Rock climbing has grown to be a major recreational sport in the United States, and Minnesota has become one of the leading states in the nation for rock climbing because of its well-known and excellent climbing sites. One of the premier climbing sites in the state is Shovel Point, a spectacular cliff along the North Shore of Lake Superior that lies within the boundaries of the Tettegouche State Park (Figure 1). In addition to being a sought-after rock climbing site, Shovel Point is also a popular hiking destination for tourists. The pressure on the land from recreational users has caused vegetation to die along the cliff edge. This die-back, or kill zone, has occurred because of severe soil compaction and erosion problems. Shovel Point is considered a unique micro-habitat because of the combination of poor, shallow-depth soils and a short growing season from the cold climate. The result is a significant negative environmental impact from human recreational use on a particularly sensitive landscape.

In 1995, the Minnesota Department of Natural Resources (DNR) established a management plan to reduce impacts from rock climbers and recreational hikers while protecting and restoring the natural landscape along the cliff edge at Shovel Point. To implement the plan, the park manager at Tettegouche State Park began an innovative program to encourage self-regulation among recreational users of the park. Through a citizens advisory committee and in consultation with natural resource and recreation professionals, the park manager sought to develop a plan to minimize user impacts, stop the kill zone.
from moving farther inland, and restore native vegetation while minimizing restrictions on rock climbers and hikers.

Beginning in June 1998, our research team began a long-range, multipart study in support of the Tettegouche State Park Management Plan, which we describe below. This research was funded in part by the Center for Community and Regional Research (CCRR) at the University of Minnesota at Duluth through a grant from CURA, with additional funding from the Minnesota DNR.

Methods
There were five distinct parts to the study we undertook in support of the management plan:

1. creation of a geo-referenced map of human-made and natural features at Shovel Point;
2. a survey of recreational users of Shovel Point regarding their attitudes toward the proposed management procedures, including marking trails, restricting access to some trails, installing decked staging areas, installing fixed anchors for climbing, and requiring climbers to access Shovel Point from a designated trailhead. Respondents were also asked about the degree to which they believed they and other climbers would adhere to the proposed procedures. The survey was field-tested to ensure validity. Interviews were conducted on alternating Saturdays, Wednesdays, and Fridays from July 15 to August 15, 1998, during either the morning or the afternoon. During this time period, we surveyed a total of 639 visitors (430 hikers and 209 rock climbers).
   - Respondents showed a strong willingness to comply with proposed park management actions that focus on—and in some cases restrict—how they use Shovel Point. Willingness to comply was related to understanding that rehabilitation and development efforts were intended to protect the land. Otherwise there was strong initial resistance to the management plan.
   - Respondents believed that other climbers would be willing to comply with proposed actions.
   - Follow-up comments some respondents provided indicated that, even if they disagreed with elements of the proposed management plan, they would support the plan if they

Geo-Referenced Map. We created a geo-referenced map of human-made and natural features at Shovel Point using ArcView 3.2 geographic information system software and global positioning system technology. The map includes topographic contours, as well as the location of trails, signage, and restoration areas on the site. The purpose of the map is to guide physical management features such as trail development and aid in physically monitoring the cliff-edge kill zone.

Visitor Behavior Survey. We surveyed rock climbers and hikers regarding their attitudes toward the proposed management procedures, including marking trails, restricting access to some trails, installing decked staging areas, installing fixed anchors for climbing, and requiring climbers to access Shovel Point from a designated trailhead. Respondents were also asked about the degree to which they believed they and other climbers would adhere to the proposed procedures. The survey was field-tested to ensure validity. Interviews were conducted on alternating Saturdays, Wednesdays, and Fridays from July 15 to August 15, 1998, during either the morning or the afternoon. During this time period, we surveyed a total of 639 visitors (430 hikers and 209 rock climbers).

Overall, rock climbers had a positive attitude toward the management plan, with at least an 80% favorable response toward all recommendations. Although most respondents were supportive of the efforts to protect the land from negative user impacts, negative comments from some respondents revealed a strong desire for a nature-based recreational experience with minimal to no contrivances. Thus, manipulating the land was considered unacceptable, even if the manipulation was intended to preserve the native character of the land.

Finally, a few respondents indicated a distrust for human-made climbing supports, primarily because of unreliability due to malicious tampering.

Primary findings of the survey can be summarized as follows:

- Respondents showed a strong willingness to comply with proposed park management actions that focus on—and in some cases restrict—how they use Shovel Point. Willingness to comply was related to understanding that rehabilitation and development efforts were intended to protect the land. Otherwise there was strong initial resistance to the management plan.
- Respondents believed that other climbers would be willing to comply with proposed actions.
- Follow-up comments some respondents provided indicated that, even if they disagreed with elements of the proposed management plan, they would support the plan if they

Figure 1. Location of Tettegouche State Park and Shovel Point Project Area
believed it would help maintain climbing access at Shovel Point.

Tallies of trail use showed heavy use of some trail segments and very light to no use on others. These results suggest where trails might be easily closed and revegetated, where “hardening” with gravel or boardwalks might be appropriate, and where visitor patterns may be difficult to change.

**Kill Zone Expansion and Trail Rehabilitation.** At the beginning of the study, we conducted a vegetation analysis using guidelines provided by the Minnesota DNR. This involved identifying a specific zone to be monitored over time. To document the extent of the kill zone, we took photographs and catalogued vegetation type and counts. These data established a baseline for measuring the success of the management plan and various trail rehabilitation efforts.

Based on our analysis, trail rehabilitation efforts appear to have succeeded in reducing the expansion of the kill zone over time. Through the use of wooden curbs and gravel, trails have been marked in a manner that is unobtrusive to the scenic value of the site but that guides visitors along designated trails more effectively. In addition, roped-off areas with accompanying signs reading “revegetation site” have succeeded in eliminating the appearance of informal spur trails. The use of signage has been key in gaining compliance from rock climbers. Low boardwalks have been constructed in some locations to identify paths to climbing areas, and wooden platforms have been erected at key staging areas where groups of climbers place their gear and plan climbs. These platforms have reduced soil compaction and erosion, resulting in protection of plant root systems. Based on our analysis, the expansion of the kill zone has been stopped.

**Revegetation Potential.** To evaluate regeneration potential on the site, we chose a trampled, eroding hillside on which to conduct plant trials. We chose to plant poverty grass (*Danthonia spicata*) and three-toothed cinquefoil (*Potentilla tridentata*), two species that are common at Shovel Point and that appear to colonize disturbed areas. We collected seed from shoreline habitats near Shovel Point and grew seedlings in a greenhouse over the winter. In spring, we established 36 plots, with 25 plants per plot. Various soil amendments were added at planting time to evaluate their effectiveness in ameliorating the harsh soil conditions. Several plots were established but not planted (one was tilled and one was left untilled) to assess the ability of vegetation to colonize without assistance. We also used several techniques to guide hikers and climbers around the planting site, including roping off areas and placing signs at critical points. We assessed plant survival rates by counting all live plants at 13 weeks and at 1 year.

Results of the revegetation effort were as follows:

- Overall survival rates were high at 13 weeks (98.7% for *D. spicata* and 86.9% for *P. tridentata*) and remained high after one year (96.7% for *D. spicata* and 79.1% for *P. tridentata*).
- After 13 weeks, *D. spicata* treated with hydrogel and fertilizer had significant growth compared to other soil treatments. *P. tridentata* treated with hydrogel, sterile soil, or a mixture of sterile and forest soil had significant growth compared to other treatments. After one year, *D. spicata* growth appeared poorest in plots amended with fertilizer or woodchips. After one year, *P. tridentata* growth appeared best in plots amended with a mixture of sterile and forest soil.
- After one year, the tilled but unplanted plots yielded nine *D. spicata* seedlings. The three untilled, unplanted plots yielded no *D. spicata* or *P. tridentata*.

**Review of Management Practices.** Finally, we interviewed park managers at climbing sites around the nation, and conducted a literature review of existing research on rock climbing and natural resource protection. Our literature review revealed no specific information about resource management practices to reduce rock climbing impacts. In addition, we found that few sites around the United States have implemented management practices similar to those in the Tettegouche State Park Management Plan. More common, some agencies we spoke to have simply banned rock climbing. For example, the Ohio Department of Natural Resources manages a park near Yellow Springs, Ohio, called Clifton Gorge. Access to the southern half of the park was restricted to protect sensitive and endangered plant life, whereas the northern half of the park was designated for hiking and rock climbing. Because of intensive use, the impact on the gorge became so negative that the park managers closed the park to climbing.

Less extreme approaches have been undertaken in some location. Acadia National Park in Maine has installed fixed anchors for climbers at its Otter Cliff climbing site, and has placed signs instructing climbers to use the fixed anchors instead of trees. The park also has roped off protected areas and placed signs asking people to stay away from those areas. Park personnel reported.
that the fixed anchors have helped in the recovery process, and that after only one year, small amounts of vegetation regrowth has occurred in roped-off areas. Interviews with a representative from the Access Fund, a nonprofit organization dedicated to promoting the sport of rock climbing while conserving natural resources, indicates that decks and benches along with the use of signs can help to protect staging areas and keep climbers on trails.

During the final implementation stage of the Tettegouche State Park Management Plan in summer 2006, fixed metal anchors were installed in the rock to reduce destruction to tree bark and roots by rock climbers.

Conclusion
Based on our findings, it would appear that a combination of trail marking and rehabilitation techniques, along with revegetation efforts, can halt and perhaps even reverse vegetative degradation in heavily used recreational areas. Surveys of recreational users gave the Minnesota DNR sufficient confidence to spend the time, money, and effort to redirect hiker and climber activity away from degraded areas, and the techniques used appear to have succeeded at altering climber behaviors. Revegetation efforts were surprisingly successful given the harsh, bare nature of the site, and minimal use of barriers and signs prevented revegetated areas from being trampled. Finally, it is clear that educating visitors about the value of natural resource rehabilitation and management can go a long way toward encouraging acceptance of and compliance with recreational management techniques.

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Trail rehabilitation efforts at Shovel Point have succeeded in reducing the expansion of the vegetative kill zone on the site.