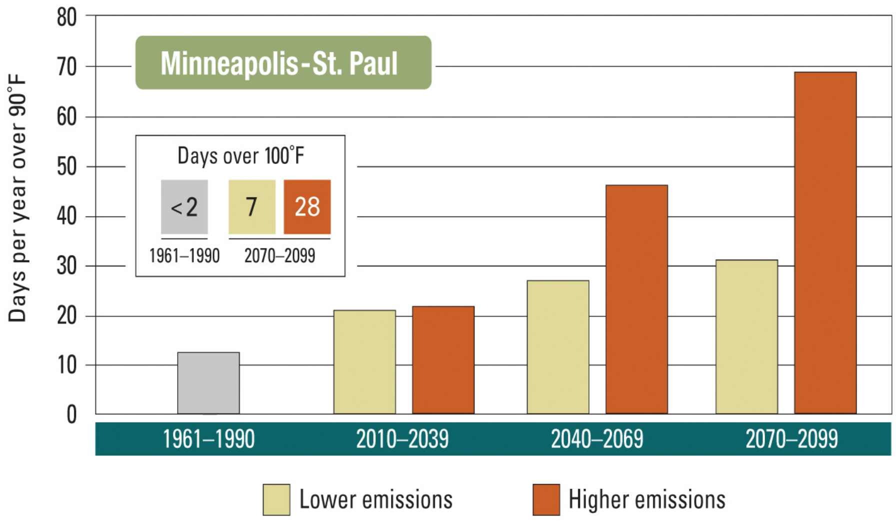


Fewer Days of Snow Falling

Union of Concerned Scientists. (2009). Confronting Climate Change in the US Midwest: Minnesota. Chicago, IL.

TRUE STATEMENTS	FALSE STATEMENTS
Even if emissions decrease, Minnesota is predicted to have shorter winters.	This graph shows that historically Minnesota has an average of 25 days of snowfall per year.


Average number of days
snow falls each year
0
10
20
30
40
50
1961-1990
2070-2099
(Lower emissions)
2070-2099
(Higher emissions)

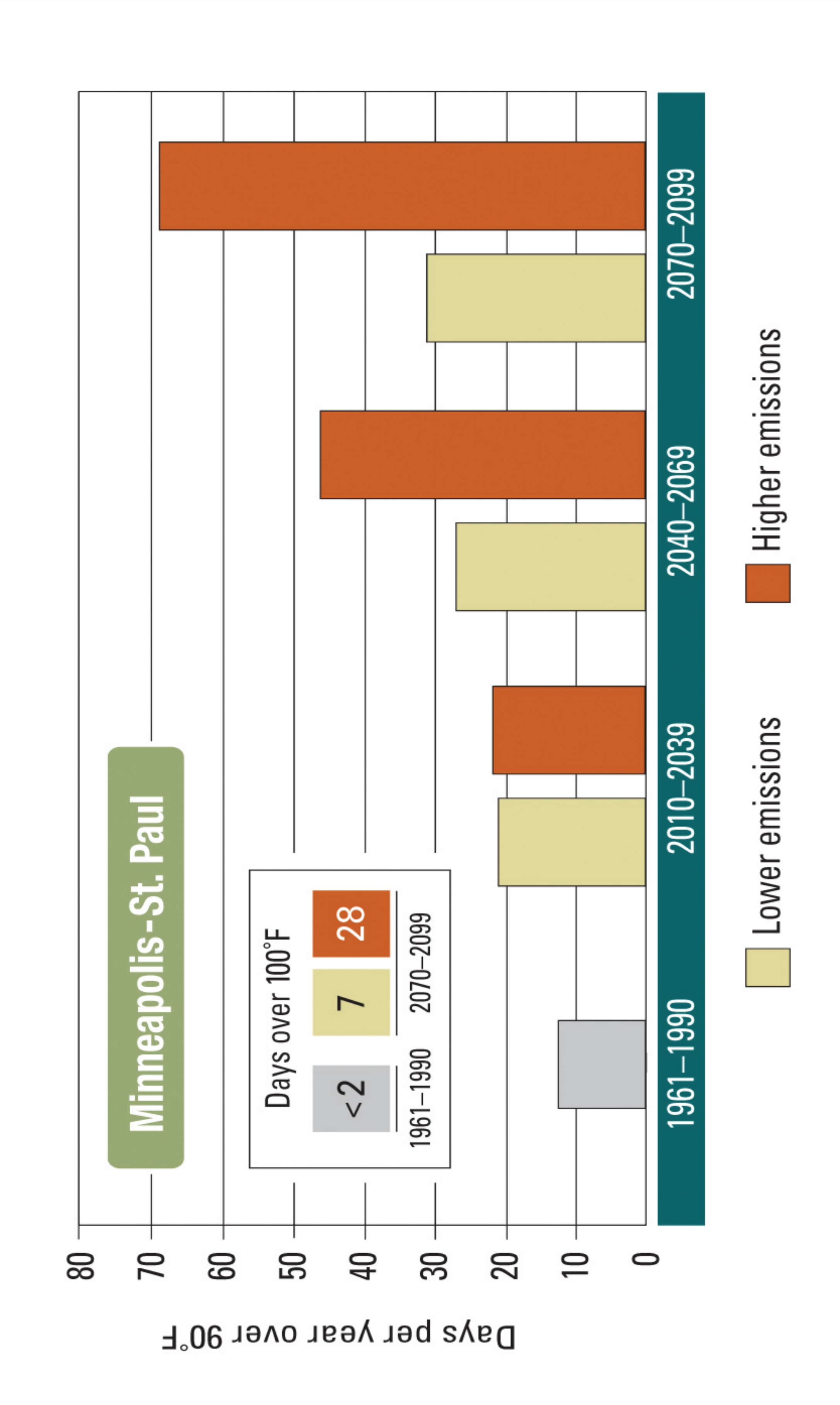


Extreme Heat Becomes More Frequent

This figure shows how models predict the temperature of the Twin Cities could change if we continue to emit large quantities of carbon dioxide (higher emissions scenario), or if we make some changes and cut our emissions (lower emissions scenario).

Union of Concerned Scientists. (2009). *Confronting Climate Change in the US Midwest: Minnesota.* Chicago, IL.

TRUE STATEMENTS	FALSE STATEMENTS
Under the higher-emissions scenario, the Twin Cities could experience almost an entire summer of days above 90 degrees F by the end of the century.	This bar graph shows how precipitation will change in the Twin Cities.


Minneapolis-St. Paul
Days over 100°F
<2
7
28
1961–1990
2070–2099
Days per year over 90°F
0
10
20
30
40
50
60
70
80
1961–1990
2010–2039
2040–2069
2070–2099
Lower emissions
Higher emissions

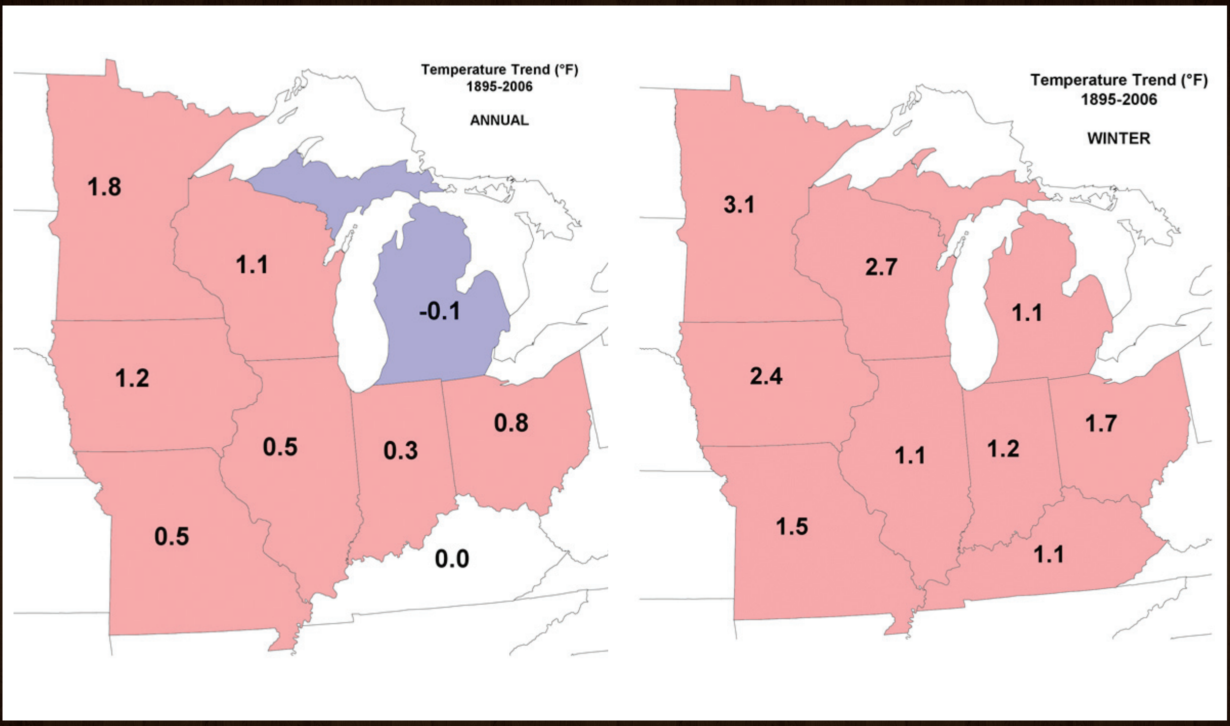
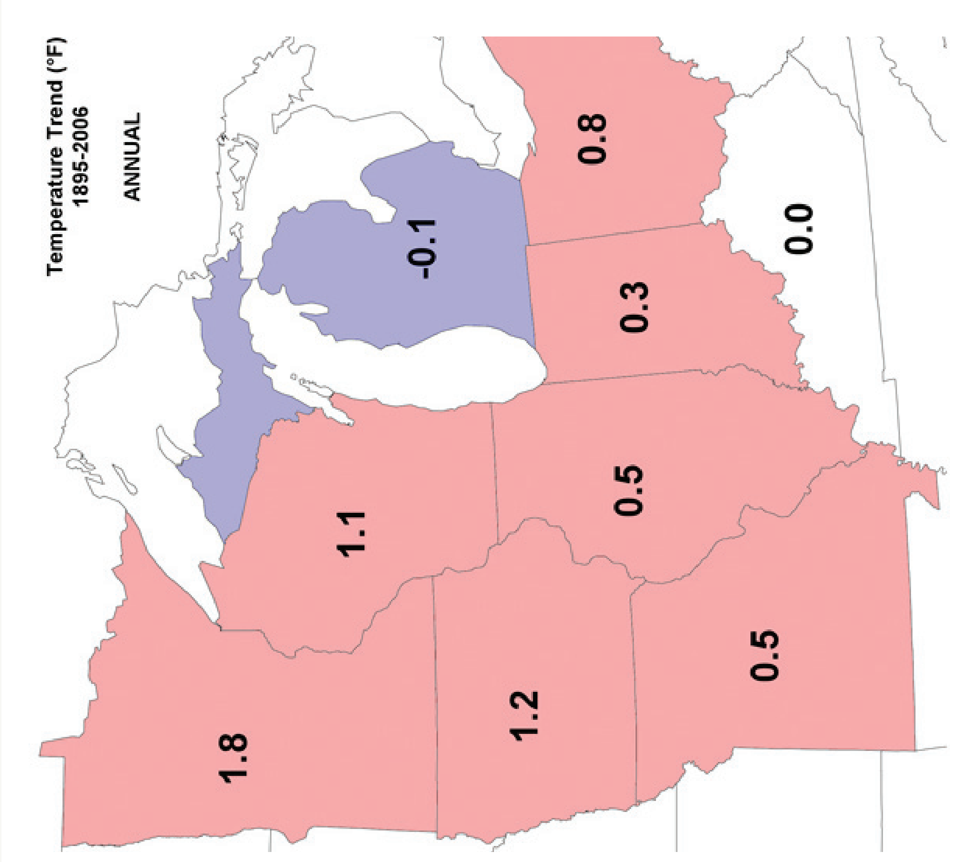
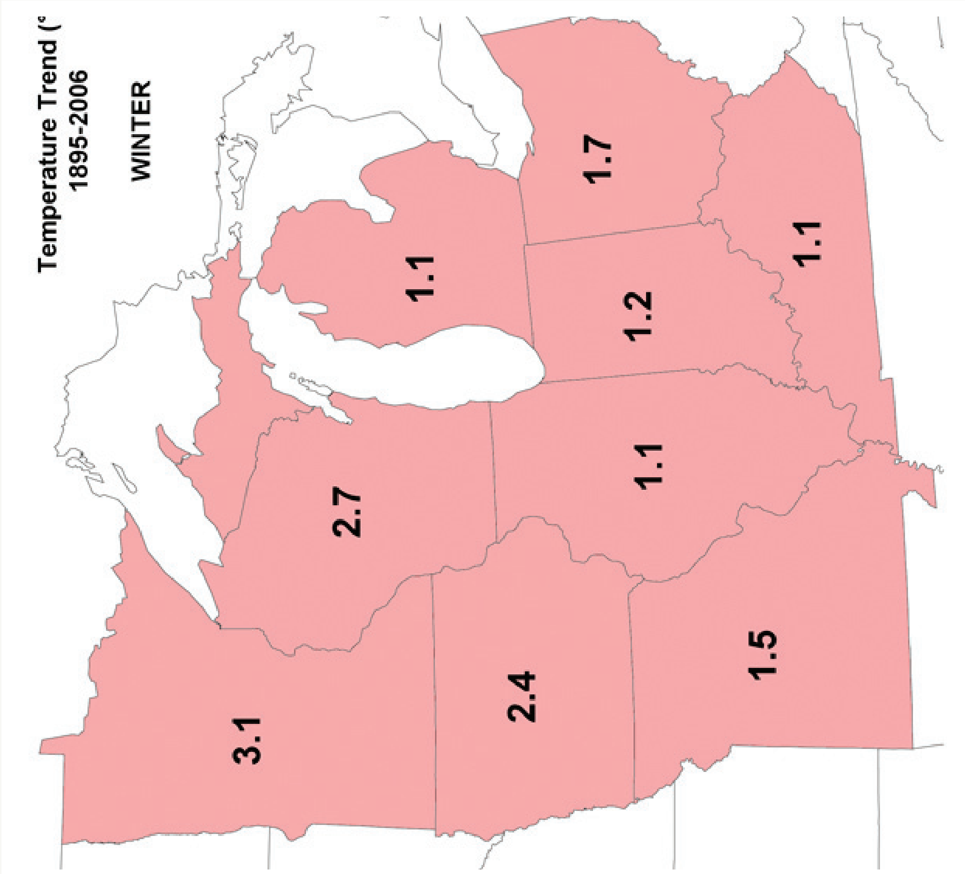


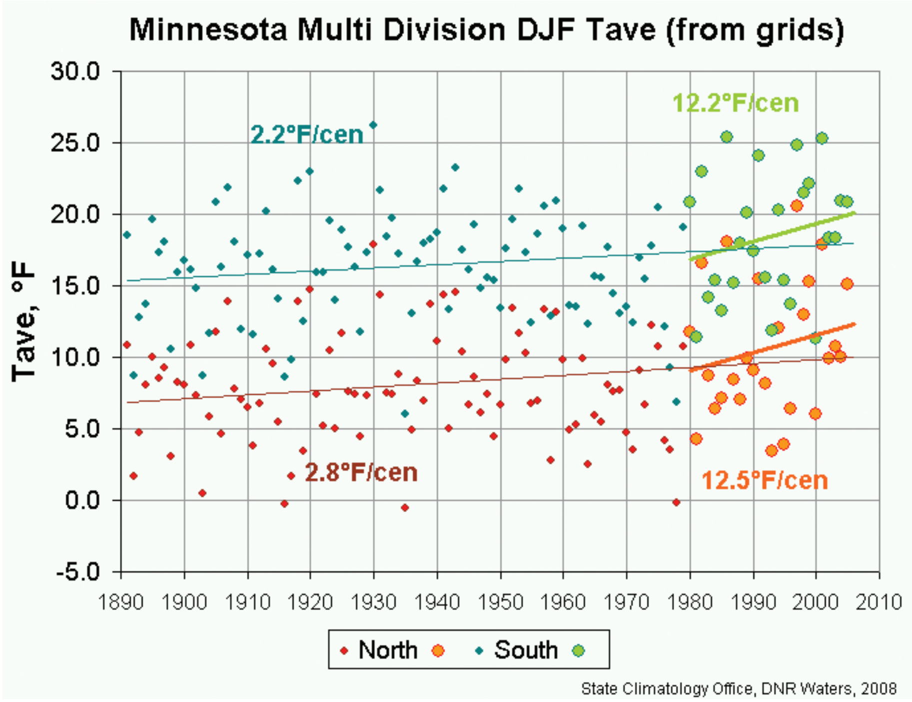
Figure 1. Annual average change in temperature, 1895-2006 (°F)
Figure 2. Average annual temperature change, winter, 1895-2006 (°F)

Minnesota Pollution Control Agency. (2010). Adapting to Climate Change in Minnesota: Preliminary Report of the Interagency Climate Adaptation Team, pp. 4-5. Retrieved from www.pca.state.mn.us/index.php/download-document.html?gid=15414

TRUE STATEMENTS	FALSE STATEMENTS
Temperature in Minnesota has increased an average of 1.8 degrees since 1895.	Minnesota winters have gotten colder since 1895.


Temperature Trend (°F)
1895-2006
ANNUAL
1.8
1.2
0.5
1.1
0.5
-0.1
0.3
0.0
0.8

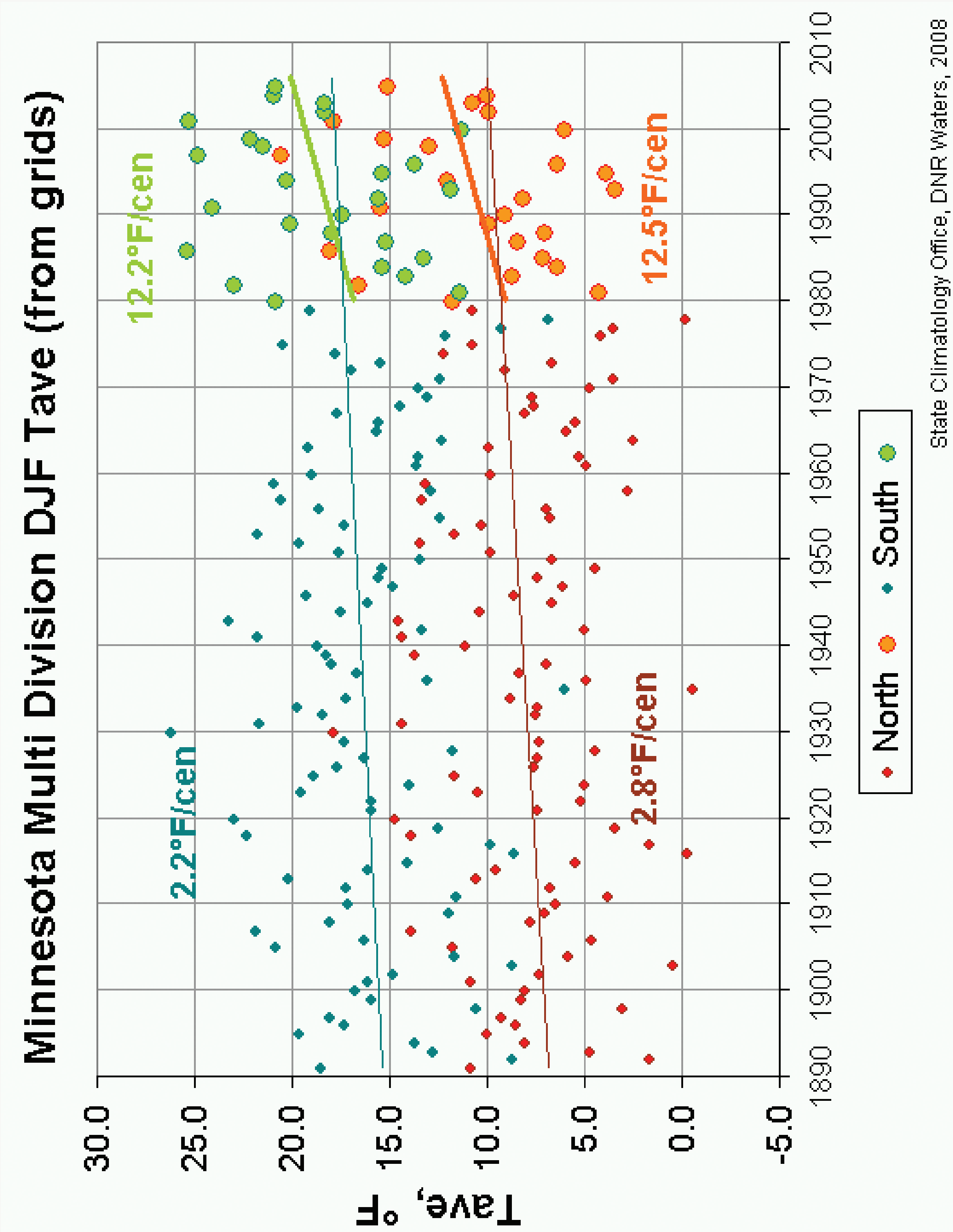

Temperature Trend (°
1895-2006
WINTER
3.1
2.4
1.5
2.7
1.1
1.1
1.2
1.1
1.7

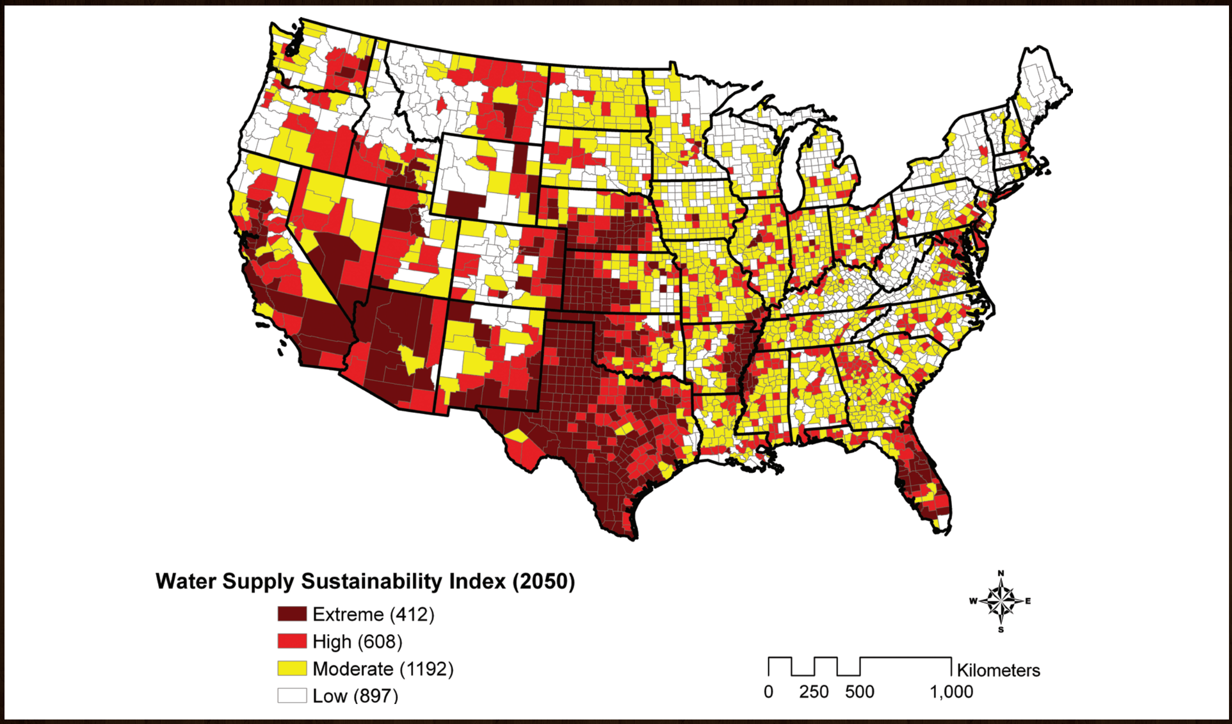


From the beginning of the record in 1891 to the early 1980s, Minnesota's average annual temperature did not change; its trend was essentially zero. Since the early 1980s the temperature has risen slightly over 1 degree F in the south to a little over 2 degrees F in much of the north; the trend has been upward.

Zandlo, Jim. (last modified 2008) Climate Change and the Minnesota State Climatology Office: Observing the Climate. Retrieved from http://climate.umn.edu/climateChange/climateChangeObservedNu.htm

TRUE STATEMENTS	FALSE STATEMENTS
If the graph ended in 1980, there would be no indication of warming in Minnesota.	The temperature on the y axis is in Celsius.

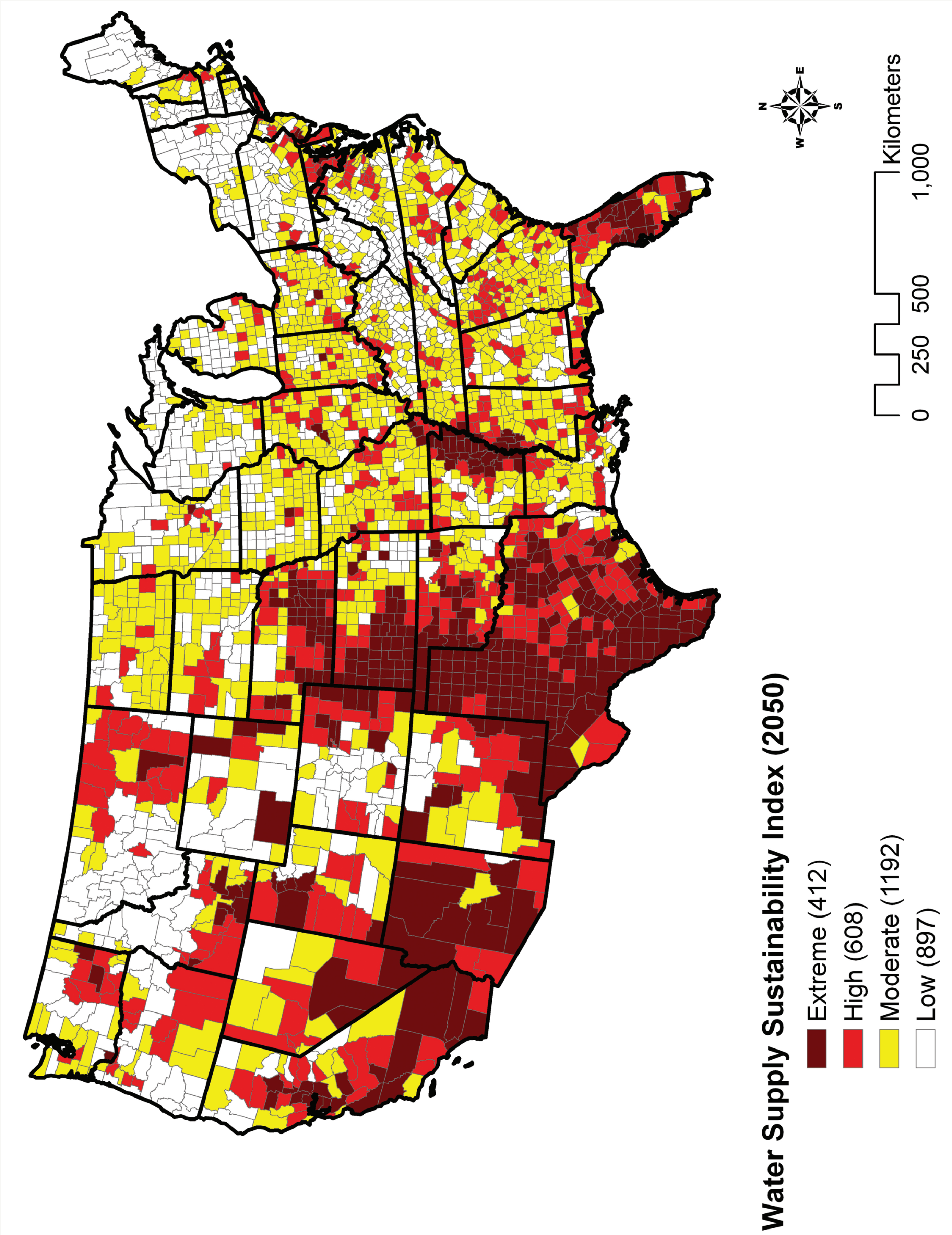

Minnesota Multi Division DJF Tave (from grids)
Tave, °F
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2.2°F/cen
2.8°F/cen
12.2°F/cen
12.5°F/cen
North
South
State Climatology Office, DNR Waters, 2008



Water Sustainability Index in 2050, with available precipitation computed using projected climate change.
(The numbers in parentheses are the numbers of counties in each category.)

Natural Resources Defense Council. (2010). Evaluating Sustainability of Projected Water Demands Under Future Climate Scenarios. Lafayette, CA: Tetra Tech, Inc.

TRUE STATEMENTS	FALSE STATEMENTS
Those at the highest risk in Minnesota are generally found in urban areas.	Those at the most risk are found in the northern parts of the country.


Water Supply Sustainability Index (2050)
Extreme (412)
High (608)
Moderate (1192)
Low (897)
0 250 500 1,000
Kilometers
N
E
S
W

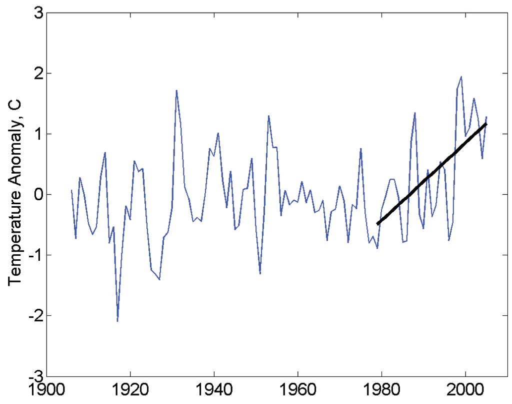


Figure A

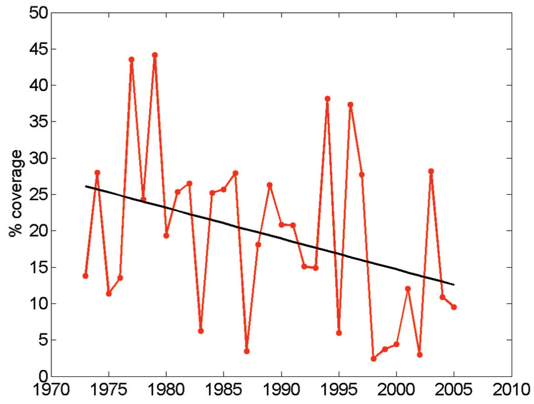


Figure B

Regional air temperature and average ice cover of Lake Superior:
a) mean July-September air temperatures from GISS sites on Lake Superior (available from http://data.giss.nasa.gov/gistemp/) and b) ice cover metric [Assel, 2003; 2005b] in percent.

Austin, J.A., and S.M. Colman. 2008. "A century of temperature variability in Lake Superior." Limnol. Oceanogr. 53, 2724–2730.

TRUE STATEMENTS	FALSE STATEMENTS
Since 1980, Lake Superior ice cover has declined almost 10 percent.	There is no correlation between ice cover and temperature.

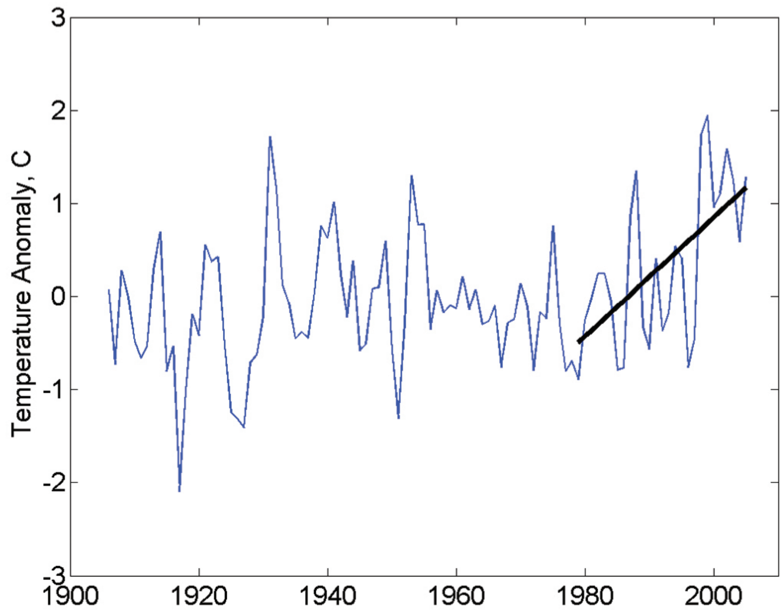


Figure A

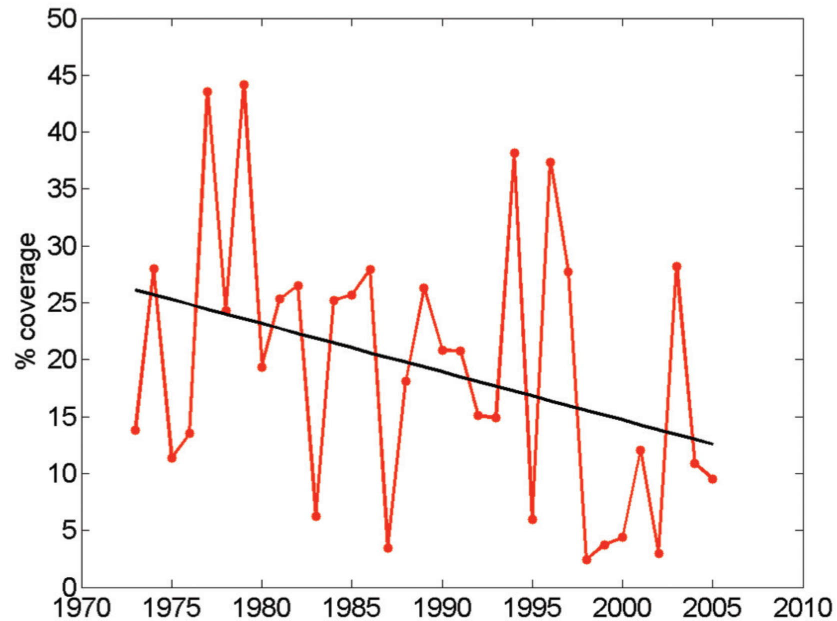
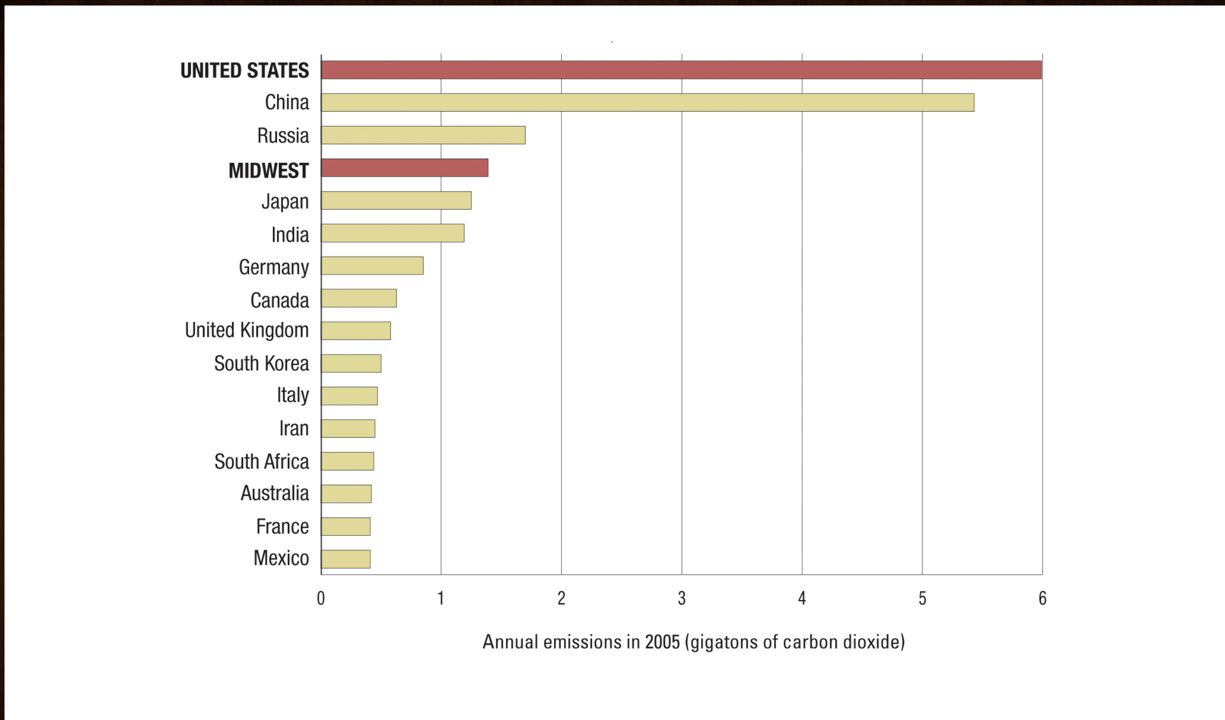


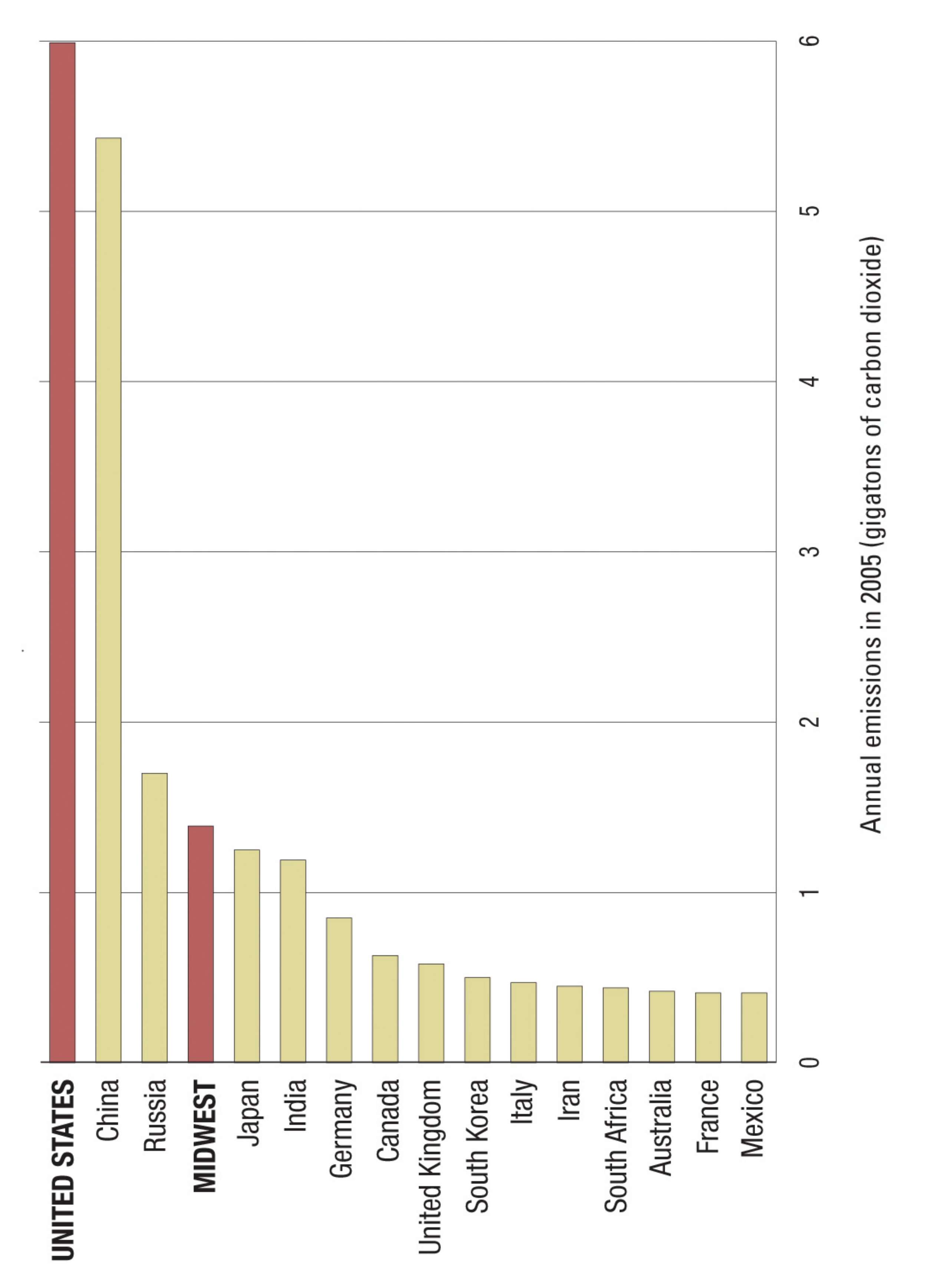
Figure B

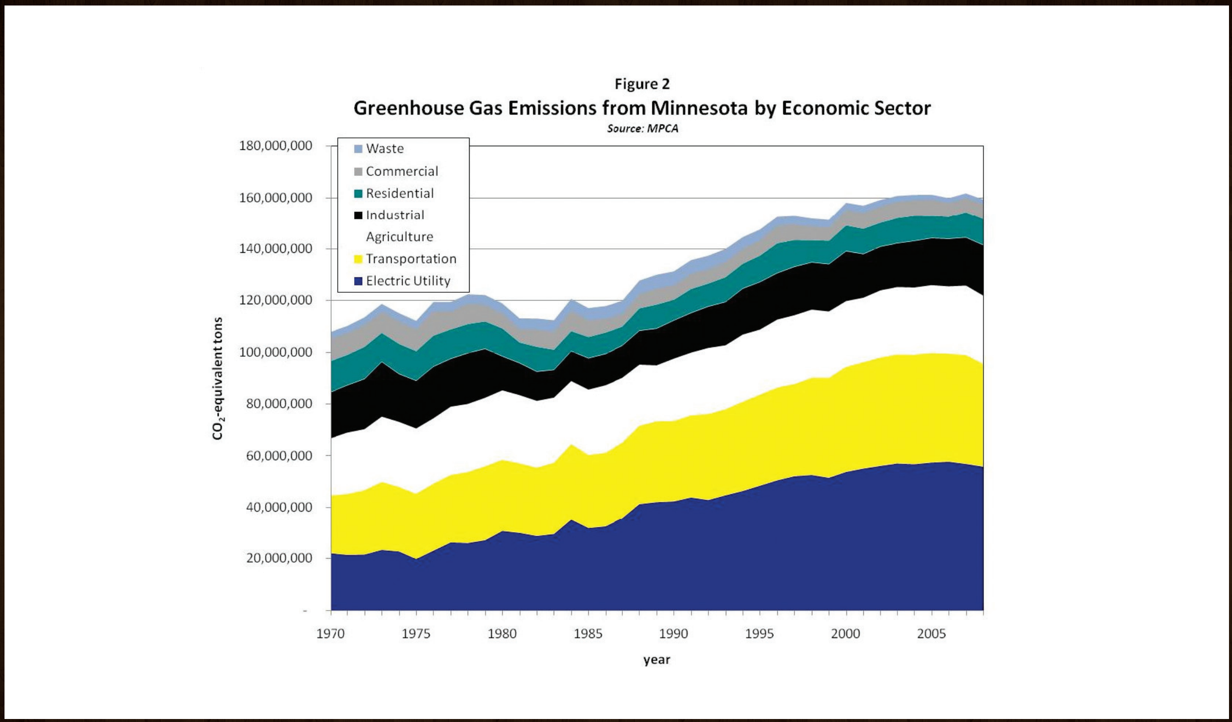


The Midwest Burns More Fossil Fuels Than Entire Nations

Union of Concerned Scientists. (2009). Confronting Climate Change in the US Midwest: Minnesota. Chicago, IL.

TRUE STATEMENTS	FALSE STATEMENTS
The total combined emissions from the eight Midwest states (Illinois, Indiana, Iowa, Michigan, Missouri, Ohio, and Wisconsin) would make the Midwest the world's fourth largest polluter if it were a nation.	China emitted more carbon dioxide than the United States in 2005.


UNITED STATES
China
Russia
MIDWEST
Japan
India
Germany
Canada
United Kingdom
South Korea
Italy
Iran
South Africa
Australia
France
Mexico
0
1
2
3
4
5
6
Annual emissions in 2005 (gigatons of carbon dioxide)



Greenhouse Gas Emissions from Minnesota by Economic Sector

Minnesota Department of Commerce, and Minnesota Pollution Control Agency. (2011) Annual Legislative Proposal Report on Greenhouse Gas Emission Reductions and Biennial Greenhouse Gas Emissions Report to the Minnesota Legislature. Minn. Statt. 216H.07, subd. 3 and 4.

TRUE STATEMENTS	FALSE STATEMENTS
The long-term trend shows increasing greenhouse gas emissions.	The waste sector accounts for the majority of the greenhouse gas emissions from Minnesota.

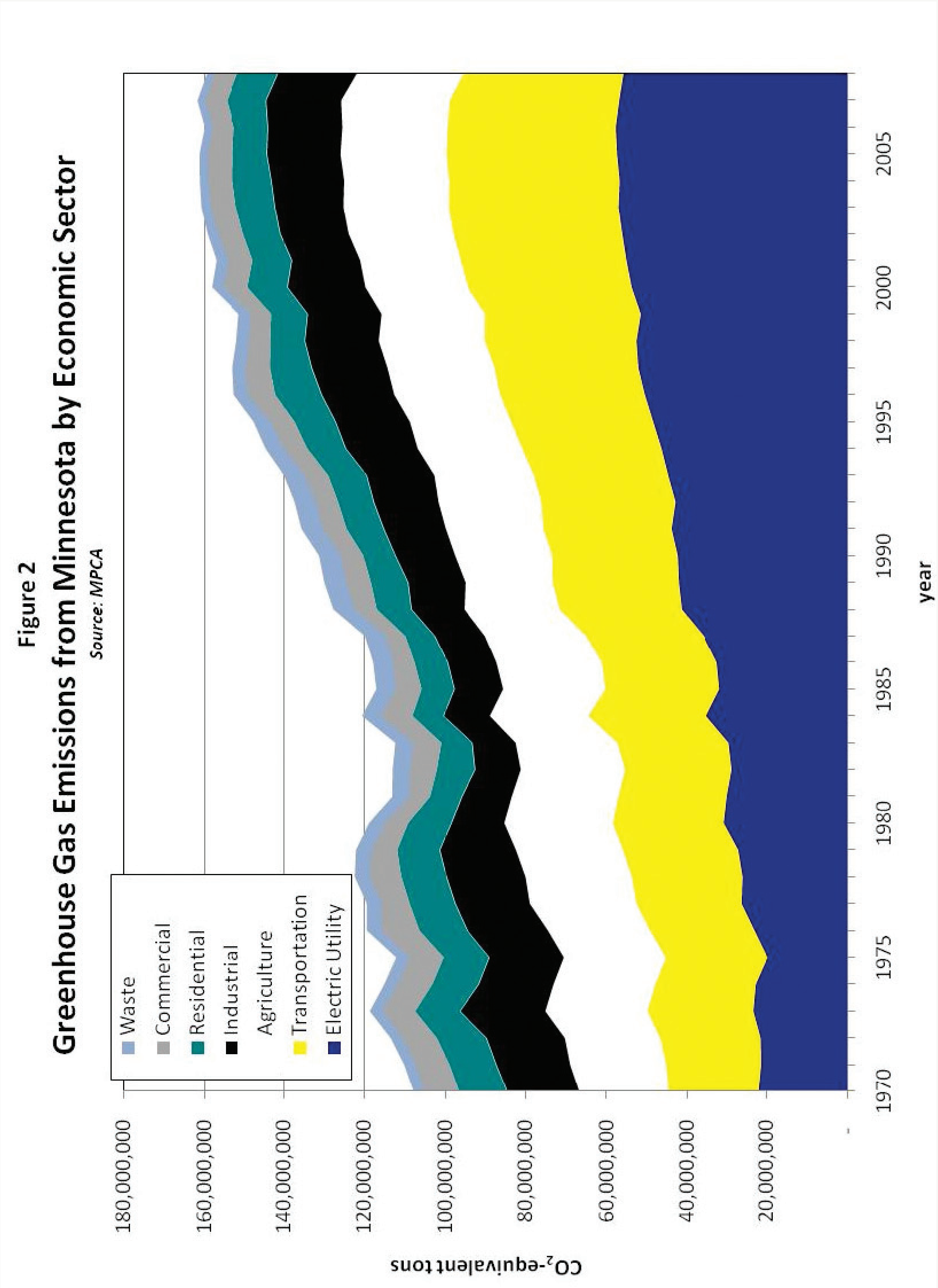
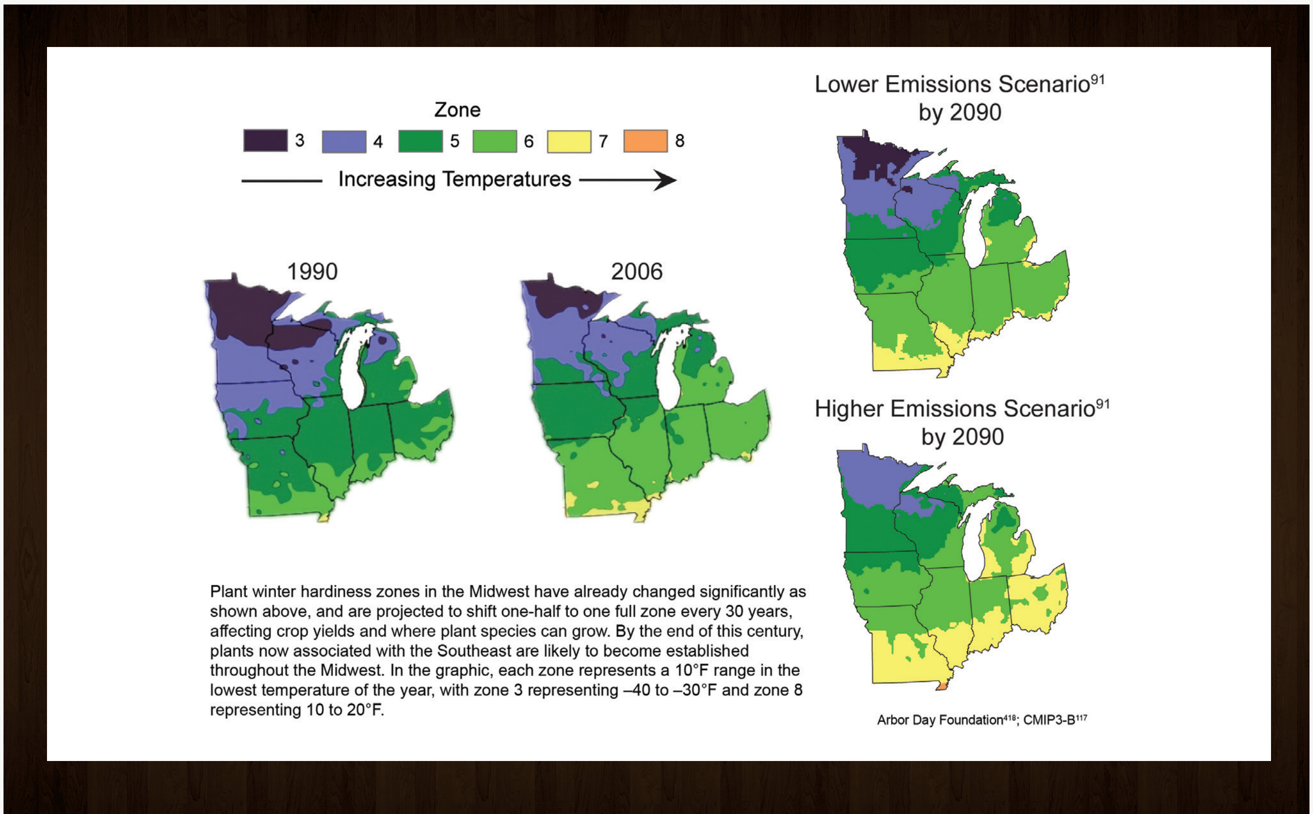


Figure 2
Greenhouse Gas Emissions from Minnesota by Economic Sector
Source: MPCA
Waste
Commercial
Residential
Industrial
Agriculture
Transportation
Electric Utility
180,000,000
160,000,000
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
-
CO2-equivalent tons
1970
1975
1980
1985
1990
1995
2000
2005
year

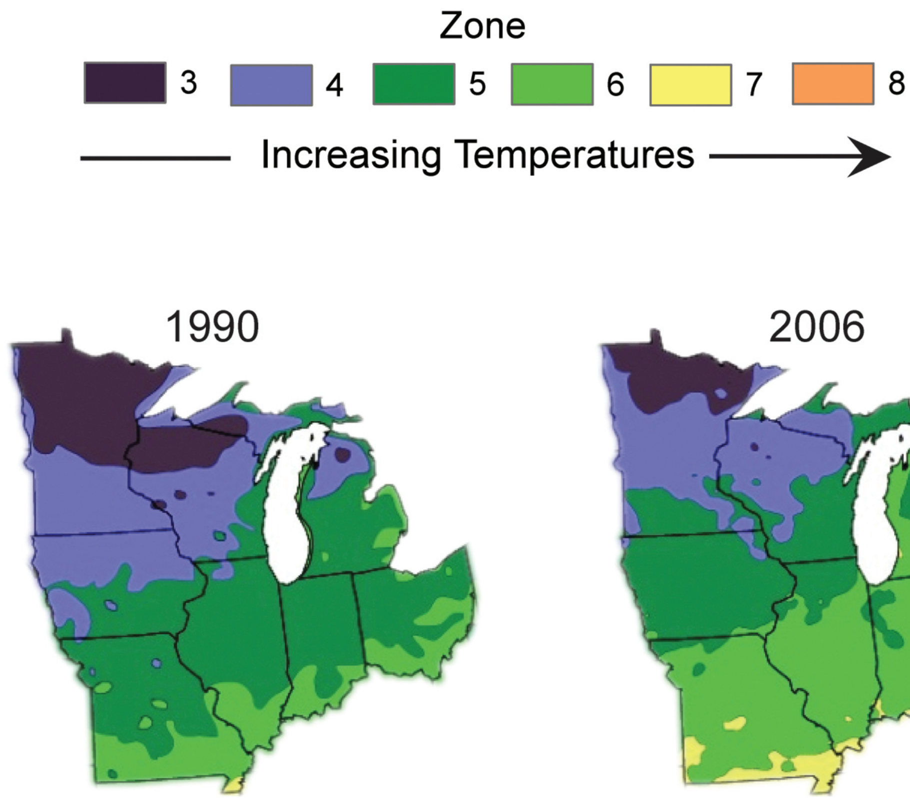


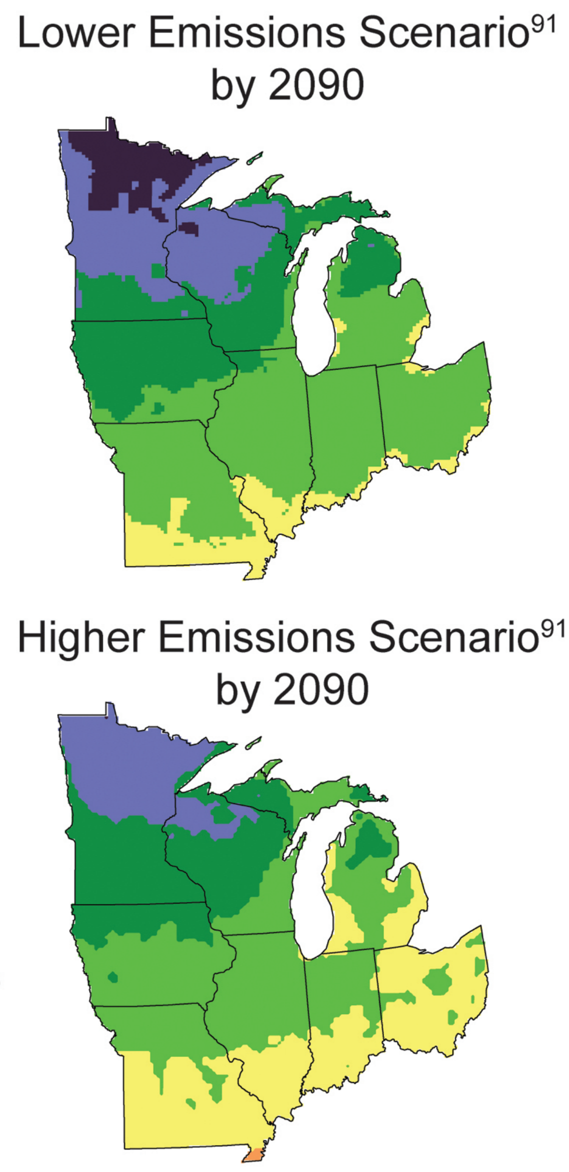
Observed and Projected Changes in Plant Hardiness Zones

Each zone represents a 10 degree F range in the lowest temperature of the year, with zone 3 representing -40 to -30 degree F and zone 8 representing 10 to 20 degrees F.

U.S. Global Change Research Program. (2009). Global Climate Change Impacts in the United States. New York, NY: Cambridge University Press.

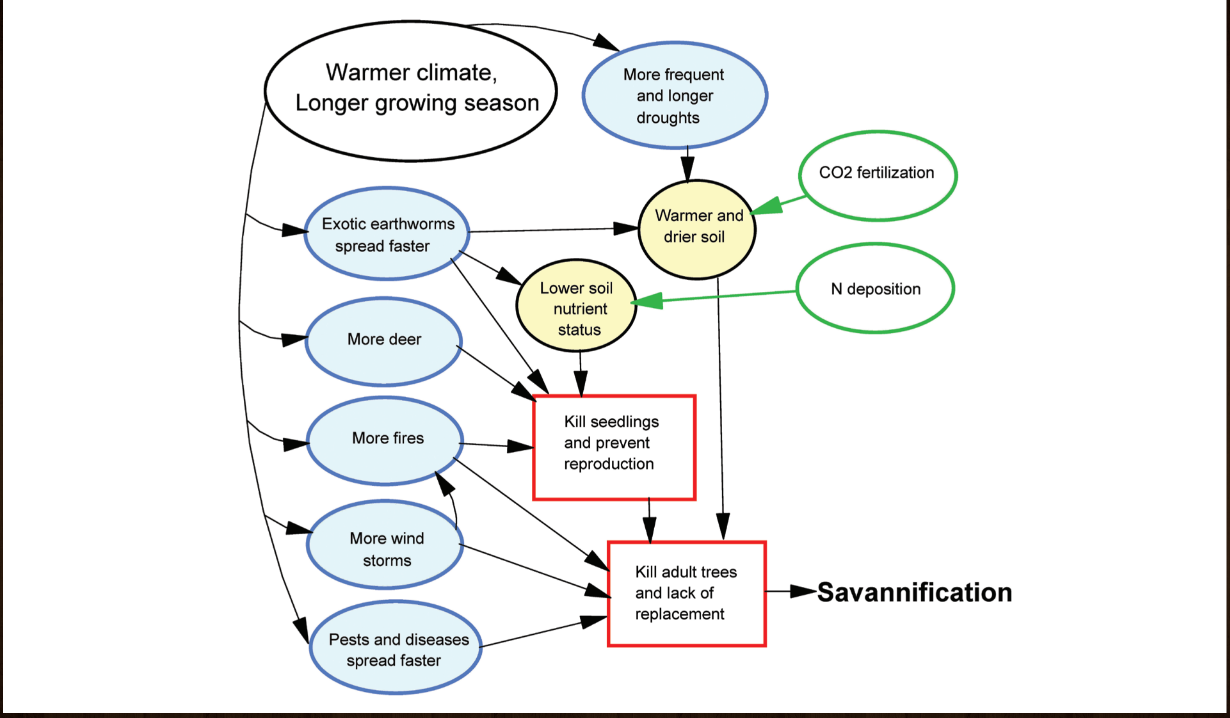
TRUE STATEMENTS	FALSE STATEMENTS
By the end of this century plants now associated with the Southeast are likely to become established throughout the Midwest.	Minnesota will see little change in plant zones under these projections.





Plant winter hardiness zones in the Midwest have already changed significantly as shown above, and are projected to shift one-half to one full zone every 30 years, affecting crop yields and where plant species can grow. By the end of this century, plants now associated with the Southeast are likely to become established throughout the Midwest. In the graphic, each zone represents a 10°F range in the lowest temperature of the year, with zone 3 representing –40 to –30°F and zone 8 representing 10 to 20°F.

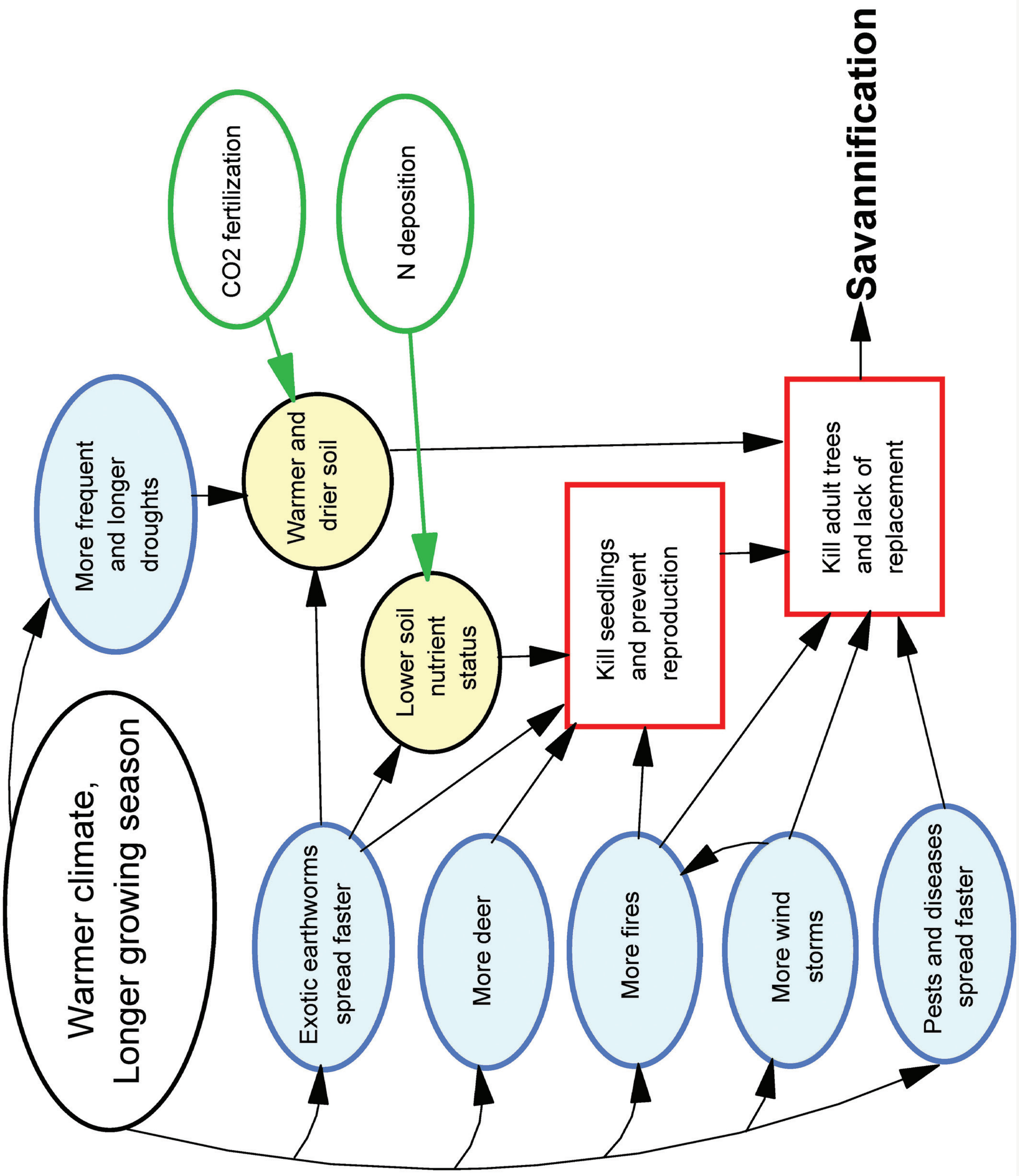
Arbor Day Foundation[418]; CMIP3-B[117]



This chart shows interactions between global warming and other drivers of change affecting the prairie-forest border of central North America, and other impacts on trees. Blue ovals represent drivers with potential negative impacts on trees that are likely to be enhanced by a warmer climate. Yellow ovals represent basic resources that may be changed by a warmer climate or by its interactions with other drivers. Green ovals represent drivers that may counteract negative impacts on trees to some extent. Red rectangles show the results of drivers on trees and their reproduction.

Frehlich, L.E., and Reich, P.B. 2009. "Will environmental changes reinforce the impact of global warming on the prairie-forest border of central North America?" Frontiers In Ecology.

TRUE STATEMENTS	FALSE STATEMENTS
A warmer climate could lead to an increase in deer populations.	Earthworms will help fight the impacts of a warming climate.



Warmer climate, Longer growing season
More frequent and longer droughts
Exotic earthworms spread faster
More deer
More fires
More wind storms
Pests and diseases spread faster
CO2 fertilization
N deposition
Warmer and drier soil
Lower soil nutrient status
Kill seedlings and prevent reproduction
Kill adult trees and lack of replacement
Savannification

TRUE STATEMENTS	FALSE STATEMENTS

Age Level:	Grades 3-12
Time Needed:	To be determined by students
Materials:	Poster paper Markers Action Worksheet and Template
Student Learning Outcomes:	• Students will brainstorm appropriate solutions and select one for their group, class or school • Students will develop a climate action plan and begin to implement it

Background Information:

Student action to mitigate the effects of climate can take many forms. Crafting position statements and testifying before the legislature, designing public service announcement posters, videos or podcasts, planting trees to absorb carbon dioxide, starting or joining a citizen science project to record phenology, or starting a compost for school or home food waste to decrease methane gas release are all legitimate actions, especially when student driven.

> We need to start communicating...we need to really get active and do what we can in our own sphere of influence ... we need the youth.
>
> —Will Steger at youth event, September 2, 2008

The most important outcome of this lesson and unit on *Minnesota's changing climate*, is that this final action project is <u>student</u> led and <u>student</u> driven. Making sure students feel that they can part of the solution and that their ideas are valuable is an essential key to helping them not feel overwhelmed by the current and predicted impacts of climate change. In addition, the action projects that they develop are valuable assessments of what they understood and connections that they made about what is causing climate change and how it will impact their lives, biome and Minnesota as whole.

Activity Description

This is only one suggested way to help identify student action projects. Throughout this unit, project ideas may have already been developed or started. As noted earlier, the two most important outcomes are that there is a project so that students feel part of a solution, and that these projects are as student-initiated and driven as possible.

Introduction

1. Divide students into five groups and hand out one key issue to each group. Ask each group to dissect the issue to the root cause.
2. Ask students to glue the issue in the center of a large piece of butcher paper or poster board. From the issue, ask them to break it into smaller and smaller parts to identify the root cause or problem. (See example below)

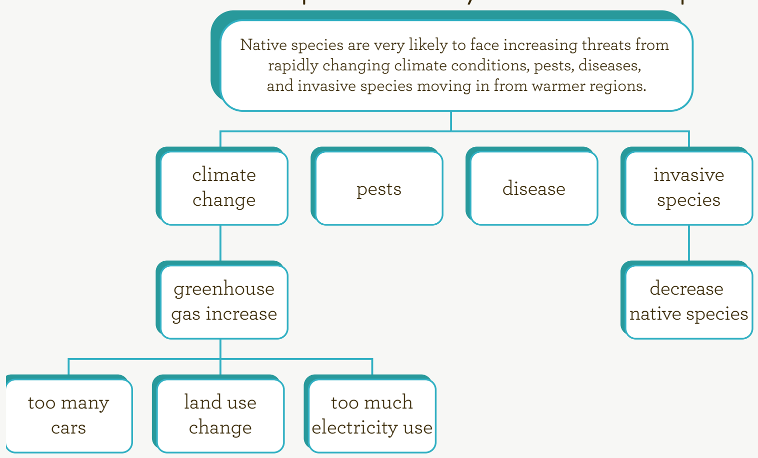


Diagram 1: Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.

3. Once they have identified a few problems, ask them to turn their poster over and put one problem in the middle of their paper and make a concept map of solutions. Encourage creative thinking and tell them no idea is too crazy at this point. (See example below) This may also be a time to do some Internet research about solutions and project ideas.

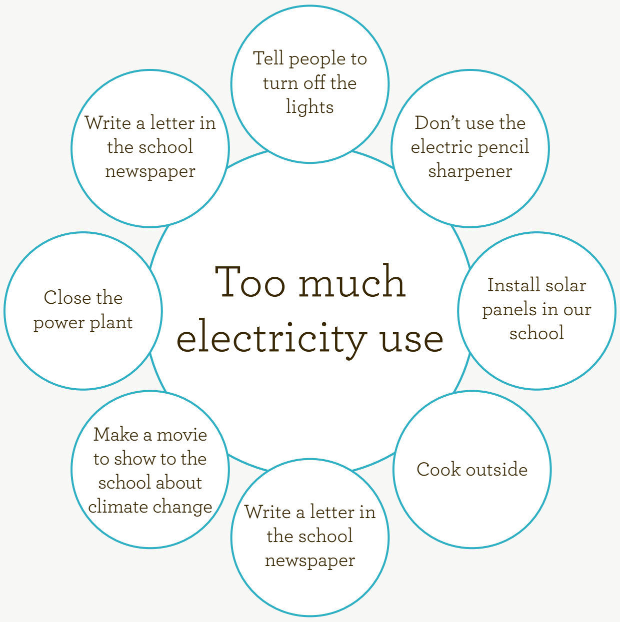


Diagram 2: Too much electricity use

Activity: Developing Action Plans

1. Once the groups have identified solutions. Ask them to post their visuals and have everyone in the class walk around to read the different solutions. Take notes in their journal about which solutions they think are the most interesting and which ones they would be interested in working on.
2. Identify a few solutions through voting as a class, and ask students to break into interest groups to work on an action plan. Use the attached climate action plan worksheet and template.

Journaling Connection

Ask students to document their "action journey" in their journal. This could be in words, poetry, cartoons, photos pasted in or whatever creative way they can think of.

Take It Outside—Connecting With Your Place

There are many action projects connected with climate change that can happen in your schoolyard or nature area close by. If your students are able to articulate the connection between what they are proposing and climate change, that is the most important part.

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org

Submit your climate action plans, as well as photos and videos of you in action, or email them to education@willstegerfoundation.org

Climate Action Plan Template

Part One: Brainstorming

1. What issue are you most passionate about regarding the impacts of climate change in Minnesota? Why?

2. What do you want to see change at your school and/or what does your school or community need to do to help mitigate or adapt to the impacts of climate change?

3. What connections do you see between your passions and the needs of your school/community?

4. Use the space below to jot ideas for potential projects based on the previous questions and your participation in workshops/discussions:

Part Two: Action Plan

Now that you've done some brainstorming, it's time to get more specific. Here is a step-by-step process that can help you identify a project and develop SMART goals. Use the Project Planning Worksheet to create a strategic and successful action project while referring to the steps below to guide your work.

Step One: Choose a Project Focus

Some potential areas to work on are listed below, but don't limit yourself to these ideas. Get creative, and address the greatest needs in your school or community.

Project ideas include: energy efficiency on campus, climate change curriculum/awareness/eco-literacy education, greening your school cafeteria, organic gardening, composting, recycling, reducing your school's carbon footprint, less dependence on fossil fuel transportation, make your school a bike friendly school, install a rain garden, plant trees and native plants, green financing/purchasing, etc.

The area I will focus on for this action plan is: ______________________________

Step Two: Setting SMART Goals

Something to keep in mind when you're creating your Goals and Objectives is S.M.A.R.T. decision-making. S.M.A.R.T. stands for "Specific, Measurable, Achievable, Realistic, and Timely." You can begin with some pretty lofty goals (such as the desire to make your community 100% carbon neutral), but they have to be broken down into manageable activity chunks that have specific measures of success. For example, rather than have a goal of "Get everyone at school to start recycling," the S.M.A.R.T. way of stating that goal would be to say … get two recycling bins placed in each classroom and create a student-led pick-up program for this year."

There are two major benefits of having realistic goals with definite measurements of success. One, you'll feel a sense of accomplishment when you've met your goal. The community will also be able to see progress—and will therefore be much more likely to get involved. Two, the people who give you money for your project will prefer those kinds of specific goals. If you need to write a grant or ask the local millionaires' club for a donation, they will ask for specifics to make sure that their money goes toward some tangible achievement.

S.M.A.A.R.T.T.

Specific	can be well-defined and clearly understood by anyone who has basic knowledge of the project
Measurable	can know if a goal is obtainable, when it has been achieved and how far away completion is
Achievable	can be achieved within the current environment
Agreed Upon	agreement with all the stakeholders what the goals should be
Realistic	can be accomplished within the availability of resources, knowledge and time
Timetable	are limited by a timeframe
Tangible	anyone can experience it

Step Three: Building Your Team

As much as you'd love to do this solo, you're going to have to partner with a team, group, and/or organization in order to achieve your goals. You may already have a team you're working with, or you may be starting from scratch; either way, it's helpful to know who you'll be working with. Brainstorm a list of the people that you want to include in your team. This could include students passionate about your issue, students working in related groups, educators/advisors/administrator, facility management, community members, parents, etc.

Step Four: Identifying Potential Roadblocks

Brainstorm a list of potential obstacles you may need to overcome in order to reach your goal (for example: lack of funding, disinterested students, no administrative support, intimidating facilities manager, etc.)

Step Five: Identifying Your Project Resources
What space, money, materials and other resources do you have that will help to achieve your goals?

Consider your assets:
Human assets – individual skills and knowledge of members of your community
Association assets – groups that have come together for a common purpose
Institutions (public or private) – schools, local government, businesses, nonprofits
Built Assets – buildings, public spaces, other infrastructure
Financial Assets – funding potential, grants, investments, etc.

Step Six: Building Support
Who needs to know about this project? How will you share your story and build the support you need?

Step Seven: Making a Project Timeline
Create a realistic and concrete timeline that includes preparation for your project, project implementation, and any wrap-up or follow through that needs to happen.

Step Eight: Implement Your Project
Get out there and DO something great!

Step Nine: Share Your Success!
Report on your accomplishments to your school and community via newspapers, forums and social media, including: http://classroom.willstegerfoundation.org

Part Three: Climate Action Plan Summary

Use the action plan worksheet to fill out this summary.
Full name of lead educator/adult mentor contact: ______________________
First names of student group members: ______________________

Email: ______________________
Phone number: ______________________
School/grade: ______________________
What is your project focus? ______________________

Please list your top three S.M.A.R.T. goals
a) ______________________
b) ______________________
c) ______________________

Include a brief summary of your timeline ______________________

We would love to share your plan and the outcomes of your project! Please return this form by mail, email or fax with photos or other relevant supporting documents to:
Minnesota's Changing Climate Project
Will Steger Foundation
2810 21st Avenue South, Ste 110
Minneapolis, MN 55407
education@willstegerfoundation.org
Fax# (612) 278-7101

Or upload it on the *Minnesota's Changing Climate* website at:
http://classroom.willstegerfoundation.org

ACTION PLAN WORKSHEET

1 Project Focus: ____________________

2 Goals/Objectives:	3 Your Team:	4 Road Blocks:	5 Resources/Assets:	7 Timeline of Activities (by month):
				Nov:
				Dec:
				Jan:
				Feb:
				Mar:
				Apr:
				May:
				June:
				Next School Year:

6 Building Support:

Specific
Measurable
Achievable
Realistic
Timetable

Will Steger Foundation 2801 21st Ave S, Suite 110 Minneapolis, MN 55407
Tel: 612-278-7147 Email: info@willstegerfoundation.org
www.willstegerfoundation.org

Lesson 1:

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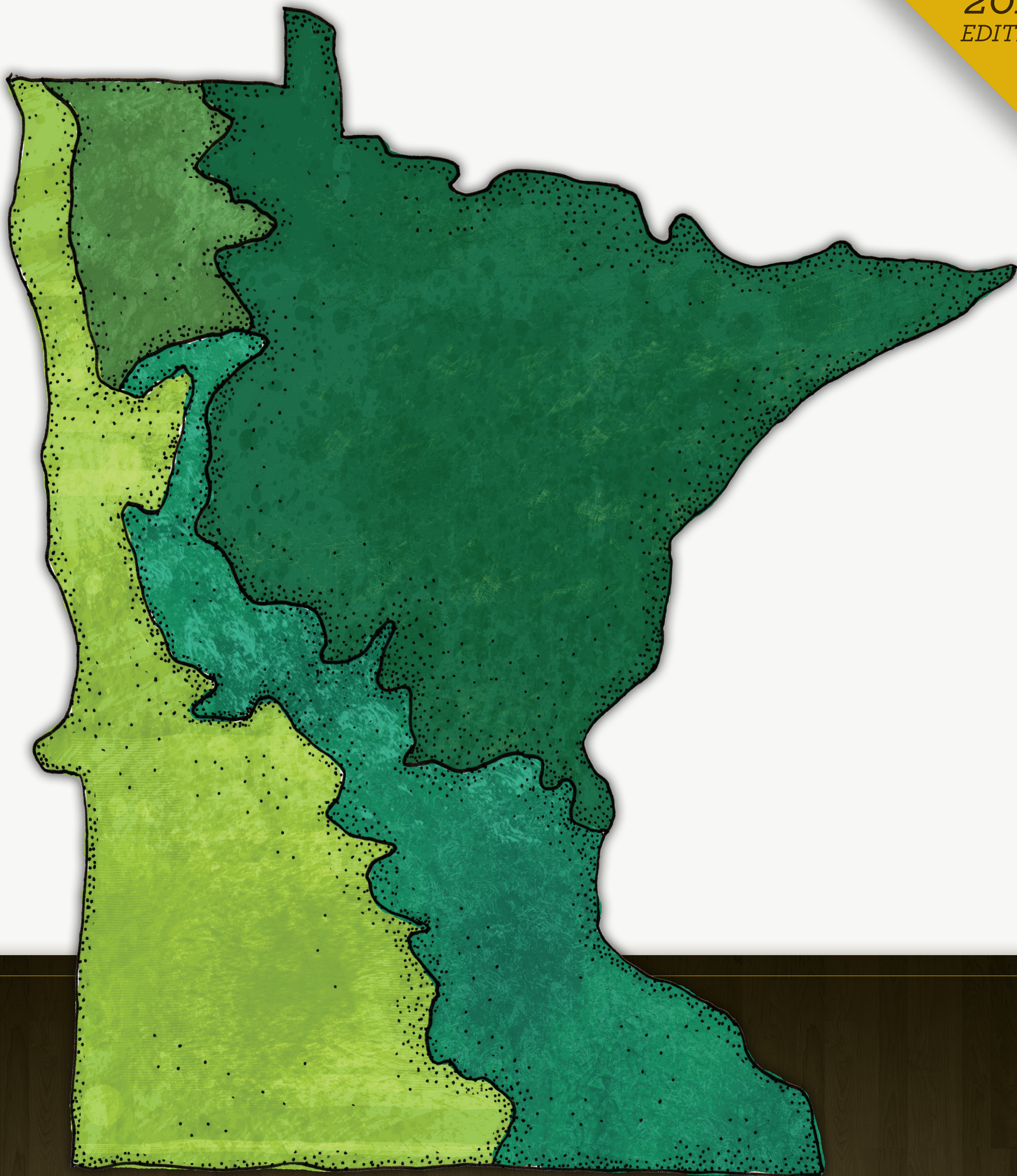

Minnesota's Changing Climate

Grades 9–12

WILL STEGER
FOUNDATION

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Acknowledgements

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Curriculum written by Kristen Iverson Poppleton, Director of Education, Will Steger Foundation with assistance from Ann Benson, project assistant, Will Steger Foundation.

Minnesota Science Standard alignment by Angela Rosendahl.

Graphic design by Michael Diener, http://www.michaeldiener.com. Sketches and cover map by Leigh Simmons. Cartoon illustrations copyrighted by David Gillette.

For additional information on the Will Steger Foundation please visit:
http://www.willstegerfoundation.org

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Minnesota's Changing Climate - Curriculum Introduction

Dear Educator:

The Will Steger Foundation created *Minnesota's Changing Climate* because we believe that environmental stewardship and action begins with a local connection and sense of appreciation, or *environmental sensitivity*, towards the natural environment. As educators, you have the unique opportunity to lead your students through the environmental education continuum of knowledge, awareness, and skills that lead to an informed and active environmental citizenry. *Minnesota's Changing Climate is* a great place to start because it follows this model of inspiring an appreciation and understanding of Minnesota's natural environment and empowering action.

Climate change is one of the most critical issues of our time. The overwhelming consensus of the scientific community for the past two decades has been that the planetary warming we are now experiencing, and the resulting climate change, is largely a human-induced phenomenon. This was reconfirmed with overwhelming consensus in 2007 with the release of the fourth report by the Intergovernmental Panel on Climate Change (IPCC). Climate change is largely driven by human activities, primarily the burning of fossil fuels to produce electricity and drive our cars, which in turn emit gases—principally carbon dioxide—that blanket the planet and trap heat, raising the earth's surface temperature.

Minnesota is at risk from climate change. From the Boundary Waters Canoe Area Wilderness and the great northern boreal forests, to the northern tall grass prairie, water is a critical element of Minnesota's rich ecological character. Lake Superior borders the state to the northeast, the Mississippi and Red Rivers define large portions of the eastern and western borders respectively, and there are thousands of inland lakes throughout the state. Minnesotans benefit from the many recreational, inspirational, and economic opportunities provided by this diversity of biomes. It is precisely these ecological and natural resources that are at risk from climate change.

Will Steger 's compelling life story of adventure has motivated thousands of Minnesotan's to care about our state and has generated real concern over the threat of climate change to our economy, natural resources, and way of life. Using Will's archives, starting when he was a young boy growing up in the suburbs of Minneapolis, to his Mississippi River adventures, to his homestead on the edge of the Boundary Waters wilderness, and the inspiration these experiences gave him to explore the Arctic, we share his story to inspire others. It was Will's early observation of the natural world and his curiosity of weather and climate that eventually enabled him to explore and survive in the Arctic. It is these critical skills that we focus on in *Minnesota's Changing Climate.*

In this set of lessons, we explore and learn about Minnesota's unique biomes and what a changing climate will mean for the state. Specifically, we examine how Minnesota's climate has already changed and how it is projected to change; how these changes may impact agriculture, forests and wildlife, aquatic ecosystems, our economy, and tourism and recreation; and how you can help reduce these potential impacts and help your biome adapt to a changing climate.

The following section gives suggestions of how to integrate this curriculum into your educational setting. We welcome and appreciate feedback and stories from all of you. Please share them with us at education@willstegerfoundation.org and don't forget to visit our online classroom developed in conjunction with this written curriculum http://classroom.willstegerfoundation.org

Thank you for your commitment to climate change education!

Kristen Poppleton

Kristen Iverson Poppleton
Director of Education
Will Steger Foundation

The Will Steger Foundation Education Program

Will Steger Foundation

Established in January 2006 by polar explorer Will Steger, the Will Steger Foundation (WSF), located in Minneapolis, Minn, is dedicated to creating programs that foster international cooperation and leadership through environmental education and policy. The Will Steger Foundation has seen firsthand the dramatic effects of climate change on both the environment and the human condition through the efforts of its founder, Will Steger, who has explored the polar regions for 45 years. With that knowledge, WSF is leading humanity to slow the pace of climate change.

The Will Steger Foundation educates, inspires and empowers people to engage in solutions to climate change. The strategic goal of our education program is:

To support educators, students and the public with science-based interdisciplinary educational resources on climate change, its implications and solutions to achieve climate literacy.

K-12 Education Program Overview

WSF's education program offers thought-provoking and practical solutions for educators and students by developing, supporting and connecting them with:

- Climate Change Curriculum
- Professional Development Opportunities
- Online Resources

Climate Change Curriculum

WSF offers a suite of curriculum resources via our two online learning portals, as well as our Educator Resources Binder and *Minnesota's Changing Climate* lesson plans. All lesson plans are available for free online and include lessons appropriate for grades 3-12. Aligned with the national and Minnesota state standards, the curriculum has been reviewed by the National Education Association, and the Union of Concerned Scientists. It can be purchased or downloaded for free at http://www.willstegerfoundation.org.

Educator Resources Binder

The Educator Resource binder was developed to support educators looking for innovative and engaging ways to integrate climate change into their classroom. In addition to the three sets of lesson plans for Grades 3-12 in the binder, each lesson is linked to archived video and audio footage of past expeditions, as well as other online resources.

Minnesota's Changing Climate Curriculum

WSF created *Minnesota's Changing Climate* because we believe that environmental stewardship and action begins with a local connection and sense of appreciation, or *environmental sensitivity*, towards the natural environment. This set of lesson plans for Grades 3-8 and 9-12 explores Minnesota's unique biomes and what a changing climate will mean for the state.

Online Curriculum

- Arctic Community Online Curriculum: This curriculum features the Arctic community as seen by animals, native peoples, explorers and scientists; all with diverse perspectives and ways of knowing, and all contributing to knowledge and action to slow climate change. The focus is on solutions and positive messages of hope and action.
- *Minnesota's Changing Climate* Online Classroom: This online classroom was developed in conjunction with the *Minnesota's Changing Climate* lessons. Through the classroom, students have the opportunity to learn about Minnesota's unique biomes and the impacts of climate change. Students also have the opportunity to contribute their own observations and action projects, in photo or written format, and see what other students from around the state have observed.

Professional Development Opportunities

Summer Institute for Climate Change Education: WSF has provided professional development to educators for six years through annual summer institutes. The institutes provide educators with tools to communicate climate change in the classroom. Past keynote speakers have included Bill McKibben, Dr. James Hansen, Andrew Revkin, and Dr. Naomi Oreskes.

Graduate Course on Communicating Climate Change in the Classroom (2 credits): WSF staff teach an annual graduate level course in the fall at Hamline University on "Teaching Climate Change in the Classroom."

Online Resources

Climate Lessons Blog for Educators: WSF maintains a weekly blog dedicated to providing tools and references for educators and communicators of climate change.

Video Gallery: WSF's video gallery contains 100s of videos featuring past expedition footage in the polar regions, as well as presentations by leading climate scientists and other climate educators.

Adventure Learning: WSF is a leader in adventure learning, a hybrid distance education approach that provides students with opportunities to explore real-world issues through authentic learning experiences. WSF harnesses the power of adventure learning by providing the organization's website and its virtual library of multi-media resources, classroom visits, and real-time web conferences to classrooms during WSF expeditions.

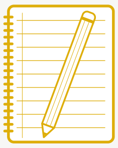
Using Minnesota's Changing Climate in your educational setting

Minnesota's Changing Climate was created with the following goals in mind:

1. To build awareness and interest in
   • Minnesota's natural environment
   • The impact of climate change
2. To provide educators and students with the tools necessary for active and lifelong stewardship.

Recognizing the time constraints and standards-based school environment that exists today, WSF developed these six lessons to make them as useful as possible to educators. They are aligned to Minnesota State Science and Literacy Standards, as well as the Climate Literacy Principles. It is not meant to provide students with an in-depth introduction to the science of climate change, but rather as a review if they have studied it before, or an introduction if it is a new issue. For educators interested in providing students with a more in-depth study of climate change, our Grades 3-5 and Grades 6-12 Global Warming 101 Lessons provide this opportunity and can be downloaded for free at http://www.willstegerfoundation.org.

This set of lessons will be most effective when used in their entirety, including the "Journal Connection" and "Take It Outside-Connecting With Your Place" sections, in conjunction with the online classroom. That said, these lessons could be used in a variety of educational settings. It can also follow a variety of different timelines such as over an intense week of study or once a week over the course of a month and a half. The following suggestions might be helpful when developing your plan of implementation for *Minnesota's Changing Climate*, but we also trust that as an educator you are the experts and will change and adapt lessons best for your situation. We would love to hear how you are using the curriculum in your classroom or school. Please share your stories and photos or videos with us at education@willstegerfoundation.org or upload them to our online classroom at http://classroom.willstegerfoundation.org



Document, document, document

The first lesson of this curriculum is about starting a journal and includes examples of different ways of documenting and reflecting. This lesson was deliberately developed with the idea that a journal, science notebook or blog can provide students with an excellent means to practice reflection, observation and synthesis of information. In addition, if used throughout the implementation of this curriculum, the final product can provide educators with a great assessment of student learning.

Teach Across the Curriculum

Some schools work in team settings with different educators taking on different subject areas. While this is the norm in middle and high school, it can occur in elementary classrooms as well. If possible, break apart the lessons between educators or subject area teaching time, and emphasize the relevant content.

For example:

Lesson 1: What is a journal for?

This lesson is obviously well aligned with any English/language arts course; however, many science classes have begun using science notebooks, and an art class could work on creating the stylistic/graphic design. In addition, it could be possible to set up a blog for each or your students, putting an emphasis on technology skills.

Lesson 2: What defines Minnesota's biomes?

This lesson could fit well with life science, environmental science, earth science and physical geography, depending on what content you wanted to emphasize.

Lesson 3: What defines Minnesota's climate?

Earth science, life science and math could address this lesson.

Lesson 4: What is climate change and what does it mean for Minnesota?

Although this lesson presents students with climate science information, there is a big emphasis on communicating the information that would work well in any English or public speaking course or unit.

Lesson 5: What does the data show?

This lesson is very data- and graph-focused and therefore would work well with any earth science or life science unit focused on interpretation of information. It could also be used and extended in a math course.

Lesson 6: What can I do?

Some schools have volunteer or service learning staff that might be able or interested in facilitating this lesson. Bringing together all the staff that participated, and making this the assessment for students that have completed this unit would also be an exciting possibility. Finally, students may be able to take on this part in an after-school setting through an environmental club.

We really mean it when we say "Take It Outside!"

The "Take It Outside—Connecting with Your Place" section of each lesson is not meant to be an extension, but rather an integral part of each lesson. Connecting students with the biome in which they live and providing them with the skills to be eyewitnesses to the changing climate we live in is an important goal of this project. Not only do we think this is important, but research shows that getting students outside daily is beneficial not only to their health, but their ability to perform in school. (See http://www.childrenandnature.org/research/) Suggestions of how to "Take it Outside" with your classroom include:

- Make an outing to your schoolyard once a week throughout the entire year to observe the same area and record changes in a journal or science notebook.
- Select a weather reporter each day that records the temperature, precipitation, etc. as well as researches weather history via the Internet or an almanac. Record in the classroom and use data for different graphing exercises and compare year to year.
- Ask students to select an area to observe near their home and make weekly observations in a journal or science notebook.

Use the Online Classroom

The Online Classroom designed in conjunction with this curriculum is a fantastic way to bring some of the content alive in the classroom or in an educator-facilitated setting. Ideally, students will be introduced to the classroom and given time to explore it at school. Additional opportunities for assessment are available through the classroom, and if your students have the Internet available at home, exploring pieces of the classroom could be integrated as homework. We highly encourage educators and students to share what they have learned through this curriculum, and the online classroom is a place where students and educators can upload photos of their biome, journal entries and other observations, as well as see what other schools around the state are doing.

Do an Action Project

Climate change can be overwhelming and frightening. Students should understand the consequences and impacts of climate change in Minnesota, but then be offered the opportunity to discuss and learn about potential solutions. Facilitating a discussion of possible action projects, rather than selecting one for students to do, will make students feel more involved and empowered, as well as provide educators with a good assessment of what the students have learned and how much they have connected the causes of climate change with possible actions.

Science							
Grade - 9–12 Strand - 1. The Nature of Science and Engineering Substrand - 1. The Practice of Science Standard - 1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
9.1.1.1.2	Understand that scientists conduct investigations for a variety of reasons, including: to discover new aspects of the natural world, to explain observed phenomena, to test the conclusions of prior investigations, or to test the predictions of current theories.	•	•	•		•	•
Grade - 9–12 Strand - 1. The Nature of Science and Engineering Substrand - 1. The Practice of Science Standard - 2. Scientific inquiry uses multiple interrelated processes to pose and investigate questions about the natural world.							
9.1.1.2.2	Evaluate the explanations proposed by others by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the scientifically acceptable evidence, and suggesting alternative scientific explanations.						•
9.1.1.2.3	a line of reasoning to judge the validity of a claim.						•
9.1.1.2.4	Use primary sources or scientific writings to identify and explain how different types of questions and their associated methodologies are used by scientists for investigations in different disciplines.			•	•	•	
Grade - 9–12 Strand - 1. The Nature of Science and Engineering Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics and Society Standard - 1. Natural and designed systems are made up of components that act within a system and interact with other systems.							
9.1.3.1.1	Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs. For example: A power plant or ecosystem.		•	•			•
9.1.3.1.2	Identify properties of a system that are different from those of its parts but appear because of the interaction of those parts.			•			
9.1.3.1.3	Describe how positive and/or negative feedback occurs in systems. For example: the greenhouse effect				•	•	•
Grade - 9–12 Strand - 1. The Nature of Science and Engineering Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics and Society Standard - 3. Science and engineering operate in the context of society and both influence and are influenced by this context.							
9.1.3.3.2	Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual, or written means.						•

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Grade - 9–12 Strand - 1. The Nature of Science and Engineering Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics, and Society Standard - 4. Science, technology, engineering and mathematics rely on each other to enhance knowledge and understanding.							
9.1.3.4.2	Determine and use appropriate safety procedures, tools, computers and measurement instruments in science and engineering contexts. For example: Consideration of chemical and biological hazards in the lab.			•			
9.1.3.4.3	Select and use appropriate numeric, symbolic, pictorial, or graphical representation to communicate scientific ideas, procedures and experimental results.		•	•	•	•	•
Grade - 9–12 Strand - 2. Physical Science Substrand - 4. Human Interactions with Physical Systems Standard - 1. There are benefits, costs and risks to different means of generating and using energy.							
9.2.4.1.1	Compare local and global environmental and economic advantages and disadvantages of generating electricity using various sources or energy. For example: Fossil fuels, nuclear fission, wind, sun or tidal energy.				•		
Grade - 9–12 Strand - 3. Earth and Space Science Substrand - 4. Human Interactions with Earth Systems Standard - 1. People consider potential benefits, costs and risks to make decisions on how they interact with natural systems.							
9.3.4.1.2	Explain how human activity and natural processes are altering the hydrosphere, biosphere, lithosphere and atmosphere, including pollution, topography and climate. For example: Active volcanoes and the burning of fossil fuels contribute to the greenhouse effect.				•	•	•
Science (continued)							
Grade - 9–12 Strand - 4. Life Science Substrand - 4. Human Interactions with Living Systems Standard - 1. Human activity has consequences on living organisms and ecosystems.							
9.4.4.1.2	Describe the social, economic and ecological risks and benefits of changing a natural ecosystem as a result of human activity. For example: Changing the temperature or composition of water, air or soil; altering populations and communities; developing artificial ecosystems; or changing the use of land or water.		•		•	•	•
Chemistry Strand - 1. The Nature of Science and Engineering Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics and Society Standard - 3. Developments in chemistry affect society and societal concerns affect the field of chemistry.							
9C.1.3.3.1	Explain the political, societal, economic and environmental impact of chemical products and technologies. For example: Pollution effects, atmospheric changes, petroleum products, material use or waste disposal.				•		

Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Physics Strand - 1. The Nature of Science and Engineering Substrand - 3. Interactions Among Science, Technology, Engineering, Mathematics and Society Standard - 3. Developments in physics affect society and societal concerns affect the field of physics.							
9P.1.3.3.1	Describe changes in society that have resulted from significant discoveries and advances in technology in physics. For example: Transistors, generators, radio/television or microwave ovens.				•		
Social Studies - Geography							
Grades - 9–12 Substrand - B. Essential Skills Standard - The student will use maps, globes, geographic information systems, and other databases to answer geographic questions at a variety of scales from local to global.							
	1. Students will demonstrate the ability to obtain geographic information from a variety of print and electronic sources. 2. Students will make inferences and draw conclusions about the character of places based on a comparison of maps, aerial photos, and other images.		•				
Grades - 9–12 Substrand - C. Spatial Organization Standard - The student will understand the regional distribution of the human population at local to global scales and its patterns of change.							
	1. Students will describe the pattern of human population density in the United States and major regions of the world.		•				
Grades - 9–12 Substrand - C. Spatial Organization Standard - The student will use regions and the interaction among them to analyze the present patterns of economic activity in the United States and around the world at various scales.							
	8. Students will explain the variations in economic activity and land use within the state of Minnesota, analyze issues related to land use, and reach conclusions about the potential for change in various regions.		•				
Grades - 9–12 Substrand - D. Interconnections Standard - The student will describe how humans influence the environment and in turn are influenced by it.							
	1. Students will provide a range of examples illustrating how types of government systems and technology impact the ability to change the environment or adapt to it. 2. Students will analyze the advantages and drawbacks of several common proposals to change the human use of environmental resources. 3. Students will understand and analyze examples of the impacts of natural hazards on human activities and land use.		•	•	•	•	

English Language Arts - K–12

Please note: Due to the extensive number of standards aligned there is not as much detail provided below. More information on Minnesota Language Arts Standards can be found at:
http://education.state.mn.us/MDE/EdExc/StanCurri/K-12AcademicStandards/index.htm

English Language Arts							
Grades - 9–12 READING in Science and Technical Subjects							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
		13.6.6	12.1.1 12.2.2 13.3.3 13.4.4 13.5.5 13.7.7 13.10.10	12.1.1 12.2.2 13.4.4 13.5.5 13.7.7 13.9.9 13.10.10	12.1.1 12.2.2 13.4.4 13.5.5 13.7.7 13.9.9 13.10.10	12.1.1 12.2.2 13.4.4 13.5.5 13.7.7 13.9.9 13.10.10	12.1.1 12.2.2 13.3.3
Grades - 9–12 WRITING in History/Social Studies, Science and Technical Subjects							
		14.3.3 14.4.4 14.10.10	14.2.2 14.3.3 14.4.4 14.7.7 14.8.8 14.10.10	14.2.2 14.3.3 14.4.4 14.6.6 14.8.8 14.10.10	14.2.2 14.3.3 14.4.4 14.6.6 14.8.8 14.10.10	14.1.1 14.2.2 14.3.3 14.4.4 14.6.6 14.8.8 14.10.10	14.2.2 14.3.3 14.4.4 14.5.5 14.6.6 14.10.10

Minnesota Environmental Literacy Scope and Sequence Benchmarks							
Grades - 9–12							
Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
	The interaction of social and natural systems can create properties that are different from either individual system.		•	•	•	•	
	Interaction between social and natural systems is defined by their boundaries, relation to other systems, and expected inputs and outputs.		•	•	•	•	
	Feedback of output from some parts of a managed social or natural system can be used to bring it closer to desired results.		•	•	•	•	•
	It is not always possible to predict accurately the result of changing some part or connection between social and natural systems.		•	•	•	•	

The Essential Principles of Climate Literacy

Developed through a cooperative effort of numerous US federal agency scientists, formal and informal educators, interested individuals, and representatives from nongovernmental organizations and other institutions involved in climate research, education, and outreach, the Essential Principles of Climate Science summarizes the most important principles and concepts of climate science. It presents important information for individuals and communities to understand Earth's climate, impacts of climate change, and approaches for adapting and mitigating change. Principles can serve as discussion starters or launching points for scientific inquiry. They can also serve educators who teach climate science as part of their science curricula.

More information can be found at: http://cleanet.org/cln/climateliteracy.html

A climate literate person will

- understand the essential principles of Earth's climate system;
- knows how to assess scientifically credible information about climate;
- communicates about climate and climate change in a meaningful way;
- is able to make informed and responsible decisions with regard to actions that may affect climate.

The Essential Principles of Climate Literacy						
The Guiding Principle for Informed Climate Decisions Principle: Humans can take actions to reduce climate change and its impacts.						
Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
A. Climate information can be used to reduce vulnerabilities or enhance the resilience of communities and ecosystems affected by climate change. Continuing to improve scientific understanding of the climate system and the quality of reports to policy and decision makers is crucial.				•	•	•
B. Reducing human vulnerability to the impacts of climate change depends not only upon our ability to understand climate science, but also upon our ability to integrate that knowledge into human society. Decisions that involve Earth's climate must be made with an understanding of the complex interconnections among the physical and biological components of the Earth system as well as the consequences of such decisions on social, economic, and cultural systems.				•	•	•
C. The impacts of climate change may affect the security of nations. Reduced availability of water, food, and land can lead to competition and conflict among humans, potentially resulting in large groups of climate refugees.						
D. Humans may be able to mitigate climate change or lessen its severity by reducing greenhouse gas concentrations through processes that move carbon out of the atmosphere or reduce greenhouse gas emissions.						•
E. A combination of strategies is needed to reduce greenhouse gas emissions. The most immediate strategy is conservation of oil, gas, and coal, which we rely on as fuels for most of our transportation, heating, cooling, agriculture, and electricity. Short-term strategies involve switching from carbon-intensive to renewable energy sources, which also requires building new infrastructure for alternative energy sources. Long-term strategies involve innovative research and a fundamental change in the way humans use energy.						•
F. Humans can adapt to climate change by reducing their vulnerability to its impacts. Actions such as moving to higher ground to avoid rising sea levels, planting new crops that will thrive under new climate conditions, or using new building technologies represent adaptation strategies. Adaptation often requires financial investment in new or enhanced research, technology, and infrastructure.						•
G. Actions taken by individuals, communities, states, and countries all influence climate. Practices and policies followed in homes, schools, businesses, and governments can affect climate. Climate-related decisions made by one generation can provide opportunities as well as limit the range of possibilities open to the next generation. Steps toward reducing the impact of climate change may influence the present generation by providing other benefits such as improved public health infrastructure and sustainable built environments.						•

The Essential Principles of Climate Literacy (continued)						
The Essential Principles of Climate Science 1. The sun is the primary source of energy for Earth's climate system.						
Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Sunlight reaching the Earth can heat the land, ocean, and atmosphere. Some of that sunlight is reflected back to space by the surface, clouds, or ice. Much of the sunlight that reaches Earth is absorbed and warms the planet.						
When Earth emits the same amount of energy as it absorbs, its energy budget is in balance, and its average temperature remains stable.						
The tilt of Earth's axis relative to its orbit around the sun results in predictable changes in the duration of daylight and the amount of sunlight received at any latitude throughout a year. These changes cause the annual cycle of seasons and associated temperature changes.						
Gradual changes in Earth's rotation and orbit around the sun change the intensity of sunlight received in our planet's polar and equatorial regions. For at least the last 1 million years, these changes occurred in 100,000-year cycles that produced ice ages and the shorter warm periods between them.						
A significant increase or decrease in the sun's energy output would cause Earth to warm or cool. Satellite measurements taken over the past 30 years show that the sun's energy output has changed only slightly and in both directions. These changes in the sun's energy are thought to be too small to be the cause of the recent warming observed on Earth.						
The Essential Principles of Climate Science 2. Climate is regulated by complex interactions among components of the Earth system.						
Earth's climate is influenced by interactions involving the sun, ocean, atmosphere, clouds, ice, land, and life. Climate varies by region as a result of local differences in these interactions.						
Covering 70% of Earth's surface, the ocean exerts a major control on climate by dominating Earth's energy and water cycles. It has the capacity to absorb large amounts of solar energy. Heat and water vapor are redistributed globally through density-driven ocean currents and atmospheric circulation. Changes in ocean circulation caused by tectonic movements or large influxes of fresh water from melting polar ice can lead to significant and even abrupt changes in climate, both locally and on global scales.						
The amount of solar energy absorbed or radiated by Earth is modulated by the atmosphere and depends on its composition. Greenhouse gases—such as water vapor, carbon dioxide, and methane—occur naturally in small amounts and absorb and release heat energy more efficiently than abundant atmospheric gases like nitrogen and oxygen. Small increases in carbon dioxide concentration have a large effect on the climate system.						
The abundance of greenhouse gases in the atmosphere is controlled by biogeochemical cycles that continually move these components between their ocean, land, life, and atmosphere reservoirs. The abundance of carbon in the atmosphere is reduced through seafloor accumulation of marine sediments and accumulation of plant biomass, and is increased through deforestation and the burning of fossil fuels as well as through other processes.						
Airborne particulates, called "aerosols," have a complex effect on Earth's energy balance: they can cause both cooling, by reflecting incoming sunlight back out to space, and warming, by absorbing and releasing heat energy in the atmosphere. Small solid and liquid particles can be lofted into the atmosphere through a variety of natural and manmade processes, including volcanic eruptions, sea spray, forest fires, and emissions generated through human activities.						
The interconnectedness of Earth's systems means that a significant change in any one component of the climate system can influence the equilibrium of the entire Earth system. Positive feedback loops can amplify these effects and trigger abrupt changes in the climate system. These complex interactions may result in climate change that is more rapid and on a larger scale than projected by current climate models.						

The Essential Principles of Climate Literacy (continued)

The Essential Principles of Climate Science
3. Life on Earth depends on, is shaped by, and affects climate.

Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Individual organisms survive within specific ranges of temperature, precipitation, humidity, and sunlight. Organisms exposed to climate conditions outside their normal range must adapt or migrate, or they will perish.		•	•			
The presence of small amounts of heat-trapping greenhouse gases in the atmosphere warms Earth's surface, resulting in a planet that sustains liquid water and life.				•		
Changes in climate conditions can affect the health and function of ecosystems and the survival of entire species. The distribution patterns of fossils show evidence of gradual as well as abrupt extinctions related to climate change in the past.						
A range of natural records shows that the last 10,000 years have been an unusually stable period in Earth's climate history. Modern human societies developed during this time. The agricultural, economic, and transportation systems we rely upon are vulnerable if the climate changes significantly.						
Life—including microbes, plants, and animals and humans—is a major driver of the global carbon cycle and can influence global climate by modifying the chemical makeup of the atmosphere. The geologic record shows that life has significantly altered the atmosphere during Earth's history.						
The Essential Principles of Climate Science 4. Climate varies over space and time through both natural and man-made processes.						
Climate is determined by the long-term pattern of temperature and precipitation averages and extremes at a location. Climate descriptions can refer to areas that are local, regional, or global in extent. Climate can be described for different time intervals, such as decades, years, seasons, months, or specific dates of the year.			•	•	•	
Climate is not the same thing as weather. Weather is the minute-by-minute variable condition of the atmosphere on a local scale. Climate is a conceptual description of an area's average weather conditions and the extent to which those conditions vary over long time intervals.			•			
Climate change is a significant and persistent change in an area's average climate conditions or their extremes. Seasonal variations and multi-year cycles (for example, the El Niño southern oscillation) that produce warm, cool, wet, or dry periods across different regions are a natural part of climate variability. They do not represent climate change.			•	•		
Scientific observations indicate that global climate has changed in the past, is changing now, and will change in the future. The magnitude and direction of this change is not the same at all locations on Earth.				•	•	
Based on evidence from tree rings, other natural records, and scientific observations made around the world, Earth's average temperature is now warmer than it has been for at least the past 1,300 years. Average temperatures have increased markedly in the past 50 years, especially in the North Polar region.				•	•	
Natural processes driving Earth's long-term climate variability do not explain the rapid climate change observed in recent decades. The only explanation that is consistent with all available evidence is that human activity is playing an increasing role in climate change. Future changes in climate may be rapid compared to historical changes.				•	•	
Natural processes that remove carbon dioxide from the atmosphere operate slowly when compared to the processes that are now adding it to the atmosphere. Thus, carbon dioxide introduced into the atmosphere today may remain there for a century or more. Other greenhouse gases, including some created by humans, may remain in the atmosphere for thousands of years.						

The Essential Principles of Climate Literacy (continued)						
The Essential Principles of Climate Science 5. Our understanding of the climate system is improved through observations, theoretical studies, and modeling.						
Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
The components and processes of Earth's climate system are subject to the same physical laws as the rest of the Universe. Therefore, the behavior of the climate system can be understood and predicted through careful, systematic study.					•	
Environmental observations are the foundation for understanding the climate system. From the bottom of the ocean to the surface of the sun, instruments on weather stations, buoys, satellites, and other platforms collect climate data. To learn about past climates, scientists use natural records, such as tree rings, ice cores, and sedimentary layers. Historical observations, such as native knowledge and personal journals, also document past climate change.	•	•	•	•	•	
Observations, experiments, and theory are used to construct and refine computer models that represent the climate system and make predictions about its future behavior. Results from these models lead to better understanding of the linkages between the atmosphere-ocean system and climate conditions and inspire more observations and experiments. Over time, this iterative process will result in more reliable projections of future climate conditions.					•	
Our understanding of climate differs in important ways from our understanding of weather. Climate scientists' ability to predict climate patterns months, years, or decades into the future is constrained by different limitations than those faced by meteorologists in forecasting weather days to weeks into the future.			•			
Scientists have conducted extensive research on the fundamental characteristics of the climate system and their understanding will continue to improve. Current climate change projections are reliable enough to help humans evaluate potential decisions and actions in response to climate change.				•	•	
The Essential Principles of Climate Science 6. Human activities are impacting the climate system.						
The overwhelming consensus of scientific studies on climate indicates that most of the observed increase in global average temperatures since the latter part of the 20th century is very likely due to human activities, primarily from increases in greenhouse gas concentrations resulting from the burning of fossil fuels.				•	•	
Emissions from the widespread burning of fossil fuels since the start of the Industrial Revolution have increased the concentration of greenhouse gases in the atmosphere. Because these gases can remain in the atmosphere for hundreds of years before being removed by natural processes, their warming influence is projected to persist into the next century.				•	•	
Human activities have affected the land, oceans, and atmosphere, and these changes have altered global climate patterns. Burning fossil fuels, releasing chemicals into the atmosphere, reducing the amount of forest cover, and rapid expansion of farming, development, and industrial activities are releasing carbon dioxide into the atmosphere and changing the balance of the climate system.				•	•	
Growing evidence shows that changes in many physical and biological systems are linked to human-caused global warming. Some changes resulting from human activities have decreased the capacity of the environment to support various species and have substantially reduced ecosystem biodiversity and ecological resilience.			•	•	•	
Scientists and economists predict that there will be both positive and negative impacts from global climate change. If warming exceeds 2–3°C (3.6–5.4°F) over the next century, the consequences of the negative impacts are likely to be much greater than the consequences of the positive impacts.				•		

The Essential Principles of Climate Literacy (continued)

The Essential Principles of Climate Science
7. Climate change will have consequences for the Earth system and human lives.

Supporting concepts	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Melting of ice sheets and glaciers, combined with the thermal expansion of seawater as the oceans warm, is causing sea levels to rise. Seawater is beginning to move onto low-lying land and to contaminate coastal fresh water sources, and beginning to submerge coastal facilities and barrier islands. Sea-level rise increases the risk of damage to homes and buildings from storm surges such as those that accompany hurricanes.						
Climate plays an important role in the global distribution of freshwater resources. Changing precipitation patterns and temperature conditions will alter the distribution and availability of freshwater resources, reducing reliable access to water for many people and their crops. Winter snowpack and mountain glaciers that provide water for human use are declining as a result of global warming.				•	•	
Incidents of extreme weather are projected to increase as a result of climate change. Many locations will see a substantial increase in the number of heat waves they experience per year and a likely decrease in episodes of severe cold. Precipitation events are expected to become less frequent but more intense in many areas, and droughts will be more frequent and severe in areas where average precipitation is projected to decrease.				•	•	
The chemistry of ocean water is changed by absorption of carbon dioxide from the atmosphere. Increasing carbon dioxide levels in the atmosphere is causing ocean water to become more acidic, threatening the survival of shell-building marine species and the entire food web of which they are a part.						
Ecosystems on land and in the ocean have been and will continue to be disturbed by climate change. Animals, plants, bacteria, and viruses will migrate to new areas with favorable climate conditions. Infectious diseases and certain species will be able to invade areas that they did not previously inhabit.				•		
Human health and mortality rates will be affected to different degrees in specific regions of the world as a result of climate change. Although cold-related deaths are predicted to decrease, other risks are predicted to rise. The incidence and geographical range of climate-sensitive infectious diseases—such as malaria, dengue fever, and tick-borne diseases—will increase. Drought-reduced crop yields, degraded air and water quality, and increased hazards in coastal and low-lying areas will contribute to unhealthy conditions, particularly for the most vulnerable populations.				•	•	

Grades 9–12 Lesson Organizer

Lesson Outcomes	*Lesson Materials*
Lesson 1: What is a journal for?	
• Students will identify key features of a journal • Students will identify journal entry themes • Students will compare journal entries from different time periods and in different styles • Students will create their own journal to be used for outdoor observation and documenting their exploration of Minnesota's *Changing Climate*	Three Will Steger Journal Entries Three Excerpts from *Eden Summer Collages* (David Coggins) Four Historical Biome Journal Excerpts
Lesson 2: What defines Minnesota's biomes?	
• Students will identify Minnesota's four main biomes. • Students will identify characteristic vegetation and animals found in each biome. • Students will describe and compare factors that define each biome.	Will Steger Journal Entry Handout 1: Biome Cards Handout 2: Minnesota Biomes Table Handout 3: Minnesota Biomes Map Handout 4: 1990's Census of the Land Handout 5: The Natural Vegetation of Minnesota
Lesson 3: What defines Minnesota's Climate?	
• Students will define climate and weather • Students will define climate change • Students will define phenology • Students will gather their own weather data from their school site and record it in their journal • Students will graphically represent authentic data from Minnesota's Climatology site • Students will make three predictions of how a change in climate might affect Minnesota's biomes	Three Will Steger Journal Entries Handout 1: Normal Mean Temperature Annual Map Handout 2: Normal Annual Precipitation Map Handout 3: What defines Minnesota's climate? Student Worksheet Handout 4: Annual Climate Trends in Precipitation and Temperature Handout 5: Selection of Seasonal, Regional Climate Trends
Lesson 4: What is climate change and what does it mean for Minnesota?	
• Students will explain the causes of climate change • Students will explain the implications of climate change • Students will predict how climate change might impact or is impacting the area where they live • Students will describe five key climate change implications for Minnesotans	Will Steger Journal Entry Handout 1: Key Implications for Minnesotans Facing Climate Change Cards Handout 2: Climate Change Fact Cards
Lesson 5: What does the data show?	
• Students will make their own interpretations of figures of data that represent different impacts of climate change on Minnesota. • Students will make the connection between 3-D objects and what the data represents. • Students will divide 3 statements about each graph into true or false categories. • Students will share their results. • Students will brainstorm how climate change could affect their biome.	Will Steger Journal Handout 1: Twelve Activity Sheets Handout 2: Full Size Figures Handout 3: Activity Sheet Template/Gameboard
Lesson 6: What can I do?	
• Students will brainstorm appropriate solutions and select one for their group, class or school. • Students will develop a climate action plan and begin to implement it.	Handout 1: Climate Action Template Handout 2: Climate Action Plan Worksheet

Lesson 1: Minnesota's Changing Climate

What is a journal for?

Age Level:	Grades 3-12
Time Needed:	50 minutes
Materials:	Journal/Notebook for each student Access to the Internet (to watch videos and view journal examples) Projector or handouts of journal examples
Student Learning Outcomes:	• Students will identify key features of a journal. • Students will identify journal entry themes. • Students will compare journal entries from different time periods and in different styles. • Students will create their own journal to be used for documenting their outdoor observations and exploration of *Minnesota's Changing Climate*.

Background Information

Journals are a tool for exploring the natural world and can be used to develop many different skills. In this lesson, students will have the opportunity to look at journal excerpts written by Will Steger at different points in his life. They show different styles of journaling and ways of observing and documenting the natural world. In addition to excerpts from Will's journals, there are examples from individuals who have kept journals about Minnesota's natural world throughout history. Finally, David Coggins, a Minnesota writer and artist, provided us with beautiful examples of art/collage journals. Journal excerpts are found on pages 6-13.

Journal Assignment

Each lesson in the *Minnesota's Changing Climate* includes journaling activities, and assessments that should be kept together in a journal or notebook. Students will conclude this lesson by designing their own journal. Students should paste their work from this lesson in the journal to look back on in later lessons.

> There is something to journaling that is extremely important. It's a way of learning where you absorb yourself... you put your mind and your attention and your focus on one observation. It's a mechanism of where you are going through your curiosity and your thought and you're documenting and you're writing it down....It's a learning process. The idea [is] to see [nature] in a different way.
>
> —Will Steger, Interview, July, 2010

Activity Description

Introduction

Click on the "Journal Basics" category of the "Journals" section in any biome in the learning module of the online classroom at http://classroom.willstegerfoundation.org to play Will Steger's short video clip on journaling. Afterwards, have a short discussion about journaling and journals.

There are many different types of journals. Nature journals, personal journals, travel journals, scrapbooks, sketchbooks and blogs are just a few examples. Will shows examples of some of his journal entries in the video and talks about why he thinks it is important.

1. What has Will used his journals for and why were they important?
2. What does he mean when he says the point of journaling is "to see nature in a different way?"
3. Has anyone used a journal before or does anyone have a journal, or a diary?
4. What do you use it for?
5. What sorts of things do you put in it?
6. Is it just writing or do you sketch or put other objects (newspaper clippings, programs, stickers, pressed flowers, etc.)?
7. Why do you think journals might be useful?

Activity: Explore different styles of journals

1. Hand out copies of the different journal excerpts found on pages 6-13 or access them online at http://classroom.willstegerfoundation.org/handouts. If you have internet access also show the examples listed below under Internet Journal Examples. These journal examples show a number of different styles of journals focused on nature observation, and provide a broad array of examples from the early exploration of Minnesota's natural resources to more contemporary and artistic enjoyment of nature.

Journal Excerpts Include:

- Weather Journal, 1956, Will Steger (12 years old)
- Astronomy Journal-when Sputnik was launched, 1957, Will Steger (13 years old)
- Phenology Journal, 1978, Will Steger
- Art/Collage Journal, 2004, David Coggins (3 entries)
- Historical Minnesota Biome Journal Excerpts (4 entries)

Internet Journal Examples

- Botany Journal, 1836, Charles Geyer
  http://www.stolaf.edu/academics/nicollet/geyerjournalintro.html
- Selection of Natural History Blogs found at
  http://neurophilosophy.wordpress.com/2007/03/03/natural-history-blogs/

3. Ask the students to answer the following questions independently on a sheet of paper:
   1. What journal entry did you think was the most interesting? Why?
   2. What journal entry do you think was the most useful? Why?
   3. How were the journal entries similar?
   4. How were the journal entries different?
   5. What topics were covered in the journal entries?
   6. If you were to start a journal what would you use it to record? What would be important to include in each entry? Ask them to answer the questions.

4. Bring the students back together as a class. On the board make a list of
   - Things they found interesting;
   - Things that were common between the examples;
   - Things that are different between the examples;
   - Topics or themes that the different journal entries covered.

5. Ask the students to choose one of the journal entries. Hand out pieces of paper and ask them to write their own journal entry in the same style as the journal entry they chose. Before they start they should identify key elements that define the journal entry. This could include date, sketches, observations of weather, or lists of birds or plants seen.

Concluding Activity

The students will have investigated different styles of journaling through the excerpts provided. Students should now create or be provided with a notebook that will be their own journal to use during their exploration of *Minnesota's Changing Climate*. Students should personalize their journal and integrate the exploration of Minnesota's biomes, the impacts of climate change, and solutions that can happen at schools and be led by students.

Descriptions of different styles of journals are provided in the following pages. If you have time, take a few class periods or portions of class periods to explore the different styles of journaling described in the following pages. Discuss when each type of journal might be used and how most journals don't just use one style, but depending on the person's mood or what information they would like to record, may have many different styles.

Science Notebooks

Materials:

- Notebook
- Colored pencils
- Graphing paper
- Items for investigations

Klentschy writes, "A science notebook is a central place where language, data, and experience work together to form meaning for the student."(2005) Creating and using a science notebook helps develop skills such as student organization, data recording and interpretation, question development, reasonable predictions, and reflection.

Each entry in a science notebook should begin with a question that is investigable. Developing good questions that don't have yes or no answers can be difficult. Taking the students outside a few times observing and exploring will often elicit curiosity around a particular subject. Developing a question about something that is real and tangible and interesting to them will lead to a much richer project.

Once the student has developed a question, they should also come up with a prediction of what they will discover through their investigation.

After the student develops the question, they will need to determine how they can go about answering it through an investigation. Planning for their investigation should include the steps involved, material needs and how they will organize the data they collect. It will be important to have a discussion about charts, tables, graphs, Venn diagrams, and labeled sketches or diagrams as possible data organizers.

Once students have determined their question, prediction, and how they will organize their observations they may begin their investigation. Investigations can last an hour to an entire school year depending on the questions they ask.

Once students have finished their investigation they will need to review their science notebook and data. Their observations should help them develop some sort of claims related to their question and help them develop a statement of what they learned. This step of interpreting and explaining what they learned is an important skill in science and can involve oral presentations, PowerPoints, graphing and other multimedia. The science notebook will be integral to development of any presentation.

Finally, the students should be asked to think about what new questions they have as a result of their investigation. If they could do another investigation, what would they do?

Art or Collage Journals

Materials:

- Notebook
- Colored pencils
- Flower/plant press
- Glue
- Photos

Some students may be interested in making their observations through sketching, poetry or creative writing, or collages of objects associated with their observations. Pressed flowers, photos, maps are just a few examples of what can go into this type of journal.

Blogging

Materials:

- Internet access
- Digital camera
- Computer

If you are interested in sharing and collaborating with students or others anywhere in the world, a blog is an easy and fun way to do this. A blog, or web log, is an online shared journal. In addition to written material, it is possible to embed videos, photos and audio in a blog. Blogs can generally be made as publicly accessible as you want them to be and after each blog post it is possible to leave comments for the writer. This function makes it possible for peer interaction around a particular topic both locally and globally. Some good places to start a blog include posterous.com or blogspot.com.

Take it Outside—Connecting With Your Place

Phenology Journals

Materials:

- Notebook
- Colored pencils
- Thermometer
- Rain gauge
- Barometer
- Cloud charts
- Historic weather data
- Camera

Phenology is the study of the cyclical nature of biological events as they relate to climate and season. Phenology journals often include observations of the natural world, sketches, photographs and other data that relate. Because phenology is the study of how the natural world responds to climate and season, there are a few elements that are important to include in a journal entry. Date, time, location, temperature, and precipitation type or amount are basic things that should be included. Barometric readings, cloud cover and type, as well as historic highs and lows of temperature can also be included.

Phenology journals are ideally done outside, but can be done looking out the window of a classroom as well. Spending five minutes at the start of every day asking students to record certain weather elements and what observations they made of the natural world on their way to school is another method. Observations might include what color the trees were turning, if they saw birds flying south or north, what birds or other animals they saw and what the observed animals were doing. Asking the students good questions about what they saw will help them remember to look more closely the next day.

Observations of the natural world can be made in writing, sketches or photos. It can be interesting for students to choose a spot that they follow throughout the school year, observing and recording the changes with the seasons.

Temperatures and other numeric data recorded over time can be used to make graphs either in the student journals, on graph paper and then pasted in. Consider keeping your own phenology journals year to year, and making them available for students to view, to use for comparing of the timing of seasonal events.

Extensions

Take time to try out the different styles of journaling as described above.

Online Classroom Connection

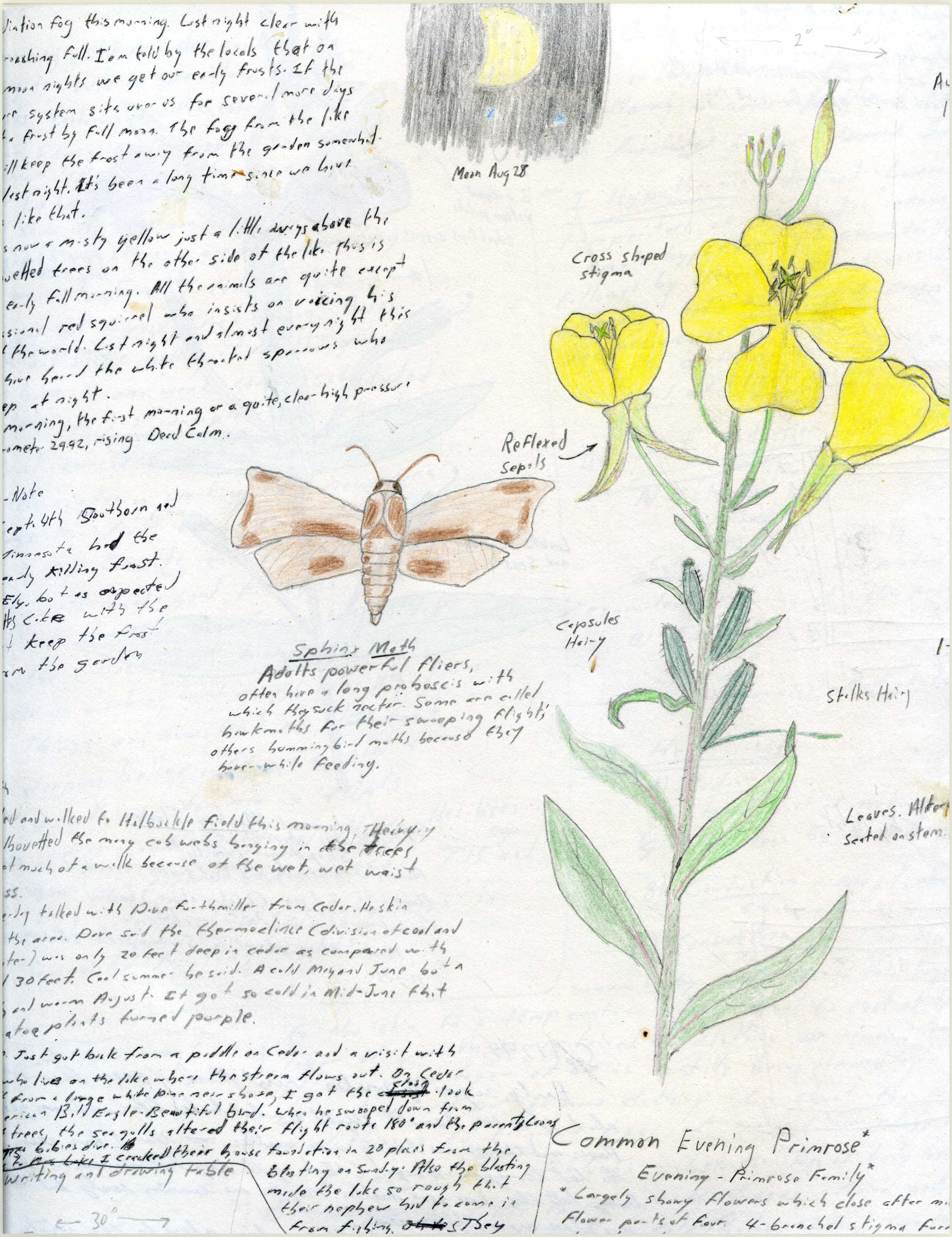
Visit http://classroom.willstegerfoundation.org

1. There are a variety of journal examples provided for each biome. Read through each journal entry and discuss them as a class, or ask students to try and write their own journal entry in the style of one those shared.
2. Upload journal entries from your classroom! Upload them at http://classroom.willstegerfoundation.org/get-social/share-your-observations
   Read and comment on entries from other students.

Monday October 8 1956
Partly cloudy
temperature 58 degrees
high 58
Low 49
Humidity at 6:30 p.m 38 per cent
Precipitation 24 hours ending at 6:30 p.m.: none. Total since Jan. 1 to date 23.27 inches.
Sun rises 6:21 a.m, set 5:39 p.m,
Moon phase new, Rises 12:06 p.m., sets 9:22 p.m
Wind at 4:05 p.m 15 miles per hour and at 4:30 p.m. miles per hour coming from the North west
Year ago high 67 Low 38
All-time record high for the date 80, in 1905,
All-time record Low for this date 28, in 1917

Seattle, cloudy
San Francisco, clear
Los Angeles, clear
Billings, Partly cloudy

Weather Journal, 1956, Will Steger (12 years old)



...iation fog this morning. Last night clear with
...roaching full. I'm told by the locals that on
...moon nights we get our early frosts. If the
...r system sits over us for several more days
... frost by full moon. The fog from the lake
...ill keep the frost away from the garden somewhat.
...last night. It's been a long time since we have
... like that.

...s now a misty yellow just a little ways above the
...wetted trees on the other side of the lake. This is
...early fall morning. All the animals are quite except
...sional red squirrel who insists on voicing his
... the world. Last night and almost every night this
...have heard the white throated sparrows who
...ep at night.
... morning, the first morning on a quite, clear high pressure
...ometer 29.92, rising. Dead Calm.

Moon Aug 28

...Note
...ept. 4th Southern and
...innesota had the
...early killing frost.
...Ely, but as expected
...ths lake with the
... keep the frost
...m the garden

Sphinx Moth
Adults powerful fliers,
often have a long proboscis with
which they suck nectar. Some are called
hawkmoths for their sweeping flights,
others hummingbird moths because they
hover while feeding.

2"

Cross shaped stigma

Reflexed Sepals

Capsules Hairy

Stalks Hairy

Leaves. Alter...
Seated on stem.

...ed and walked to Halbuckle field this morning. The heavy
...lhouetted the many cob webs hanging in the trees
...t much of a walk because of the wet, wet waist
...ss.
...ly talked with Dave Fu...miller from Cedar. He skin...
... the area. Dave said the thermocline (division of cool and
...ter) was only 20 feet deep in Cedar as compared with
... 30 feet. Cool summer he said. A cold May and June but a
... and warm August. It got so cold in Mid-June that
...ato plants turned purple.

... Just got back from a paddle on Cedar and a visit with
... who lives on the lake where the stream flows out. On Cedar
... from a large white pine near shore, I got the ~~close~~ close look
...erican Bald Eagle. Beautiful bird. When he swooped down from
... trees, the seagulls altered their flight route 180° and the parent loons
... babies dive. ... cracked their house foundation in 20 places from the
...writing and drawing table
blasting on Sunday. Also the blasting
made the lake so rough that
their nephew had to come in
from fishing. ~~...~~ They

← 30" →

Common Evening Primrose*
Evening - Primrose Family*
* Largely showy flowers which close after m...
Flower parts of four. 4-branched stigma fo...

Phenology Journal, 1978, Will Steger

at 4:00 a.m.

October 4 1957

Russia launched the first Earth Satellite today. The Satellite can be picked up by a ham radio at 20.005 and 40,002 megacycles. It is estimated to be 23 inches in diameter, 187 pounds, going at 18,000 miles per hour, altitude 560 miles, circles the earth once every one hour and 31 minutes and estimated life not more than three weeks.

October 5 1957

Russia misplaced the decimal place. It Weights 18.7 pounds and goes around the earth every 93 minutes

October 20 1957

The Orionids meteor shower will reach it peak at the 21st at 20 meteor per hour. 2:20-4:00 I saw 15 meteors. The Orionids are swift in flight.

2:15-400

1 2:31, swift, Red, Magnitude 3d
2 2:34, ~~swift~~, Red, long, Magnitude 1st
3 2:40, swift, Red, Magnitude 2d
4 2:42, swift, Red, train leaving meteors, Magnitude 1st
5 2:48, swift, Red, short, Magnitude 2d
6 2:51 swift. Red, long, train, Magnitude 2d
7 2:57, swift, Red, the only one going toward Orion, Magnitude 2d
8 3:01, swift, Red, long, train leaving meteors, Magnitude 1st
9 3:20, swift, Red, long, Magnitude
10 3:25 swift, Red, very faint, magnitude 4th
11 3:28, swift, Red, short, faint, Magnitude 3d
12 3:32, swift, Red, train lasting 3 seconds, Magnitude 2d
13 3:46, swift, Red, magnitude 3d

Astronomy Journal-when Sputnik was launched, 1957, Will Steger (13 years old)

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moon sets in ethereal pale blue across the lake
quarter of it luminous white, the rest faint orange
low and big above trees and close
it's magnetic, supernatural as it drops
by the time it's gone sky is a navy blanket of stars
in front of me as I grill
flying squirrels, small with dark bulging eyes,
glide serenely to and from trees around bird feeder
they land on silent feet [redacted] chase each other up and down
like children in impossibly fast race cars
this is the first year I 've seen them
they come out only whe[redacted] it gets dark

21 august 2004

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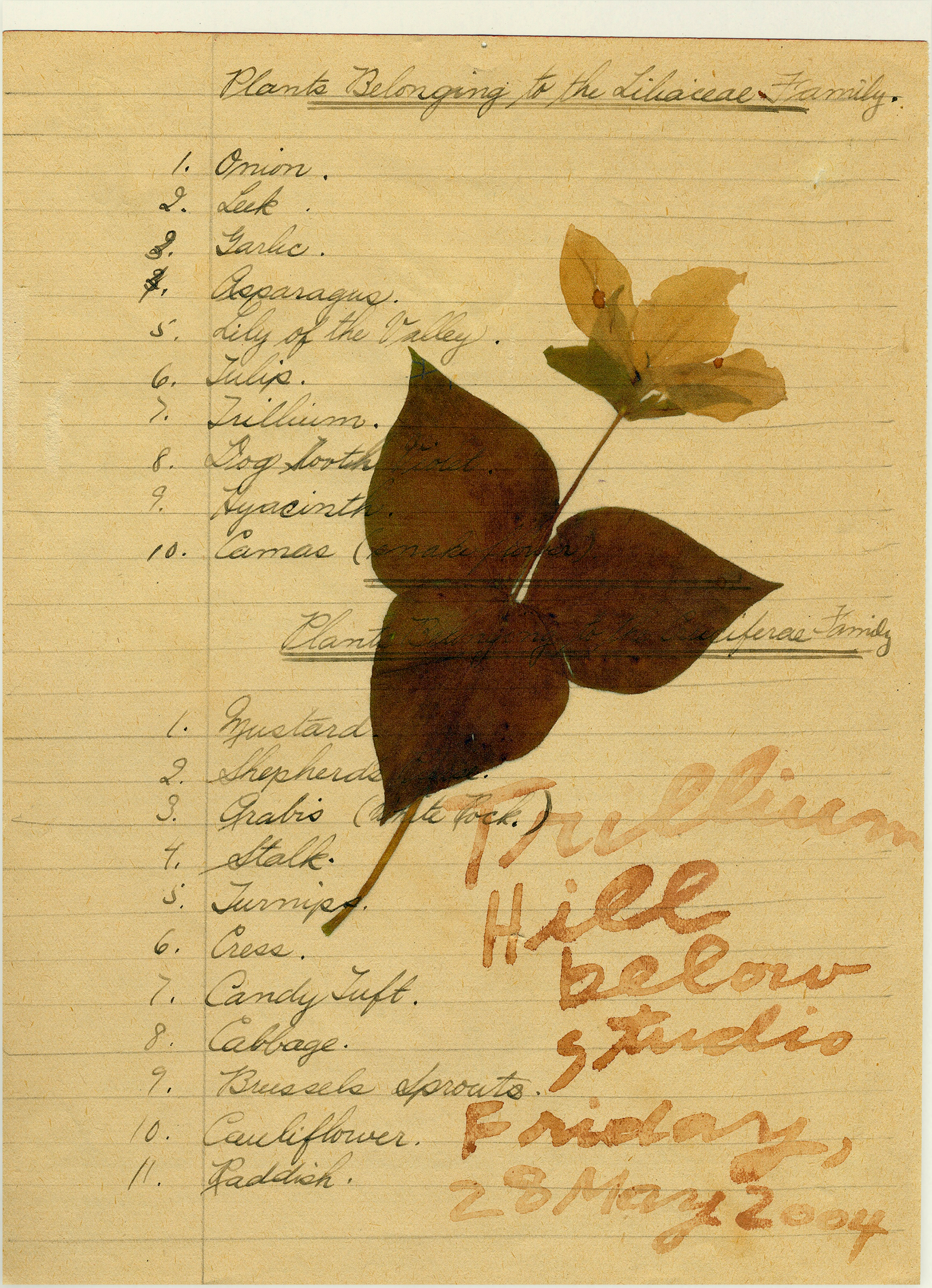

Plants Belonging to the Liliaceae Family.

1. Onion.
2. Leek.
3. Garlic.
4. Asparagus.
5. Lily of the Valley.
6. Tulip.
7. Trillium.
8. Dog Tooth Violet.
9. Hyacinth.
10. Camas (Snake flower).

Plants Belonging to the Cruciferae Family

1. Mustard.
2. Shepherds Purse.
3. Arabis (White Rock.)
4. Stalk.
5. Turnips.
6. Cress.
7. Candy Tuft.
8. Cabbage.
9. Brussels Sprouts.
10. Cauliflower.
11. Raddish.

Trillium
Hill
below
studio
Friday,
28 May 2004

Historical Journal Excerpt Describing Minnesota's Tallgrass Aspen Parkland Biome, from Henry Hind (1823-1908)

The ancient Lake Ridge...extends in an unbroken line, except where the river from the higher level in the rear has cut channels through it, from near Lake Winnipeg, far beyond the international boundary. At the crossing-place on the Roseau, about forty-six miles from the Red River, its height is estimated to be the same as at the Middle Settlement; it forms a beautiful dry gravel road wherever traversed, and suffers only from the drawback of being the favorite haunt of numerous badgers, whose holes in the flank, and sometimes also on the summit, are dangerous to horses; it is, apparently, perfectly level for a hundred miles, and everywhere, as far as my observation enabled me to judge, shows the same even rounded summit; it may yet form an admirable means of communication through the country, and it marks the limit of the good land on the east of Red River. This ridge is a favourite resort of the prairie hen (Tetro cupido), when they perform their curious dances in the early spring months.

from: Narrative of the Canadian Red River Exploring Expedition of 1857 and Reports of Progress on the Assiniboine and Saskatchewan Exploring Expedition

Historical Journal Excerpt Describing Minnesota's Prairie Grassland, from Joseph Nicollet (1786-1843)

Thursday, June 28, 1838

We enter the Great Oasis, which offers the only direction to take without going into water several feet deep. This beautiful grove is surrounded by large lakes [Crooked, Great Oasis, Rush, and Bear] ornamented with aquatic plants, in which live innumerable families of muskrats and water birds. These lakes are from 7 to 12 feet deep, and the soil that surrounds them is suitable for potatoes and other vegetables. The distance through the grove is about 1½ miles. The growth of the various species forming it is as beautiful as any which can be seen in the basin of the lower Missouri. I will list the principle ones: 1. The linden [basswood] - 30 to 40 feet; the white birch - 20 to 30; swamp white oak- 20 to 30; swamp ash - 20 to 30; beaver wood [aspen] - 15 to 20; prickly ash - to 15 feet. As this oasis is protected from the spring and fall fires by the lakes which surround it, one can understand why the climate has been able to develop such a richness here. It is good testimony in favor of my opinion that all the prairies watered by the Mississippi and the Missouri are the work of the Indians who destroyed by fire the rich vegetation to assure themselves of animal food. Let the vast and shorn prairies that we cross remain untouched and the forests, with time will reappear.

from: 1838 Minnesota River and Blue Earth River Expeditions, Published 1843, Joseph N. Nicollet: On the Plains and Prairies, Pages 54-55, 66-67

Historical Journal Excerpt Describing Minnesota's Coniferous Foreset, from William Keating (1799-1844)

We entered Rainy-Lake River on the morning of the 28th of August, and reached its head early on the 31st. The length of this stream is about one hundred miles. Its breadth at its mouth is about four hundred yards; it becomes narrower above; its average breadth is three hundred yards; its current is rapid and uniform; there are very few obstructions to the navigation, there being but two places at which canoes are lightened and towed up. The longest of these is about one mile.

At its mouth the banks of this stream are low and marshy; beyond this they rise somewhat, but present few hills; the river runs in many places over a pebbly bed. The country assumes a more smiling appearance, which led us to anticipate the meeting with limestone rocks; we saw none along the river, but some precipices, seen at a distrance, were supposed from their horizontal stratification to be composed of limestone. On the river the rocks seldom appear in place; where we saw them they were principally mica-slate, sometimes, however, sienite. Dr. Bigsby found staurotide in the slate of this river.

from: Narrative of an expedition to the source of St. Peter's River, Lake Winnepeck, Lake of the Woods performed in the year 1823, by order of the Hon. J.C. Calhoun, Secretary of war, under the command of Stephen H. Long, Major U.S.T.E. Volume 1. Published: 1824

Historical Journal Excerpt from Minnesota's Deciduous Forest, from Jonathon Carver (1710-1780)

June 4, 1767
Came to the great meadows or plains. Here I found excellent good land and very pleasant country. [This is the area near Lake Pepin on the Wisconsin-Minneesota border.] One might travel all day and only see now and then a small pleasant grove of oak and walnut. This country is covered with grass that affords excellent pasturage for the buffeloe which here are very plenty. Could see them at a distance under the shady oaks like cattle in a pasture and sometimes a drove of an hundred or more shading themselves in these groves at noon day which afforded a very pleasant prospect for an uninhabited countyr.

We killed several of these buffaloes, one of which we all judged would weigh fifteen hundred weight and if the same could be fed as is common to fatten our tame cattle undoubtedly would weigh three thousand, they being by far the largest creatures in bulk that I ever saw...

from: Travels through the Interior Parts of North America in the Years 1766, 1767, and 1768. Published: 1778

Find more on each of these writers and hear more of their excerpts read outloud in the Will Steger Foundation online classroom within each biome's featured journal section.

Lesson 2: Minnesota's Changing Climate

What defines Minnesota's biomes?

Age Level:	Grades 9-12
Time Needed:	Two 50-minute periods
Materials:	Animal and plant biome cards (1 for each student) Biome Map (1 for each student to paste in journal or large poster for classroom) Biomes Table (1 for each student to paste in journal) 1990s Census of the Land (1 for each student to paste in journal) The Natural Vegetation of Minnesota (1 for each student to paste in journal)
Student Learning Outcomes:	• Students will identify Minnesota's four main biomes. • Students will identify characteristic plants and animals found in each biome. • Students will describe abiotic and biotic factors that define each biome. • Students will describe how Minnesota biomes have changed in the last 100 years

Educator Prep:

- Cut out the animal and vegetation biome cards. Laminate for longevity. Make a classroom set that has equal numbers of plants and animals from each biome. Hole punch each card and put enough string through it so that it can hang around the student's neck.
- Using masking tape, make the shape of the map of Minnesota on the floor of your classroom large enough so that all of the students in your class would fit. Using chalk outside would work as well.
- Make copies of the Minnesota Biomes Table for each student
- Make copies of the Minnesota map of biome boundaries for each student
- Make copies of the 1990s Census of the Land for each student
- Make copies of the Natural Vegetation of Minnesota for each student (Note: color pdfs of the biome cards can be downloaded from the website at http://classroom.willstegerfoundation.org)

Background Information

The Minnesota DNR uses the word "biome" to describe a biological community. Usually, biomes occur over large areas and include many similar plant communities and the animals that live in them. Climate is what defines the geographical area of a biome. It is important to understand that a biome is an area that is climatologically capable of supporting certain species; however, because of human-induced land use change, characteristic species may be less abundant or absent. (MN DNR-Biomes Sheet) Abiotic and biotic factors allow or limit plants and animals to live where they live. Abiotic factors include climate and soil types.

Journal Assignment

At the end of this lesson, student journals should include the names of all four Minnesota biomes, what defines them, a map of Minnesota that shows approximately where each biome is, a map of Minnesota that shows vegetation at the turn of the century, and a map that shows land use in Minnesota today.

I have spent much time alone on the porch this summer, reading and writing and other quiet things. The local animals have taken me as just another piece of furniture for they don't pay me any attention.

—Will Steger, August 17, 1974

The key is to be comfortable in order to relax and take in actually what is happening, the raw nature that is experienced: the sting of the wind on hands and nose, the freshness of the air, the beauty of the sky and land forms in such weather.

—Will Steger, Ely Homestead, January 25-27, 1977

Activity Description

Introduction

1. Read out loud a journal excerpt from the biome where your school is located. These can be found in the Journals section of each biome in the online classroom at http://classroom.willstegerfoundation.org. Ask the students to write an excerpt in their own journal that describes the plants and animals they see every day. Compare and contrast journal excerpts discussing why there may or may not be similarities.
2. If there is time, read an excerpt from another biome and discuss.

Activity: Biome Meet and Greet

1. Ask each student to sit with their eyes shut. Hang a card around each of their necks with it hanging on their back. Explain that they will have to figure out what kind of animal or plant is on their back using yes or no questions, one per person in the class. Allow them to walk around the room asking other students.
2. Once they determine their animal or plant, they should still participate, helping other students out.
3. Ask students to take a seat. Explain that they are all wearing a plant or animal that is native to Minnesota. Show or draw a biome map of Minnesota on your blackboard, wipe board or smart board. Ask them to read silently about their animal or plant on the back of the card. In what biome are they found?
4. Hand out the biomes table for them to paste in their journal. What makes the different biomes unique based on the table and the different plants and animals they greeted?
5. Using the panoramic view available on the online classroom, show examples of each biome, watch the video excerpts about each biome, or if you have access to a computer lab, allow the students to individually "explore" each biome. If you are viewing as a class, ask a few of them to share the information on their card as the biome where their plant or animal comes up, and to explain how their animal or plant fits into the biome.

Activity: Biomes Yesterday and Today

1. Hand out the Minnesota biomes map, the Natural Vegetation of Minnesota at the Time of the Public Land Survey: 1847-1907 and the 1990s Census of the Land. Ask students to spend some time looking over the maps.
   - Are the biome boundaries based on the map from modern day or the turn of the century?
   - How has each biome changed since the turn of the century?
   - What biotic and abiotic factors allow and/or limit the plants and animals that live in each biome?
2. Ask the students to paste the maps in their journal and write a few sentences about how each biome has changed in the last 100 years and how this may or may not have affected the plant or animal they learned about in the opening activity.

Concluding Activity: Design your own state boundaries

1. Discuss the biome where your school is found, ask if any of the students are familiar with the plants and animals listed in the biomes table. Why or why not? Would they describe the area they live as being uniquely different from another biome in the state? How?
2. What else defines the different biomes of Minnesota besides its plants, animals and climate? Use the 1990s Census of the Land map to determine or theorize where agriculture might be common? Winter tourism? Forestry? Urban centers? If the students could split up the state based on their own boundaries what would be they be?
3. In their journals, have students describe their new state boundaries, explain what they are based upon, and create a visual to show where they are.

Journaling Connection

Note: The Take It Outside activity also involves use of the journal.

1. In their journal, the students should paste the photo of their animal or plant.
2. Ask the students to write a story about their plant or animal including what they know about the biome where the animal or plant lives.

Take It Outside—Connecting With Your Place

Materials

Field guides for your region

Journal

1. Ask students to turn to a page in their journal and make a line down the middle of the page to make two columns, label one fauna and one flora (please remind them that insects are animals).
2. Take students out into the schoolyard, or to a nearby nature area if possible. Ask them to choose a place where they are comfortable to sit and are able to look all around them. Ask them to make a list of what they see. If they don't know the name of the animal ask them to sketch it. If you have digital cameras they could also take a photo, or if they have guidebooks they could use it to identify whatever they are observing.
3. Return inside and make a list on the board of what was seen. Look back at the list of common animals and plants found in your biome. Were any of these seen? Discuss why or why not you may have seen them.

Extensions

1. Ask students to research the animal or plant they were in the biome meet and greet game. Create a classroom encyclopedia of Minnesota flora and fauna.
2. Ask students to write a story from the perspective of the animal or plant they were in their biome meet and greet.
3. The websites listed in the resources section have extensive opportunities to explore various data related to Minnesota's landscapes. Choose a theme for all the students to explore or let each select a theme to explore and research Minnesota's landscape.

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org

1. Explore each biome virtually. Watch the intro video for each biome.
2. Connect with another classroom in another biome and use Skype (web conference) to discuss the different or similar animals and plants they see outside their window.
3. Upload photos and journal entries to http://classroom.willstegerfoundation.org/get-social/share-your-observations. Look through other photos uploaded by students around the state.

Resources

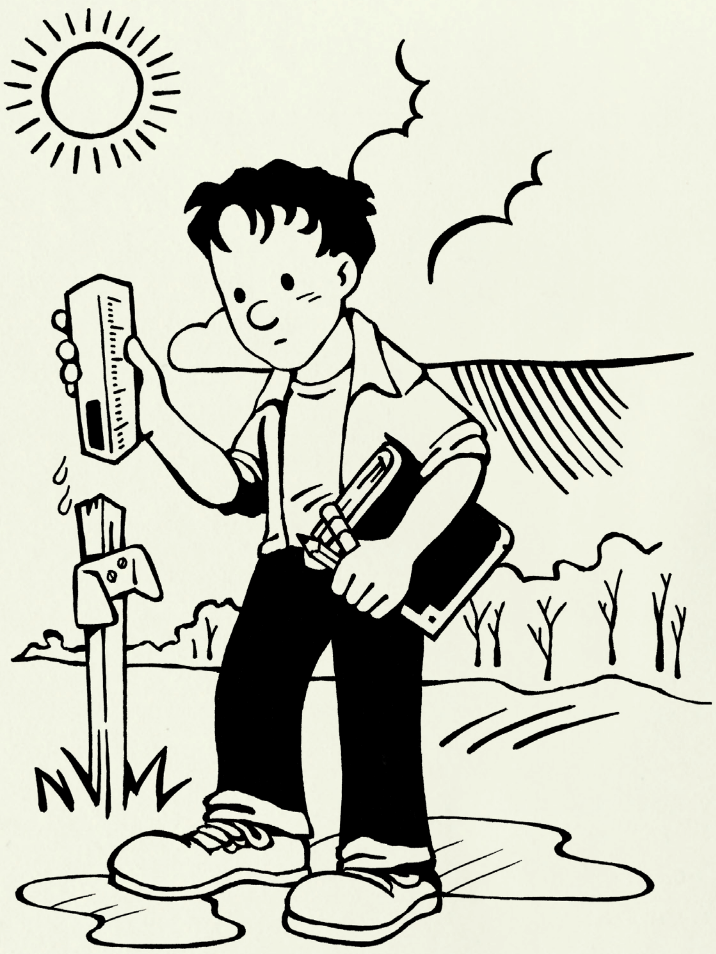
Monitoring Minnesota's Changing Landscapes
http://land.umn.edu/quickview_data/index.html

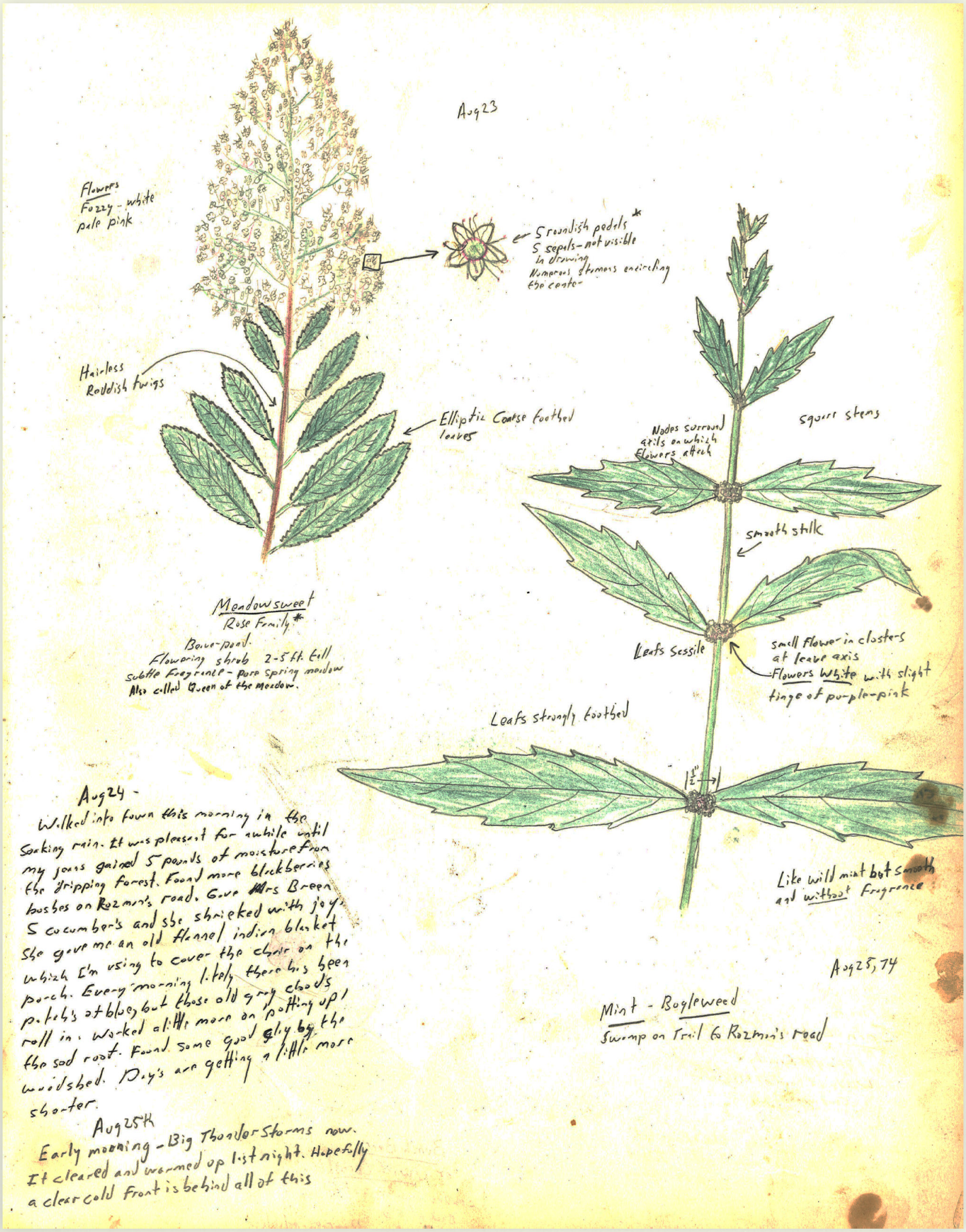
Land Use/Cover Info for Minnesota
http://www.mngeo.state.mn.us/chouse/land_use.html

Ely Homestead
Aug 17th, 1974

Another clear day. It's 8:00am, 57° and barometer steady. There are also a few small patches of altocumulus and fracto-cumulus clouds. The fracto-cumulus are a sign of later thundershowers. There is a squirrel perched by the railing in his usual spot eating balsam pine cones. He is watching me and eating at the same time. Last night he sat on my lap when I was reading. I have spent much time alone on the porch this summer, reading and writing and other quiet things. The local animals have taken me as just another piece of furniture for they don't pay me any attention. I have watched a white throated sparrow family grow. Soon the young will be on their own.

Quiet morning, the sound of a few August flies, a noisy blue jay family down the lake, pine cones falling and hitting branches as the squirrels begin to harvest and stock up for the winter, peep-peep-peep of the white throated sparrow and the wind in the poplars across the lake. A ruby-throated hummingbird was hovering around the trees this morning in front of the porch. I have seen him a score of times this summer near the cabin.

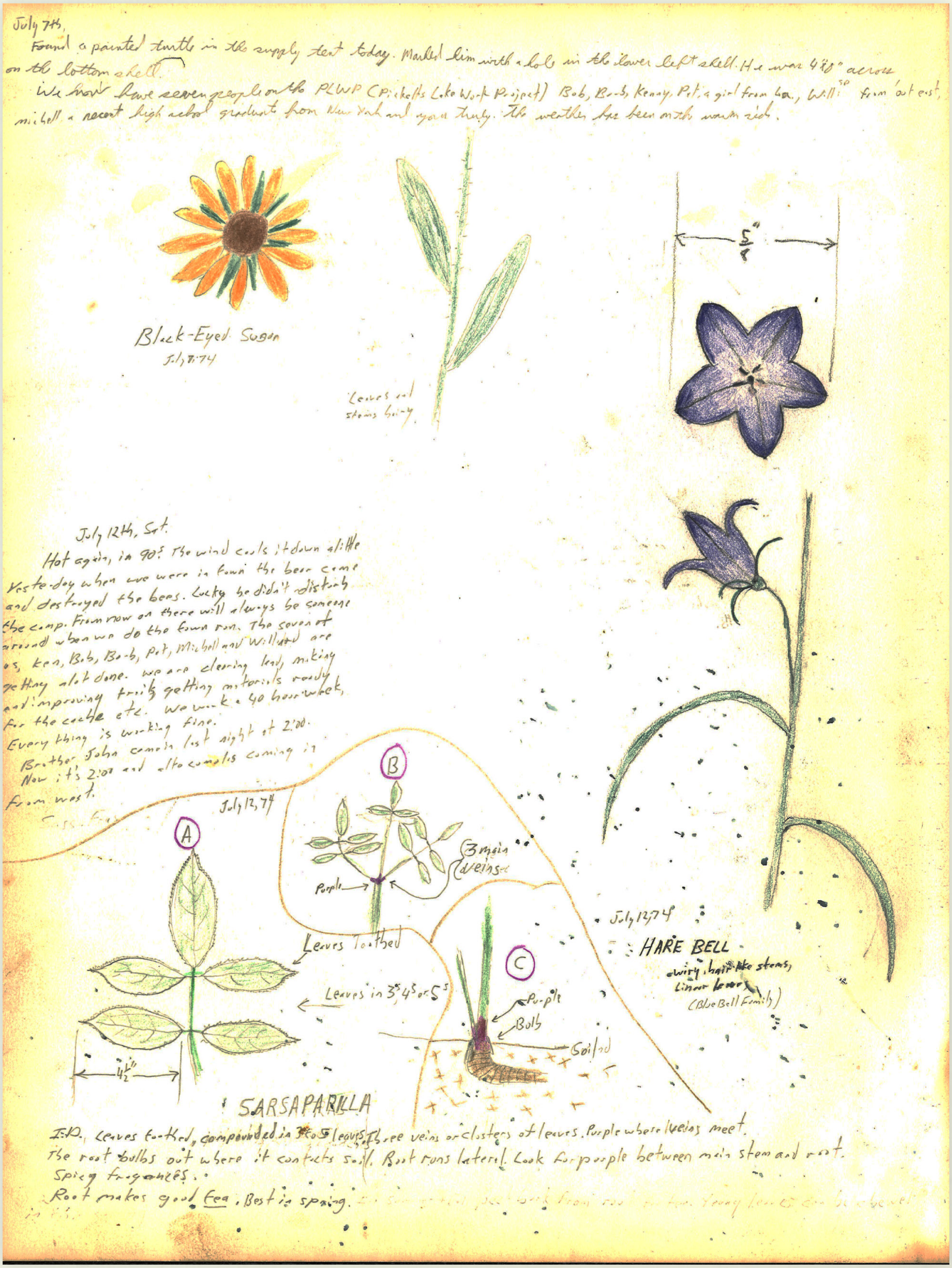




Aug 24 -
Walked into town this morning in the soaking rain. It was pleasant for awhile until my jeans gained 5 pounds of moisture from the dripping forest. Found more blackberries bushes on Rozman's road. Gave Mrs Breen 5 cucumber's and she shrieked with joy. She gave me an old flannel indian blanket which I'm using to cover the chair on the porch. Every morning likely there has been patch's of blue, but those old gray clouds roll in. Worked a little more on putting up the sod roof. Found some good [illegible] by the woodshed. Day's are getting a little more shorter.

Aug 25th
Early morning - Big Thunder Storms now. It cleared and warmed up last night. Hopefully a clear cold Front is behind all of this

Phenology Journal, Will Steger, 1978



Phenology Journal, Will Steger, 1978

Phenology Journal, Will Steger, 1978

Heart-Leaved Willow

Salix cordata

Biome: Tallgrass Aspen Parkland

Heart-leaved willow is a perennial plant that is found in sandy soils, often on the shores of a lake.

Aspen

Populus tremuloides

Biome: Tallgrass Aspen Parkland

Aspen leaves are 1 to 4 inches long with a broad oval shape and finely toothed edges. They become yellow in the fall. Aspen trees have a white to grey-green bark that is thin and smooth. Aspen grows quickly and grows in space left by a fire or harvest. Aspen can grow well on sandy soil but grows best on a more nutrient-rich soil.

Small White Lady's Slipper

Cypripedium candidum

Biome: Tallgrass Aspen Parkland

Habitat: Prairies and grasslands

Threats: Loss of habitat, listed as Minnesota State Special Concern Species

The small white lady's slipper is a perennial plant that blooms in the spring—usually by early June. It can be 4 to 13 inches tall. The small white lady's slipper has one flower per stem that is white and shaped like a pouch, and this can have some purple spots or streaks. The flower column in the middle of the pouch is yellow. There are also two twisted side petals that are a greenish shade. This wildflower is threatened by loss of habitat due to land use change from prairie to agriculture or an urban environment, and invasion of weeds or more woody forest species.

Wiregrass Sedge

Carex lasiocarpa

Biome: Tallgrass Aspen Parkland

Wiregrass sedge is a perennial herb that grows in bogs and marshes, often in shallow water. It has very thin leaves and stems that can grow to about 3 feet. Wiregrass sedge has the characteristics that allow it to form a floating mat structure in a bog.

Sharp-Tailed Grouse

Tympanuchus phasianellus

Biome: Tallgrass Aspen Parkland

Diet: Seeds in the summer and fall; buds and twigs in the winter

Threats: Loss of open brushland and grassland, the suitable sharp-tailed grouse habitat

The range of sharp-tailed grouse in Minnesota has declined significantly due to the decline in their habitat. This brown and grey grouse is 15 to 20 inches long and weighs from 2 to 3 pounds. Its predators include great horned owls, foxes, skunks and raccoons.

Little Bluestem

Schizachyrium scoparium

Biome: Tallgrass Aspen Parkland

Little bluestem begins to grow in August with the appearance of its thin blue or blue-green stems. In can grow to be about 3 feet tall and becomes a deep red color in the fall. In the winter, little bluestem produces fuzzy white seeds that attract birds. The deep, dense root system of little bluestem allows it to be less susceptible to droughts and grow successfully in the drier prairie soils. Little bluestem also serves as habitat for many animals.

American Bittern

Botaurus lentiginosus

Biome: Tallgrass Aspen Parkland

Diet: Fish, insects, amphibians, crayfish, small mammals, snakes

Habitat: Freshwater wetlands

Threats: Habitat loss, Minnesota Species of Greatest Conservation Need

The American bittern is 23 to 34 inches long. It is well camouflaged in its wetland habitat and feeds by slowly following its prey or waiting for it to approach.

Sandhill Crane

Grus Canadensis

Biome: Tallgrass Aspen Parkland

Diet: Omnivore—grains, plants, insects, worms, mice, snakes

Habitat: Wetlands

Threats: Loss of wetland habitat

Sandhill cranes find most of their food in shallow wetlands and wetland soil, but they are also able to find seeds, such as corn, that have been planted in agricultural land. This can damage crops and cause conflicts with farmers. Sandhill cranes have a red crown on their heads and are grey, however, they often appear brown because they groom themselves with mud from their wetland area.


Family Cervidae
Cervus elaphus canadensis
E. C. Oaks
ASM - MIL


© Smithsonian Institution

American Elk

Cervus elaphus

Biome: Tallgrass Aspen Parkland

Habitat: Forests and open areas

Diet: Plants such as grasses and woody plants, including parts of aspen trees

Threats: Winter habitat loss, forests are needed and can be lost due to land use change

The American elk requires both forested habitat as well as open areas since forest offers the cover and protection while open areas offer the grasses and other plants that American elk eats. The American elk eats a wide variety of plants, so they will eat what is available. The American elk also has different summer and winter coats that have different appearances.

Canadian Toad

Bufo hemiophrys

Biome: Tallgrass Aspen Parkland

Diet: Insects, worms

Habitat: Woodlands, near water

The Canadian toad is 2 to 3.5 inches and is active at night. It digs burrows and its habitat includes more water than the habitats of other toads in Minnesota. Its main predator is the hognose snake as well as raccoons and skunks.

Northern White Cedar

Thuja occidentalis

Biome: Coniferous Forest

Threats: Structures that restrict movement of water through soil, such as roads, pipelines or beaver dams

Northern white cedar requires an area where water moves well through the soil in order to grow successfully. They can grow to be 50 to 60 feet tall. Northern white cedar will grow near black spruce on wetter soils and aspen on drier soils. This is a shade-tolerant tree. White-tailed deer and snowshoe hares feed on the seedlings, and this can damage a young, growing population.

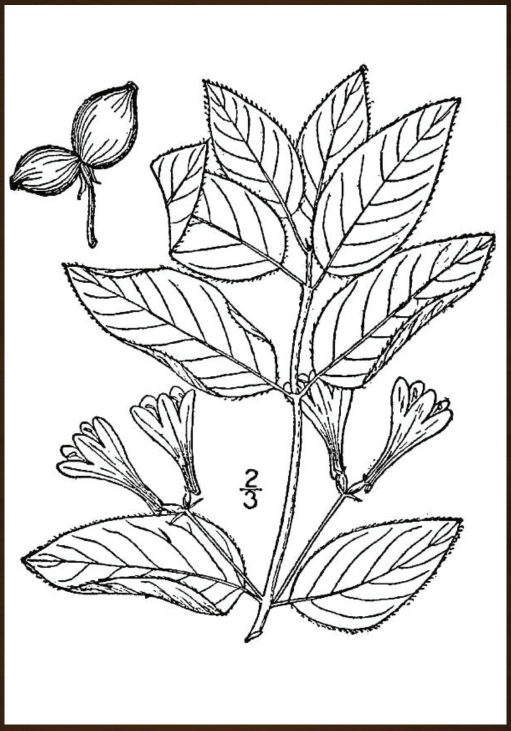
Black Spruce

Picea mariana

Biome: Coniferous Forest

Threats: Eastern dwarf-mistletoe

Black spruce trees often grow in areas after fires have occurred, and produce cones to reproduce. They grow on wet soils and can live for 200 years. Black spruce trees are harvested primarily for pulp as well as Christmas trees and lumber. The spruce grouse relies on black spruce trees for its habitat.



Red Pine

Pinus resinosa

Biome: Coniferous Forest

Red pine's bark is red-brown plates, the leaves are dark green needles and it produces light brown cones. It often grows in areas after fires and can grow to be 60 to 80 feet high. Red pine grows on dry soils, does not tolerate shade and grows well in cold environments. Red pine is a habitat for many animals as well as food for deer and snowshoe hares. Birds, mice and chipmunks eat red pine seeds. Red pine is grown for a variety of uses including pulp and lumber.

Balsam Fir

Abies balsamea

Biome: Coniferous Forest

Threats: Spruce budworm insect; needle rust and root rot disease; easily killed by fires

Balsam fir grows well in cool, damp environments. It has smooth, gray bark, narrow leaves that are ½ to 1 inch long and purple cones. It can be 60 feet high and live for 100 years. It can also grow in shady conditions, so it can grow under forests under other trees. Balsam fir serves as food and habitat for a variety of species such as moose, white-tailed deer, snowshoe hare, red squirrel and grouse. Balsam fir is also used for pulp, Christmas trees and lumber.

Wood Frog

Rana sylvatica

Biome: Coniferous Forest

Diet: Small invertebrates

Habitat: Forests, bogs

The wood frog has a dark band over its eyes that appears to be a mask. It is 2 to 2.75 inches long. The wood frog breeds in bodies of water and then often moves far from these areas, into the forest. It lives well in cold climates.

Fly Honeysuckle

Lonicera canadensis

Biome: Coniferous Forest

Fly honeysuckle is perennial shrub that is about 7.5 feet high. It has yellow and white flowers that are in bloom April to July. This plant is beneficial to hummingbirds and butterflies.


Family Canidae
Canus lupus
L. L. Master
ASM - MIL


Family Cervidae
Alces americanus
J. O. Wolff
ASM - MIL

Compton’s Tortoise Shell Butterfly

Nymphalis vaualbum

Biome: Coniferous Forest

The Compton’s tortoise shell caterpillars depend on aspen, cottonwood, willow, gray birch and paper birch trees. The butterfly emerges as an adult in July and has a wing span of 2.5 to 3 inches.

Boreal Chickadee

Poecile hudsonicus

Biome: Coniferous Forest

Diet: Seeds and insects

Habitat: Spruce and fir forests

Threats: Destruction of spruce and fir forests due to industry and climate change

Boreal chickadees are often omnivores that eat seeds and insects. They store seeds and insect larvae for the winter. They find food in groups, except during breeding. They construct their nests in holes in trees and do not migrate during the winter.

Moose

Alces alces

Biome: Coniferous Forest

Diet: Aspen, maple and cherry trees and aquatic plants

Habitat: Forests

Threats: Warmer climate

Moose weigh 950 to 1,000 pounds, making them Minnesota’s largest wild animal. They have strong senses of smell and hearing. Moose are very stressed by warmer temperatures, which makes them more susceptible to diseases. Wolves and bears are moose predators.

Gray Wolf

Canis lupus

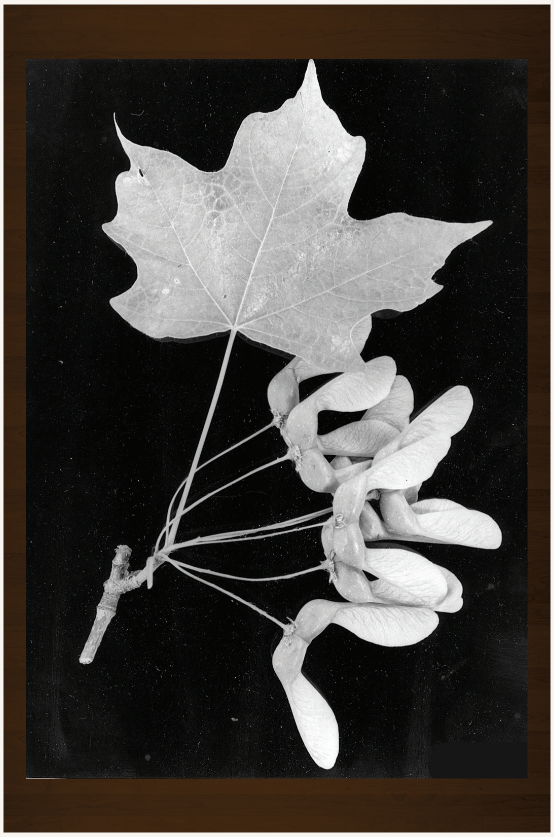
Biome: Coniferous Forest

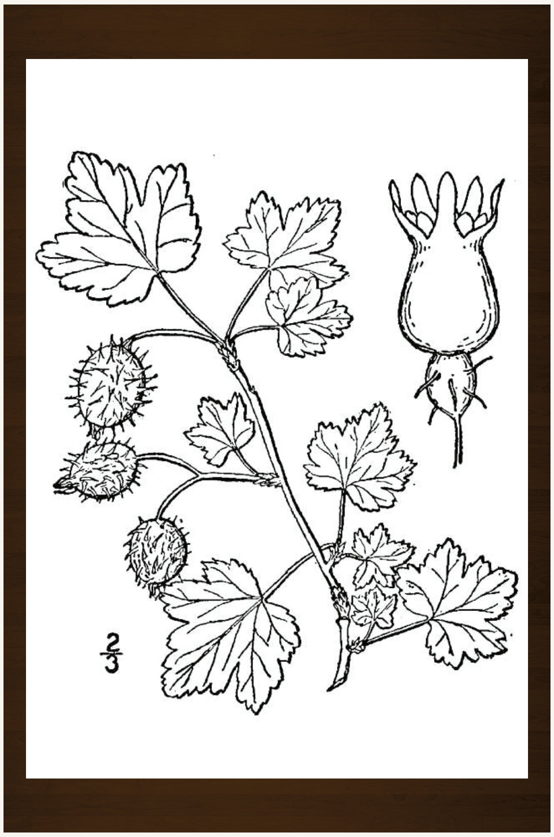
Diet: Small mammals and deer, moose and beavers

Habitat: Forests

Threats: Endangered Species

Gray wolves live in packs that are made up of 5 to 12 wolves. The pack hunts together, which allows them to catch the larger animals. Gray wolves weigh 60 to 120 pounds and their sense of smell is 100 times stronger than humans.




2/3

American Basswood

Tilia americana

Biome: Deciduous Forest

The American basswood tree has white-yellow flowers that bloom around June and are fragrant. It grows in forests with sugar maple trees as well as northern red oaks. American basswood can be 60 to 80 feet high with gray bark. Its leaves are 3 to 6 inches long and heart-shaped.

Northern Red Oak

Quercus rubra

Biome: Deciduous Forest

Threats: Oak wilt fungus and gypsy moths

Northern red oak grows quickly and can be 55 to 80 feet tall. Its leaves are 5 to 9 inches long and they turn bright red in the fall. It provides a good habitat for many animals. The northern red oak also produces acorns. These, as well as leaves and seedlings, are food for deer, elk, moose and rabbits. Northern red oak is harvested for lumber and grows well in urban areas. Oak wilt fungus has become a serious threat to northern red oak trees in Minnesota.

Prickly Gooseberry

Ribes cynosbati

Biome: Deciduous Forest

Prickly gooseberry is a perennial shrub that is about 36 inches tall. Its flowers are a green-yellow color and bloom in May or June. It also has a bristly, purple berry that birds often eat.

Sugar Maple

Acer saccharum

Biome: Deciduous Forest

Threats: Asian long-horned beetle

Sugar maple grows to a height of 80 feet or more. It grows slowly and can grow well in shady conditions. Its leaves are 3 to 5 inches long with 3 to 5 points. Sugar maple is used for lumber and it also produces maple syrup.

Eastern Hognose Snake

Heterodon platyrhinos

Biome: Deciduous Forest

Diet: Toads primarily and small mammals

Habitat: Edge of forests, on sandy soil

The eastern hognose snake is not venomous and its predators are hawks and other mammals. This snake is usually 24 to 46 inches long and can be a variety of colors: yellow, gray, brown or black

Rue Anemone

Anemonella thalictroides

Biome: Deciduous Forest

Rue anemone is a perennial flower that often grows in shady areas. Its flowers can be white or light purple and it blooms in April or May. This flower grows in areas of healthy soil.

Eastern Pipistrelle Bat

Perimyotis subflavus

Biome: Deciduous Forest

Diet: Insects such as moths, flies, beetles, ants

Habitat: Caves, primarily

Threats: Minnesota Species of Special Concern, disturbance during hibernation

The eastern pipistrelle bat is the smallest bat species in Minnesota. It is known as a tricolored bat because of the variation in color of its individual hairs. This bat hibernates from October to April in caves or tunnels.

Cerulean Warbler

Dendroica cerulean

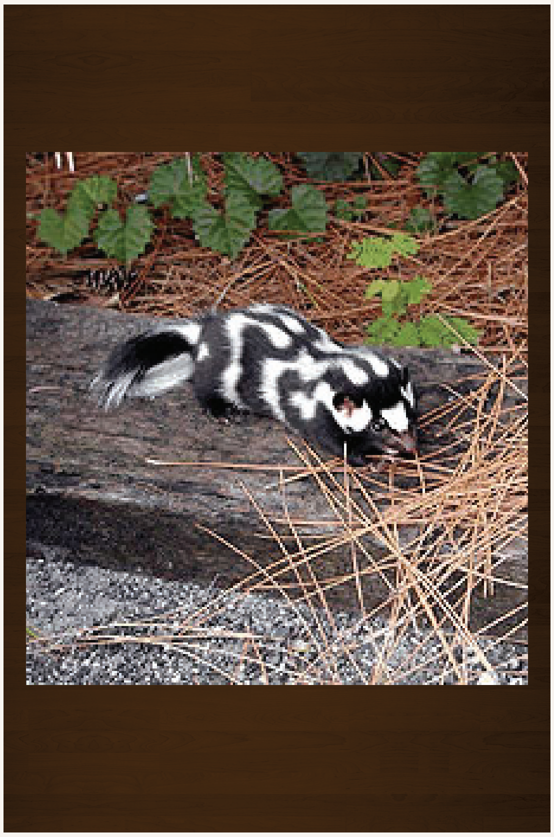
Biome: Deciduous Forest

Diet: Insects

Habitat: Large areas of deciduous forest

Threats: Loss of forest habitat

The cerulean warbler migrates a long distance to South America for the winter, and it arrives in Minnesota around May each year. The cerulean warbler lives in forests with oak, maple and basswood trees. It lives in forest areas with older, mature trees.



Eastern Spotted Skunk

Spilogale putorius

Biome: Deciduous Forest

Diet: Insects and small rodents

Habitat: Woodlands, thickets, brush

Threats: Minnesota Threatened Species

The eastern spotted skunk is 18-22 inches long and its tail usually has a white tip. This skunk lives in dens during the winter and is an extremely rare species. They eat primarily insects and small rodents but will eat almost anything they can find.

Gray Fox

Urocyon cinereoargenteus

Biome: Deciduous Forest

Diet: Small mammals such as rabbits

Habitat: Forest

The gray fox can be identified by the dark stripe along its back and bushy tail. It is 35 to 40 inches long. The gray fox can climb trees, which is a unique characteristic for this type of animal. Its main predator is the coyote.

Blazing Star

Liatris spicata

Biome: Prairie Grassland

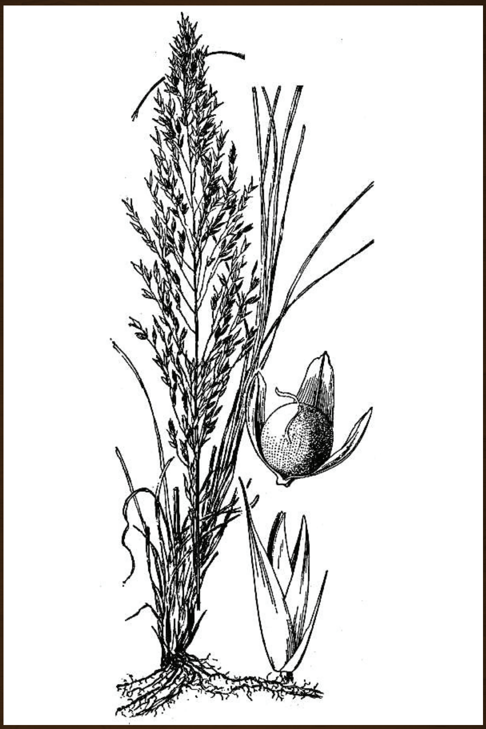
Blazing star is a perennial that can be 18 inches tall. Its pink-purple spike blooms in August.

Big Bluestem

Andropogon gerardii

Biome: Prairie Grassland

Big bluestem is a perennial grass that grows in moist soil. It has a blue tint and there is a purple flower cluster at the top of this grass. Big bluestem provides nesting habitat for birds and insects. Songbirds and prairie chickens also eat its seeds while white-tailed deer and bison eat the grass itself. This grass can also be grazed by livestock.



Prairie Dropseed

Sporobolus heterolepis

Biome: Prairie Grassland

Prairie dropseed is a grass that grows to about 2 feet tall and has orange flowers. These flowers are in bloom beginning in late summer.

Purple Prairie Clover

Petalostemum purpureum

Biome: Prairie Grassland

Purple prairie clover is a perennial that is 1 to 3 feet tall. Its purple flowers are in bloom from July to September. This plant attracts many butterfly species.

Great Plains Toad

Bufo cognatus

Biome: Prairie Grassland

Diet: Insects and earthworms

Habitat: Damp areas in prairies, farm fields

The great plains toad is 2 to 3.5 inches long, making it Minnesota's largest toad. They breed in bodies of water, so this habitat must also be nearby. This toad burrows into the ground for shelter.

Leadplant

Amorpha canescens

Biome: Prairie Grassland

Leadplant is a perennial that has blue or purple flowers. It is from 1 to 3 feet tall and its flowers are in bloom from late spring to summer.

Upland Sandpiper

Bartramia longicauda

Biome: Prairie Grassland

Diet: Insects

Habitat: Prairies

Threats: Species of Greatest Conservation Need, loss of habitat

The upland sandpiper is about 1 foot tall. Other sandpiper species live near water, but the upland sandpiper lives in a prairie habitat. Upland sandpipers migrate to South America for the winter and arrive in Minnesota in April or May.

Greater Prairie Chicken

Tympanuchus cupido

Biome: Prairie Grassland

Diet: Plants and insects

Habitat: Open prairies

Threats: Minnesota Species of Special Concern, loss of habitat

The greater prairie chicken nests in tall grass and is well known for its displays during the mating season. Its predators are red-tailed hawks and great-horned owls. The greater prairie chicken's habitat is threatened as it is being lost to agriculture or forest.

Badger

Taxidea taxus

Biome: Prairie Grassland

Diet: Insects and small mammals such as mice and gophers

Habitat: Prairies

The badger is 20 to 35 inches long and lives primarily underground. It can be identified by the white stripe from its nose to the base of its neck. The badger is a nocturnal animal.

Plains Pocket Gopher

Geomys bursarius

Biome: Prairie Grassland

Diet: Plants

Habitat: Prairies

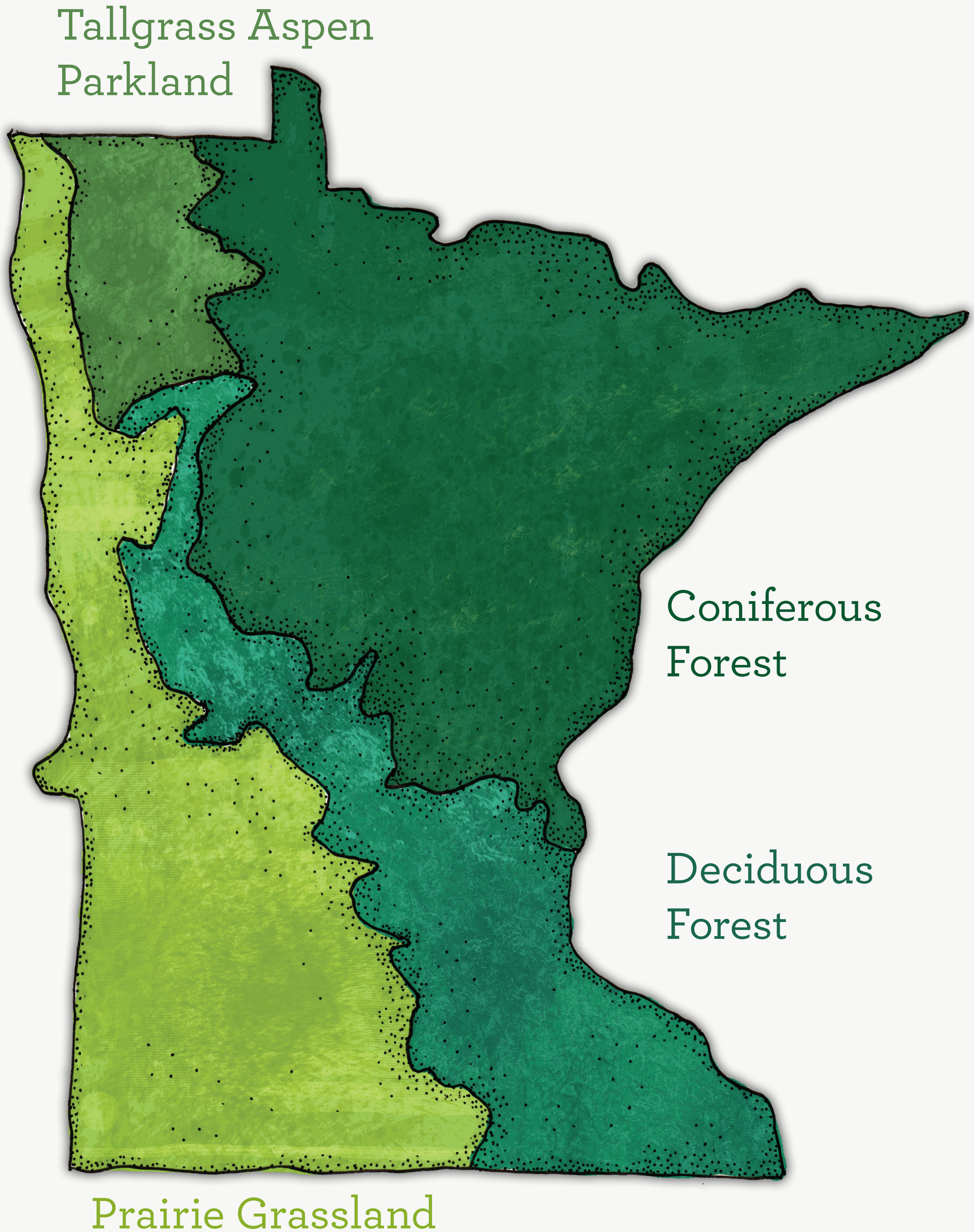
The plains pocket gopher is about 1 foot long and its tail has a white tip. It digs underground tunnels in the spring and fall and lives mostly underground. The plains pocket gopher lives in areas with sandy soil.

Minnesota Biomes Table

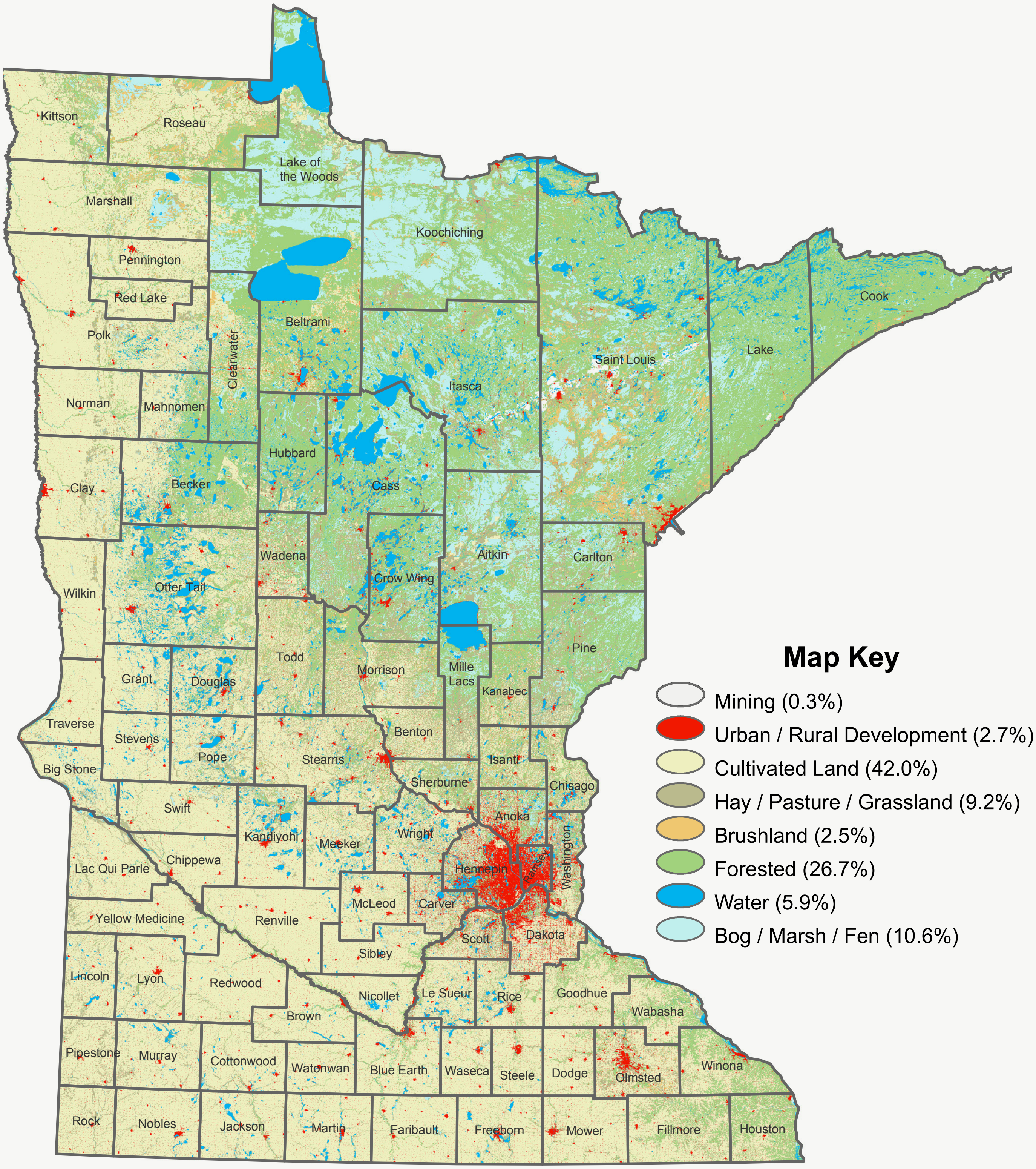
"Biome" is a term used to describe a biological community. Usually, biomes occur over large areas and include many similar plant communities and the animals that live in them. The table below shows examples of conditions within Minnesota's biomes.

	Average Annual Precipitation	*Average Annual Temperature*	*Vegetation Examples*	*Animal Examples*	*Average Growing Season Length*
Tallgrass Aspen Parkland Biome	20" – 22"	35° – 44° F	-Aspen -Heart-leaved Willow -Winegrass Sedge -Small White Lady's Slipper -Little Bluestem	-Sharp-tailed Grouse -Sandhill Crane -American Bittern -Canadian Toad -American Elk	90-130 days
Coniferous Forest Biome	21" – 32"	36° – 41° F	-Black Spruce -Northern White Cedar -Balsam Fir -Red Pine -Fly Honeysuckle	-Wood Frog -Boreal Chickadee -Compton's Tortoise Shell Butterfly -Gray Wolf -Moose	90 – 100 days
Deciduous Forest Biome	24" – 35"	39° – 45° F	-Northern Red Oak -American Basswood -Sugar Maple -Prickly Gooseberry -Rue Anemone	-Eastern Hognose Snake -Cerulean Warbler -Eastern Pipistrelle Bat -Gray Fox -Eastern Spotted Skunk	100 – 130 days
Prairie Grass-land Biome	18" – 33"	37° – 45° F	-Big Bluestem -Blazing Star -Purple Prairie Clover -Prairie Dropseed -Leadplant	-Great Plains Toad -Greater Prairie Chicken -Upland Sandpiper -Pocket Gopher -Badger	130 – 180 days

For a fun way to learn about Minnesota's biomes, plants, and animals, check out the Junior Park Naturalist Program at a state park near you, or call the DNR's Information Center at (651) 296-6157 (metro area) or 1-999-646-6367 (toll free).


Tallgrass Aspen Parkland
Coniferous Forest
Deciduous Forest
Prairie Grassland

1990s CENSUS OF THE LAND

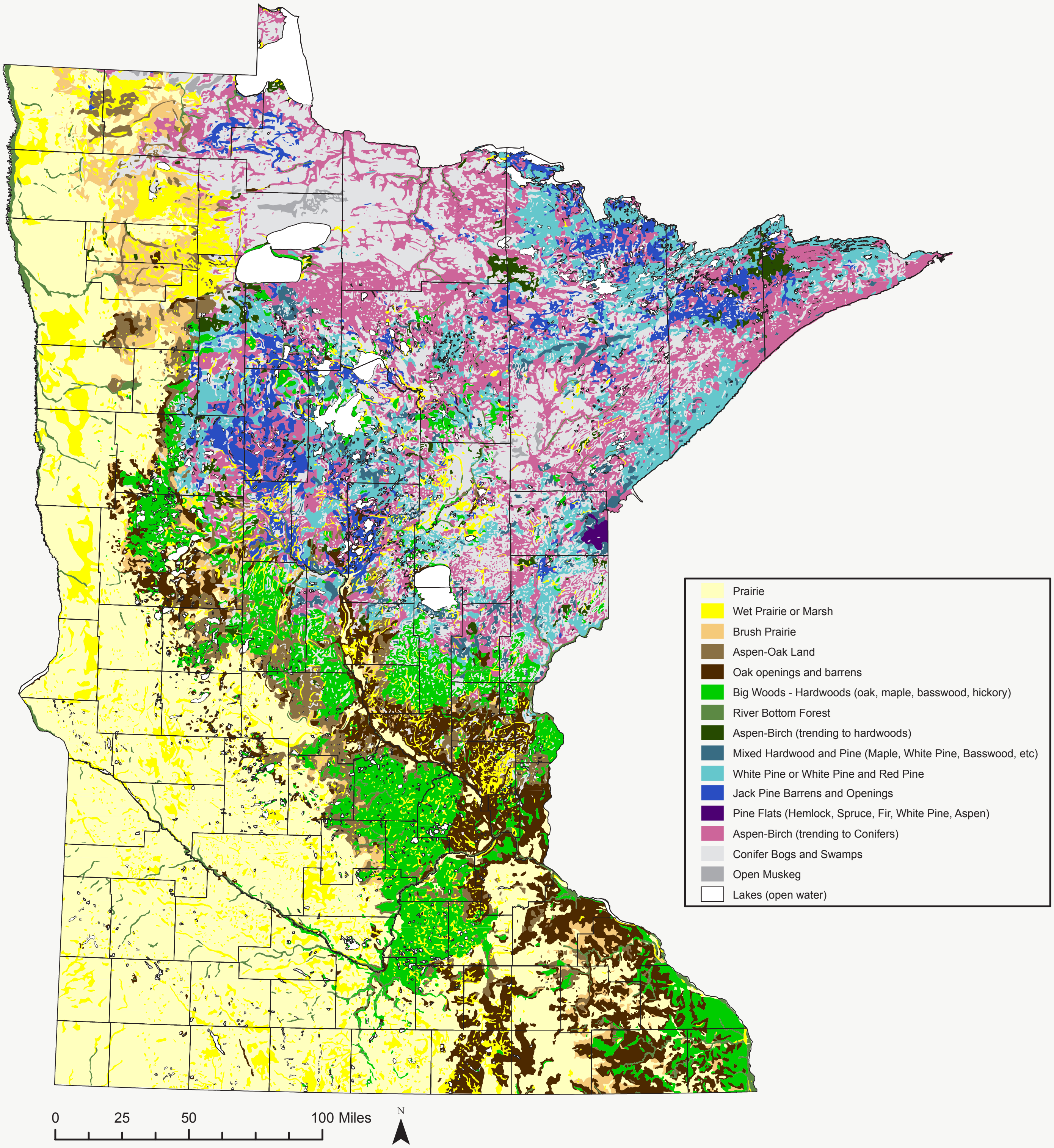


Data Source: Mn Dept. of Natural Resources; this data set integrates six different source data sets to provide a generalized overall view of Minnesota's land use / cover.

Metadata: http://www.lmic.state.mn.us/chouse/metadata/luse8.html

Map Production: Mn Land Management Information Center; 3/11/05 jch

The Natural Vegetation of Minnesota at the Time of the Public Land Survey: 1847-1907



This map was compiled from Minnesota Department of Natural Resources Geographic Information System digitized data, available on the DNR's web site at http://deli.dnr.state.mn.us/. The digitized data files were created from the Original Vegetation of Minnesota, a map compiled in 1930 by F.J. Marschner from the U.S. General Land Office Survey Notes and published in 1974 under the direction of M.L. Heinselman of the U.S. Forest Service by the North Central Forest Experiment Station in St. Paul, Minnesota.
Map compiled by DNR Natural Heritage and Nongame Research Program, June, 2005

Age Level:	Grades 9-12
Time Needed:	50-75 minutes
Materials:	Normal Annual Precipitation handout (1 per student or projection) Normal Annual Mean Temperature handout (1 per student or projection) Climate Trends in Precipitation-Annual (1 per student or projection) Climate Trends in Temperature-Annual (1 per student or projection) Graphing paper Colored pencils for graphing **optional: selection of graphs showing seasonal and regional climate trends
Student Learning Outcomes:	• Students will define climate, weather and phenology. • Students will define climate change. • Students will discuss what defines the climate and biomes of Minnesota. • Students will graphically represent authentic data from Minnesota's Climatology site. • Students will interpret graphs showing long-term precipitation and temperature trends in MN. • Students will discuss the importance of longitudinal data. • Students will gather their own weather data from their school site and record it in their journal.

Background Information

This lesson will introduce the terms *weather, climate* and *phenology*. These terms are essential to understanding climate change and how it is impacting and will impact biomes. In addition, as discussed in lesson 2, climate is an important and defining characteristic of the biomes of Minnesota. Finally, students will learn about the importance of longitudinal data and how they can participate as "citizen scientists."

The difference between weather and climate is an essential concept to understand when learning about climate change. Minnesota climatologist Mark Seeley defines climate as the "quantitative description of historical weather for a given place over a given interval of time ... [climate descriptions] include the physical and biological features of earth's surface, their interactions and atmospheric feedbacks." In other words, climate is not just one instance of snow or rain or heat, but the many weather events over long periods of time (multiple years) that define a particular geographical area as hot and dry, cold and wet, etc.

Weather, on the other hand, is "... the recent, current, and near-future state of the atmosphere. The most common elements include temperature, humidity, precipitation, cloudiness, visibility and wind." Weather is what is going on outside your window right now and one instance of weather does not define a particular area. Another way to think about this is if you were collecting data, weather would be one data point whereas climate would be the entire collection.

According to the USA National Phenology Network; "Phenology refers to recurring plant and animal life cycle stages ... such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. Many of these events are sensitive to climatic variation and change. ..." (http://www.usanpn.org/) Keeping track of the phenology outside your school can be a

I always had an incredible interest in weather. I wanted to be able to predict the weather, understand where the weather came from.

—Will Steger. Interview, August 2010

In pre-spring the weather systems really come and go. The constant sound of wind seems like continual music.

—Will Steger, Ely Homestead, March 4, 1972

As usual, the weather dictated the mood of the day.

—Will Steger, Ely Homestead, September 28, 1971 fun way for students to make connections between the physical factors related to climate and the biotic reactions by flora and fauna. Regardless of where your school is located, students will be able to observe phenology, and it is an excellent way to draw connections between climate and living things.

The major reason that climate change is undeniable is because of not only the sheer volume of evidence that has accumulated, but the varied and longitudinal nature of the evidence. This corroborative and longitudinal evidence comes in the form of tree rings, pollen and ice cores, instrumental records, phenological written observations, as well as now photos and video. Students can play a valuable role themselves as "citizen scientists" by recording their own observations and adding to what we know about the climate and phenology of a particular biome.

Journal Assignment

At the end of this lesson, student journals should contain a definition for weather, climate and phenology, two graphs that show average temperature and precipitation for each of the four biomes, an interpretation of line graphs showing precipitation and temperature trends in the state, and three predictions of possible impacts on Minnesota biomes from an increase in temperature and precipitation. Students should also have at least the annual temperature and precipitation historical trends graph from 1895.

**Note. The line graphs included in this lesson are from the Southern Climate Impacts Planning Program, http://www.southernclimate.org/data.php and show:

- The Historical Climate Trends line graphs provide a comparative seasonal or annual analysis for a specified climate division or state. Long-term averages are taken from NCDC's monthly and annual temperature and rainfall datasets. These long-term averages are depicted in each chart as a horizontal line in the middle of the chart. Five-year moving averages of seasonal (or annual) values are plotted in comparison to the long-term average as red or blue curves for temperature, and green or brown curves for precipitation. When looking at the temperature graphs, a red curve indicates a warmer period than the historical average, while a blue curve is a period that is cooler than the historical average. On the precipitation graphs, a green curve indicates a period that is wetter than the historical average, while a brown curve is drier than the historical average.

- The Monthly Summaries graphs provide monthly temperature and rainfall values for a specified year and region (climate division or state). Long-term averages are included for comparison. This graph provides a quick look back at monthly values to show how temperature and rainfall compared to long-term averages. Climate Divisions are as follows:
    - Northwest-01
    - North Central- 02
    - Northeast- 03
    - West Central- 04
    - Central- 05
    - East Central- 06
    - Southwest- 07
    - South Central- 08
    - Southeast- 09

Activity Description

Introduction

1. Pre-write…
    A. If you were going to describe to someone who has never been to Minnesota, what the climate of Minnesota is like, how would you describe it? Would you compare or contrast it with somewhere else so that they would be able to picture it? Where?
    B. If you were going to descri be to someone what the weather is like today, how would you describe it?
    C. What is the weather like today for the animal or plant you "met" in lesson 2? Look on the map and describe what you think of when you think of the climate of the biome where that animal or plant is found.
2. Share with your neighbor what you wrote. Did you write similar things for A and B?
3. Share examples in Will's journal of observations he has made throughout his life and how learning about the weather at a younger age was what helped him anticipate and survive some of the extreme weather he has encountered in his Arctic and Antarctic adventures.

Activity: What are climate, weather and phenology?

1. Explain to the students that climate, weather, and the effect climate has on living things will be the topics of the day. Use the background information to explain weather, climate and phenology. Make sure students conclude the discussion with clear definitions of all three written in their journal.
2. On the board make four bubbles and write Fall, Winter, Spring, Summer in each bubble. Draw two lines from each bubble with a bubble on the end (see diagram below). In one bubble write weather and in one bubble write phenology. Repeat for each season. Ask the students to describe each season to them in terms of the common weather they might observe and make a concept map off of the weather bubble.
3. Explain to the students the concept of phenology, and ask them to help make a concept map of common phenology of the season you are working on as a group. See the example below.

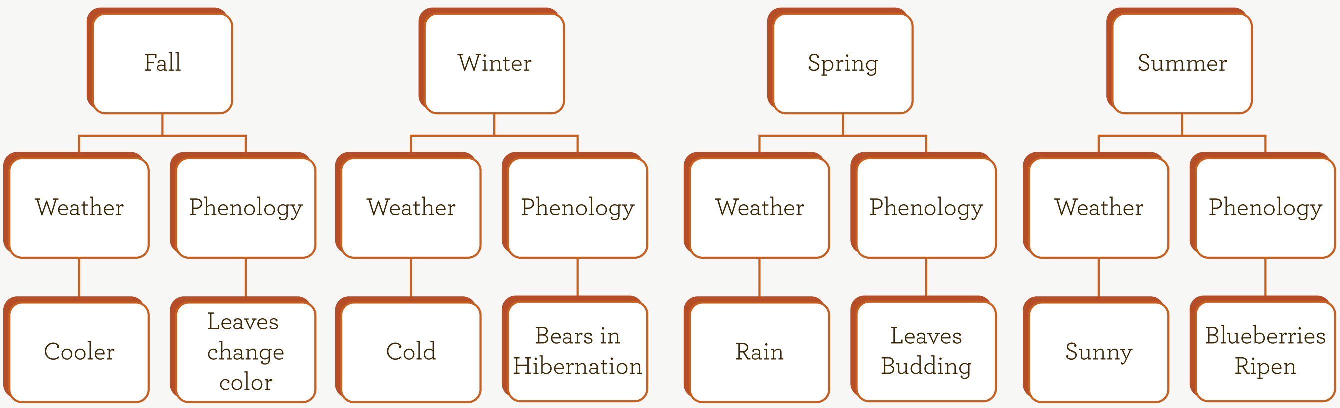


Figure 1: Common Minnesota Seasonal Weather and Phenology

4. In their journals and individually, ask the students to repeat for the other three seasons. If there is time, ask them to share.
5. At this point the students could be led outdoors to do the weather report and phenology activity in the Take It Outside section, or continue to the interpretation of data activity.

Activity: Interpretation and Representation of Data

1. Hand out or project the Minnesota map of *Normal Annual Mean Temperature* and *Normal Annual Precipitation*. Ask the students what the maps show. Point out the different colors and ask what they represent.
2. Hand out the worksheets found on page 68. You may need to guide them through the worksheet together as a group, or if your students are comfortable with graphing you could ask them to make a graph on their own without the graph "blanks." An example graph is provided below.
3. Discuss in small groups or as a class what the graphs tell us sbout Minnesota's biomes and climate, individually and also when combined. Do the students prefer the maps or the graphs as ways of showing the data?
4. Is there a mean temperature and/or precipitation where all biomes could exist? If temperatures and precipitation were to change in each biome, what could that mean for the plants and animals commonly found there? Refer back to the table describing biomes (page 43)

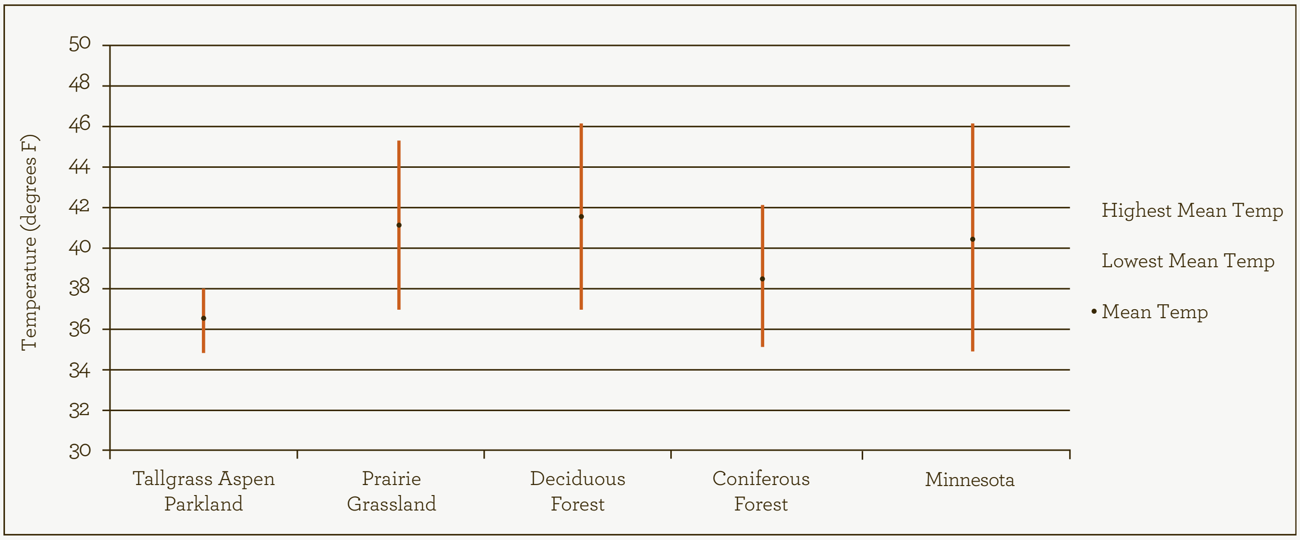


Figure 2: Mean Temperature Range of Minnesota Biomes

Activity: Data Comparison and Trends

1. Students should have two graphs that compare the average temperature and precipitation of the biomes of Minnesota and the state as a whole.
2. Hand out the two line graphs that show the annual average temperature and precipitation of Minnesota since 1895. Ask students to answer the questions below in their journal.
    a. What are the warmest five years on record?
    b. If you were to only look at the temperature between 1950 and 1970, what would you conclude? How about 1910 to 1930?
    c. Why is longitudinal data (data collected over time) important and valuable?
    d. What is the temperature trend since 1895?
    e. What are the wettest five years on record?
    f. What is the precipitation trend since 1895?
    g. What other data might be useful to have for a better understanding of temperature and precipitation trends in Minnesota?
3. Some of the data that students might find useful include seasonal data and data from different parts of the state.

Make the other graphs included in this lesson available to them and ask them to draw some larger conclusions based on these graphs. Questions to consider include:

a. What season has seen the greatest increase in temperature or precipitation?
b. What region has seen the greatest departure from average temperature or precipitation and how does this relate to the climatological boundaries of each biome?

Concluding Activity: Climate and Biomes

1. If temperatures and precipitation were to increase in each biome, what could that mean for the plants and animals found in each biome?
2. If biomes are based on climatological boundaries, as discussed in lesson 2, what could this mean for the biome boundaries?
3. Ask students to refer back to the table describing the biomes again. Emphasize the importance of climate in defining each of the biomes. Discuss how a change in temperature of precipitation might affect the animals and plants of a biome and/or the phenology of different species.
4. Ask students to make three predictions of how an increase in precipitation and temperature might affect specific living things in their biome. Write the prediction in their journal.
5. Brainstorm what it could mean for different sectors of state (i.e., the impacts on tourism, agriculture, economy). Make a list they can keep in their notebook.

Journaling Connection

Students will use their journals to record weather observations. Ask the students what information they think would be important to record every day and make a table for students to paste or create in their journal. Include research on historical weather events for the day and common phenology as a part of this.

Take It Outside—Connecting With Your Place

Materials

Journal and writing utensil
Thermometer
Rain gauge
Beaufort Scale handout
Anemometer
Field guides

1. Based on weather reports they look at online or that are clipped from the paper, brainstorm with your students a list of things that would be important to include in a weather report. This list could include precipitation, temperature, wind speed and direction, historical highs and lows, historical average and important historical events.
2. Take your students outside and ask them to make their own weather reports in their journal. Provide thermometers, rain gauge and the Beaufort scale if you do not have an anemometer to measure wind speed. Also ask them to take a photo or draw an image that they might include to represent that day's weather.
3. After students have recorded their weather data, ask them to make a phenological observation.
    a. If they didn't know what day of the year it was, what signs in nature could they use to determine the date or at least the month?
    b. Can they see any birds or insects?
    c. Are there leaves on the trees? What color are they?

Extensions

1. Guide students through creating best-fit lines using the data provided of annual temperature and precipitation. See the resource section below for some very helpful resources on how to guide your students through this process.
2. Continue to make weather observations and phenology with your class. Keep a weather log or journal for the class and maintain it over time so that the data can be used for graphing or, if kept over a period of years, compared to past years.
3. Find phenological data, such as first flowering or arrival of birds, to include with temperature and precipitation data.

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org

1. In the learning module of the online classroom click on "Climate Change Basics" and then "From Ice Age to Today," to learn more about how Minnesota's climate has changed over time and to play thte game.
2. Submit your weather observations and data to the online classroom via the share button.

Best Fit Lines and Understanding Trends Resources
Guiding Students Through Approximating Trends
http://serc.carleton.edu/mathyouneed/graphing/bestfit_inst.html

Understanding Trends
http://serc.carleton.edu/quantskills/methods/quantlit/trends.html

Weather and Climate Resources
Watch Dr. Mark Seeley's talk on weather vs. climate at:
http://vimeo.com/15885303

National Weather Service Weather and Climate Data
http://www.weather.gov/

Minnesota Historical Climate Data
http://climate.umn.edu/doc/historical.htm

Southern Climate Impacts Planning Program: Trends
http://www.southernclimate.org/products/trends.php

Hey—How's the weather?
http://www.dnr.state.mn.us/young_naturalists/weather/

Climate-Minnesota DNR
http://www.dnr.state.mn.us/climate/

Current Conditions
http://www.dnr.state.mn.us/current_conditions/

Paul Douglas Weather Column
http://pauldouglasweather.blogspot.com/

Phenology Resources

Gilbert, Jim. *Jim Gilbert's Minnesota Nature Notes.* Minneapolis: Nodin Press, 2008.

Weber, Larry. *The Backyard Almanac: A 365-day guide to the plants and critters that live in your backyard.* Pfeifer-Hamilton Publishers, 1995.

Minnesota Breeding Bird Atlas Project
http://www.mnbba.org/

Minnesota Phenology Network
http://phenology.cfans.umn.edu/index.htm

National Penology Network
http://www.usanpn.org

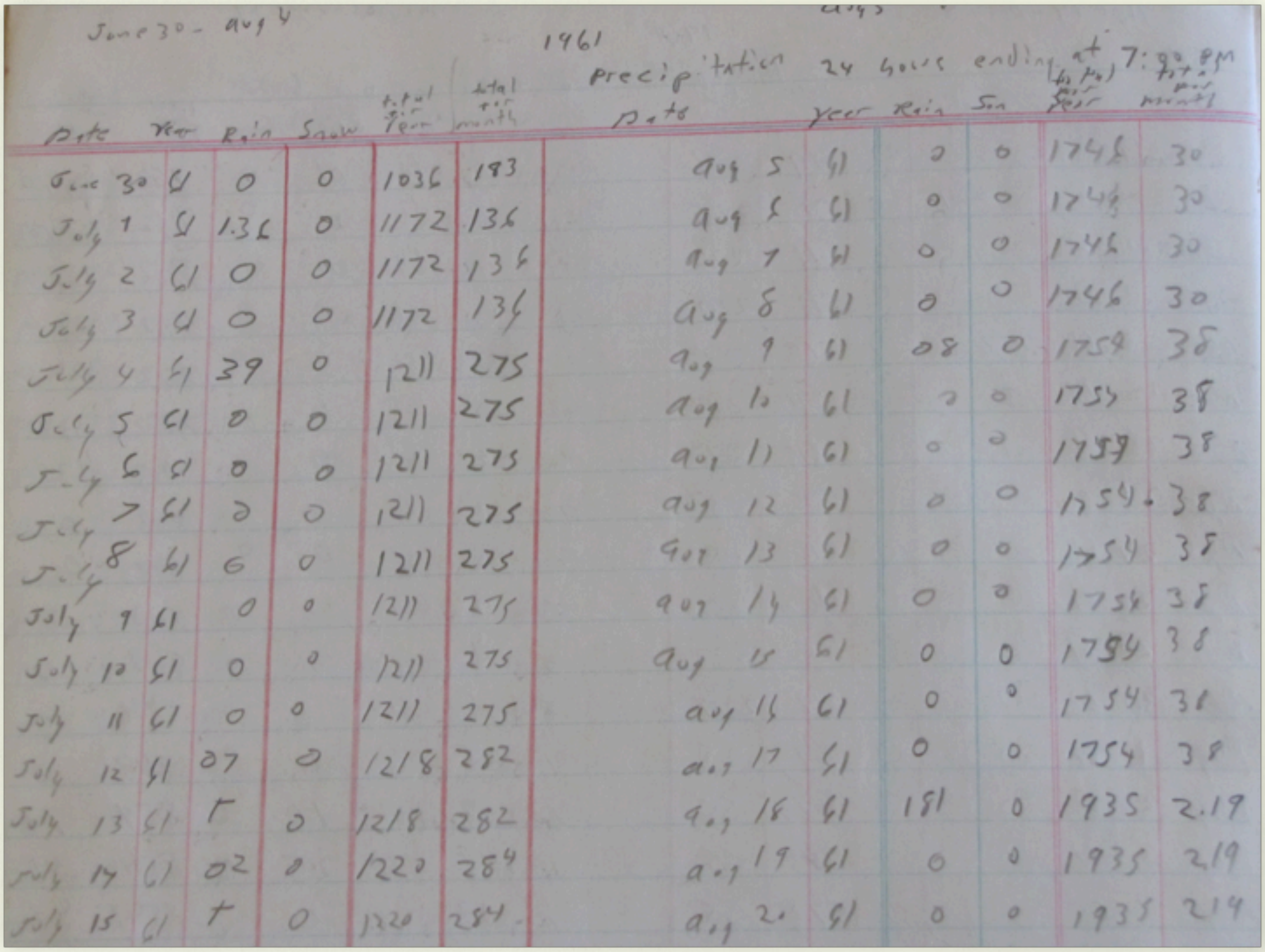
Twin Cities Naturalist Blog
http://www.twincitiesnaturalist.com

USA National Phenology Network
http://www.usanpn.org/

Globe
http:///www.globe.gov

Youth:

When Will Steger was young, he kept detailed charts recording his observations. The chart seen here shows observations of clouds, precipitation and temperatures.



June 30 - aug 4

1961

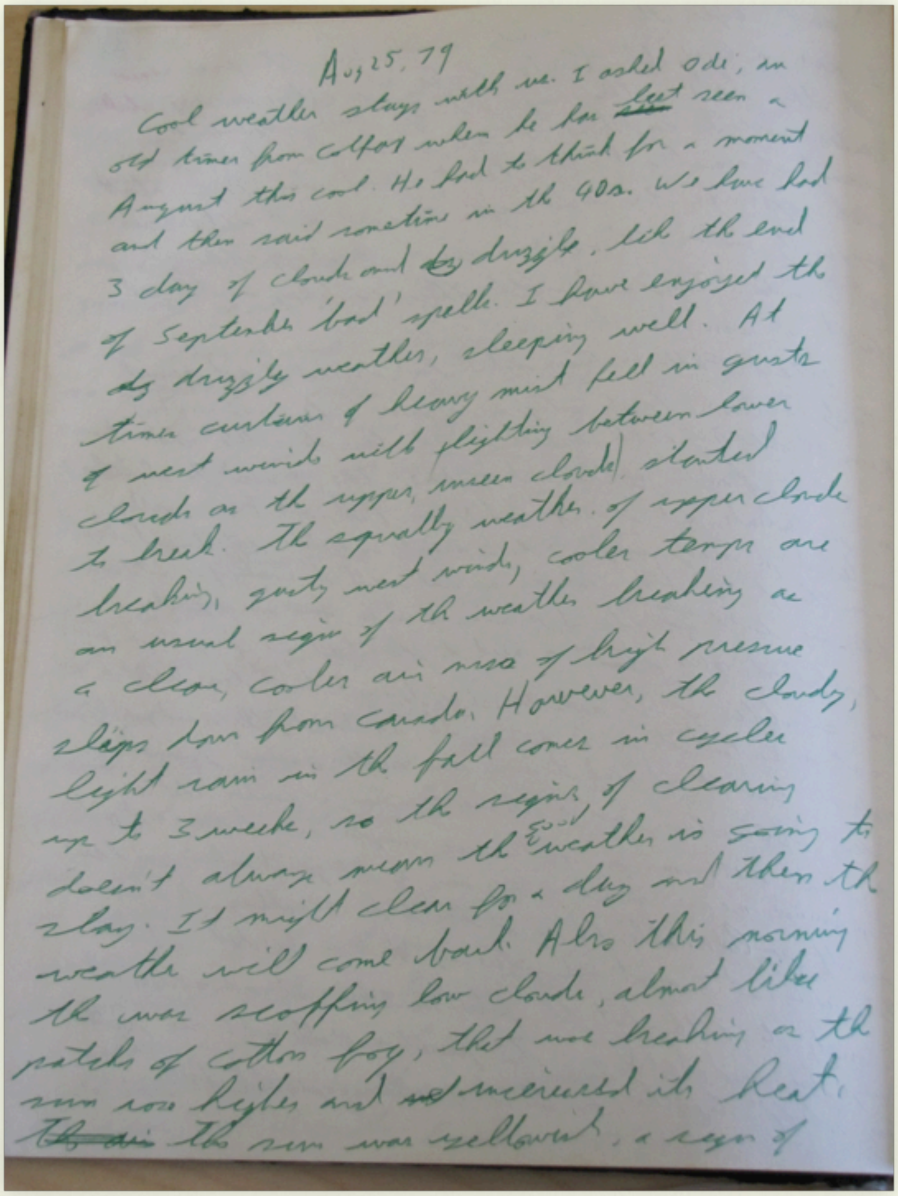
precipitation 24 hours ending at 7:00 PM

Date	Year	Rain	Snow	total for year	total for month
June 30	61	0	0	1036	183
July 1	61	1.36	0	1172	136
July 2	61	0	0	1172	136
July 3	61	0	0	1172	136
July 4	61	39	0	1211	275
July 5	61	0	0	1211	275
July 6	61	0	0	1211	275
July 7	61	0	0	1211	275
July 8	61	6	0	1211	275
July 9	61	0	0	1211	275
July 10	61	0	0	1211	275
July 11	61	0	0	1211	275
July 12	61	07	0	1218	282
July 13	61	T	0	1218	282
July 14	61	02	0	1220	284
July 15	61	T	0	1220	284

Date	year	Rain	Sn	total for year	total for month
aug 5	61	0	0	1746	30
aug 6	61	0	0	1746	30
aug 7	61	0	0	1746	30
aug 8	61	0	0	1746	30
aug 9	61	08	0	1754	38
aug 10	61	0	0	1754	38
aug 11	61	0	0	1754	38
aug 12	61	0	0	1754	38
aug 13	61	0	0	1754	38
aug 14	61	0	0	1754	38
aug 15	61	0	0	1754	38
aug 16	61	0	0	1754	38
aug 17	61	0	0	1754	38
aug 18	61	181	0	1935	2.19
aug 19	61	0	0	1935	219
aug 20	61	0	0	1935	219

Ely Homestead:
August 25, 1979

Cool weather stays with us. I asked Ode, an old timer from Colfax when he had last seen an August this cool. He had to think for a moment and then said sometime in the 40s. We have had 3 days of clouds and drizzle, like the end of September bad spells...The squally weather of upper clouds breaking, gusty west winds and cooler temperatures are a typical sign of the weather breaking as a clear, cooler air mass of high pressure slips down from Canada. However, the cloudy, light rain in the fall comes in cycles of up to 3 weeks, so the clearing doesn't always mean that the good weather is going to stay. It might clear for a day and then the weather will come back. Also this morning, there were low clouds, almost like patches of cotton. They were breaking as the sun rose higher and increased its heat. The sun was yellowish, a sign of water vapor. After a period of moisture when the sun comes out, like today, the sun's heat will evaporate the moisture to form clouds and even more rain.

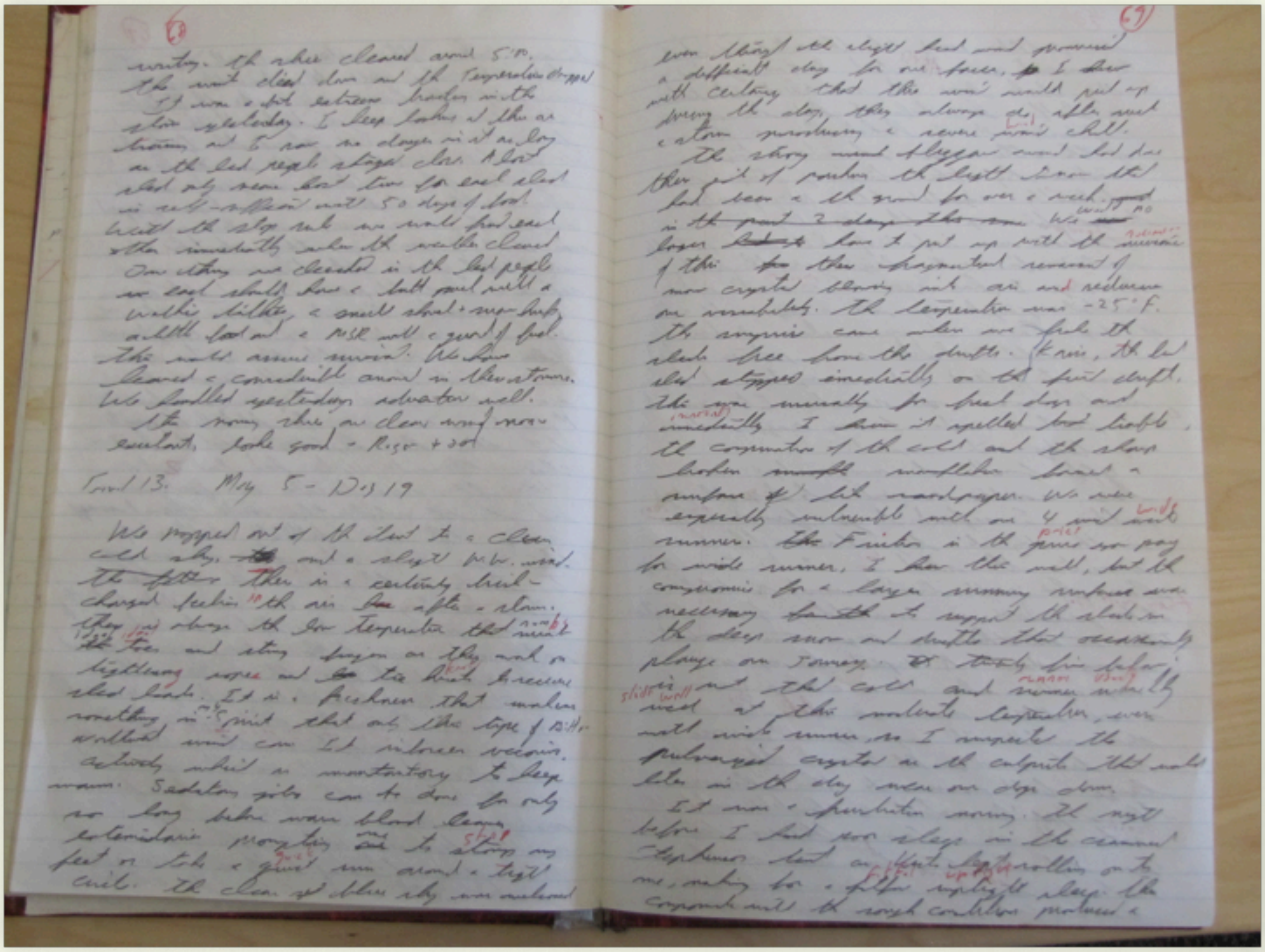

Aug 25, 79

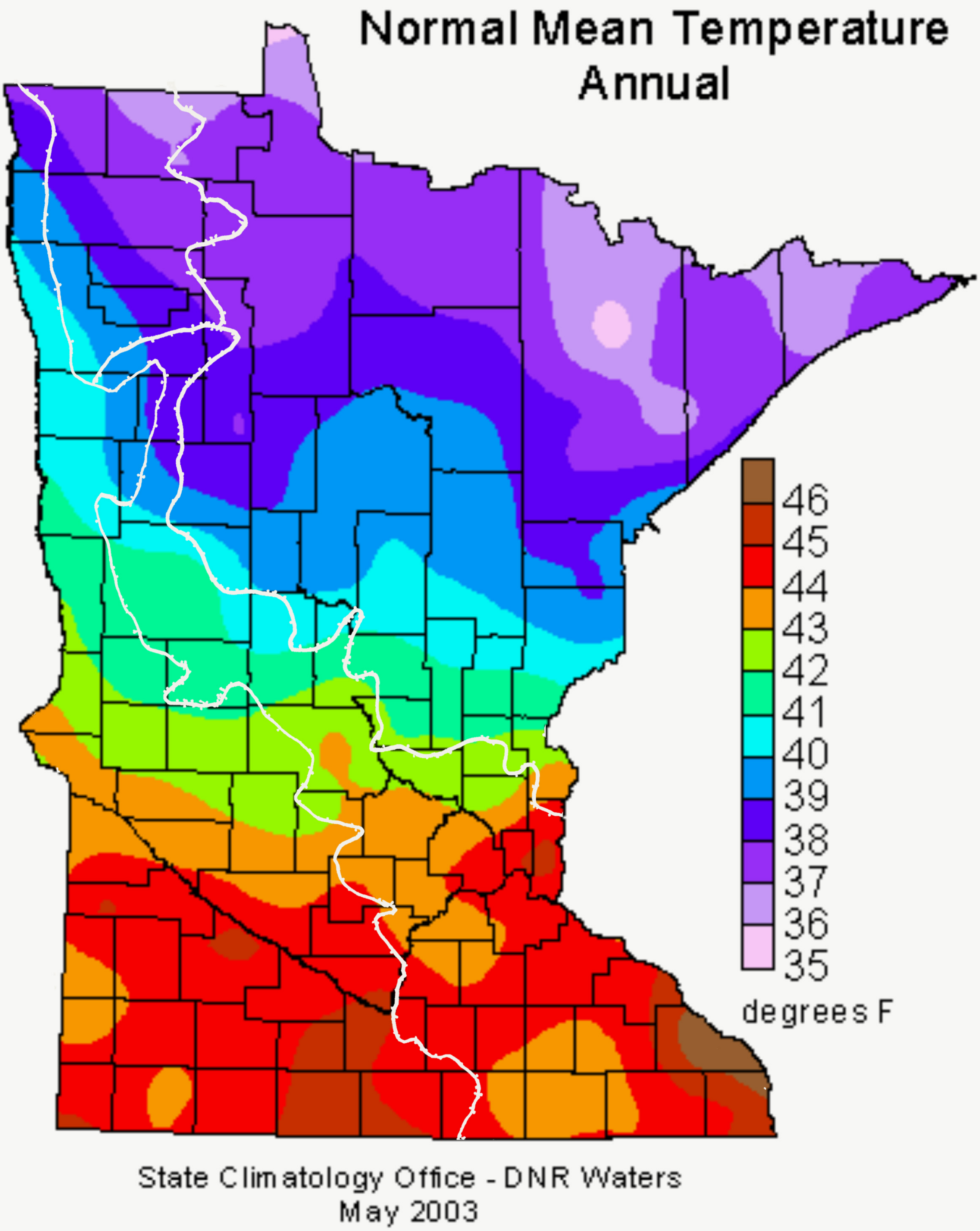
Cool weather stays with us. I asked Ode, an old timer from Colfax when he had last seen an August this cool. He had to think for a moment and then said sometime in the 40s. We have had 3 days of clouds and ~~dr~~ drizzle, like the end of September 'bad' spells. I have enjoyed the dry drizzly weather, sleeping well. At times curtains of heavy mist fell in gusts of west winds with flighting between lower clouds on the upper, [illegible] clouds started to break. The squally weather of upper clouds breaking, gusty west winds, cooler temps are an usual sign of the weather breaking as a clear, cooler air mass of high pressure slips down from Canada. However, the cloudy, light rain in the fall comes in cycles up to 3 weeks, so the sign of clearing doesn't always mean the good weather is going to stay. It might clear for a day and then the weather will come back. Also this morning there was scoffing low clouds, almost like patches of cotton fog, that were breaking as the sun rose higher and ~~sl~~ increased its heat. ~~The air~~ The sun was yellowish, a sign of

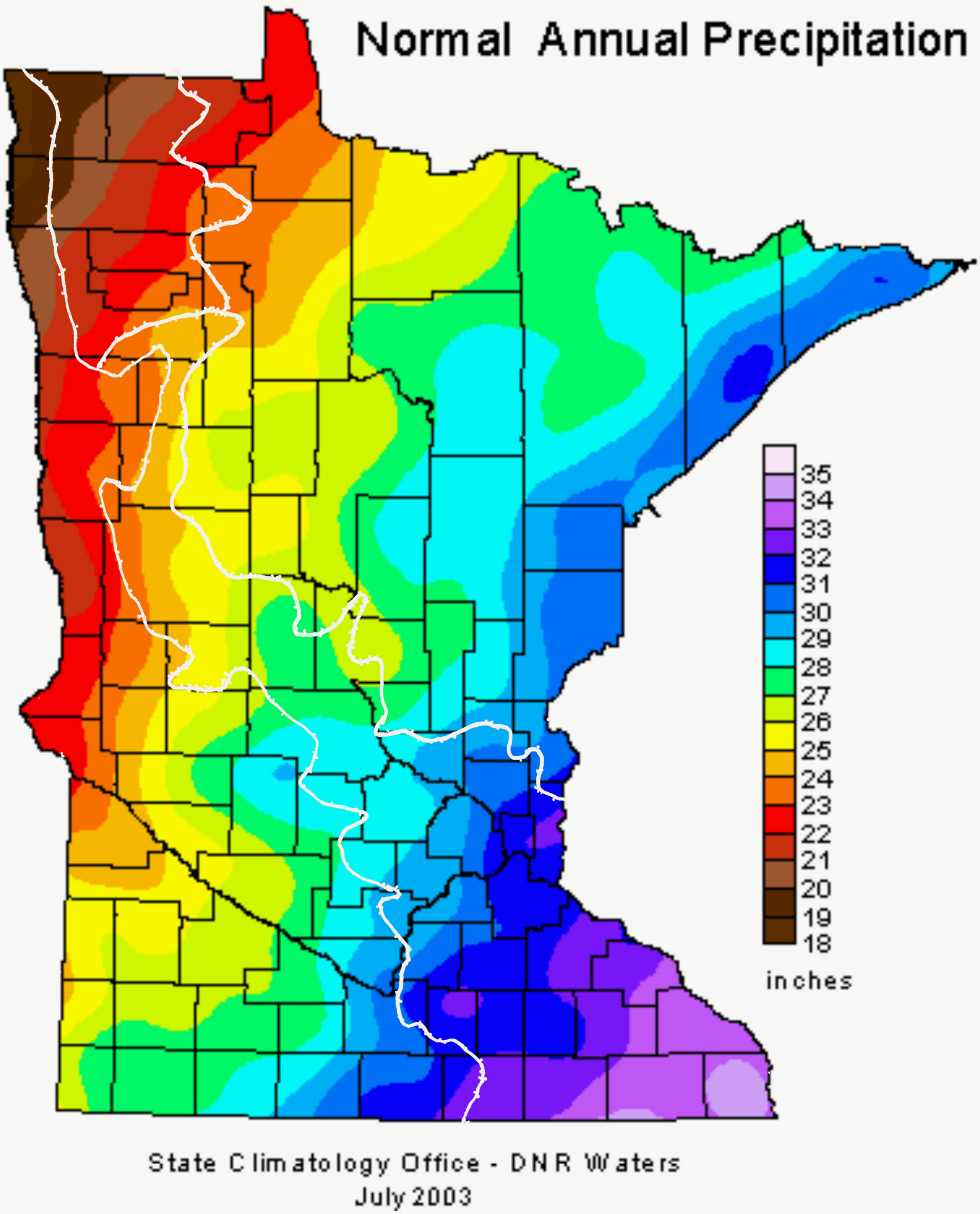
Expedition:

May 5, 1988

The clear, blue sky was welcome, even though I knew with certainty that these winds would pick up during the day; they always do after such a storm, producing a severe windchill. The strong blizzard winds had done their job in packing the light snow that had been on the ground for over a week. We would no longer have to put up with the nuisance of these fragmented remains of snow crystals blowing into the air and reducing our visibility. The temperature was -25F.




Normal Mean Temperature
Annual
46
45
44
43
42
41
40
39
38
37
36
35
degrees F
State Climatology Office - DNR Waters
May 2003


Normal Annual Precipitation
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
inches
State Climatology Office - DNR Waters
July 2003

Name ______________________________

Date ______________________________

1. Look at the Normal Annual Mean Temperature Map.What does each color represent?

2. Fill in the following table with the higest and lowest mean temperatures, and mean temperature for each biome and the state as a whole.

Biome	*Highest Mean Temperature*	*Lowest Mean Temperature*	*Mean Temperature*
Tallgrass Aspen Parkland			
Coniferous Forest			
Deciduous Forest			
Prairie Grassland			
Minnesota			

3. Turn your temperature data into a graph that shows the range of mean temperatures for each biome, the mean temperature and compares the range between biomes and the state of Minnesota.
(see attached)

Explain your graph by answering the following questions:

4. What does it show?

5. What conclusions can be drawn?

6. In what ways is this type of graph useful?

7. What can be said about each biome?
    a. Tallgrass Aspen Parkland

    b. Coniferous Forest

    c. Deciduous Forest

    d. Prairie Grassland

8. Look at the Normal Annual Precipitation Map. What does each color represent?

9. Fill in the following table with the highest, lowest and mean annual precipitation for each biome and state as a whole.

Biome	*Highest Annual Precipitation*	*Lowest Annual Precipitation*	*Mean Annual Precipitation*
Tallgrass Aspen Parkland			
Coniferous Forest			
Deciduous Forest			
Prairie Grassland			
Minnesota			

10. Turn your precipitation data into a graph that shows the range of annual precipitation for each biome and compares the range between biomes and the state of Minnesota.
Explain your graph by answering the following questions:

1. What does it show?

2. What conclusions can be drawn?

3. In what ways is this type of graph useful?

4. What can be said about each biome?
    a. Tallgrass Aspen Parkland

    b. Coniferous Forest

    c. Deciduous Forest

    d. Prairie Grassland

Look at both graphs side by side.

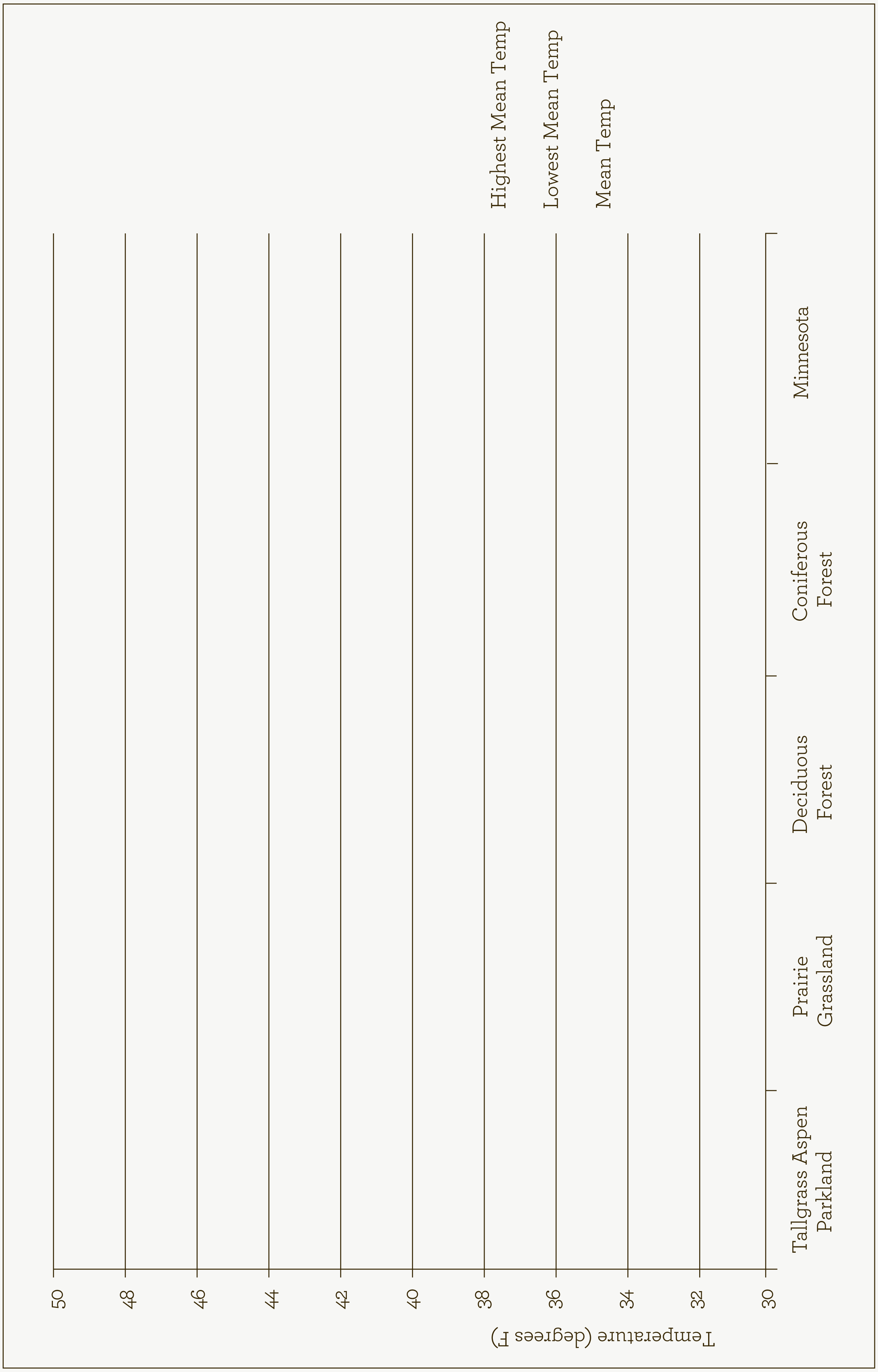
5. What can be said about each biome?
    a. Tallgrass Aspen Parkland

    b. Coniferous Forest

    c. Deciduous Forest

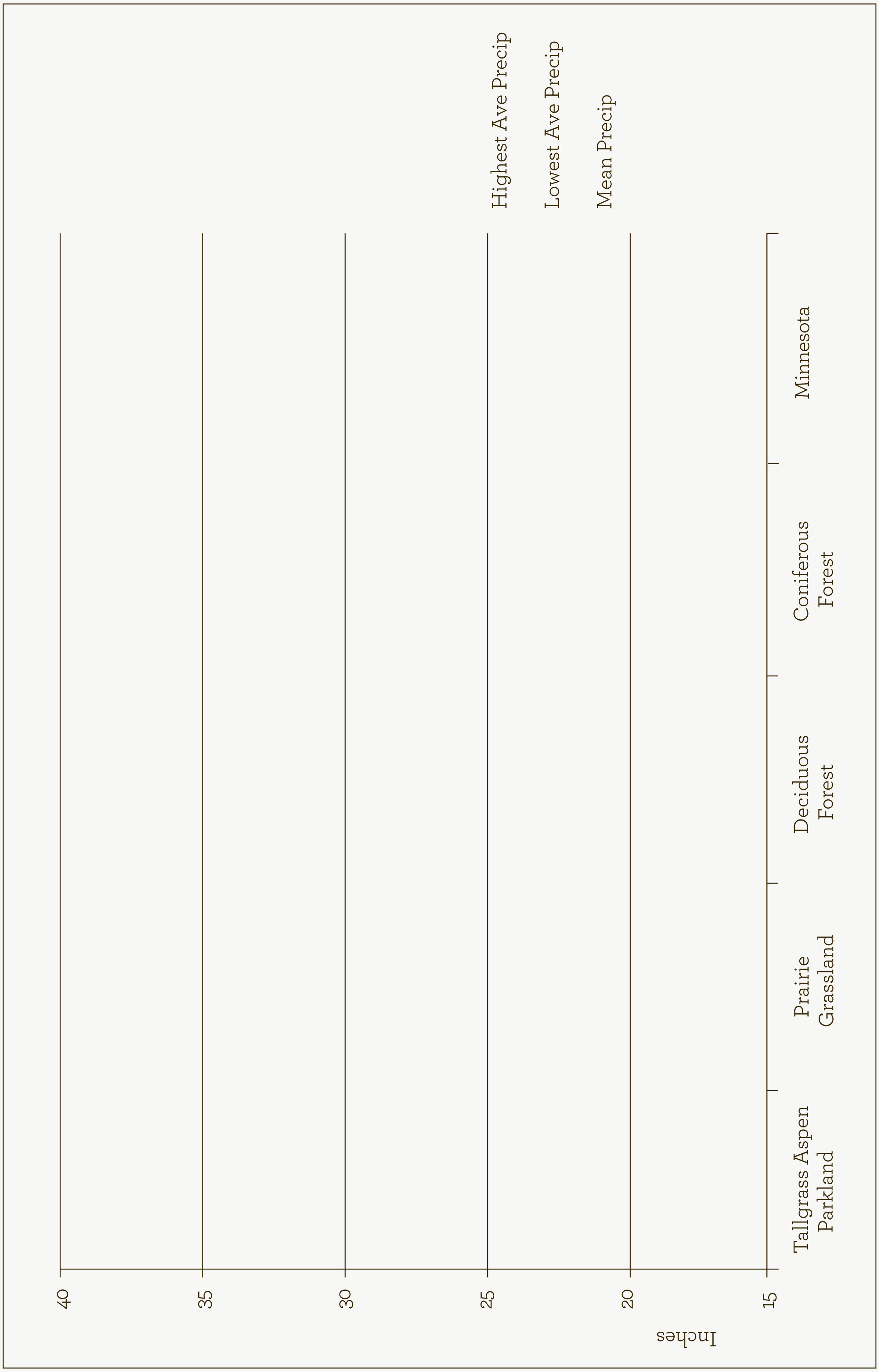
    d. Prairie Grassland

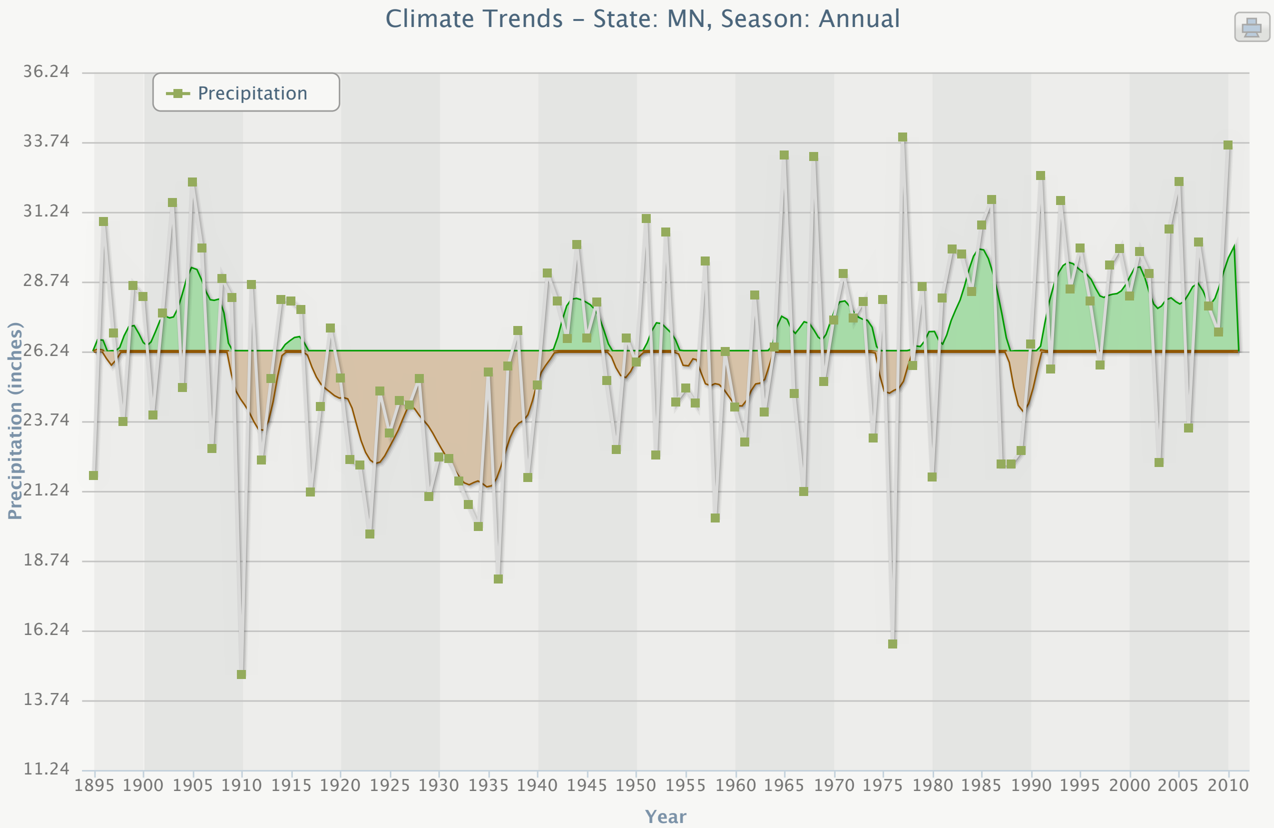
Title ______



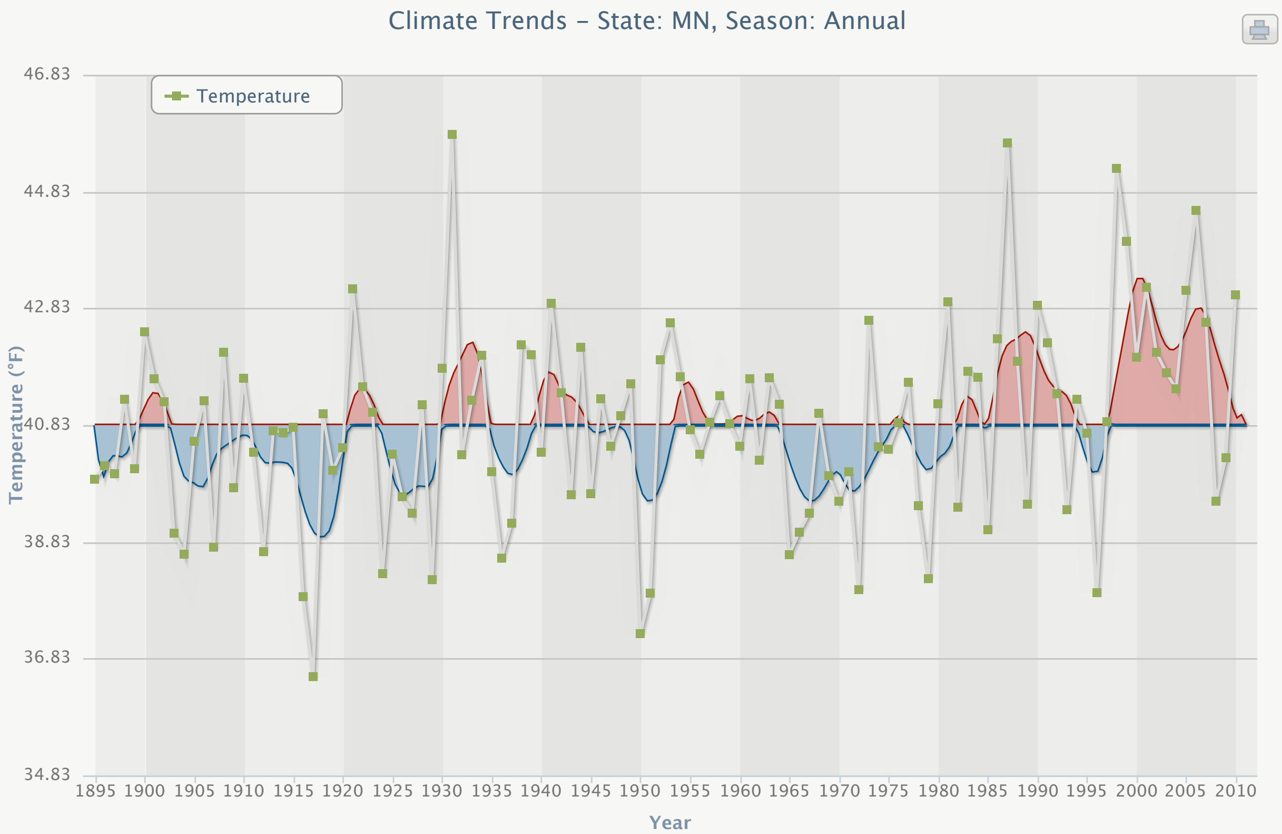
Highest Mean Temp
Lowest Mean Temp
Mean Temp
Temperature (degrees F)
50
48
46
44
42
40
38
36
34
32
30
Tallgrass Aspen Parkland
Prairie Grassland
Deciduous Forest
Coniferous Forest
Minnesota

Title ____________________


Inches
40
35
30
25
20
15
Tallgrass Aspen Parkland
Prairie Grassland
Deciduous Forest
Coniferous Forest
Minnesota
Highest Ave Precip
Lowest Ave Precip
Mean Precip

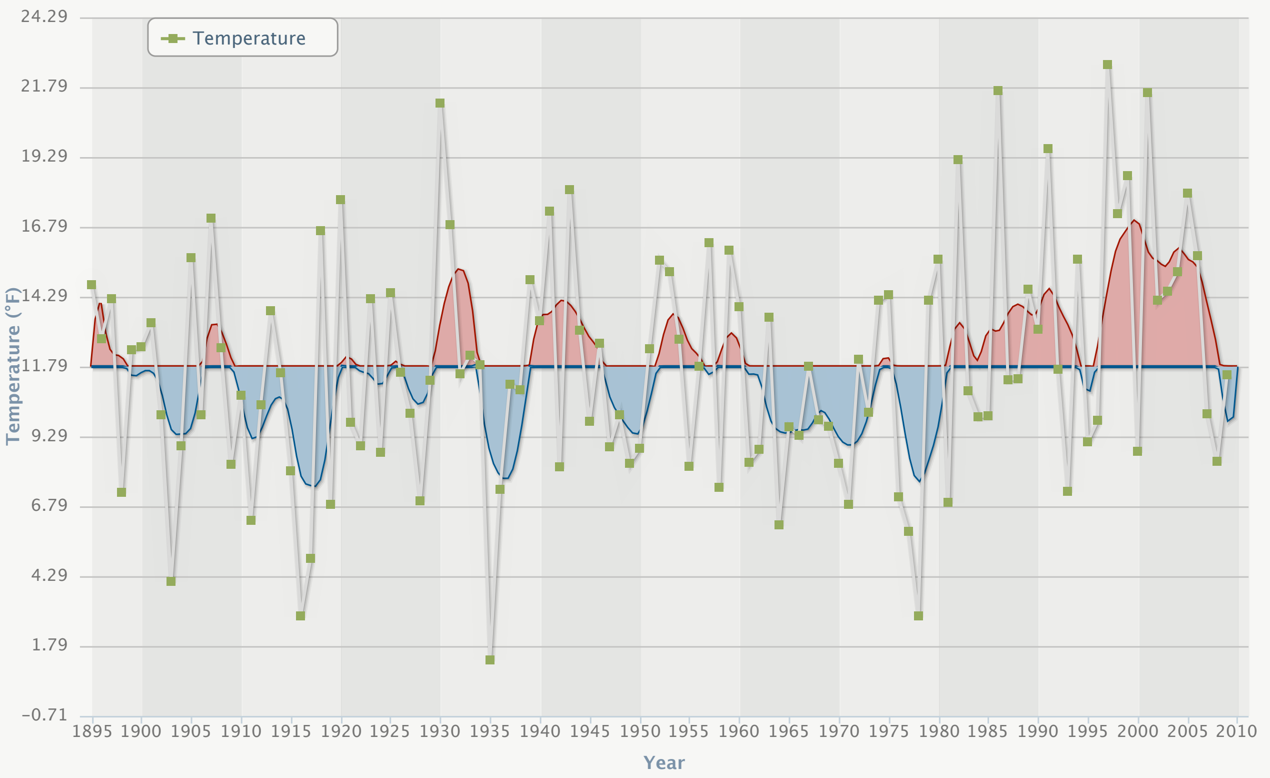


Climate Trends – State: MN, Season: Annual
Precipitation
Precipitation (inches)
36.24
33.74
31.24
28.74
26.24
23.74
21.24
18.74
16.24
13.74
11.24
1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
Year

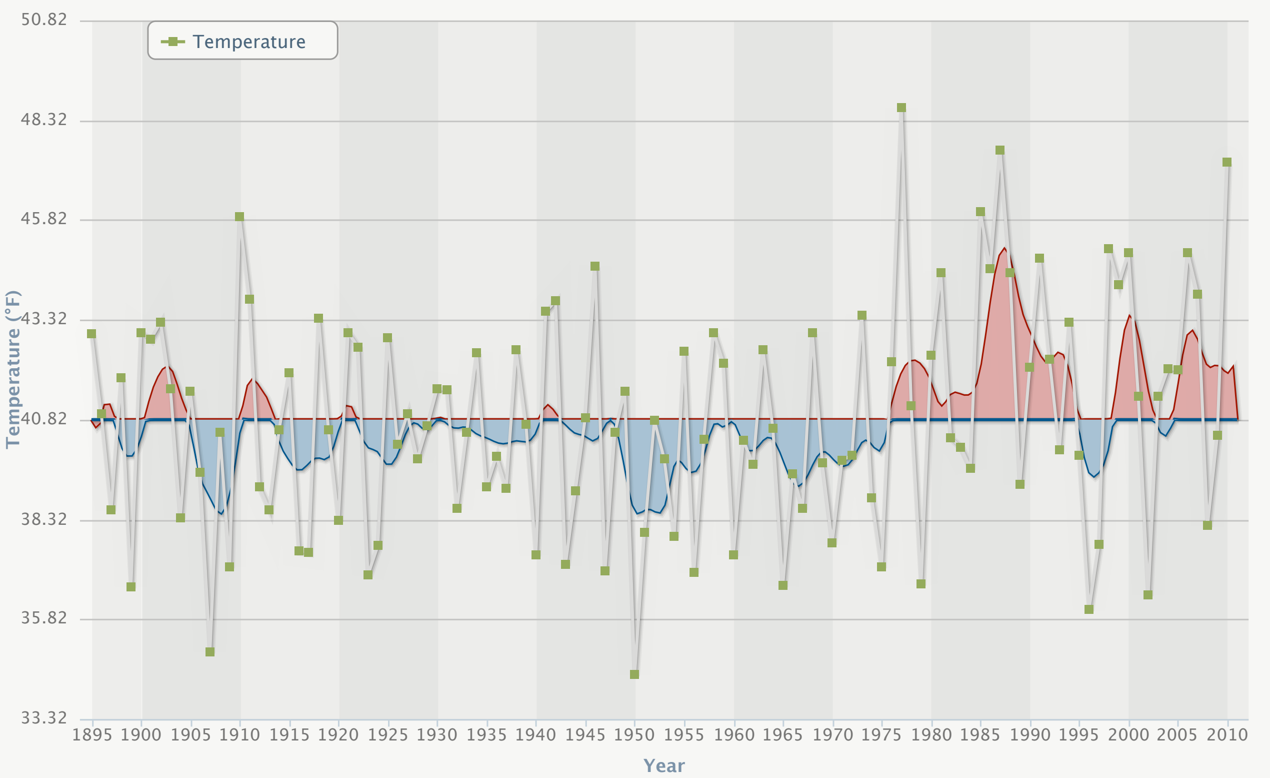


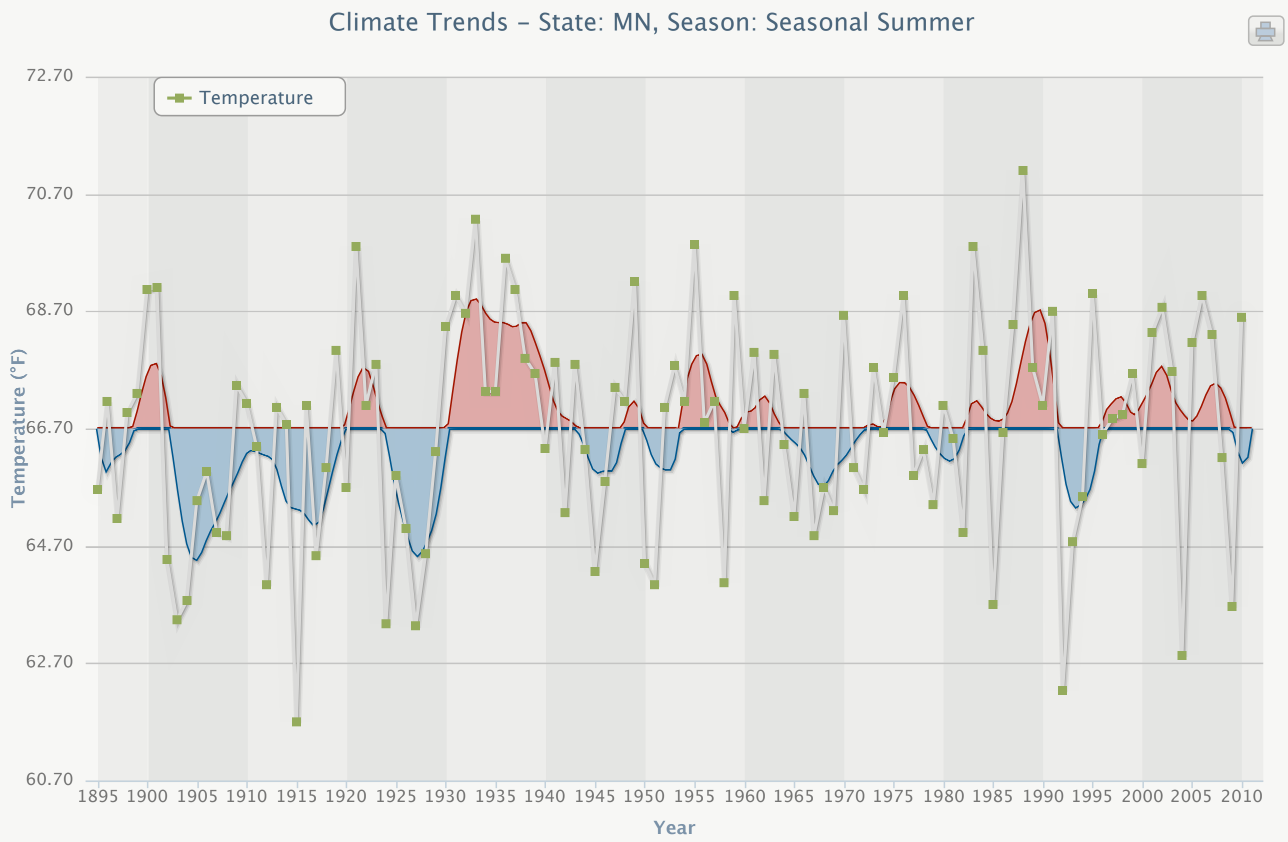
Climate Trends – State: MN, Season: Annual
Temperature
Temperature (°F)
46.83
44.83
42.83
40.83
38.83
36.83
34.83
1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
Year

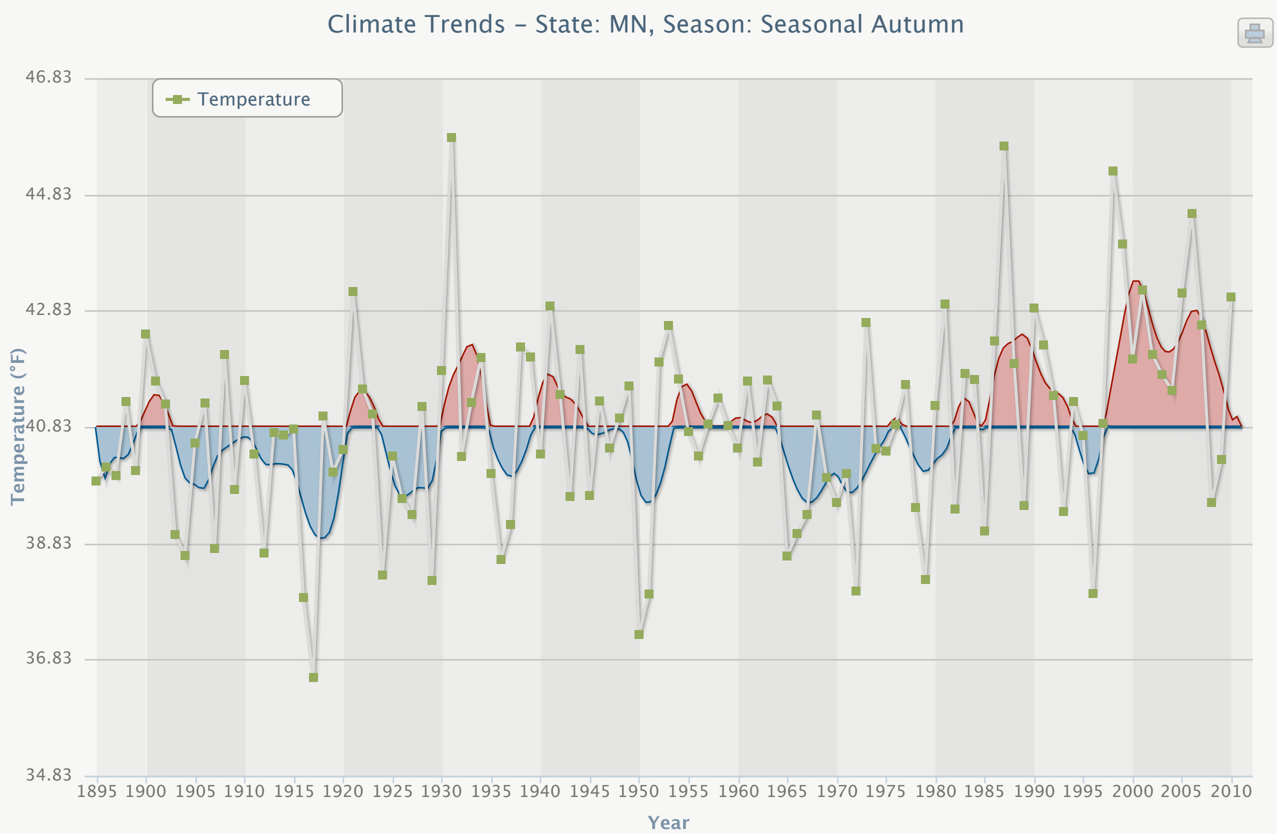
Climate Trends – State: MN, Season: Seasonal Winter



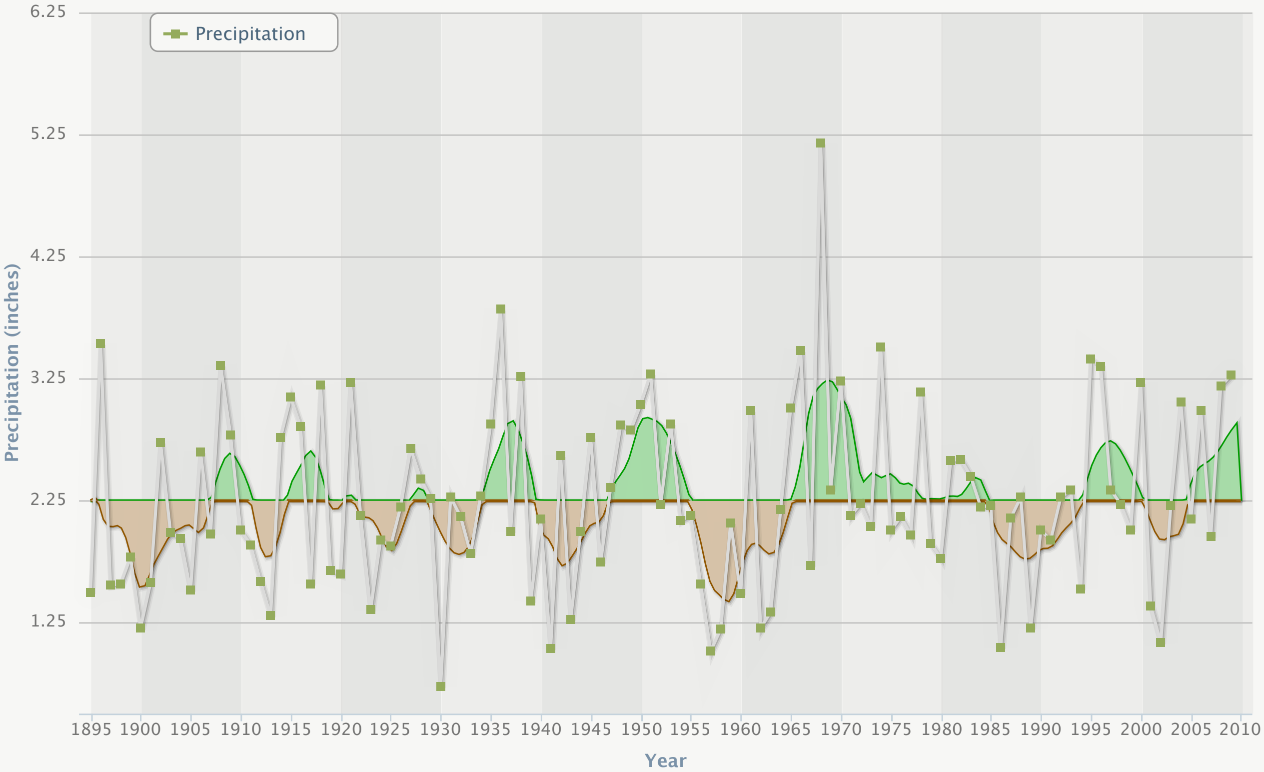
Climate Trends – State: MN, Season: Seasonal Spring



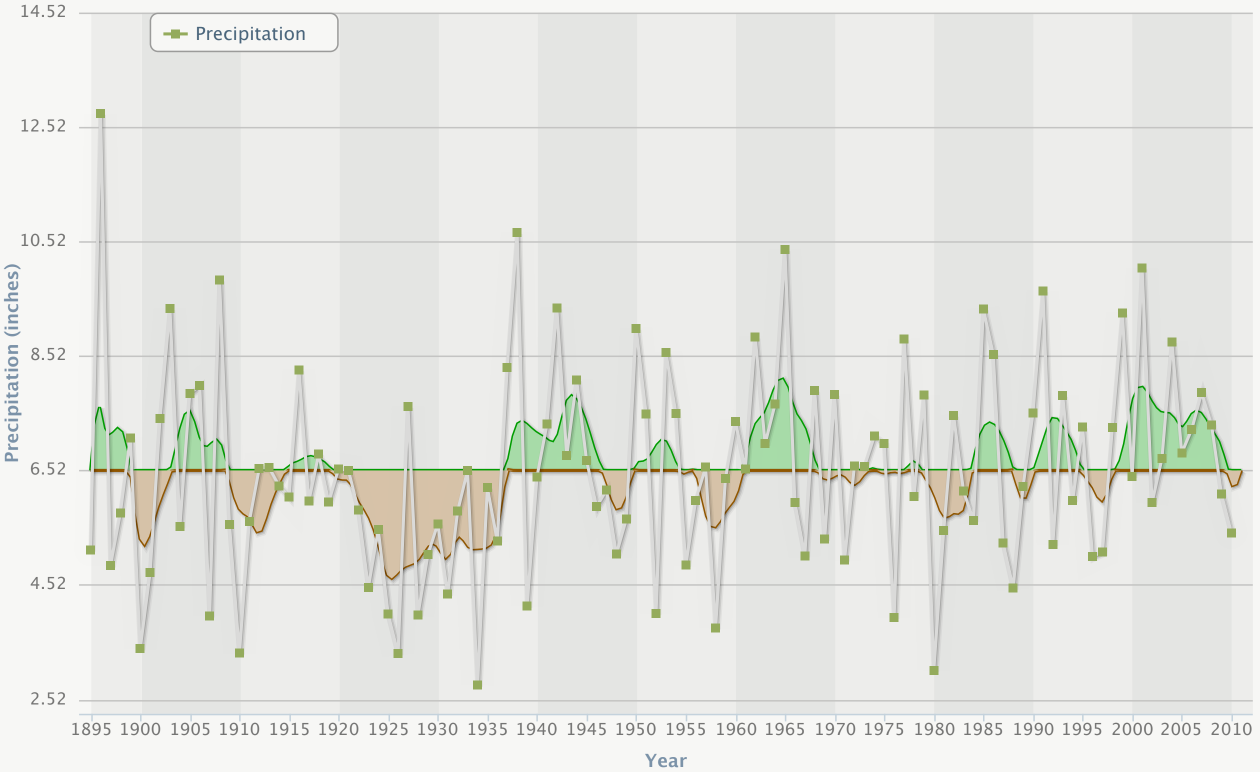

Climate Trends – State: MN, Season: Seasonal Summer
Temperature
72.70
70.70
68.70
66.70
64.70
62.70
60.70
Temperature (°F)
1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
Year


Climate Trends – State: MN, Season: Seasonal Autumn
Temperature
46.83
44.83
42.83
40.83
38.83
36.83
34.83
Temperature (°F)
1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010
Year

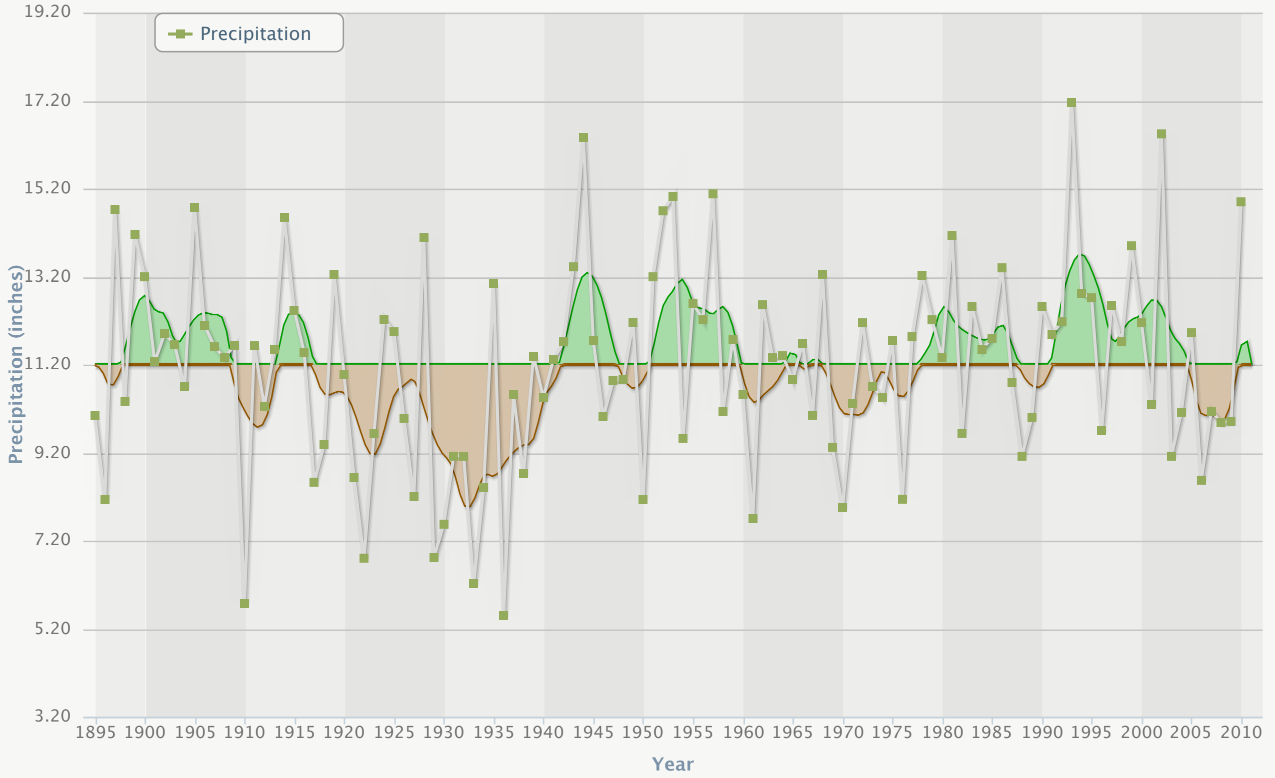
Climate Trends – State: MN, Season: Seasonal Winter



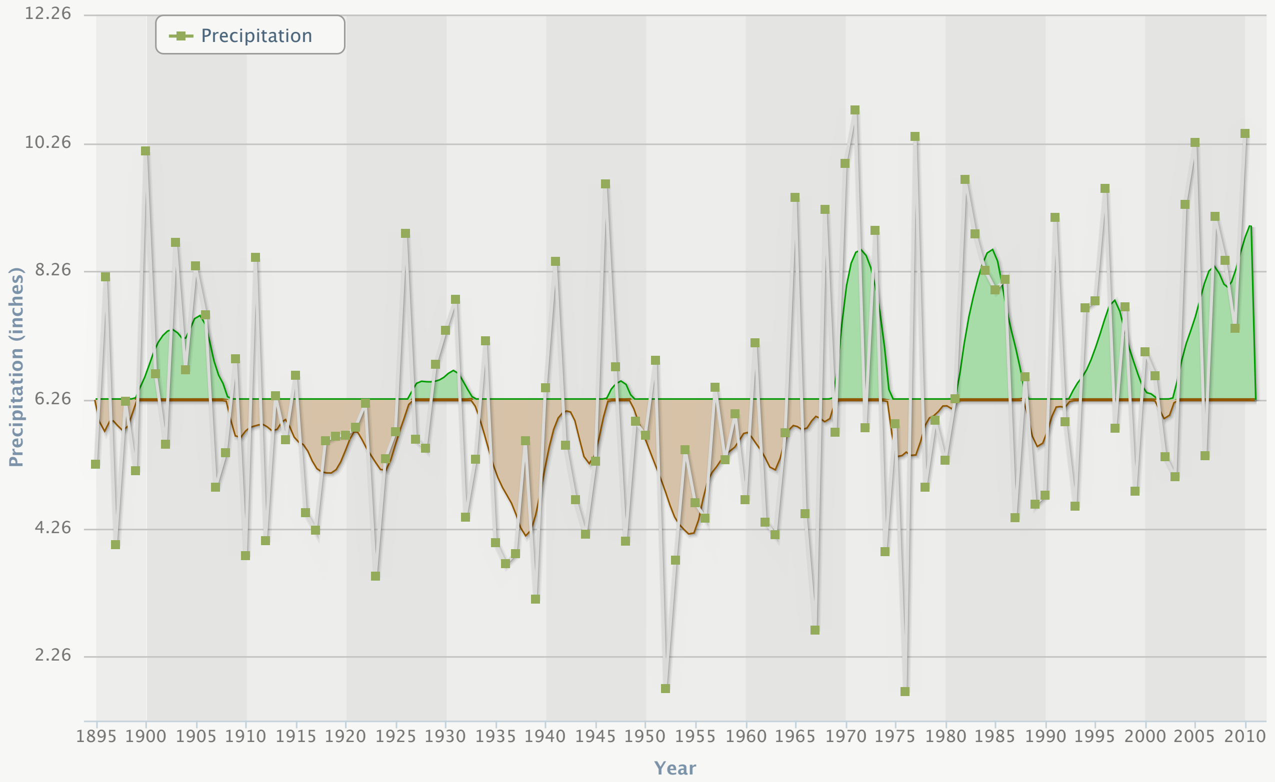
Climate Trends – State: MN, Season: Seasonal Spring

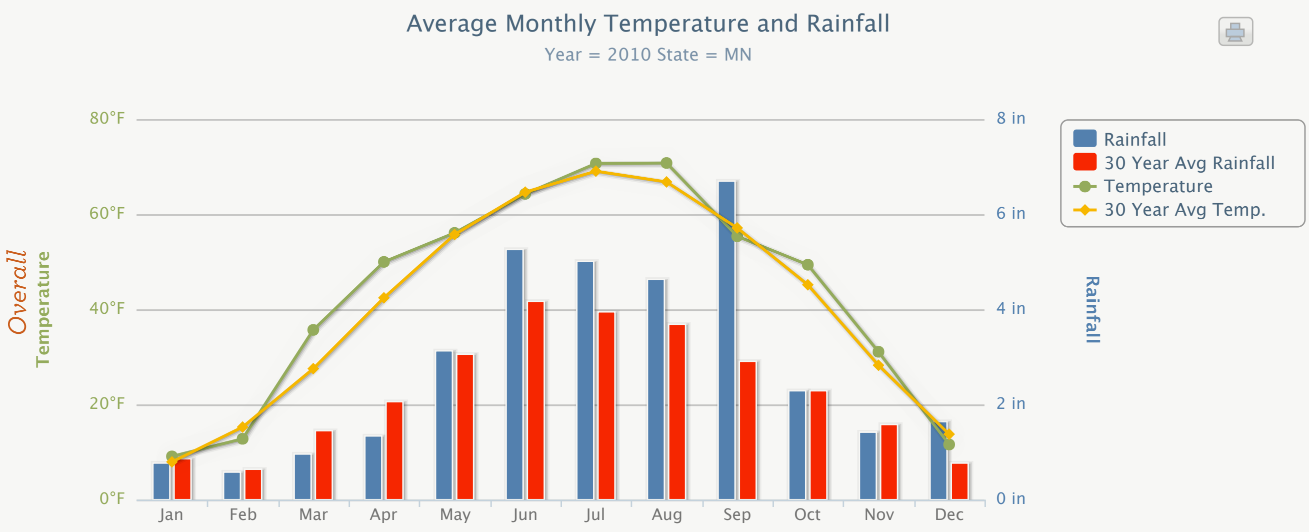


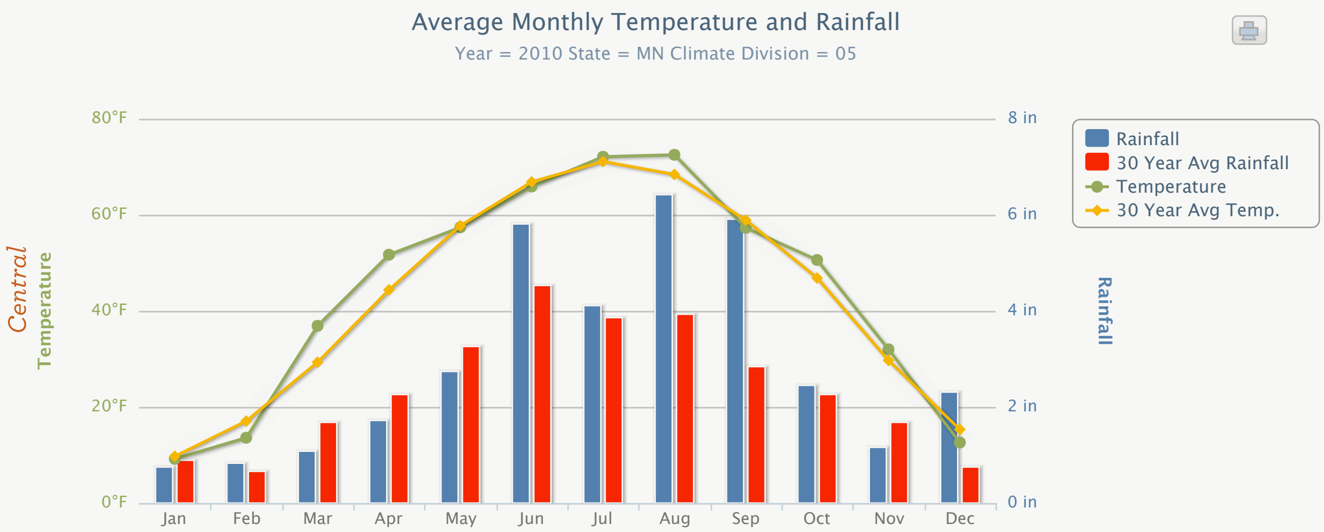
Climate Trends – State: MN, Season: Seasonal Summer

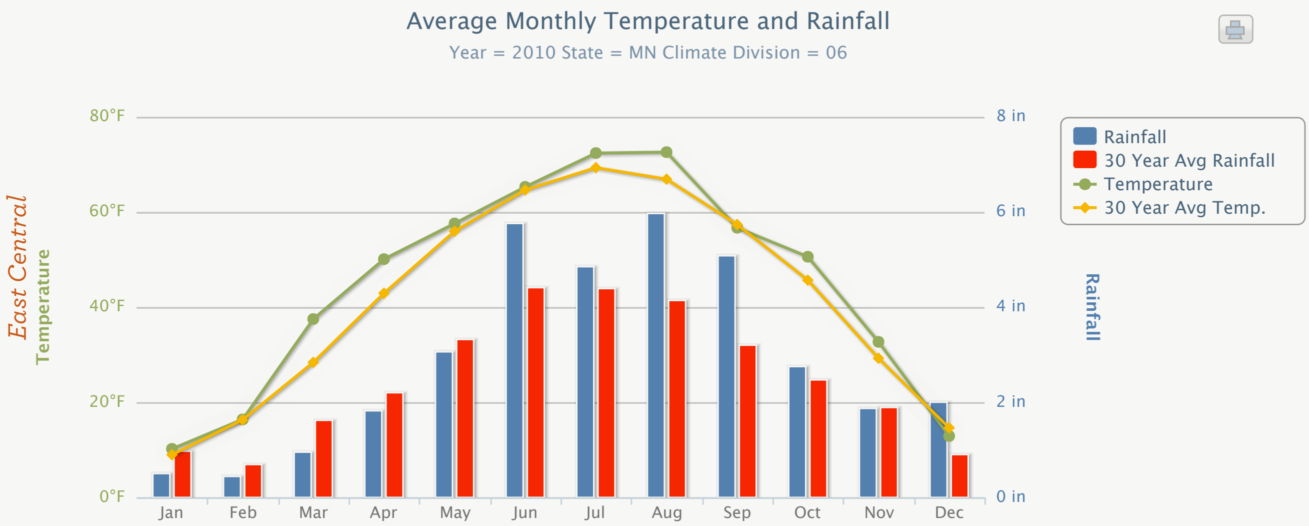


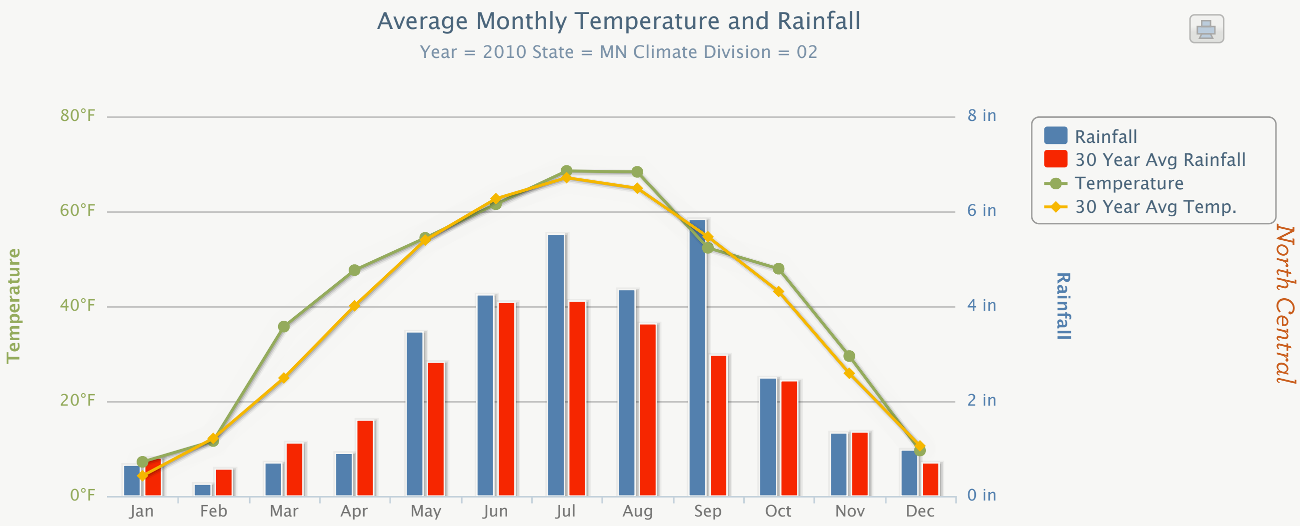
Climate Trends – State: MN, Season: Seasonal Autumn



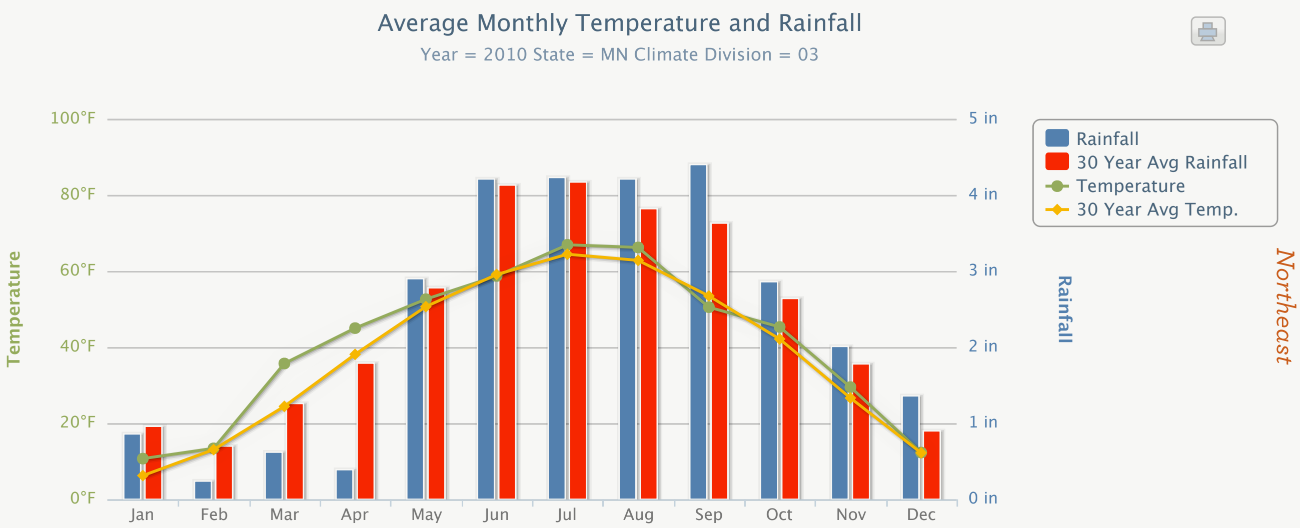

Average Monthly Temperature and Rainfall
Year = 2010 State = MN
Overall
Temperature
80°F
60°F
40°F
20°F
0°F
8 in
6 in
4 in
2 in
0 in
Rainfall
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Rainfall
30 Year Avg Rainfall
Temperature
30 Year Avg Temp.


Average Monthly Temperature and Rainfall
Year = 2010 State = MN Climate Division = 05
Central
Temperature
80°F
60°F
40°F
20°F
0°F
8 in
6 in
4 in
2 in
0 in
Rainfall
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Rainfall
30 Year Avg Rainfall
Temperature
30 Year Avg Temp.

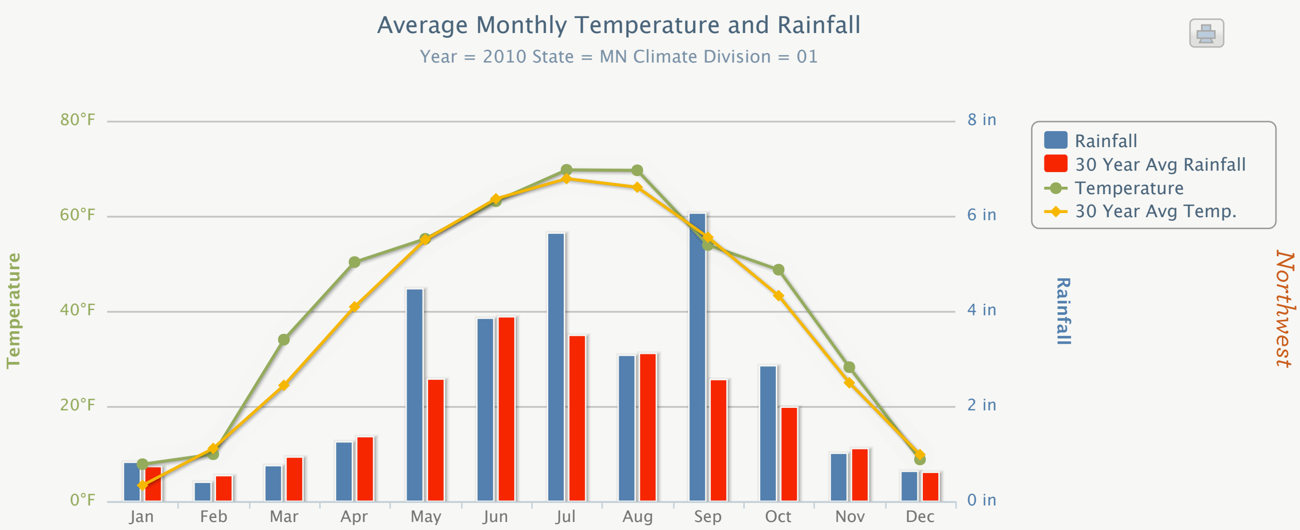

Average Monthly Temperature and Rainfall
Year = 2010 State = MN Climate Division = 06
East Central
Temperature
80°F
60°F
40°F
20°F
0°F
8 in
6 in
4 in
2 in
0 in
Rainfall
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Rainfall
30 Year Avg Rainfall
Temperature
30 Year Avg Temp.



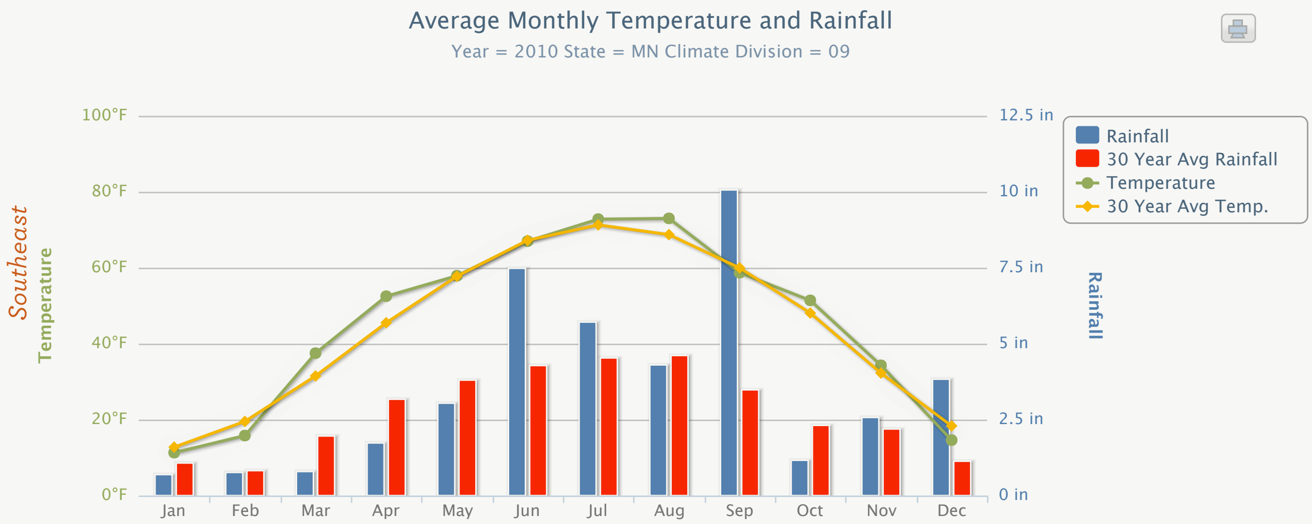
North Central

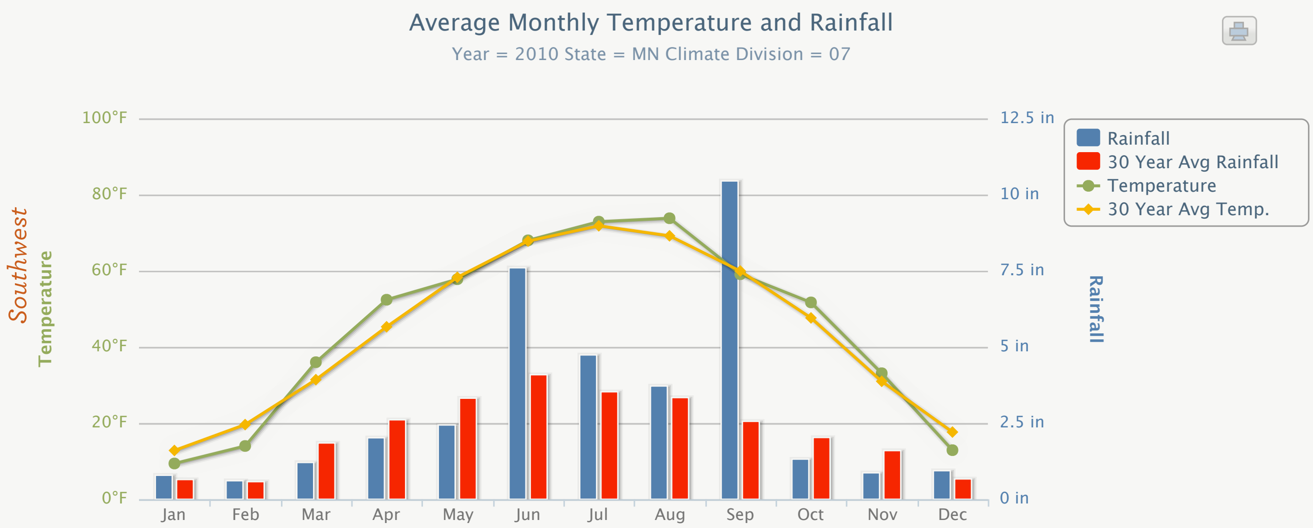


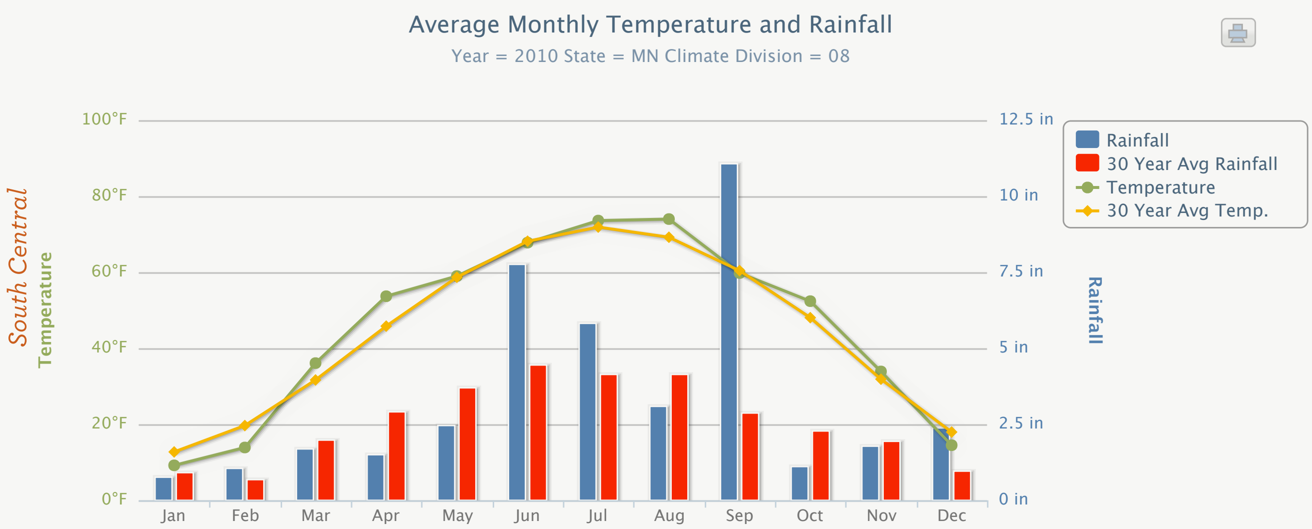
Northeast

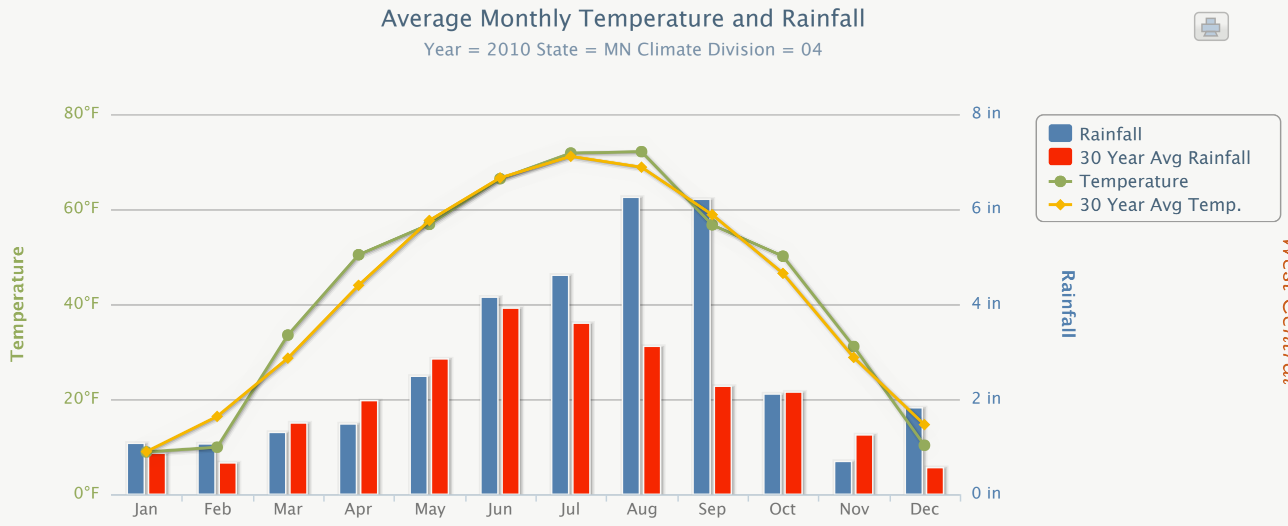


Northwest


Average Monthly Temperature and Rainfall
Year = 2010 State = MN Climate Division = 09
Southeast
Temperature
Rainfall
100°F
80°F
60°F
40°F
20°F
0°F
12.5 in
10 in
7.5 in
5 in
2.5 in
0 in
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Rainfall
30 Year Avg Rainfall
Temperature
30 Year Avg Temp.


Average Monthly Temperature and Rainfall
Year = 2010 State = MN Climate Division = 07
Southwest
Temperature
Rainfall
100°F
80°F
60°F
40°F
20°F
0°F
12.5 in
10 in
7.5 in
5 in
2.5 in
0 in
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Rainfall
30 Year Avg Rainfall
Temperature
30 Year Avg Temp.


Average Monthly Temperature and Rainfall
Year = 2010 State = MN Climate Division = 08
South Central
Temperature
Rainfall
100°F
80°F
60°F
40°F
20°F
0°F
12.5 in
10 in
7.5 in
5 in
2.5 in
0 in
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Rainfall
30 Year Avg Rainfall
Temperature
30 Year Avg Temp.



West Central

Lesson 4: Minnesota's Changing Climate

What is climate change and what does it mean for Minnesota?

Age Level:	Grades 9-12
Time Needed:	50 minutes
Materials:	Enough sets of climate change fact worksheets (8/set) that each student receives two sets Implications of Climate Change for Minnesotans handout Journals Pencils Drawing utensils
Student Learning Outcomes:	• Students will explain the causes of climate change. • Students will explain the implications of climate change. • Students will predict how climate change might impact or is impacting the area where they live. • Students will describe five key climate change implications for Minnesotans.

Background Information

Note: This lesson may be considered a nice introduction to climate change, or a review for those that have already learned about it. Educators wishing to go more in depth on climate change in their classroom should visit http://www.willstegerfoundation.org/curricula-resources to download other Will Steger Foundation lessons focusing on climate change and climate solutions.

In this lesson, students will be introduced to the basics of climate change. After learning some of the basics, students will take on the role of one sector or population that is experiencing or will potentially experience the impacts of climate change.

Important points to communicate include:

1. The earth's atmosphere that surrounds our planet is made up of gases called greenhouse gases. Greenhouse gases include carbon dioxide, methane, nitrous oxide and water vapor.
2. Greenhouse gases act like a blanket around the planet. They allow heat from the sun to enter the atmosphere. Some of this heat is absorbed and some of it is reflected back. Some of the heat is reflected into space, and greenhouse gases hold some of it in. A simple example of the greenhouse effect is when heat enters a car through its windshield and gets trapped inside, causing the ca r to heat up.
3. The greenhouse effect is a natural process that makes the earth habitable.
4. The greenhouse gas carbon dioxide (CO_2) has increased from 280 parts per million before 1870 and the industrial revolution, to over 390 parts per million today (2012). This information was determined by researchers by taking ice cores from Antarctica. The researchers measured the amounts of carbon dioxide trapped in air bubbles at different heights on the core which corresponded to periods of time. Since 1958, carbon dioxide measurements have been taken from on top of Mauna Loa, a Hawaiian volcano.
5. The burning of fossil fuels as well as land use changes from deforestation and land clearing, release carbon dioxide into the atmosphere. Fossil fuels are burned in the process of electricity production, industrial processes and the driving of vehicles. Fossil fuels include natural gas, oil and coal.
6. Throughout the history of the planet Earth, there have been increases and decreases in global average temperature. Although there have been

The melting and freezing of the ice cap has been a natural cycle for millions of years that drastically changed the weather and topography of our landforms. It is a very delicate balance that recently accounted for the past ice ages. The major problem mankind now faces is that through pollution of the atmosphere and destruction of the natural environment, the atmosphere is warming at an alarming rate.

—Will Steger, Greenland Training Expedition for Trans-Antarctic Expedition; June 12, 1988 periods of natural warming in the past, scientists are especially concerned about what is happening today because there is a change in temperature that has been rapid within the last 100 years, rather than over hundreds or thousands of years.

7. This increase in temperature has an effect on Minnesota's climate as a whole, and has enormous implications for Minnesota. The results have been and continue to be experienced across Minnesota's biomes in all living communities of organisms, including humans.
8. There are climate change solutions and students can be part of the solution. Later in this unit students will have the opportunity to learn about and develop their own solutions.

There are some important implications of climate change for the Midwest and for Minnesotans, as described below and found in the report, *Global Climate Change Impacts in the United States* (United States Global Change Research Program).

1. During the summer, public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and increasing occurrence of insect-transmitted and waterborne diseases.
2. Significant reductions in Great Lakes water level, which are projected under higher emission scenarios, lead to impacts on shipping, infrastructure, beaches and ecosystems.
3. The likely increase in precipitation in winter and spring, more heavy downpours, and greater evaporation in summer would lead to more periods of both floods and water deficits.
4. While the longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects and weeds will present increasing challenges to managing crops, livestock, and forests.
5. Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.

Journal Assignment

At the end of this lesson, student journals should contain notes on what climate change is and the list of key implications for the Midwest and Minnesotans.

Activity Description

Introduction

1. Ask students to look back in their journals at the definition they wrote of climate. Thinking about their definition of climate, ask students to write or draw what comes to mind when they hear "climate change."
2. Discuss as a class what they wrote or drew.

Activity: What is climate change?

1. Share the key points included in the introduction by handing out climate change fact cards included with this lesson to groups of four. Give each group member two cards to read in sets of 1 and 2, 3 and 4, 5 and 6, etc.
2. Ask each group member to read their cards and then to create a visual they think would be helpful to explain the information on the two cards. Alternatively, ask the students to find visuals through an Internet search to share.
3. Ask them to read aloud their cards and share their visual with their group in their numbered order.
4. Groups should discuss what the cards mean and make a list of any questions they might have in their journals.
5. Discuss as a class each card and questions that came up. Show the visuals created or found for each set of cards as you discuss them.

Concluding Activity: What are the key implications of climate change for Minnesotans?

1. Think back to "*What defines Minnesota's biomes?*" lesson 2. Review what is unique about the biome where your school is located as far as climate, flora and fauna and other defining factors. Students can look back in their journals to review.
2. Share the five climate change implications for Minnesotans either by projecting them (see included handout), reading them out loud, or handing them out to the class.
3. Ask the students to look at the implications and then look back in their journals at the graphs they looked at in Lesson 3. Does the data already recorded indicate that the predictions described in the key issues are possible?
4. Discuss which implications might impact the biome where you live the most and why. Think about what you know about the other biomes. What implications may be most important or impactful to them?
5. If you haven't already, hand out the list of implications and ask students to paste it in their journal. Ask them to choose one that concerns them the most and to write in their journal about how they think it could impact their lives.

Journaling Connection

Ask students to think about the implications of climate that were discussed. Ask them to write a journal entry that discusses how climate change may affect them directly, or ask them to choose one issue that is of particular concern to them and explain why.

Take It Outside—Connecting With Your Place

Materials
- Journals
- Colored pencils

1. Take the students outside with their journals. Make sure that they remember or have listed in their journal the key implications described.
2. Ask them to look around them and draw a picture of what they see.
3. Ask them to label different parts of their picture where they predict climate change impacts will be seen or are already being seen as they relate to the key issues described. For example, if you can see agricultural fields, they may label them and write that the growing season may be longer or there may be more flooding, or any plant life seen may be labeled "will bloom earlier."

Extensions

The Will Steger Foundation's Global Warming 101 Lessons provide an opportunity to explore climate change causes and impacts more deeply. Download lessons at:
http://www.willstegerfoundation.org/educator-resource-binder

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org
1. Scan journal entries and pictures the students have drawn and upload them to the online classroom.
2. Click on "Climate Change Basics" and then "Climate Closeup: Temperature" in the learning module of the online classroom to play a game to extend learning on climate change.

Dispatch from 2007 Baffin Island Expedition:

From what I've seen personally, from all the interviews that we did tenting and living with the Inuit people as we've traveled, basically what's happening in the Arctic regions is that global warming is being played out on the sea ice. As the extra energy is absorbed into the ocean from human induced global warming, this is warming the ocean. 80% of the excess energy goes into the ocean and that, in turn, starts melting the ice. We're seeing later freeze-ups and earlier break-ups. In other words, what we're seeing is the winter season, the ice season, which is so important for hunting and traveling, is starting to diminish. What used to be about an 8 month season in Baffin now is, in some areas, reduced to around 6 months...Also we could tell on the glaciers that we saw and the mountains and mountain passes that we've crossed, the glaciers have definitely receded.

Fact #1

The earth's atmosphere that surrounds our planet is made up of gases called greenhouse gases. Greenhouse gases include carbon dioxide, methane, nitrous oxide and water vapor.

Fact #2

Greenhouse gases act like a blanket around the planet. They allow heat from the sun to enter the atmosphere. Some of this heat is absorbed and some of it is reflected back. Some of the heat is reflected into space, and some of it is held in by greenhouse gases. A simple example of the greenhouse effect is when heat enters a car through its windshield and gets trapped inside, causing the car to heat up.

Fact #3

The greenhouse effect is a natural process that makes the earth habitable.

Fact #4

The Greenhouse Gas carbon dioxide (CO_2) has increased from 280 parts per million before 1870 and the industrial revolution, to over 390 parts per million today. This information was determined by researchers by taking ice cores from Antarctica and measuring the amounts of carbon dioxide trapped in air bubbles at different heights on the core that correspond to periods of time. Since 1958, carbon dioxide measurements have been taken from on top of Mauna Loa, a volcano in Hawaii.

Fact #5

The burning of fossil fuels releases carbon dioxide into the atmosphere, as well as land use changes from deforestation and land-clearing. Fossil fuels are burned in the process of electricity production, industrial processes and the driving of vehicles. Fossil fuels include natural gas, oil and coal.

Fact #6

Throughout the history of the planet Earth, there have been increases and decreases in global average temperature. Although there have been periods of natural warming in the past, scientists are especially concerned about what is happening today because there is a change in temperature that has been rapid in the last 100 years, rather than over hundreds or thousands of years.

Fact #7

This increase in temperature has an effect on Minnesota's climate as a whole, and has enormous implications for Minnesota. The results have been and continue to be experienced across Minnesota's biomes in all living communities of organisms, including humans.

Fact #8

There are climate change solutions and students can be part of the solution. Later in this unit students will have the opportunity to learn about and develop their own solutions.

Implications of Climate Change for Minnesotans

1. During the summer, public health and quality of life, especially in cities, will be negatively affected by increasing heat waves, reduced air quality, and increasing insect and waterborne diseases.

2. Significant reductions in Great Lakes water level, which are projected under higher emission scenarios, lead to impacts on shipping, infrastructure, beaches and ecosystems.

3. The likely increase in precipitation in winter and spring, more heavy downpours, and greater evaporation in summer would lead to more periods of both floods and water deficits.

4. While the longer growing season provides the potential for increased crop yields, increases in heat waves, floods, droughts, insects and weeds will present increasing challenges to managing crops, livestock and forests.

5. Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases and invasive species moving in from warmer regions.

Age Level:	Grades 9-12
Time Needed:	50-75 minutes
Materials:	6 sets of materials related to climate change in Minnesota (details in table on p. 88) A box or other container to hold each set of materials
Student Learning Outcomes:	• Students will make their own interpretations of authentic figures representing different impacts of climate change in Minnesota. • Students will make the connection between a 3-D object and what a figure represents. • Students will divide two statements about each graph into true or false categories. • Students will brainstorm how climate change could affect their biome. • Students will develop their own true/false statements about scientific figures and exchange with another student. • Students will share their results. • Students will discuss the importance of corroborative data in support of climate change science.

Background Information:

One of the key outcomes of this lesson is that the evidence for climate change can be illustrated through many different phenomena that are already occurring. This is important because it is the sum of this "corroborative data" that makes the reality of climate change undeniable.

In this activity, groups of four students will be given a set of materials in a box. Each set should contain two 3-D objects (or photos if no objects are available), two figures, and two sets of true/false statements that correspond to each figure. There are six sets of materials; each set is related to a common theme. The table above shows the themes of each set of materials. Depending on the number of students in your class and group size, you may need to replicate sets between groups. The figures will introduce students to different ways that data is represented and will demonstrate different impacts climate change may have on the state of Minnesota.

> Sometimes when you explore, you find things that you know and then sometimes you find other things that you can figure out and sometimes there's a total unknown. When you don't know something, what I usually do when I go back is go to a library and look it up in a book or ask somebody a question.
>
> —Will Steger in field trip with elementary students, 1995

Journal Assignment

At the end of this lesson, student journals should contain a list of key messages determined through an exploration and discussion of the figures shared.

Educator Prep:

It is important that the materials for this activity are sorted and organized correctly and together. Beginning on page 92 there are 12 figures with corresponding explanations and true/false statements and a template to be copied. These materials are also available online at: http://classroom.willstegerfoundation.org/handouts, if you would like to print them out in color. Each set of materials needs to be cut out into: figures, individual true/false statements, and figure explanations. The true/false statements for a given set of three materials can be put in an envelope and the set of figure explanations in another envelope. These envelopes, along with the corresponding two figures and two 3-D objects should be put in a box. There are six sets of two figures that are in some way related. The following table shows which figures should be clustered together, their common theme, a suggested 3-D object or photo, and one possible connection to an implication of climate change for Minnesotans as discussed in Lesson 4. All of the materials may be laminated for long-term usage.

Figure and Theme	3-D Object/Photo	Possible Connected Key Implication
Climate Change and Ice		
Minnesota Average Ice Out Date (p. 87)	Ice cube	5: more heat-tolerant aquatic species could move in
ICE OUT day of year (p. 89)	Ice Fishing Postcard	See above
Climate Change and Seasons		
Fewer Days of Snow Falling (p. 91)	Snowflake	2: fewer days of snowfall could mean lower lake levels in the spring
Extreme Heat Becomes More Frequent (p. 93)	Fan	1: dangerous heat waves could affect public health
Climate Change and Temperature		
Side by side comparison of Average Temperature Increase Since 1895 (p. 95)	MN in Winter Postcard	All
Temperature Increase in North vs. South Minnesota (p. 97)	Thermometer	5: species may move north with warming temperatures
Climate Change and Water		
Water Supply Sustainability Index (p. 99)	Water bottle	3: more floods and water deficits
Regional air temperature and average ice cover of Lake Superior (p. 101)	Ice Skates	2: impacts beaches, ecosystems, great lakes shipping, etc.
Climate Change and Fossil Fuels		
The Midwest Burns More Fossil Fuels (p. 103)	Power plant photo	The cause for all
Greenhouse Gas Emissions from Minnesota (p. 105)	Car/Bus	See above
Climate Change and Plant Life		
Observed and Projected Changes in Plant Hardiness Zones (p. 107)	Vegetable	4
Interactions between global warming and other drivers (p. 109)	Plastic worm	5: native species threatened by invasives

Activity Description

Introduction

1. Ask the students to name the five implications of climate change for Minnesotans. They can look back in their journals to review this.
2. Ask the students to write in their journals for five minutes about what issue they might be interested in studying if they were a scientist. Ask them to describe where and how they might do their research and what questions they might have based on what they've learned so far.

Activity: Data exploration

1. Hand out a box that contains a set of materials to each group of three to five students. Make sure the data sets are face down and only the 3-D objects, or photos if objects are not available, are visible.
2. Students should begin by taking out the 3-D objects without looking at the other papers in the box. In their group, they should brainstorm a list of how each of the objects might relate to climate change in Minnesota and write the list in their journals.
3. After the students have finished brainstorming their lists, they should remove the papers that are left in the box. Each student or pair of students should take a figure out and spend some time looking over it. They should think about what 3-D object the figure might be connected to and they should prepare to explain what the figures mean to the other members of their group.
4. Each student will explain their figure to their group and how the object is connected.
5. Students should look in the envelope labeled "figure explanations." Read each explanation and as a group decide which explanation fits with each figure.
6. Ask students to remove the envelope of true/false statements and take turns reading a statement and aligning it with the graph where they think it belongs. Explain that they don't need to worry if it is true or false yet.
7. Once they have lined up the statements as a group read through them again and decide if they are true or false.
8. Ask how each set of figures might be related to one of the five key issues for Minnesotans facing climate change that they learned about in lesson 4. Record their ideas in their notebook.
9. Ask the groups to look at their completed sets, discuss what they think are common themes and come up with a title for their data set.

Activity: Make Your Own Interpretations

1. Ask students in groups or individually to develop their own set of true and false statements for each figure. Review their statements for accuracy.
2. Exchange figures and statements with another group and ask them to line up the true and false.

Concluding Activity: Collect the Evidence

1. Ask each group to share what they learned from their figures either in an oral presentation or through a poster.
2. Looking at the evidence they "collected" as a whole, make a list of key messages and discuss how the data becomes more compelling when it is part of the larger collection of "corroborative data."

Journaling Connection

Ask the students to create a concept map that shows the connections between the five implications of climate change for Minnesotans and the figures they looked at in their group and/or the other groups

Take It Outside

Ask the students to think about the research that went into the figures they studied. Is there a particular experiment they could design and do in the schoolyard, their backyard or nearby nature area?

Extensions

1. Ask students to develop a report based on the key messages that can be drawn from each set.
2. Ask students to develop their own sets of figures and true/false statements. Exchange with other classmates.

Online Classroom Connection

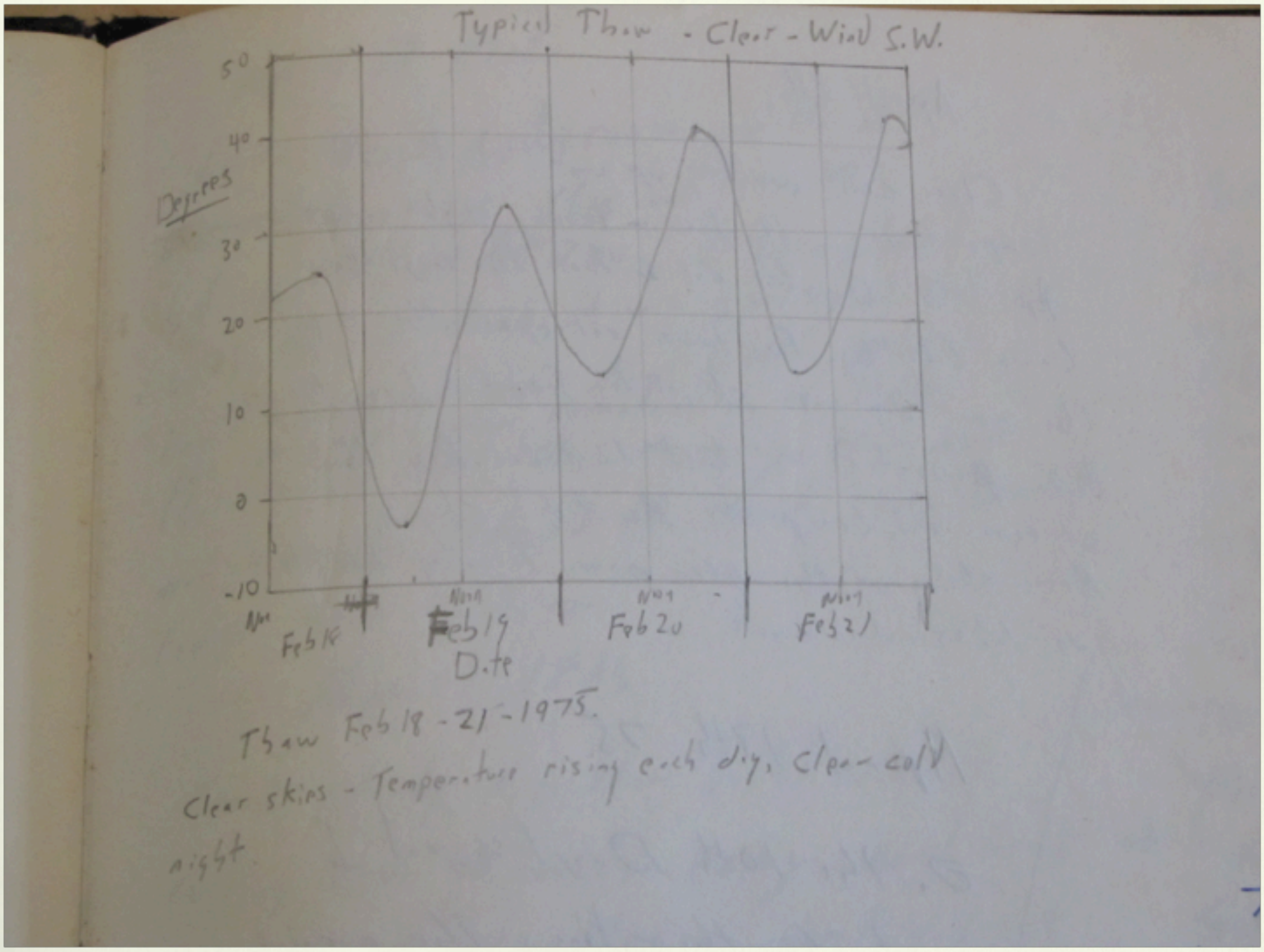
Visit http://classroom.willstegerfoundation.org
Visit the Climate Change Basics section. Watch the videos and use some of the interactives.

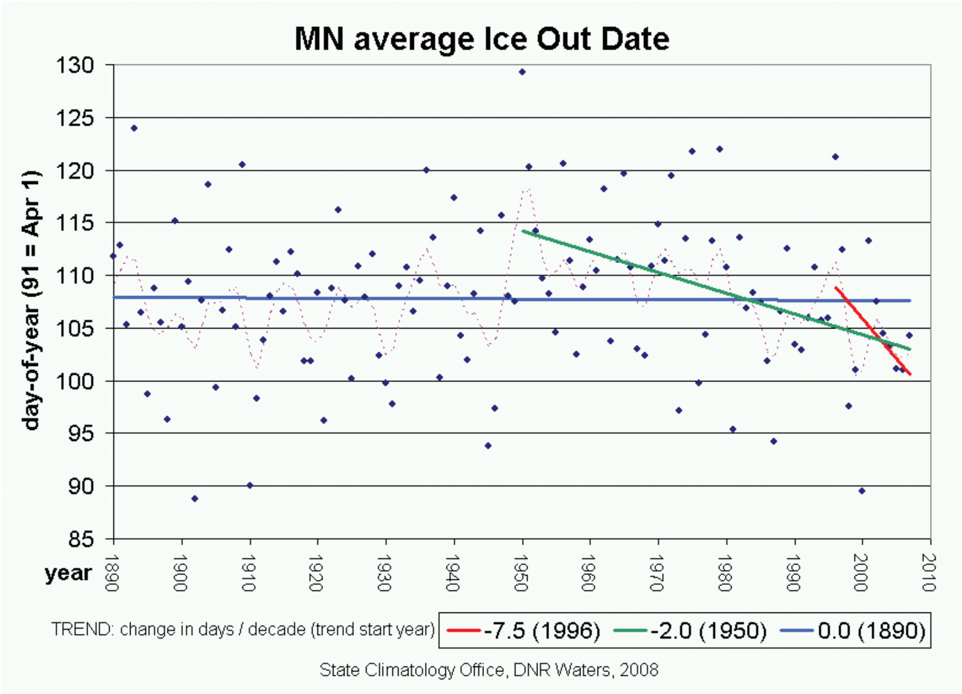
Resources

Southern Climate Impacts Planning Program: Trends
http://www.southernclimate.org/products/trends.php

United States Global Change Research Program. (2011, March 1). Global Climate Change Impacts in the United States: Midwest Chapter. Retrieved from http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts/regional-climate-change-impacts/midwest

Will Steger used graphs to interpret the data he gathered from his observations. In this example, he records the changes in temperature over the course of a February thaw in 1975.

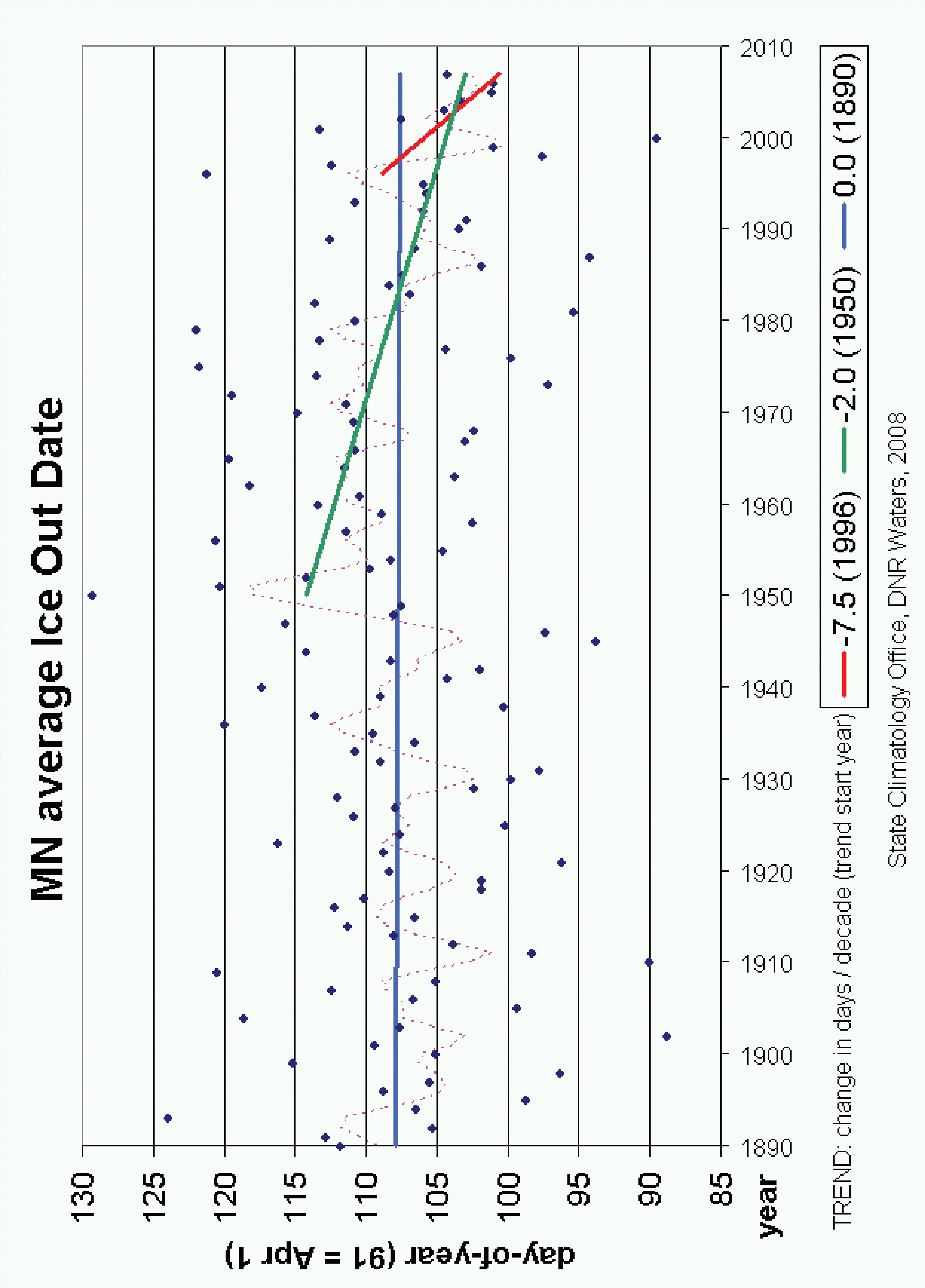


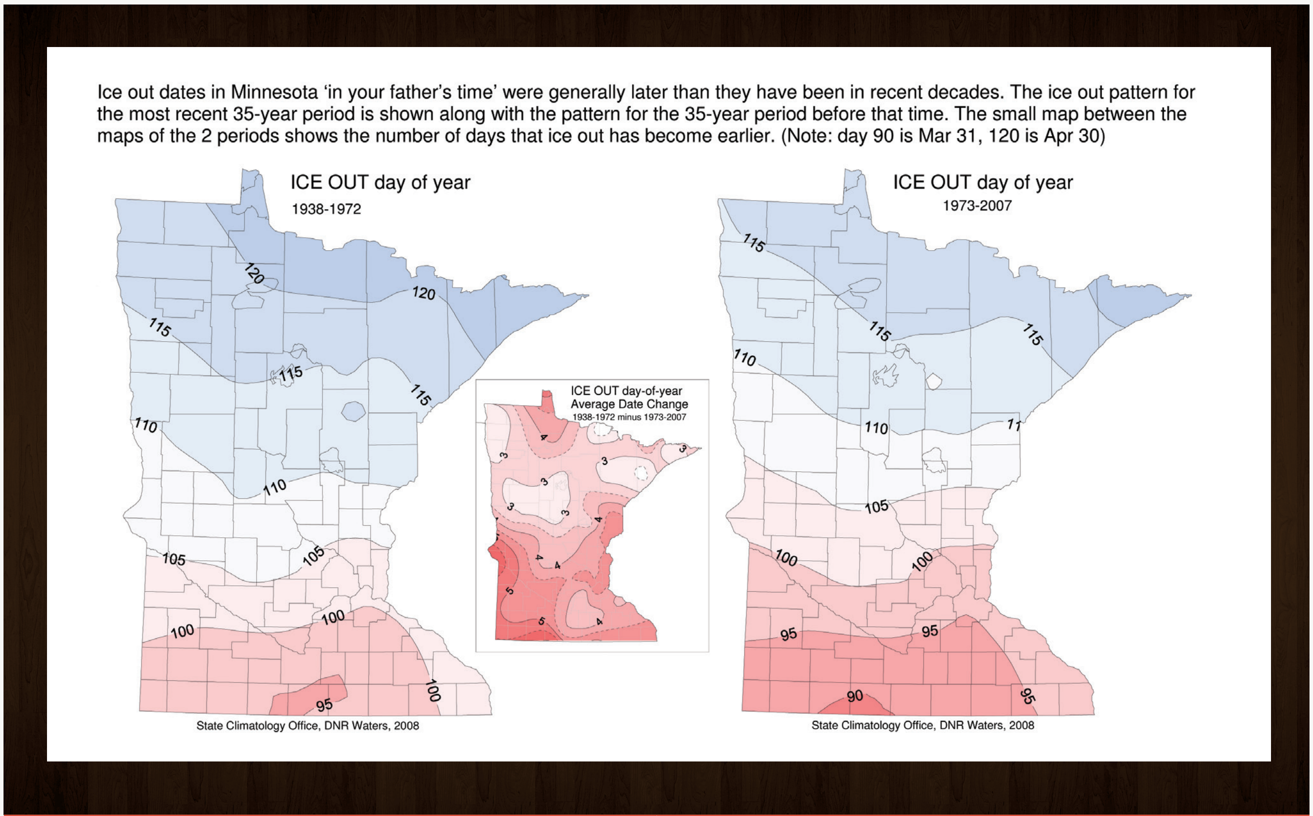


Ice out, like snow, is one of the many results of both temperature changes and humidity changes since both represent heat changes. Lake ice out has been getting earlier in the last few decades. The rate at which it has been getting earlier is greater in recent record than for longer periods.

Zandlo, Jim. (last modified 2008) Climate Change and the Minnesota State Climatology Office: Observing the Climate. Retrieved from http://climate.umn.edu/climateChange/ climateChangeObservedNu.htm

TRUE STATEMENTS	FALSE STATEMENTS
The latest day the ice was recorded to go out was in 1950.	On the y-axis, 91 is the same as May 1.


MN average Ice Out Date
day-of-year (91 = Apr 1)
130
125
120
115
110
105
100
95
90
85
year
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
-7.5 (1996)
-2.0 (1950)
0.0 (1890)
TREND: change in days / decade (trend start year)
State Climatology Office, DNR Waters, 2008

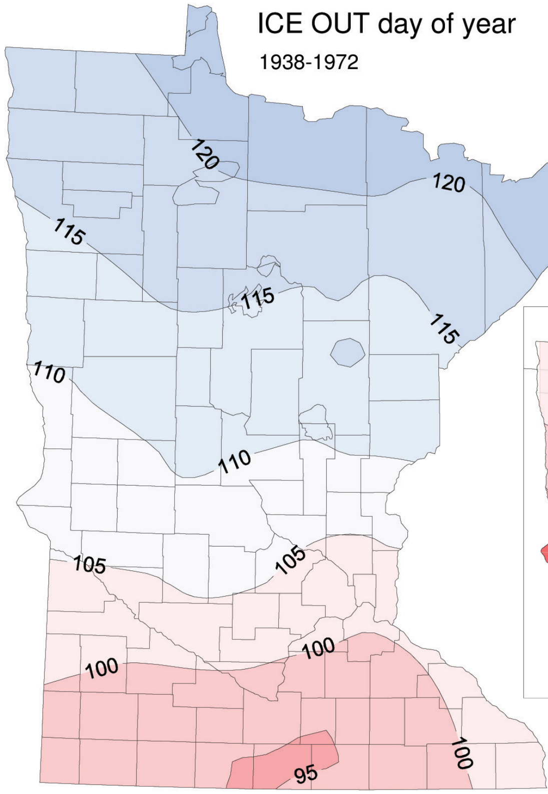


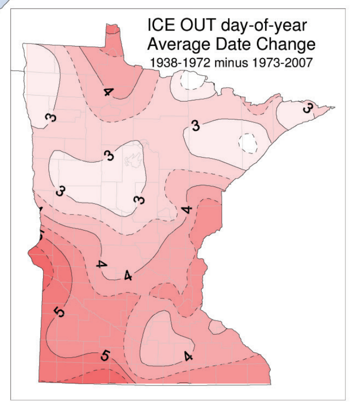
A comparison of ice-out dates in Minnesota between 1938-1972 and 1973-2007.
(Note: Day 90 is March 31, 120 is April 30)

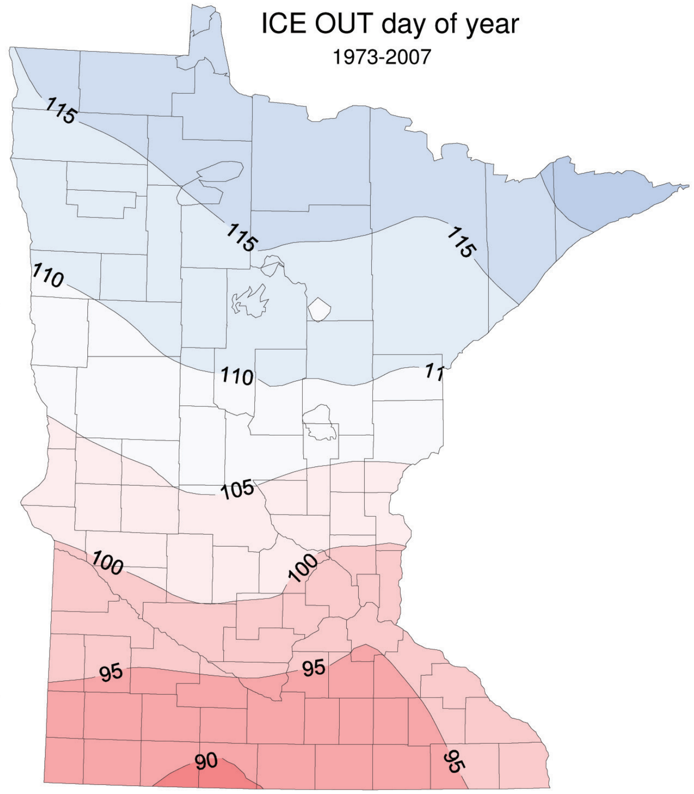
Zandlo, Jim. (last modified 2008) Climate Change and the Minnesota State Climatology Office: Observing the Climate. Retrieved from http://climate.umn.edu/climateChange/climateChangeObservedNu.htm

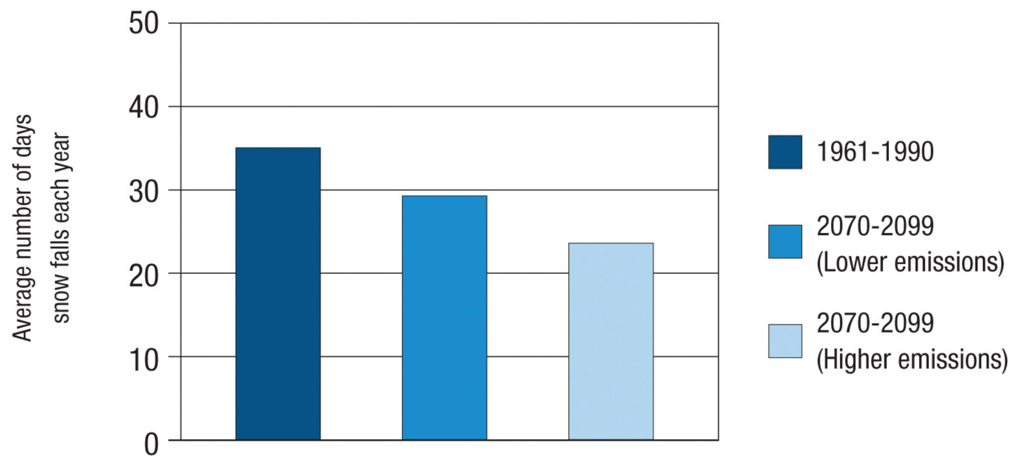
TRUE STATEMENTS	FALSE STATEMENTS
Ice out in the southwest corner of the state has been about 5 days earlier in recent decades.	The northern part of the state has seen 115 days of ice in recent decades.

Ice out dates in Minnesota ‘in your father’s time’ were generally later than they have been in recent decades. The ice out pattern for the most recent 35-year period is shown along with the pattern for the 35-year period before that time. The small map between the maps of the 2 periods shows the number of days that ice out has become earlier. (Note: day 90 is Mar 31, 120 is Apr 30)





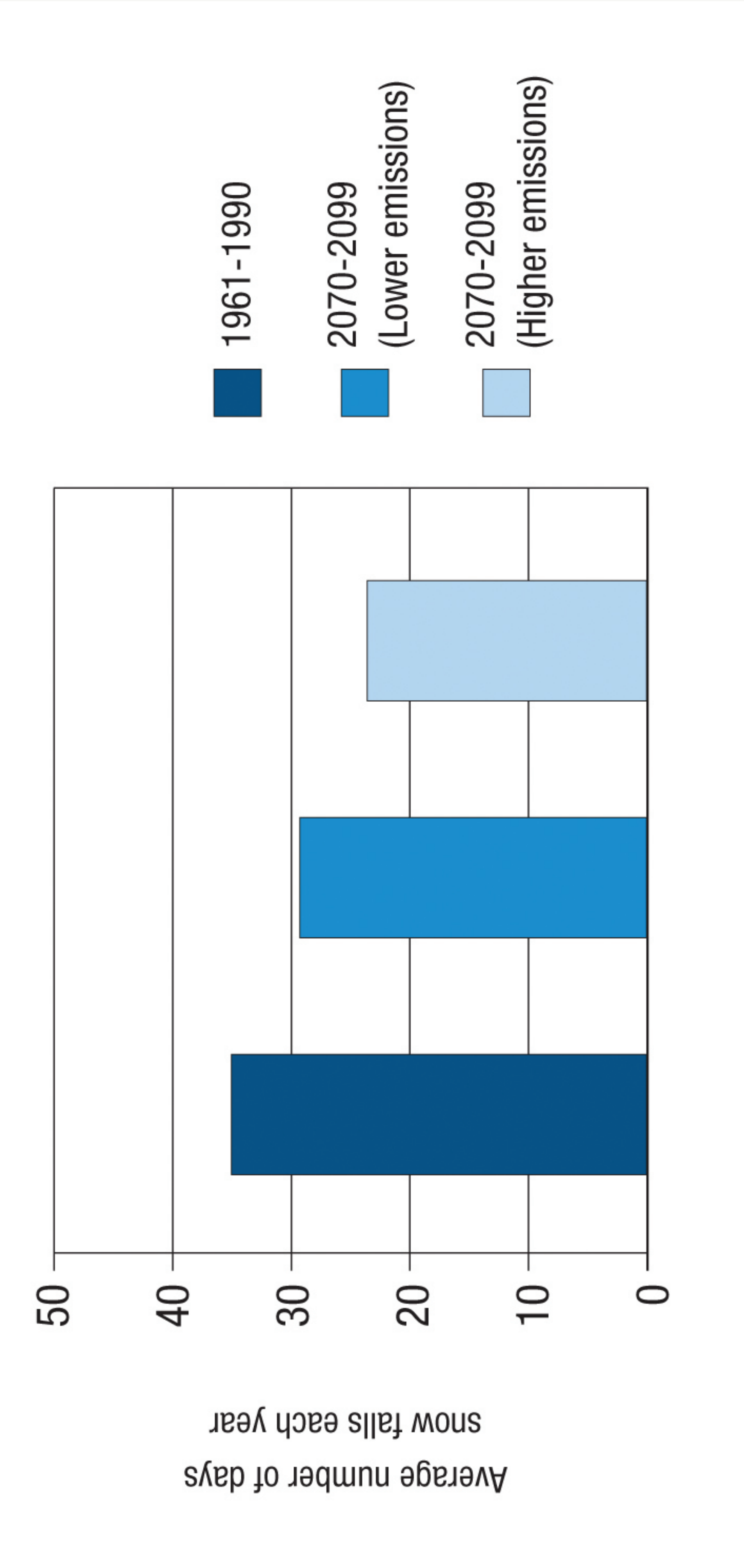


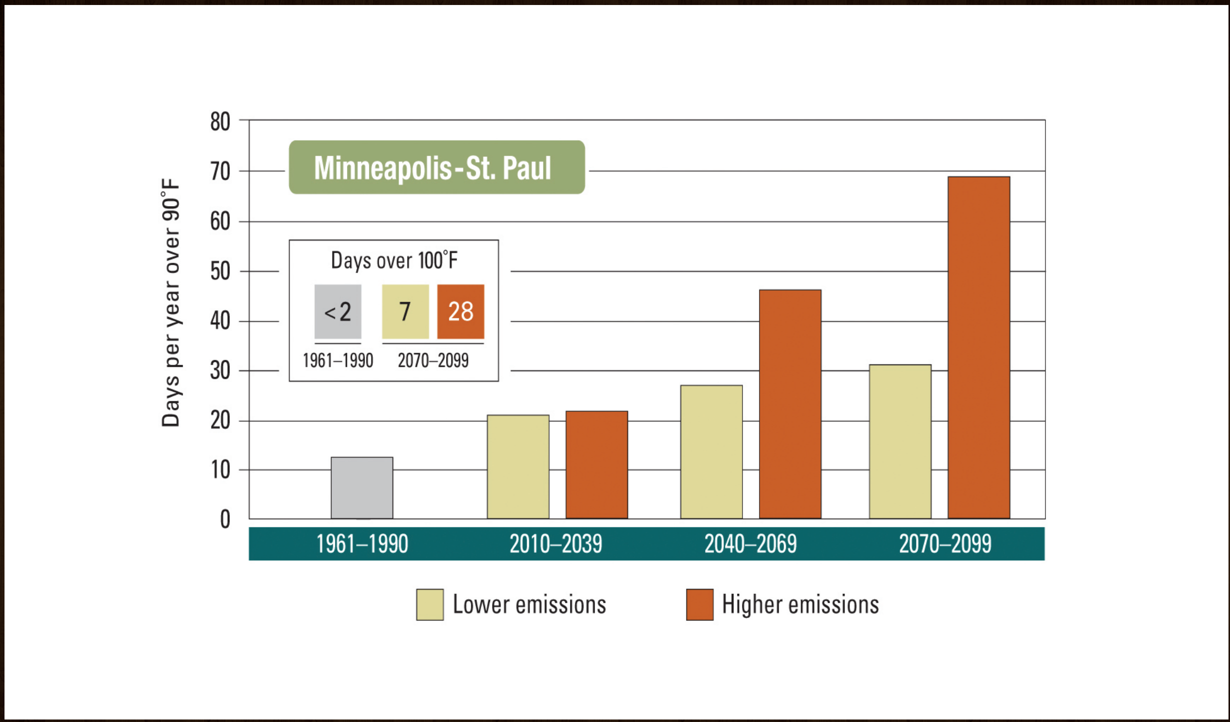


Fewer Days of Snow Falling

Union of Concerned Scientists. (2009). Confronting Climate Change in the US Midwest: Minnesota. Chicago, IL.

TRUE STATEMENTS	FALSE STATEMENTS
Even if emissions decrease, Minnesota is predicted to have shorter winters.	This graph shows that historically Minnesota has an average of 25 days of snowfall per year.


1961-1990
2070-2099 (Lower emissions)
2070-2099 (Higher emissions)
0
10
20
30
40
50
Average number of days snow falls each year

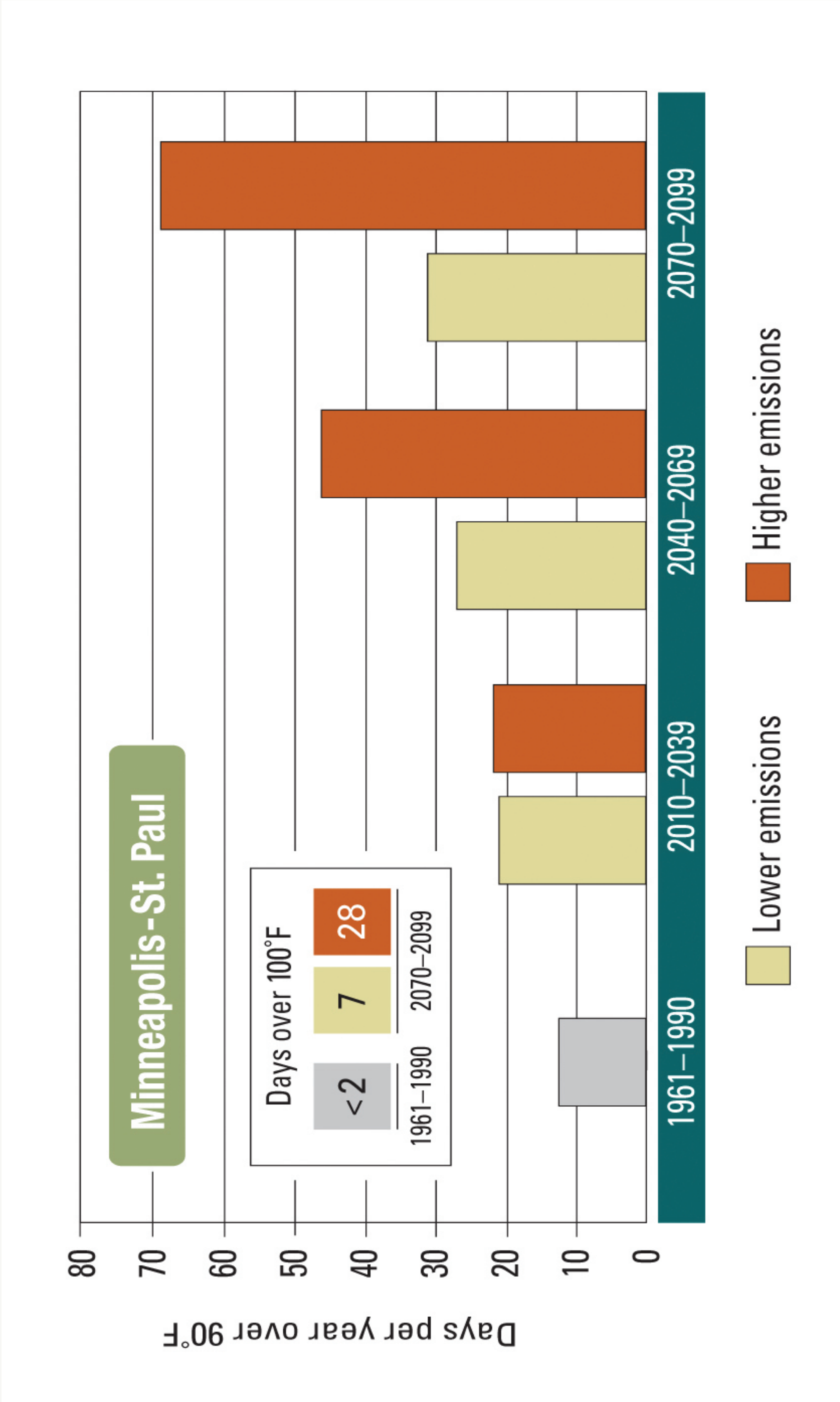


Extreme Heat Becomes More Frequent

This figure shows how models predict the temperature of the Twin Cities could change if we continue to emit large quantities of carbon dioxide (higher emissions scenario), or if we make some changes and cut our emissions (lower emissions scenario).

Union of Concerned Scientists. (2009). *Confronting Climate Change in the US Midwest: Minnesota.* Chicago, IL.

TRUE STATEMENTS	FALSE STATEMENTS
Under the higher-emissions scenario, the Twin Cities could experience almost an entire summer of days above 90 degrees F by the end of the century.	This bar graph shows how precipitation will change in the Twin Cities.


Minneapolis-St. Paul
Days per year over 90°F
0
10
20
30
40
50
60
70
80
1961–1990
2010–2039
2040–2069
2070–2099
Days over 100°F
<2
7
28
1961–1990
2070–2099
Lower emissions
Higher emissions

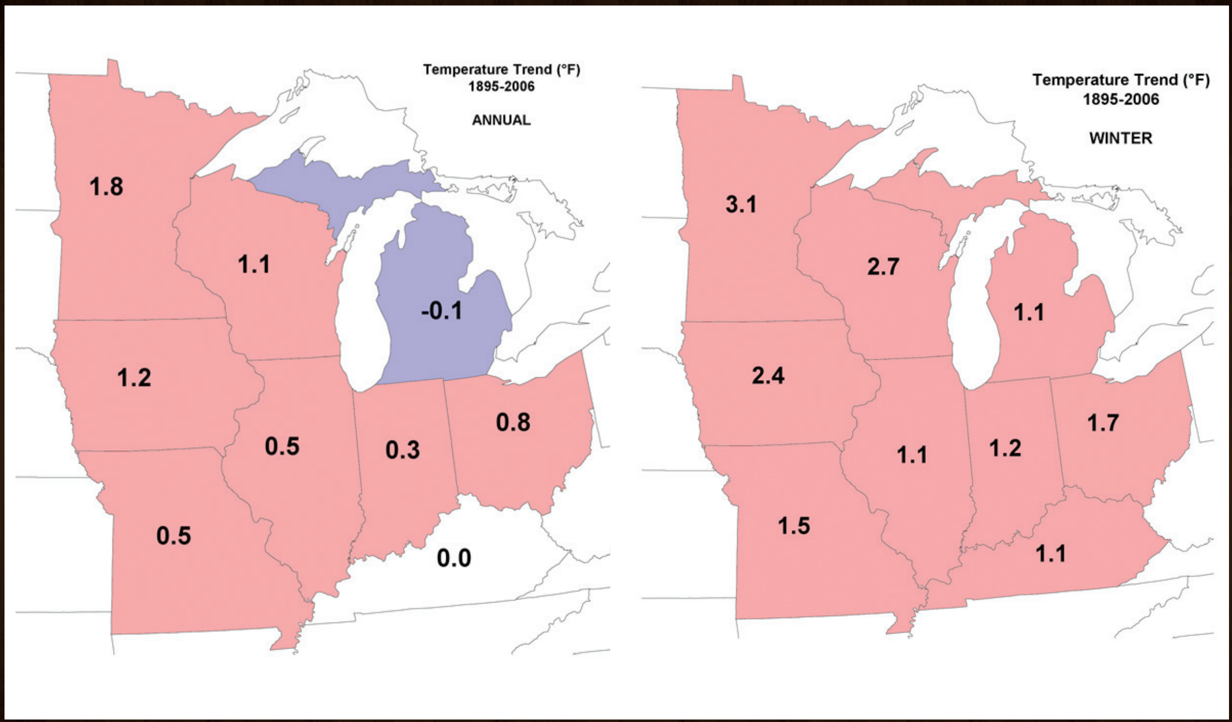
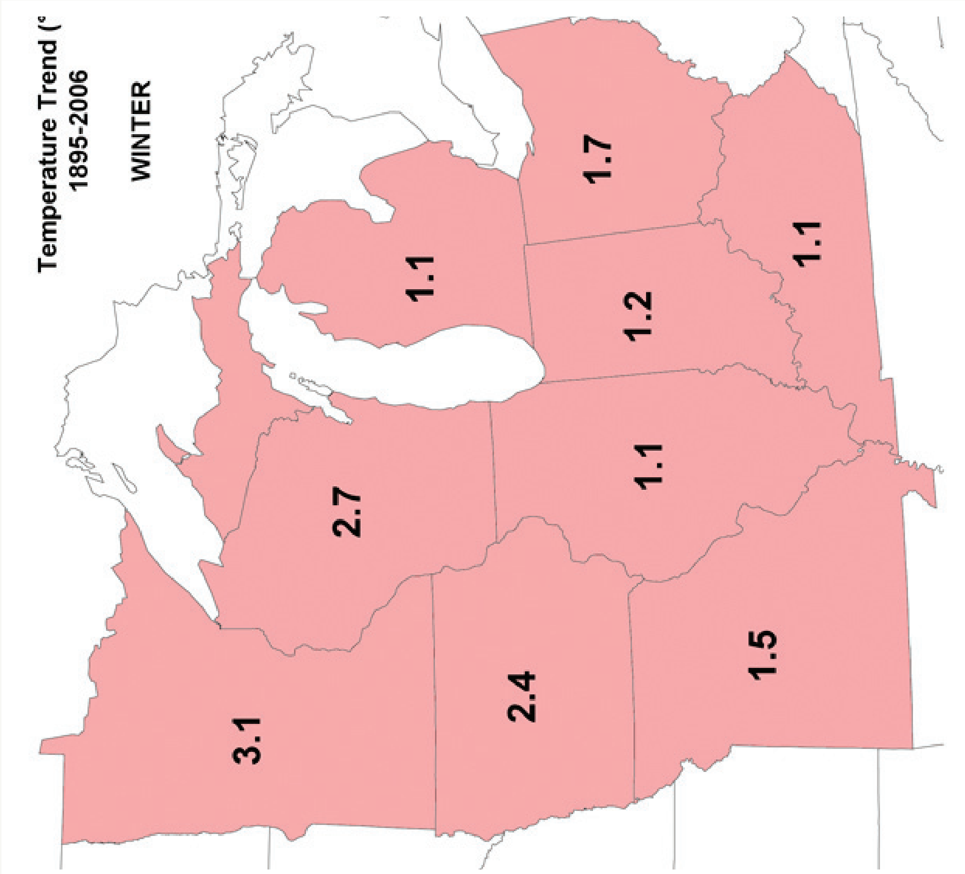
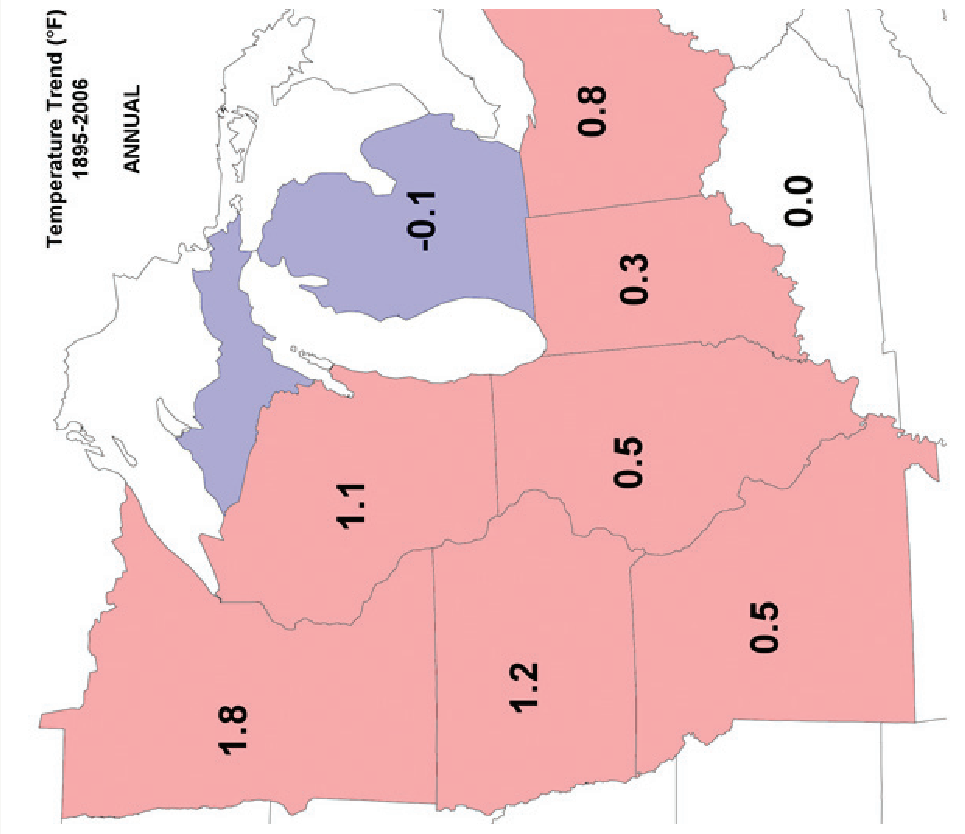


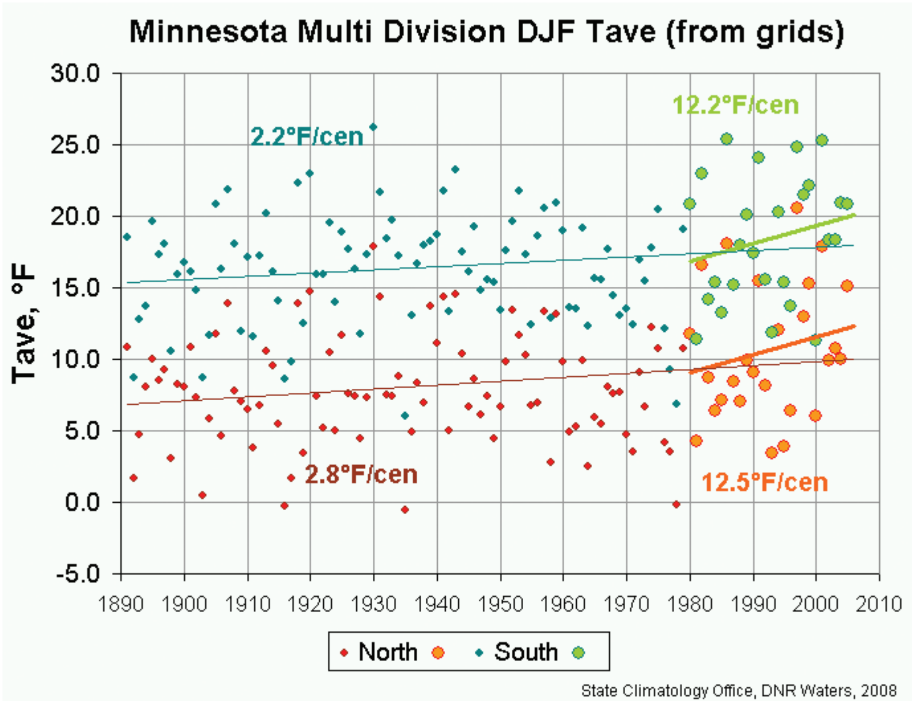
Figure 1. Annual average change in temperature, 1895-2006 (°F)
Figure 2. Average annual temperature change, winter, 1895-2006 (°F)

Minnesota Pollution Control Agency. (2010). Adapting to Climate Change in Minnesota: Preliminary Report of the Interagency Climate Adaptation Team, pp. 4-5. Retrieved from www.pca.state.mn.us/index.php/download-document.html?gid=15414

TRUE STATEMENTS	FALSE STATEMENTS
Temperature in Minnesota has increased an average of 1.8 degrees since 1895.	Minnesota winters have gotten colder since 1895.


Temperature Trend (°
1895-2006
WINTER
3.1
2.7
1.1
2.4
1.1
1.2
1.7
1.5
1.1

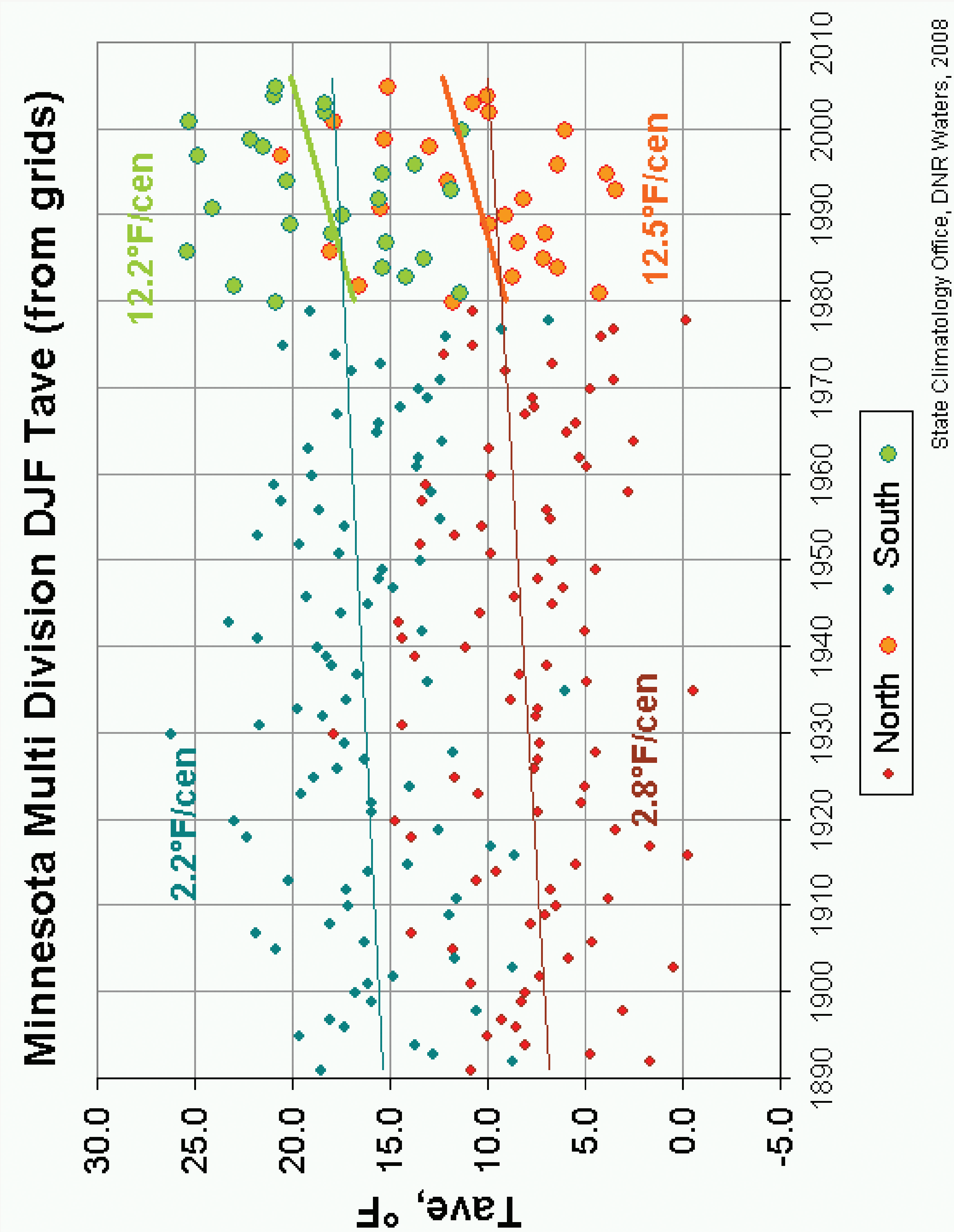

Temperature Trend (°F)
1895-2006
ANNUAL
1.8
1.1
-0.1
1.2
0.5
0.3
0.8
0.5
0.0



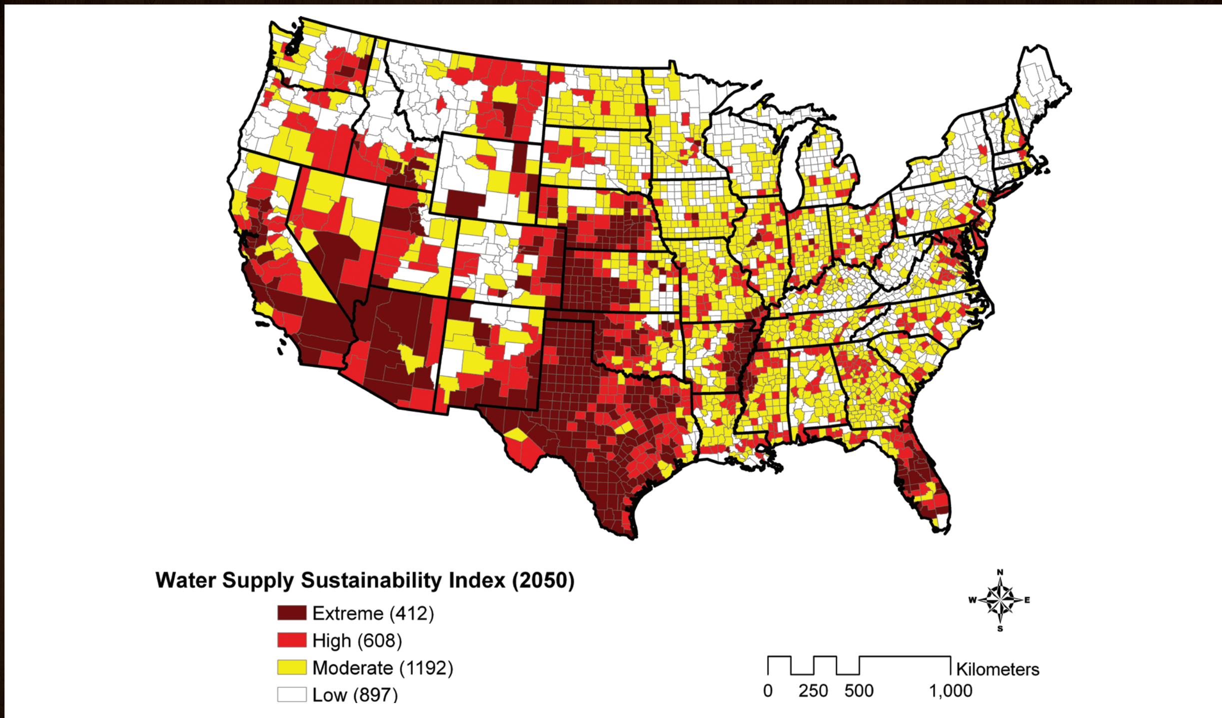
From the beginning of the record in 1891 to the early 1980s, Minnesota's average annual temperature did not change; its trend was essentially zero. Since the early 1980s the temperature has risen slightly over 1 degree F in the south to a little over 2 degrees F in much of the north; the trend has been upward.

Zandlo, Jim. (last modified 2008) Climate Change and the Minnesota State Climatology Office: Observing the Climate. Retrieved from http://climate.umn.edu/climateChange/climateChangeObservedNu.htm

TRUE STATEMENTS	FALSE STATEMENTS
If the graph ended in 1980, there would be no indication of warming in Minnesota.	The temperature on the y axis is in Celsius.



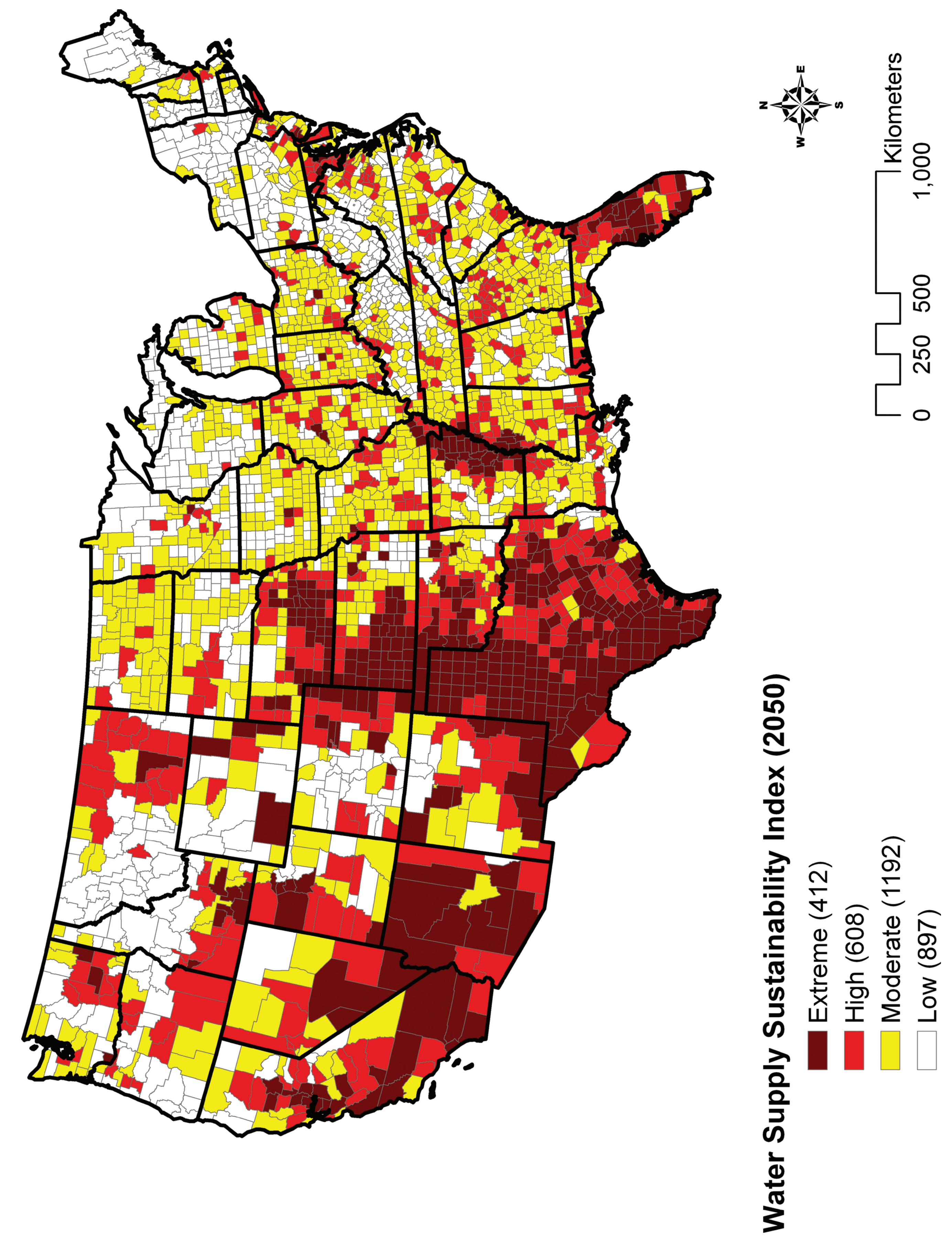
Minnesota Multi Division DJF Tave (from grids)
Tave, °F
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2.2°F/cen
2.8°F/cen
12.2°F/cen
12.5°F/cen
North
South
State Climatology Office, DNR Waters, 2008



Water Sustainability Index in 2050, with available precipitation computed using projected climate change.
(The numbers in parentheses are the numbers of counties in each category.)

Natural Resources Defense Council. (2010). Evaluating Sustainability of Projected Water Demands Under Future Climate Scenarios. Lafayette, CA: Tetra Tech, Inc.

TRUE STATEMENTS	FALSE STATEMENTS
Those at the highest risk in Minnesota are generally found in urban areas.	Those at the most risk are found in the northern parts of the country.


Water Supply Sustainability Index (2050)
Extreme (412)
High (608)
Moderate (1192)
Low (897)
0 250 500 1,000
Kilometers
N
E
S
W

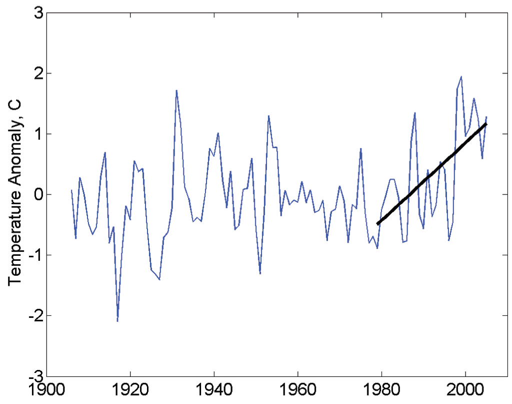


Figure A

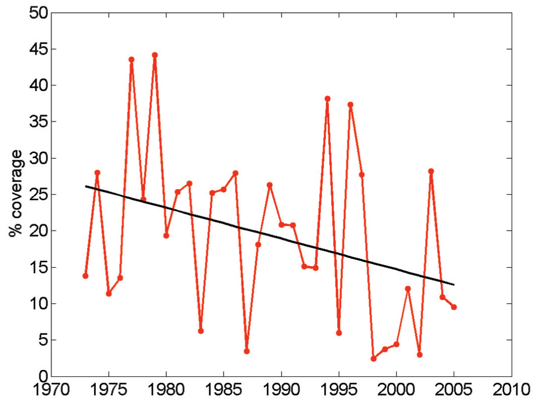


Figure B

Regional air temperature and average ice cover of Lake Superior:
a) mean July-September air temperatures from GISS sites on Lake Superior (available from http://data.giss.nasa.gov/gistemp/) and b) ice cover metric [Assel, 2003; 2005b] in percent.

Austin, J.A., and S.M. Colman. 2008. "A century of temperature variability in Lake Superior." Limnol. Oceanogr. 53, 2724–2730.

TRUE STATEMENTS	FALSE STATEMENTS
Since 1980, Lake Superior ice cover has declined almost 10 percent.	There is no correlation between ice cover and temperature.

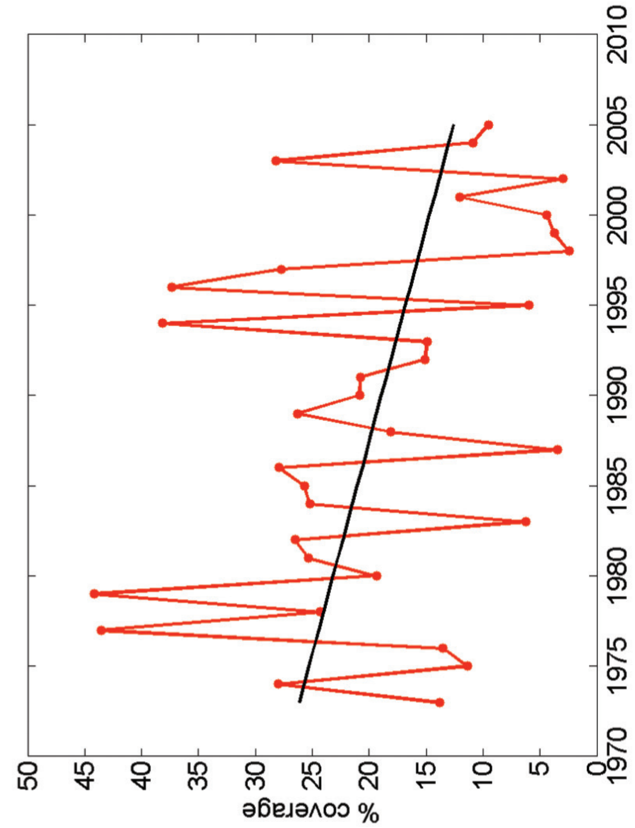


Figure B

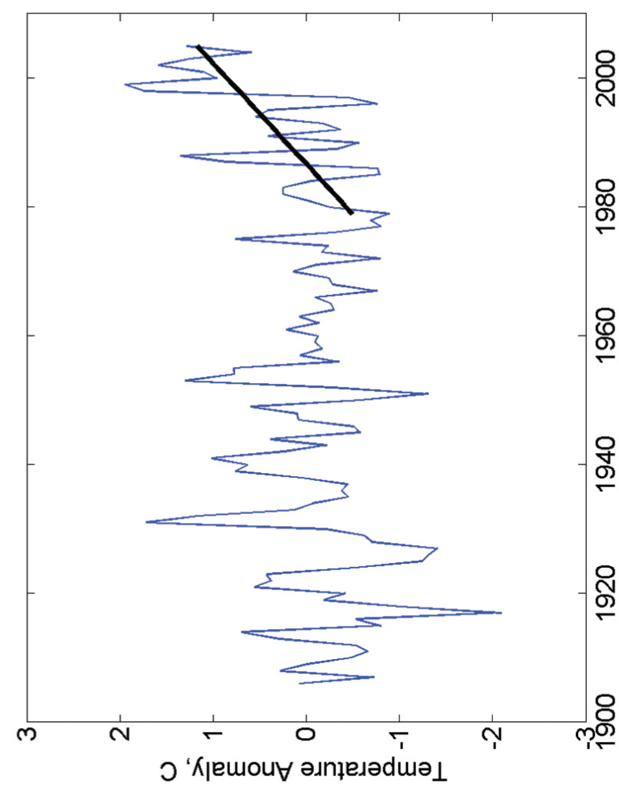
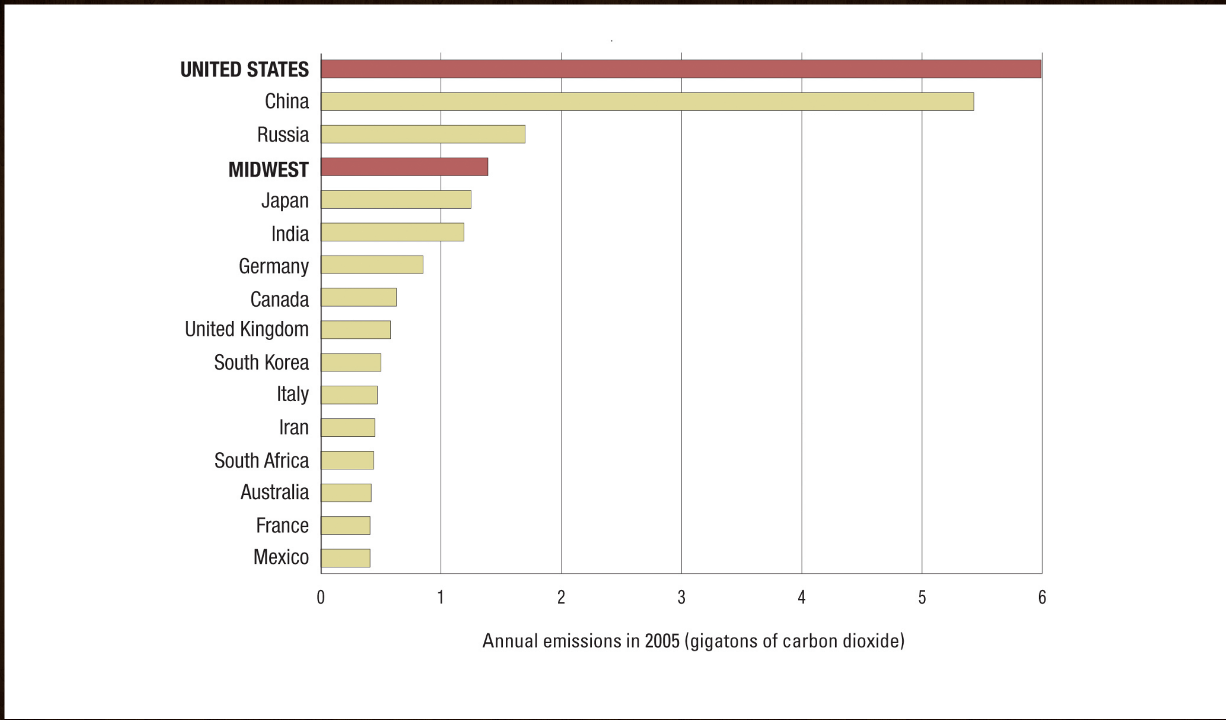


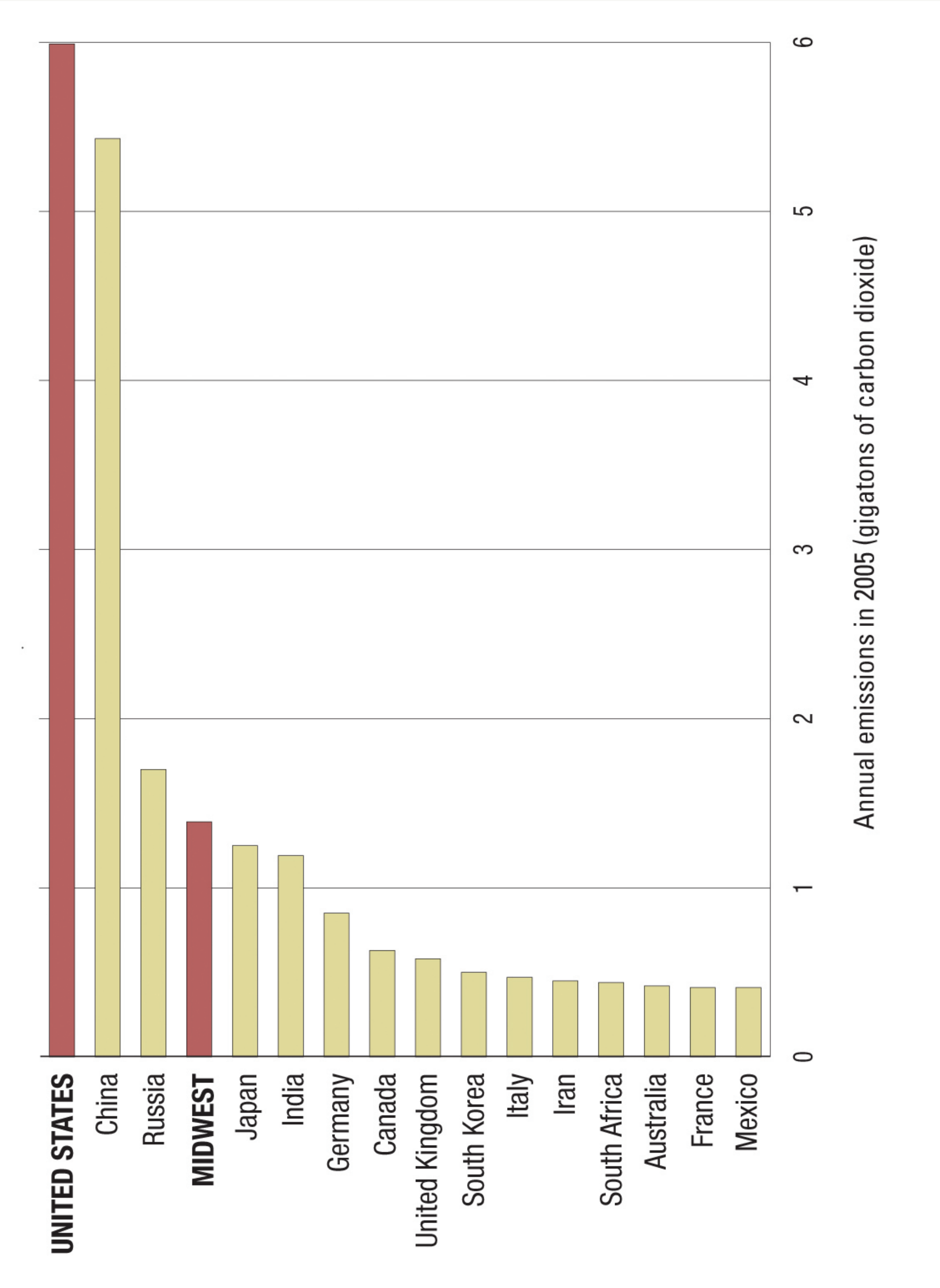
Figure A

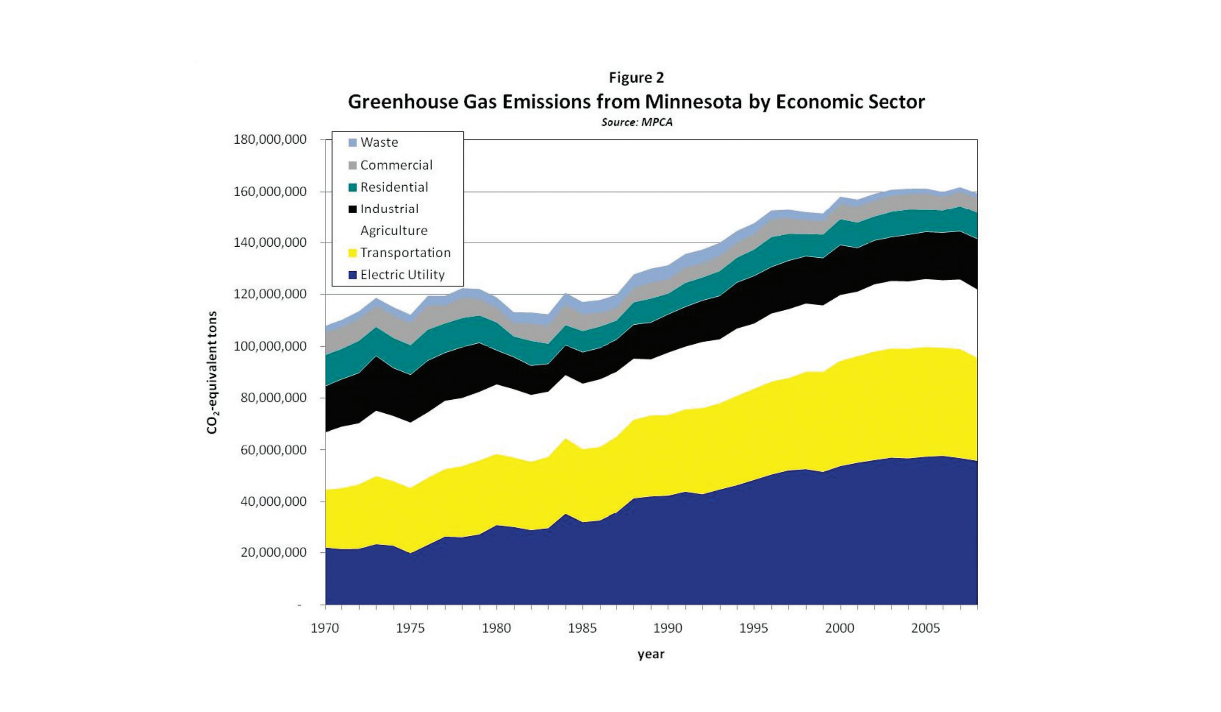


The Midwest Burns More Fossil Fuels Than Entire Nations

Union of Concerned Scientists. (2009). Confronting Climate Change in the US Midwest: Minnesota. Chicago, IL.

TRUE STATEMENTS	FALSE STATEMENTS
The total combined emissions from the eight Midwest states (Illinois, Indiana, Iowa, Michigan, Missouri, Ohio, and Wisconsin) would make the Midwest the world's fourth largest polluter if it were a nation.	China emitted more carbon dioxide than the United States in 2005.


UNITED STATES
China
Russia
MIDWEST
Japan
India
Germany
Canada
United Kingdom
South Korea
Italy
Iran
South Africa
Australia
France
Mexico
0
1
2
3
4
5
6
Annual emissions in 2005 (gigatons of carbon dioxide)



Greenhouse Gas Emissions from Minnesota by Economic Sector

Minnesota Department of Commerce, and Minnesota Pollution Control Agency. (2011) Annual Legislative Proposal Report on Greenhouse Gas Emission Reductions and Biennial Greenhouse Gas Emissions Report to the Minnesota Legislature. Minn. Statt. 216H.07, subd. 3 and 4.

TRUE STATEMENTS	FALSE STATEMENTS
The long-term trend shows increasing greenhouse gas emissions.	The waste sector accounts for the majority of the greenhouse gas emissions from Minnesota.

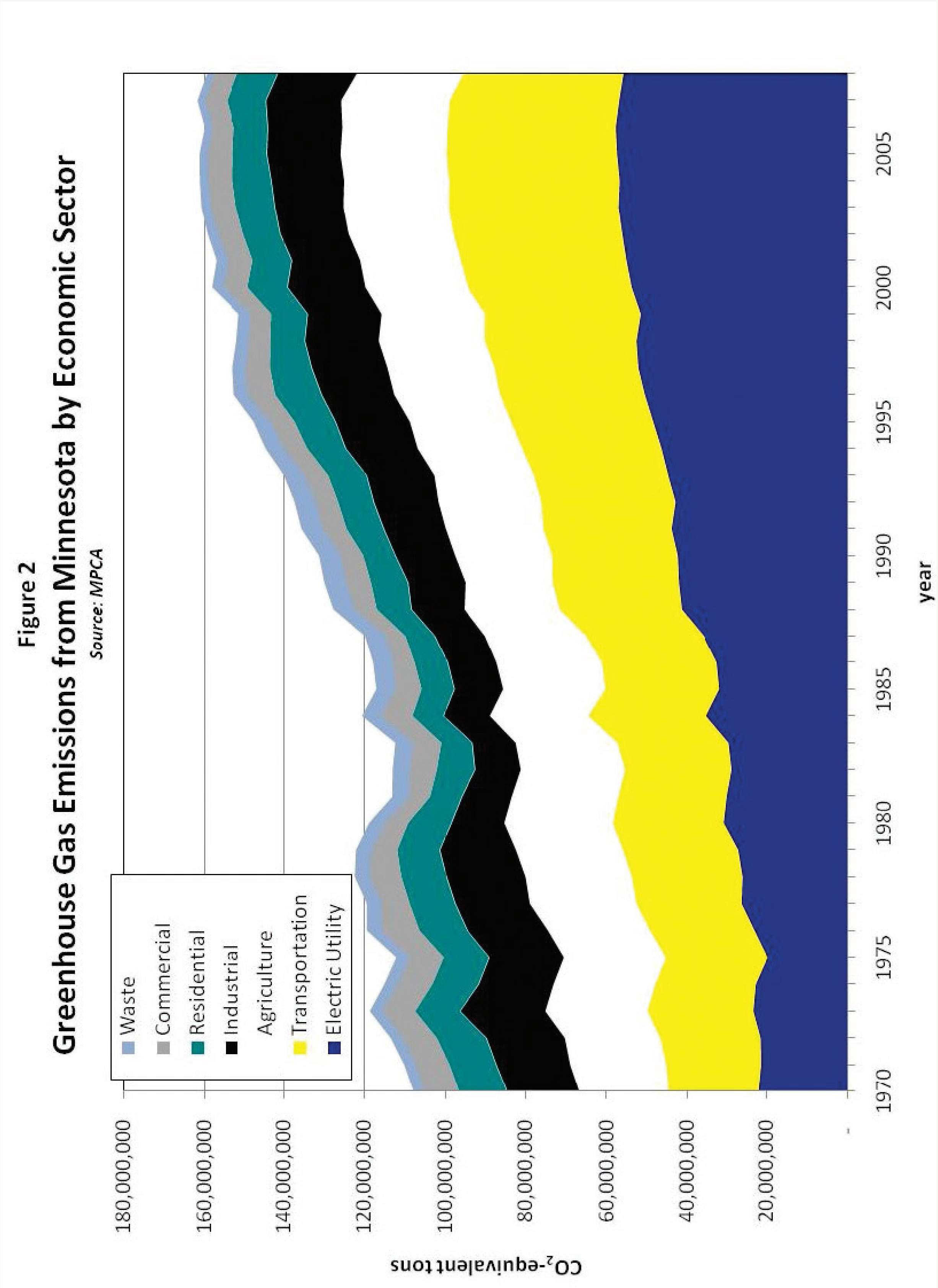
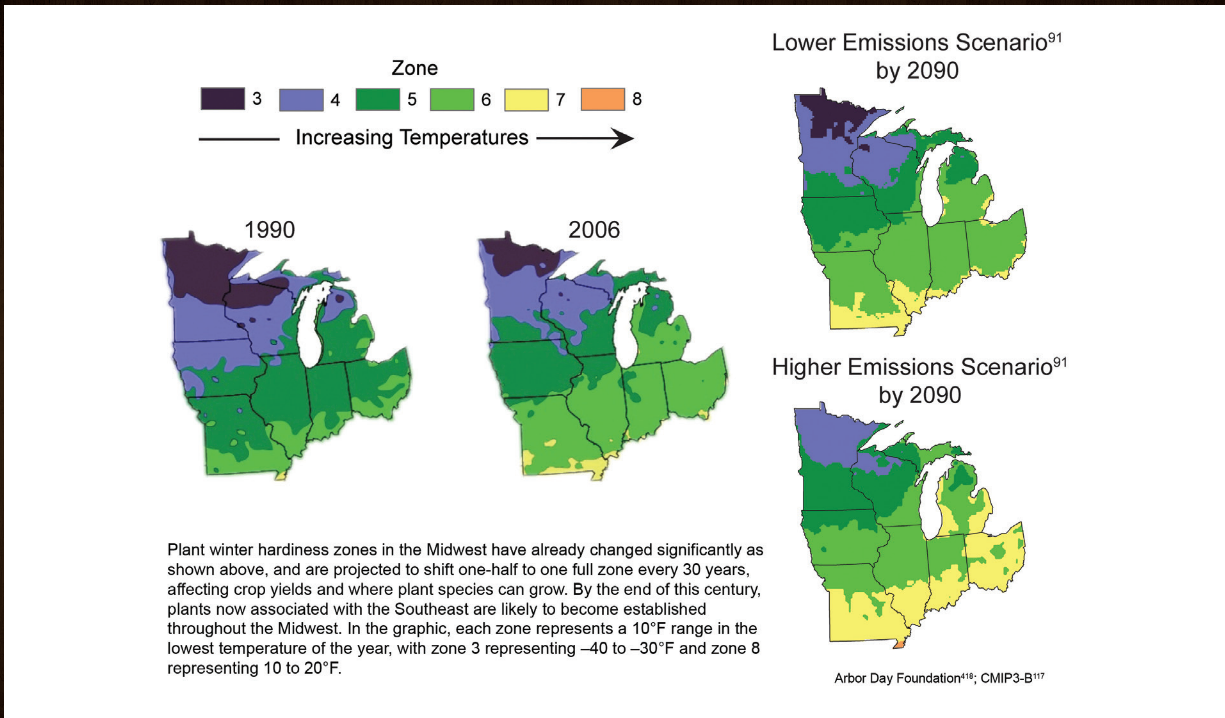


Figure 2
Greenhouse Gas Emissions from Minnesota by Economic Sector
Source: MPCA
Waste
Commercial
Residential
Industrial
Agriculture
Transportation
Electric Utility
180,000,000
160,000,000
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
-
CO_2-equivalent tons
1970
1975
1980
1985
1990
1995
2000
2005
year

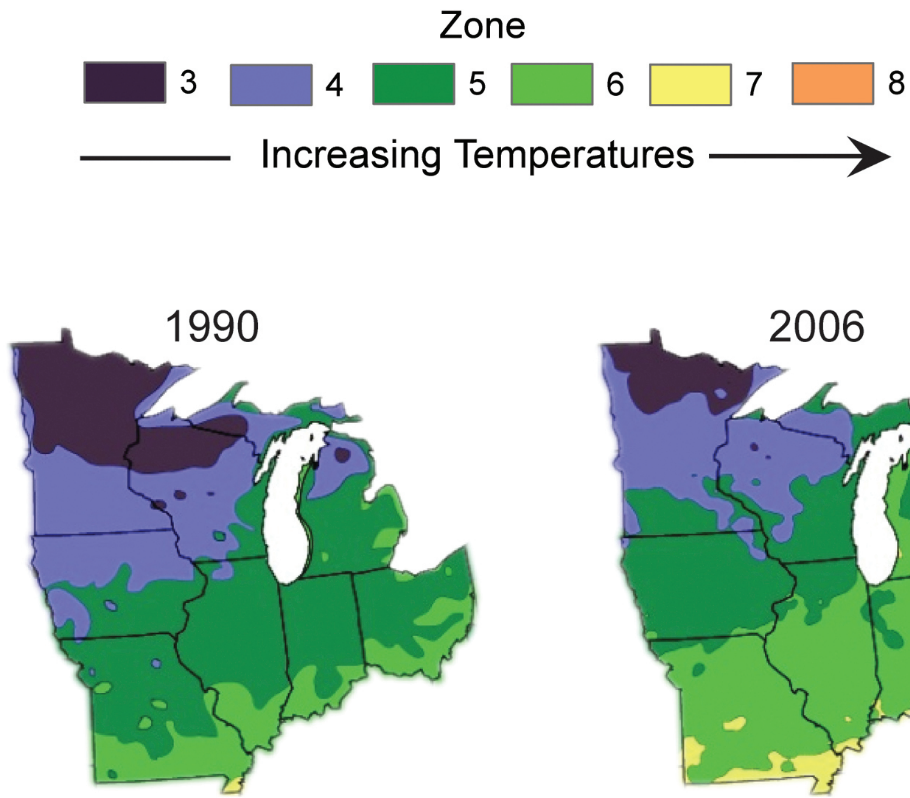


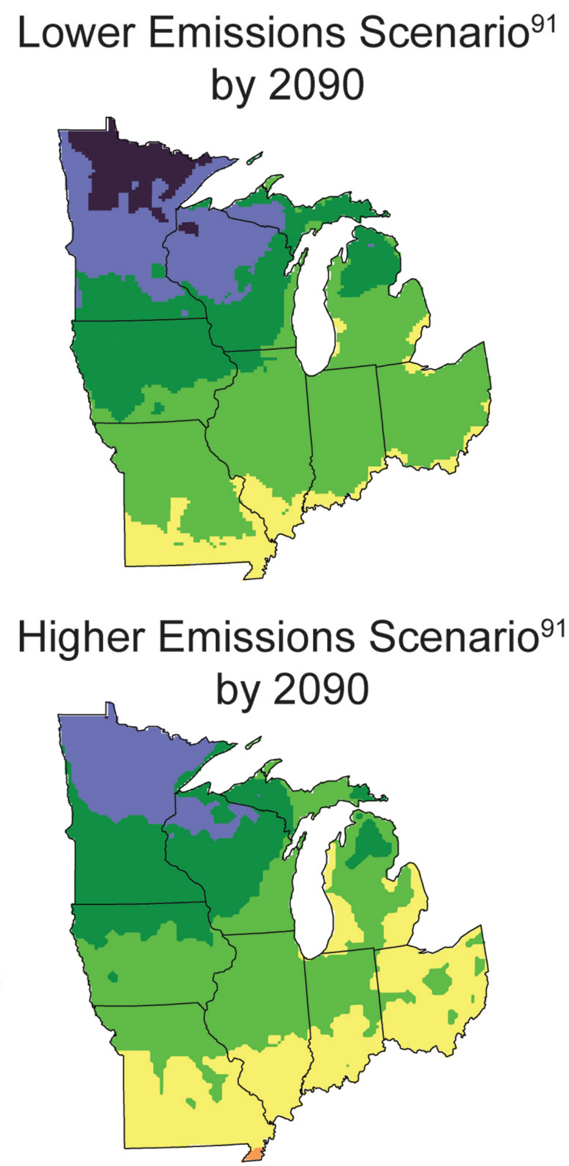
Observed and Projected Changes in Plant Hardiness Zones

Each zone represents a 10 degree F range in the lowest temperature of the year, with zone 3 representing -40 to -30 degree F and zone 8 representing 10 to 20 degrees F.

U.S. Global Change Research Program. (2009). Global Climate Change Impacts in the United States. New York, NY: Cambridge University Press.

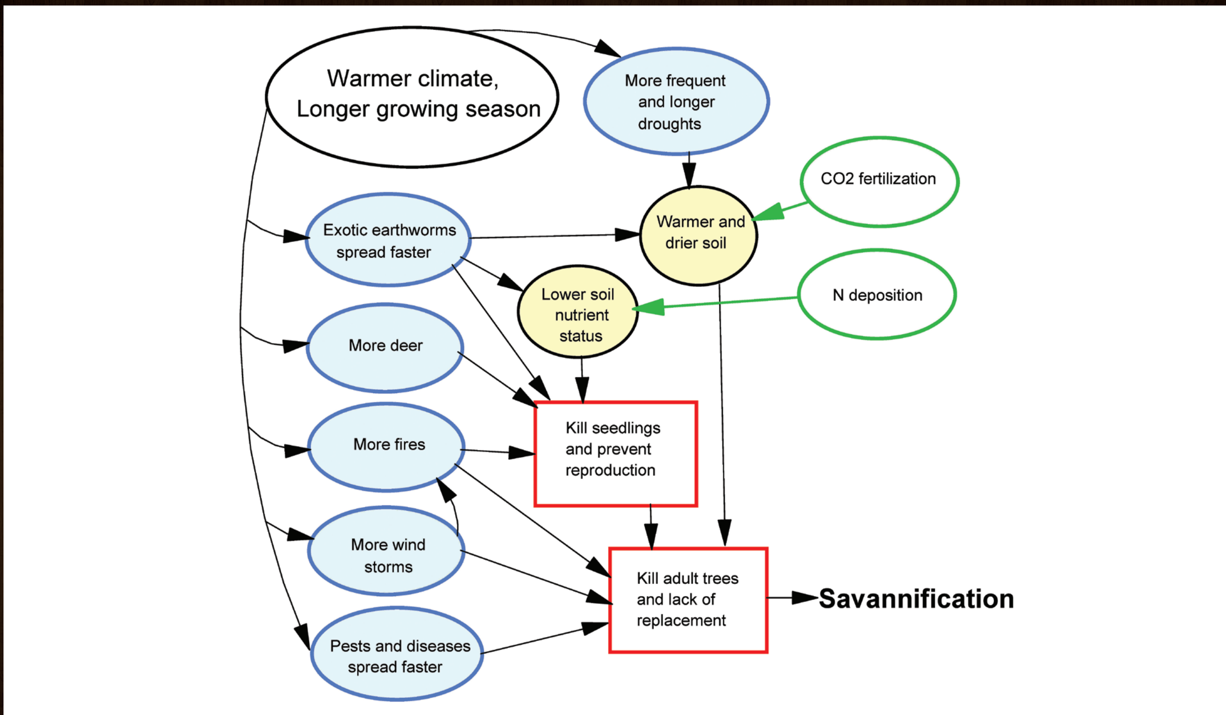
TRUE STATEMENTS	FALSE STATEMENTS
By the end of this century plants now associated with the Southeast are likely to become established throughout the Midwest.	Minnesota will see little change in plant zones under these projections.





Plant winter hardiness zones in the Midwest have already changed significantly as shown above, and are projected to shift one-half to one full zone every 30 years, affecting crop yields and where plant species can grow. By the end of this century, plants now associated with the Southeast are likely to become established throughout the Midwest. In the graphic, each zone represents a 10°F range in the lowest temperature of the year, with zone 3 representing –40 to –30°F and zone 8 representing 10 to 20°F.

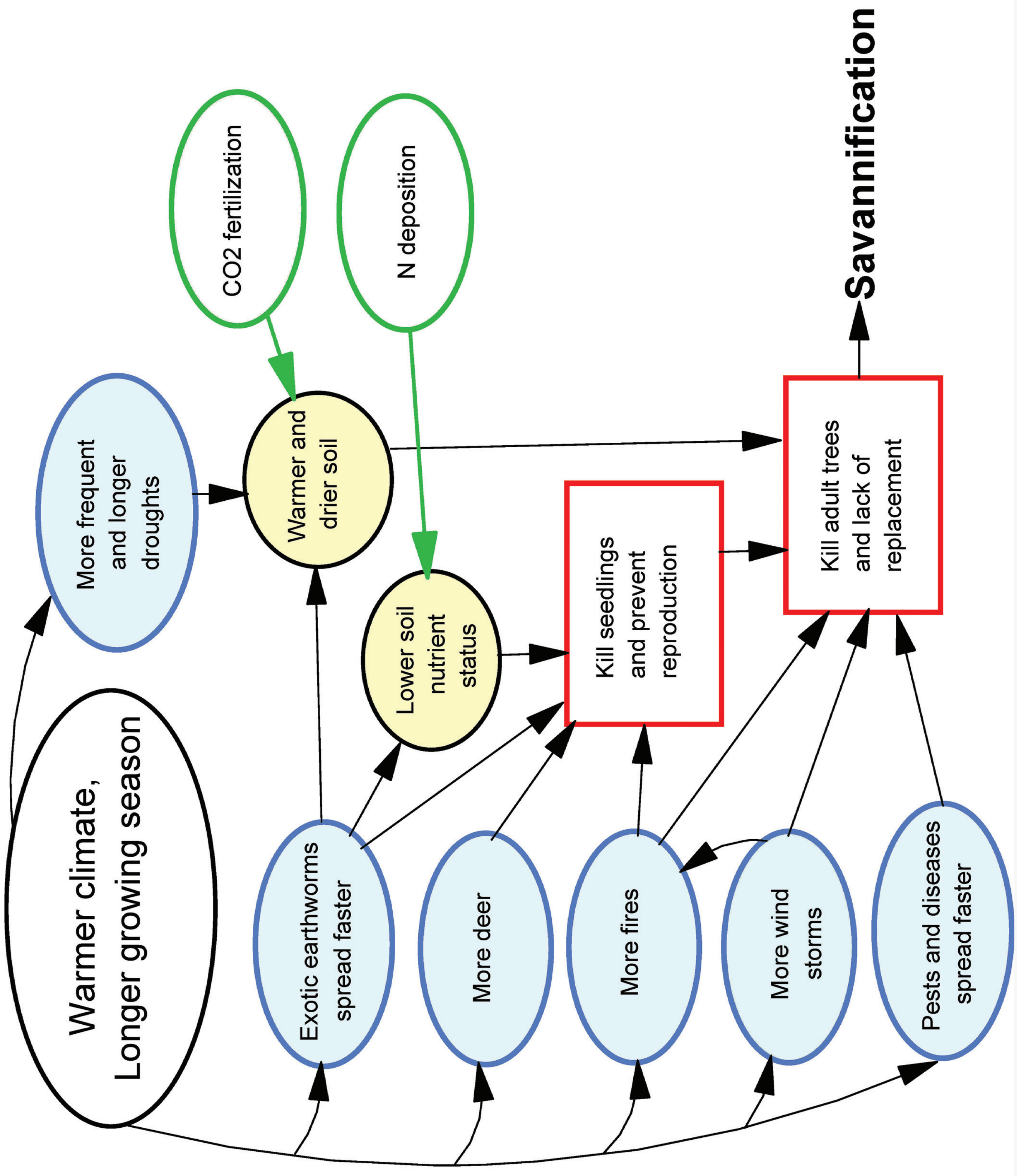
Arbor Day Foundation[418]; CMIP3-B[117]



This chart shows interactions between global warming and other drivers of change affecting the prairie-forest border of central North America, and other impacts on trees. Blue ovals represent drivers with potential negative impacts on trees that are likely to be enhanced by a warmer climate. Yellow ovals represent basic resources that may be changed by a warmer climate or by its interactions with other drivers. Green ovals represent drivers that may counteract negative impacts on trees to some extent. Red rectangles show the results of drivers on trees and their reproduction.

Frehlich, L.E., and Reich, P.B. 2009. "Will environmental changes reinforce the impact of global warming on the prairie-forest border of central North America?" Frontiers In Ecology.

TRUE STATEMENTS	FALSE STATEMENTS
A warmer climate could lead to an increase in deer populations.	Earthworms will help fight the impacts of a warming climate.


Warmer climate,
Longer growing season
More frequent and longer droughts
Exotic earthworms spread faster
More deer
More fires
More wind storms
Pests and diseases spread faster
CO2 fertilization
N deposition
Warmer and drier soil
Lower soil nutrient status
Kill seedlings and prevent reproduction
Kill adult trees and lack of replacement
Savannification

TRUE STATEMENTS	FALSE STATEMENTS

Age Level:	Grades 3-12
Time Needed:	To be determined by students
Materials:	Poster paper Markers Action Worksheet and Template
Student Learning Outcomes:	• Students will brainstorm appropriate solutions and select one for their group, class or school • Students will develop a climate action plan and begin to implement it

Background Information:

Student action to mitigate the effects of climate can take many forms. Crafting position statements and testifying before the legislature, designing public service announcement posters, videos or podcasts, planting trees to absorb carbon dioxide or starting a compost for school or home food waste to decrease methane gas release are all legitimate actions, especially when student driven.

The most important outcome of this lesson and unit on *Minnesota's changing climate*, is that this final action project is <u>student</u> led and <u>student</u> driven. Making sure students feel that they can part of the solution and that their ideas are valuable is an essential key to helping them not feel overwhelmed by the current and predicted impacts of climate change. In addition, the action projects that they develop are valuable assessments of what they understood and connections that they made about what is causing climate change and how it will impact their lives, biome and Minnesota as whole.

> We need to start communicating ... we need to really get active and do what we can in our own sphere of influence...we need the youth.
>
> —Will Steger at youth event, September 2, 2008

Activity Description

This is only one suggested way to help identify student action projects. Throughout this unit, project ideas may have already been developed or started. As noted earlier, the two most important outcomes are that there is a project so that students feel part of a solution, and that these projects are as student-initiated and driven as possible.

Introduction

1. Divide students into five groups and hand out one key issue to each group. Ask each group to dissect the issue to the root cause.
2. Ask students to glue the issue in the center of a large piece of butcher paper or poster board. From the issue, ask them to break it into smaller and smaller parts to identify the root cause or problem. (See example below)

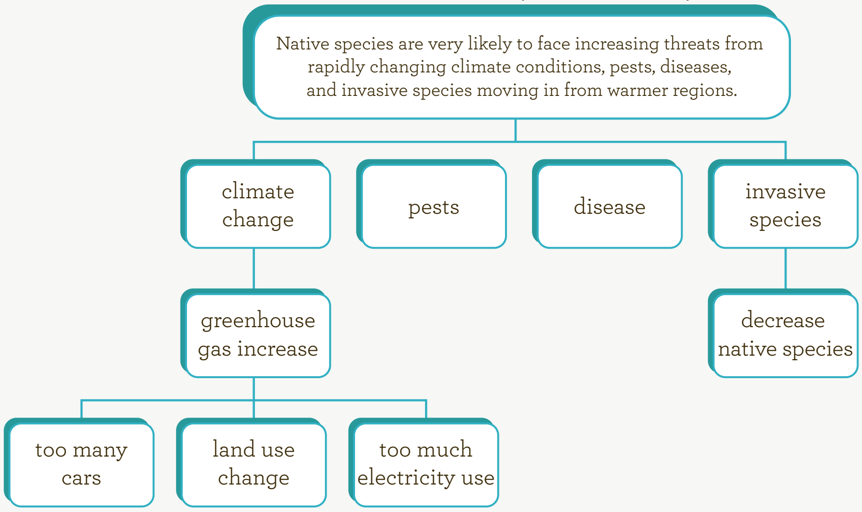


Diagram 1: Native species are very likely to face increasing threats from rapidly changing climate conditions, pests, diseases, and invasive species moving in from warmer regions.

3. Once they have identified a few problems, ask them to turn their poster over and put one problem in the middle of their paper and make a concept map of solutions. Encourage creative thinking and tell them no idea is too crazy at this point. (See example below) This may also be a time to do some Internet research about solutions and project ideas.

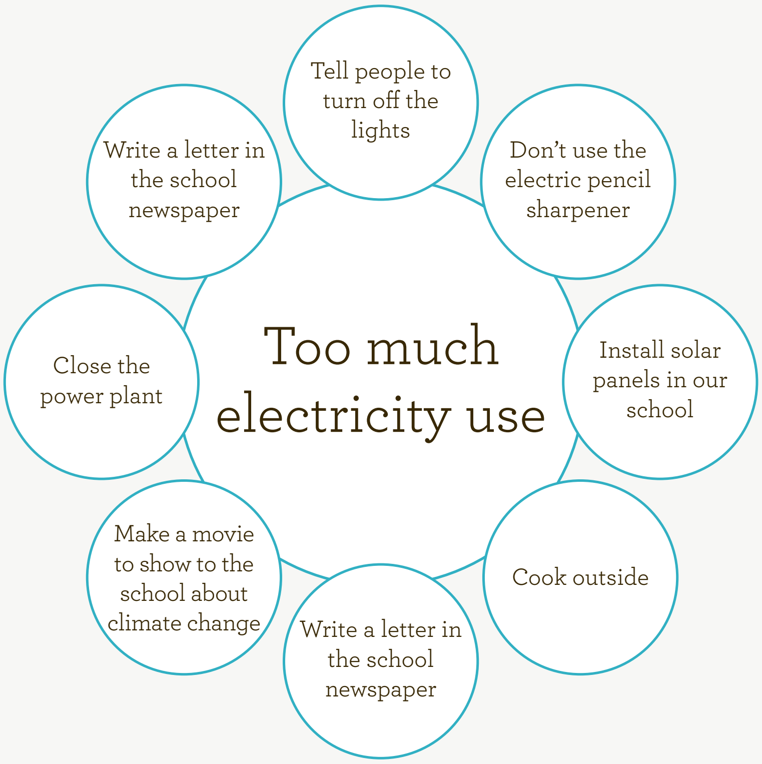


Diagram 2: Too much electricity use

Activity: Developing Action Plans

1. Once the groups have identified solutions. Ask them to post their visuals and have everyone in the class walk around to read the different solutions. Take notes in their journal about which solutions they think are the most interesting and which ones they would be interested in working on.
2. Identify a few solutions through voting ask a class, and ask students to break into interest groups to work on an action plan. Use the attached climate action plan worksheet and template.

Journaling Connection

Ask students to document their "action journey" in their journal. This could be in words, poetry, cartoons, photos pasted in or whatever creative way they can think of.

Take It Outside—Connecting With Your Place

There are many action projects connected with climate change that can happen in your schoolyard or nature area close by. If your students are able to articulate the connection between what they are proposing and climate change, that is the most important part.

Online Classroom Connection

Visit http://classroom.willstegerfoundation.org

Submit your climate action plans, as well as photos and videos of you in action, or email them to education@willstegerfoundation.org

Climate Action Plan Template

Part One: Brainstorming

1. What issue are you most passionate about regarding the impacts of climate change in Minnesota? Why?

2. What do you want to see change at your school and/or what does your school or community need to do to help mitigate or adapt to the impacts of climate change?

3. What connections do you see between your passions and the needs of your school/community?

4. Use the space below to jot ideas for potential projects based on the previous questions and your participation in workshops/discussions:

Part Two: Action Plan

Now that you've done some brainstorming, it's time to get more specific. Here is a step-by-step process that can help you identify a project and develop SMART goals. Use the Project Planning Worksheet to create a strategic and successful action project while referring to the steps below to guide your work.

Step One: Choose a Project Focus

Some potential areas to work on are listed below, but don't limit yourself to these ideas. Get creative, and address the greatest needs in your school or community.

Project ideas include: energy efficiency on campus, climate change curriculum/awareness/eco-literacy education, greening your school cafeteria, organic gardening, composting, recycling, reducing your school's carbon footprint, less dependence on fossil fuel transportation, make your school a bike friendly school, install a rain garden, plant trees and native plants, green financing/purchasing, etc.

The area I will focus on for this action plan is: ______________________________

Step Two: Setting SMART Goals

Something to keep in mind when you're creating your Goals and Objectives is S.M.A.R.T. decision-making. S.M.A.R.T. stands for "Specific, Measurable, Achievable, Realistic, and Timely." You can begin with some pretty lofty goals (such as the desire to make your community 100% carbon neutral), but they have to be broken down into manageable activity chunks that have specific measures of success. For example, rather than have a goal of "Get everyone at school to start recycling," the S.M.A.R.T. way of stating that goal would be to say … get two recycling bins placed in each classroom and create a student-led pick-up program for this year."

There are two major benefits of having realistic goals with definite measurements of success. One, you'll feel a sense of accomplishment when you've met your goal. The community will also be able to see progress—and will therefore be much more likely to get involved. Two, the people who give you money for your project will prefer those kinds of specific goals. If you need to write a grant or ask the local millionaires' club for a donation, they will ask for specifics to make sure that their money goes toward some tangible achievement.

S.M.A.A.R.T.T.

Specific	can be well-defined and clearly understood by anyone who has basic knowledge of the project
Measurable	can know if a goal is obtainable, when it has been achieved and how far away completion is
Achievable	can be achieved within the current environment
Agreed Upon	agreement with all the stakeholders what the goals should be
Realistic	can be accomplished within the availability of resources, knowledge and time
Timetable	are limited by a timeframe
Tangible	anyone can experience it

Step Three: Building Your Team

As much as you'd love to do this solo, you're going to have to partner with a team, group, and/or organization in order to achieve your goals. You may already have a team you're working with, or you may be starting from scratch; either way, it's helpful to know who you'll be working with. Brainstorm a list of the people that you want to include in your team. This could include students passionate about your issue, students working in related groups, educators/advisors/administrator, facility management, community members, parents, etc.

Step Four: Identifying Potential Roadblocks

Brainstorm a list of potential obstacles you may need to overcome in order to reach your goal (for example: lack of funding, disinterested students, no administrative support, intimidating facilities manager, etc.)

Step Five: Identifying Your Project Resources
What space, money, materials and other resources do you have that will help to achieve your goals?

Consider your assets:
Human assets – individual skills and knowledge of members of your community
Association assets – groups that have come together for a common purpose
Institutions (public or private) – schools, local government, businesses, nonprofits
Built Assets – buildings, public spaces, other infrastructure
Financial Assets – funding potential, grants, investments, etc.

Step Six: Building Support
Who needs to know about this project? How will you share your story and build the support you need?

Step Seven: Making a Project Timeline
Create a realistic and concrete timeline that includes preparation for your project, project implementation, and any wrap-up or follow through that needs to happen.

Step Eight: Implement Your Project
Get out there and DO something great!

Step Nine: Share Your Success!
Report on your accomplishments to your school and community via newspapers, forums and social media, including: http://classroom.willstegerfoundation.org

Part Three: Climate Action Plan Summary
Use the action plan worksheet to fill out this summary.
Full name of lead educator/adult mentor contact: ______________________
First names of student group members: ______________________

Email: ______________________
Phone number: ______________________
School/grade: ______________________
What is your project focus? ______________________

Please list your top three S.M.A.R.T. goals
a) ______________________
b) ______________________
c) ______________________
Include a brief summary of your timeline ______________________

We would love to share your plan and the outcomes of your project! Please return this form by mail, email or fax with photos or other relevant supporting documents to:
Minnesota's Changing Climate Project
Will Steger Foundation
2810 21st Avenue South, Ste 110
Minneapolis, MN 55407
education@willstegerfoundation.org
Fax# (612) 278-7101

Or upload it on the *Minnesota's Changing Climate* website at:
http://classroom.willstegerfoundation.org

ACTION PLAN WORKSHEET

WILL STEGER FOUNDATION

1 Project Focus: ____________________

Specific
Measurable
Achievable
Realistic
Timetable

2 Goals/Objectives:	3 Your Team:	4 Road Blocks:	5 Resources/Assets:	7 Timeline of Activities (by month):
				Nov: Dec: Jan: Feb: Mar: Apr: May: June: Next School Year:

6 Building Support:

Will Steger Foundation 2801 21st Ave S, Suite 110 Minneapolis, MN 55407
Tel: 612-278-7147 Email: info@willstegerfoundation.org
www.willstegerfoundation.org

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Lesson 5

Dr. Audrey C. Rule at the University of Northern Iowa developed the curriculum materials from which this lesson was adapted:

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