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research opportunities in minnesota and the dakotas

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Our Mission

The Nature Conservancy preserves the plants, animals and natural communities that represent the diversity of life on Earth by protecting the land and waters they need to survive.

Our Origins

The Conservancy emerged from a professional association of ecologists seeking to turn their knowledge of nature into positive action for conservation. Incorporated as a nonprofit in 1951, the Conservancy completed its first land acquisition with a modest 60-acre purchase in New York. The Conservancy's Minnesota program was established in 1958, a year after its first land purchase in Minnesota – the 80-acre Caledonia Oaks tract in Houston County, 30 miles south of Winona. The tract, which was transferred to the Minnesota Department of Natural Resources in 1987, is heavily wooded with white oak, burr oak, red oak, American elm and sugar maple trees.

The Conservancy's Science Program

Science plays a role in all steps of the conservation process. We employ scientific, systematic analyses to identify places large enough in scale and rich enough in plant and animal species to ensure meaningful conservation results. By employing this scientific planning approach – called *Conservation by Design* – we are developing a blueprint for action around the world to preserve the areas most crucial to the Earth's biodiversity. Scientific information also helps to inform effective strategies and to measure our successes. The Conservancy's highest priorities for emerge from and support our local adaptive land management activities.

Science Staff

Meredith Cornett, Director of Science (adjunct faculty member at the University of Minnesota)
Phil Gerla, Conservation Hydrologist (joint position with the University of North Dakota)
Mark White, Forest Ecologist (adjunct appointment at the Natural Resources Research Institute)
Doug Shinneman, Postdoctoral Scientist (associated with USFS Northern Research Station)
Kristen Blann, Aquatic Ecologist (affiliated with the University of Minnesota – St. Paul)

Research Opportunities

Preserves owned and managed by The Nature Conservancy are available for conservation-related research projects that are compatible with our mission. To apply for a research permit, please send us a short proposal outlining objectives, methods, and timeframe to start the process.

We have also identified a number of priorities for collaborative research. Some of these projects are ongoing, and we are seeking funds for others. If you are interested in pursuing one of these topics, TNC may dedicate a higher level of resources and collaborative support for your research. Descriptions follow for each high priority project.

Forest Ecology

Our research objectives for the forested landscapes in the Superior Mixed Forest and Prairie Forest Border Ecoregions are driven by characteristic ecological systems and their natural variability in composition, structure and spatial patterns. Natural variability of forest ecosystems can be viewed as the interaction of species assemblages, abiotic factors at multiple scales, and the frequency and severity of natural disturbance. The ecological classification system, at the finer scales (landscape ecosystem and native plant community) is the key organizing factor for developing natural variability based objectives.

1. **Defining natural dynamics silviculture in the forests of northern Minnesota**. In a variety of forest systems, we will empirically test the assumption that developing silvicultural systems based on our understanding of natural disturbance processes leads to a suite of desired characteristics at the stand and landscape level. Part of this process in each system will involve defining the desired characteristics for which we are managing (e.g., of older growth stages, as appropriate).
   Mesic birch-aspen-spruce-fir forests- **(Research Need: Potential MS or PhD student project)** How do the composition and structure of vegetation growth stages (VGS) compare in stands of natural and managed origin? How can we restore stands that are outside their range of variability using our understanding of natural disturbance processes? A range of management options may be applied.
   Oak-pine forests- **(Research Need: Potential MS student project)** In the Lake Alexander landscape of central Minnesota, what role should fire play in the restoration and maintenance of dry-mesic forest systems? For example, with encroachment of ironwood and sugar maple in the understory of these forests, is fire an effective tool for management? Are there opportunities to combine fire with silvicultural treatments?
   Northern hardwoods- **(Potential PhD student project)** We are exploring the use of gap-based management and natural dynamics silviculture to restore structure and composition in the Manitou Forest Landscape. In the future, we plan to better characterize size, distribution, and rate of gap development specific to the Manitou Landscape and determine whether gap treatments achieved locally appropriate goals.

2. **Appropriate timing, frequency, and intensity for the use of prescribed fire to control hazel in dry-mesic pine forests**. **(Research Need: Potential MS student project)** Hazel competition is a significant barrier to regenerating and maintaining dry-mesic pine systems. With funds from the National Fire Plan, we are implementing a combination of practices to address this barrier.

Restoration Ecology

1. **Hydrologic consequences of prescribed fire in grassland and forest ecosystems**. **(Research Need: Potential PhD/crossdisciplinary project)** We hypothesize that fire management can significantly change nutrient cycling, and may lead to changes in runoff mechanisms, down-gradient water quality, and other ecosystem functions such as carbon sequestration. TNC preserves where fire management is taking place provide an excellent opportunity to test our questions. For example, how does groundwater develops its geochemical "fingerprint?" Does periodic fire enhance the storage of carbon? Changing the fire regime likely influences runoff, although the

nature of the change and its significance in the larger prairie hydrological cycle are unknown. Tools and techniques to examine these ideas may include the installation of soil water monitoring stations and runoff samplers. Soil analysis and environmental isotopes, including N, S, O, and H, could give important information on the sources and pathways of water and nutrients in the prairie system.

2. **Comparing effectiveness and costs of mechanical vs. prescribed fire methods for reducing aspen encroachment in the Tallgrass Aspen Parkland**. **(Underway)** Land managers are hesitant to use prescribed fire to reverse aspen encroachment and have a preference for mechanical methods. We are implementing a study that will compare the effectiveness and cost per acre of the two approaches in an effort to encourage other land managers to consider fire part of the toolkit available to them. With funding from Conservation Partners (Department of Natural Resources) and the Rocky Mountain Elk Foundation, we identified sites and refined our sampling strategy in fall, 2005. We will implement a few treatments over the winter and conduct a first round of sampling in spring, 2006.

3. **Comparing livestock gains on cool season pastures dominated by a few, non-native grasses with diverse, native prairie**. **(Research Need: Potential PhD student project)** This question has important conservation implications because conversion of native pasture to cool season-dominated pastures or other forms of agriculture is one of the biggest threats to native grasslands in the northern Great Plains. We hypothesize that, given diversity-productivity-stability relationships in grassland ecosystems, gains are likely to be higher on native pastures. We will focus on measuring gains, as this is the variable that is most likely to speak to livestock producers. If the hypothesis holds up empirically, livestock producers will be more likely to invest in maintaining or enhancing native grassland rather than converting to other uses. The study will be piloted in the Sheyenne Delta of North Dakota. We are in the process of applying to the USDA National Research Initiative Managed Ecosystems Competitive Grants Program in collaboration with researchers at the U.S.D.A. Agricultural Experiment Station in Mandan, North Dakota.

4. **Testing the assumption that localized deer hunts on particular preserves will reduce deer browsing pressure**. **(Research Need: Potential MS student project)** The assumption among land managers is that one way of dealing with excessive browsing pressure on native vegetation is to allow hunts on specific preserves. Anecdotally, land managers around the state have reported positive results with this approach, but only a handful of studies in the peer-reviewed literature have attempted to document this phenomenon. TNC is interested in instituting hunts to locally reduce deer densities. A meta-analysis summarizing the experience of other land management agencies around the state with this approach, along with documentation of effects at TNC preserves would help us to evaluate the effectiveness of this technique.

5. **The importance of rocks in prairie ecosystems and approaches to redistribution in the context of vegetation restoration**. **(Research Need: Potential MS student project)** Rocks may play an important role in prairie ecosystems, providing thermal refugia, protection, habitat, and structural complexity. When grasslands are converted to agricultural fields, rocks are also typically removed and piled. We are interested in research that documents the role of large rocks in prairies, and assessment of how important it is to redistribute them to reach restoration, and recommendations for how to accomplish this task. This study will preferably take place in the Prairie Coteau of Minnesota and South Dakota, but could be conducted in any of our prairie landscapes.

6. **Selecting an appropriate fire regime for prairie restorations and remnants in the Northern Tallgrass Prairie Ecoregion**. **(Research Need: Potential Ph.D. project)** The Conservancy has developed expertise in prescribed fire in native grasslands over the past few decades. An impressive prescribed fire program has developed as a result. We are, however, in need of refining our guidelines on how often, how much, and in what configuration to burn. Our current fire return intervals are based on preliminary research south-central grassland systems. We propose developing a unique set of science-based recommendations for the northern plains.

7. **Patch burn grazing systems: can they be used on a small scale?** **(Research Need: Potential M.S. or Ph.D. project)** Patch burn grazing systems are being used successfully in of Oklahoma and Nebraska to restore natural disturbance regimes in native grassland ecosystems. To date, this practice has been tested in relatively large, intact landscapes. How well do principles of patch burn grazing transfer to smaller remnants in more northerly climates of Minnesota and the Dakotas? Is there a size threshold below which using patch burn grazing is not advisable? We need to test these questions using similar methods at three to four sites and examine plant community responses to patch burn grazing.

Landscape Ecology

1. **Global climate change- what it means for conservation strategies in Minnesota and the Dakotas**. **(Ongoing PhD student project in collaboration with the University of Wisconsin, Madison)** The Conservancy has identified a suite of important conservation areas that are intended to represent all of the biodiversity across Minnesota and the Dakotas. With funding from TNC's Rodney Johnson – Catherine Ordway program and the Cox Family Fund for Science and Research, we are currently conducting a modeling effort using LANDIS II for northern Minnesota to address the following questions:
   - How effective will these areas be at conserving biodiversity under warming conditions?
   - How can conservation groups incorporate anticipated changes and resulting effects into conservation plans, particularly related to developing strategies?

2. **Testing our assumptions about coarse scale/fine scale conservation**. **(Research Need: Potential PhD or postdoctoral project)** One of TNC's major assumptions in many of our landscapes is that we can identify threats and develop strategies to conserve the coarse scale features. Implementing the strategies and abating the threats for the coarse scale is assumed to also help the fine scale targets. The upland-wetland mosaic at Glacial Ridge provides a great opportunity to explicitly test this assumption. Here we are taking steps to document changes in vegetation at a coarse scale as restoration gets underway in this 24,000 acre landscape, and to examine how amphibian communities respond.

3. Land ownership patterns in the Border Lakes Region of Minnesota and Ontario. **(Ongoing Postdoctoral project funded by and in collaboration with USFS Northern Research Station)**
   The Border Lakes Project is a research-based effort that seeks to better understand long-term forest disturbance dynamics within the Border Lakes region, a large (5.1 million acres), lake-studded, forested landscape that straddles the Minnesota-Ontario border. The Border Lakes region is mostly (~93%) publicly owned, but contains complex patterns of land ownership and resource use. Management of conservation areas, sustainable timber production, recreational use, long-term forest health, and the use and suppression of fire are topics of major concern for most land-owners and stakeholders within the region. We are analyzing the Border Lakes forests using

LANDIS, a spatially-explicit, forest-dynamics model. The modeling will help to develop collaborative, cross-boundary strategies for managing forest resources, reducing hazardous fuels and conserving biodiversity.

Hydrology

1. **Ecological consequences of hydrologic alterations in prairie stream and wetland systems**.
   a) ***Tallgrass Aspen Parkland*- (Underway)** We are investigating the effects of altered hydrology at two different sites: Skull Lake Wildlife Management Area and TNC's Caribou Woods Preserve.
   ***Skull Lake*- (Underway)** How does the unregulated impoundment affect the ecohydrology of the glacial Lake Agassiz dunes and potholes? How have the natural hydrological conditions changed? Does mowing aspen, the current management strategy, simply decrease evapotranspiration (ET), thereby exacerbating encroachment by phreatophytic woods and brush?
   ***Caribou Woods*- (Underway)** How have 1990s ditching and roads influenced the natural hydrology at Caribou Woods? What is the most effective strategy to restore this wetland / parkland system?
   b) **Agassiz Beach Ridges- (Underway)** We are examining how hydrologic implications of prairie restorations at two sites, the Pembina Trail Preserve and the Glacial Ridge Project.
   ***Pembina Trail*- (Underway)** 1) How does soil moisture differ between paired native tallgrass prairie and newly restored uplands? We have collected 2+ years of data to address this question. 2) What is the relationship between the phenology of the federally threatened western prairie fringed orchid (*Platanthera placata*) and hydrological dynamics?
   ***Glacial Ridge*- (Underway)** How do ET rates vary for different land cover and restoration ages? We are collaborating with the University of North Dakota using a combination of remote sensing/SEBAL analysis and field measurements to address this question, and may also use NDVI as a way to assess the condition and progess of restorations quickly.

2. **Groundwater recharge and geochemistry**
   ***Ongoing and recently-completed research*-** Over the last two years, Conservancy scientists have been working to define the groundwater recharge zone for the unique springs and seeps at Pigeon Point in the Sheyenne Delta of North Dakota **(Corey Askin, MS student, University of North Dakota)**. This work is important to conservation because it helps us to understand in how large an area we need to be managing vegetation to a certain standard, e.g., restoring it to prairie. As a follow up we will characterize the geochemistry of the springs, with specific attention to how the water composition and redox conditions relate to land cover and position along soil water and groundwater pathlines **(Bill Lenarz, MS student, University of North Dakota)**. The North Dakota Water Resources Research Institute will provide start-up funds in 2005.We are trying to understand these patterns better, as it relates to how nutrients and contaminants may move throughout the system.
   ***Future projects*-** TNC is seeking funds to examine the electrical resistivity or electromagnetic conductivity to delineate the effect of uncontrolled flowing wells on groundwater and soil salinity.

3. **Data development for effective numerical hydrological models of prairie and wetland ecosystems**. **(Research Need: Potential PhD student project)** To better understand hydrologic processes in prairie ecosystems, MODFLOW and HYDRUS 2D offer well-known and broadly accepted hydrological modeling codes. They contain modules that provide for flexibility in modeling water loss through ET. To develop effective numerical hydrological models of prairie and wetland systems, data on the root structure of various prairie and wetland plant communities are necessary. These data are generally available for major agricultural crops, but seriously lacking for natural systems. We are submitting a collaborative research proposal with a the University of North Dakota to TNC's Rodney Johnson-Katherine Ordway research grant program to explore this idea.

4. **Research questions following the stream classification conducted for the Northern Tallgrass Prairie Ecoregion.** 1) What is the relationship between stream physical classes and biological data? 2) What is the sensitivity of sub-watersheds to changes in key watershed factors and processes? 3) To what degree have key watershed processes been altered in each sub-watershed?

Invasive Species

1. **Prairie reconstructions as barriers to weed invasions for native prairie remnants**. **(Research Need: Potential MS student project)** Recent peer-reviewed work has documented the effectiveness of native prairie plantings as barriers to invasion of agricultural fields by noxious weeds. Such a study seems like it is just documenting the obvious, but was extremely important as everyone assumed it had already been done. It would be a nice contribution to document a similar phenomenon for native prairie remnants in places where we have installed adjacent reconstructions. The Glacial Ridge Project or other prairie preserves of western Minnesota represent excellent study sites to address these questions. In addition, this study could be a formal exploration of another alternative weed management strategy.

2. **Can we control leafy spurge? Biocontrol experiments and the response of native vegetation.** **(Underway – Nearly complete)** We are entering our fifth year of the project in 2006. Study locations are at TNC's Broken Kettle Preserve (Iowa), the Sheyenne Delta (North Dakota), and the Prairie Coteau (South Dakota). Recent analyses from Altamont preserve in South Dakota (Cornett et al., *Ecological Restoration*, in review) demonstrated the effectiveness of flea beetles (*Apthona* sp.) in controlling leafy spurge, as well as the response of plant species richness both to suppression and release. With a fifth year of data collection across three states, we will determine the wider applicability of this approach. A student interested in working with collaborators to collect field data and analyze a five-year data set may be recruited for this project. Funding for field work in 2006 has been secured through the Cox Family Fund for Science and Research.

3. **Implications of flea beetles (*Apthona* sp.) on related native insect assemblages**. **(Research Need: Potential PhD student project)** The Conservancy has been working over the last four years to document impacts of leafy spurge and its biocontrol, *Apthona* sp., on the native plant diversity of prairie communities. An early analysis of preliminary data suggests that the presence of flea beetles has a positive effect on the plant community. However, we know nothing of the impacts of flea beetles on prairie insect assemblages. We propose an investigation comparing, closely-related beetles in areas where flea beetles have been

introduced vs. areas where they have not been introduced in an effort to draw some conclusions about the desirability of this approach to leafy spurge control.

4. **What are the management implications of the cow vetch (*Vicia cracca*) expansion in southeastern Minnesota**? **(Research Need: Potential MS or PhD project)** Until recently, cow vetch was perceived to be a relatively innocuous non-native posing little threat to native prairie ecosystems (http://www.dnr.state.mn.us/invasives/terrestrialplants/herbaceous/cowvetch.html) In the last few years, land managers in southeastern Minnesota, particularly the Weaver Dunes – Zumbro Delta landscape, have grown concerned about the spread of this invasive plant. In managed areas with regular control, cow vetch has been maintained as a minor part of the community. In areas where it has been neglected, the expansion has been widespread and substantial. What are the pathways of invasion for cow vetch and the most effective methods for its control? What will the future bring if we do nothing? How much would an effective control program cost?