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NOLS Research Program 1994 progress report; Project summaries and papers

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NATIONAL OUTDOOR LEADERSHIP SCHOOL
Research Program

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NOLS Research Program
1994 Progress Report

Project Summaries and Papers

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Executive Summary

The following is a synopsis of the current major project initiatives of the National Outdoor Leadership School's research program. Enclosed are brief project summaries, current budget and funding details, project progress reports, papers submitted and in progress, important correspondence, and details on pending proposals and initiatives. This report focuses on projects in progress or initiated since May 1993 and does not include previously completed works.

Project Summaries

Completed Projects

Wilderness Journal

Last fall I compiled and submitted to the Forest Service (John Twiss) the final report on the NOLS study on the feasibility of producing a Journal of Wilderness studies. Since that time Dr. John Hendee, the Director of the University of Idaho Wilderness Research Center, has also been working on developing a Journal, with input from many agencies and organizations. I am currently representing NOLS on the steering committee and will be serving as an associate editor for research. Attached is the current Journal subscription flyer. We are hoping for a Spring 1995 first issue.

NOLS education and leadership development

René Koesler and Dennis Propst have completed their study and submitted their final report to NOLS, "Factors influencing leadership development in Wilderness education" (attached). Rená was also generous enough with her time to come out to Lander this September and present her findings to the NOLS Board of Trustees.

Fragile rivers paper

This paper has been accepted and will be published if the editors can ever get their act together! I hope sometime this spring. I've attached a copy of the abstract of our paper and the citation.

Ongoing Projects

Vegetation trampling (Winds)

We have now completed three years of field work on this study and will complete the final scheduled field season this summer. I have been assisting Dave Cole with the management of the project and am working with him on examining changes in plant community structure. We presented some preliminary results at the Ecological Society meetings this past summer (see attached 'very draft' manuscript). I'm hoping to revisit this project in the next 2 months and continue data analysis.

Tundra trampling study

We now have an established research site in the Brooks Range AK, approximately 350 miles north of Fairbanks. We are examining the effects of trampling and warming on two distinct arctic tundra plant communities. We will conduct follow up measurements in August 1995 and hope to have a manuscript completed by fall. An initial draft is attached.

Environmental attitudes

Porter Hammitt, a graduate student from the University of Montana is in the process of analyzing his data on this very interesting project. Porter is working with Wayne Freimund (University of Montana), Rodney Brod (UM), and Alan Watson (Leopold Institute), and has funding from NOLS, the Leopold Institute and UM. The objective of this study is to determine the effects of participation in a NOLS Wilderness course on behavior, attitudes, and intentions as they relate to the environment. Enclosed is a preliminary report from this work and I am expecting a more thorough progress report in the next few weeks.

Projects/proposals initiated

<u>Collaborative</u>

PWS proposal

I have been working with Don Ford (AK Branch Director) and Eleanor Huffines (AK Public Policy Coordinator) to continue to solicit funding for a campsite inventory and assessment project in Prince William Sound. Our latest effort is a challenge cost share proposal in collaboration with the Chugach National forest (see attached). We hope to hear from the FS in January.

Baja conference/project

I have been working closely with Dave Kallgren (MX Branch Director) and Prof. Mario Yoshida (UABCS) to host an organizational meeting to develop a monitoring and assessment project on the Baja coast. The meeting is scheduled for January 11-14, 1995. Please see attached for more details.

Group Size

Since our research advisory board meeting in July '93, the issue of group size has been consistently raised as an important issue for NOLS. The recent developments regarding the Canyonlands management plan and the implications of the plan for all wilderness users have also increased interest in this issue. I have been in discussions on developing this project with Chad Henderson (NOLS Public Policy manager) and George Peterson. In addition we have initiated discussions with the USDI through Bill Sherman, Special Assistant to the Assistant Secretary for Policy, Management and Budget on this issue (see attached letter). Bill is actively seeking our input on this issue and Chad will be meeting with him in DC this January. In my discussions with George Peterson, we have decided to solicit proposals via a standard RFP for possible funding of a project for the 95-96 academic year. No doubt the Research Board will be closely involved with this issue.

Center for Ecotourism Research

This past July Dr. Ralf Buckley, director of the International Center for Ecotourism Research in Queensland, Australia visited NOLS. Dr.Buckley is very interested in spending the majority of his upcoming sabbatical year working with us in the research program. The two proposals he and I prepared during his visit are attached and I think they integrate NOLS and Ralf's interests well. Ralf is also applying for some fellowship grant money to support his sabbatical research. His salary will be covered buy his university so consequently, the costs of these projects to NOLS will be small. For additional information I've also included the Center's recent research report

Internal

Human waste

Instructor Amy Cillimburg and myself are working on a review paper to examine the "state of the knowledge" regarding backcountry human waste disposal practices. Amy has initiated her literature review and discussed the paper with David Cole. We are hoping to complete this project by June 1995 and submit to an appropriate Journal as well as circulate to the NOLS community.

Rope safety

Phil Powers has discussed with me some of his concerns regarding the standard NOLS climbing rope retirement and use policy. As a consequence, we have designed a basic study on some new and used NOLS ropes to evaluate this process. Currently there is little reliable data on the relative safety of ropes as they age and are subjected to the normal wear and tear in mountaineering. We are in the process of collaborating with several rope manufacturers and testing facilities on this project. This is a good example of how a little advice on basic experimental design can contribute directly to the NOLS outdoor program .

Aquatic System Health (Winds)

I have contracted a graduate student intern, Melissa Stern to write a review paper on the state of the knowledge of Aquatic systems in the Wind River range. This study would follow the outline in Peter Landres' proposal that was prepared at the July '95 meeting. Melissa is a two time NOLS grad and will be using this paper as her MS project at Duke University.

Research library

We now have a research library of over 1000 reprints and growing that is searchable with Library Browser software. Though mainly for internal use, this will provide us with a current and complete database of wilderness and related research and information.

LNT Collaboration

With my close physical proximity to NOLS' Leave No Trace and Outreach Department, I am finding many collaborative ties with Rich Brame and his staff. There is a continued need for research integration with the LNT program (e.g. educational efficacy, specific recreational impact issues, and monitoring of national recreation research developments) and the role of research is continually evolving. Rich, Chad and myself explored some of these issues in a paper that we presented at the Santa Fe Wilderness meetings (attached). I interact with the LNT staff virtually on a daily basis, and I'm sure LNT has benefited from this involvement. As the LNT program grows, I hope to continue to be directly involved with integrating research into the program.

Budget FY 1995

The following is a brief budget synopsis for FY 94 and a projection for FY 95. Despite incurring an unexpected expense on the Leadership Project (due to an accounting oversight), we were able to come in under budget in research funding for FY 94. This fiscal year, we may be as much as 20% over budget, if we are awarded the FS challenge cost share (Chugach proposal, attached) and we move ahead with other initiatives as itemized. I have already received preliminary approval from the NOLS Directors on this matter.

	Budget FY 94	Actual FY 94	Budget FY 95
Research Funding Total	34000		32000
Part time salary	0		5000
Conferences	6200		6200
Projects Itemized			
Tundra	10000	10,169.80	8000
Baja			5000
Leadership		8,597.00	
Wilderness ethics	5000	5034.00	
Veg trampling (winds)	6,500	7,241.67	4000
Human Waste	n/a		4000
Aquatic Systems	n/a		1500
Ralf Buckley's work	n/a		3500
PWS Cost share	n/a		12500
Total itemized funding		31,042.47	38500
% over/under bugdet		-8.7%	+20.4

Publications accepted, 1994

Morgan, J., Hunt, H.W., Monz, C.A., and LeCain, D.R. 1994. Consequences of long-term growth at various [CO_2] and temperatures on gas exchange of western wheatgrass (C3) and blue grama (C4) *Plant Cell and Envt*. 17, 1023-1033.

Lyon, D.W., C.A. Monz, R.A. Brown, A.K Metherell. 1994. Soil organic matter changes over two decades of winter wheat-fallow cropping in western Nebraska. In: Soil organic matter in temperate agroecosystems: Driving variable controls across a site network. E.A. Paul and C.V. Cole eds. *In press*.

Elliott, E.T., I.C. Burke, C.A. Monz, S. B. Frey, K. Paustian, H.P. Collins, E.A. Paul, C.V. Cole, R.L. Belvins, D.J. Lyon, W.W. Frye A.D. Halverson, D.R. Huggins, R.F. Turco, M. Hickman. 1994. Terrestrial carbon pools in grasslands and agricultural soils: preliminary data from the corn belt and great plains regions. *In*: Defining soil quality for a sustainable environment. J.W. Doran, D.C. Coleman, D.F. Bezdicek, and B.A. Stewart, eds. *Soil Science Society of Anerica*. Special publication number 35.

Monz, C.A., Hunt, H.W., Reeves, B.R., Elliott, E.T. 1994. Response of mycorrhizal colonization to elevated CO_2 and climate change in *Agropyron smithii* and *Bouteloua gracilis* . *Plant and Soil*. *In press*.

Williams, J. and C.A. Monz 1994 Fragile rivers: current knowledge regarding minimum impact use and identification of significant research gaps. In: Proceedings from the Third North American Interdisciplinary Wilderness Conference, Ogden UT. *In press*

Monz, C.A., C. Henderson, R.A. Brame. 1994. Perspectives on the integration of Wilderness research, education and management. In: 6th National Wilderness Conference proceedings, Santa Fe, NM.

Manuscripts in progress

Monz, C.A., G.A. Meier, D.N. Cole, and J.M.Welker, 1994. Responses of mpoist and dry arctic tundra to trampling and warmer temperatures.*In preparation* .

Monz, C.A., D.N. Cole, L.A. Johnson and D.R. Spildie. 1994. Vegetation response to trampling in five native plant communities in the Wind River Range, Wyoming, USA. *In preparation* .

Monz, C.A., J.M.Welker, H.W. Hunt, and R. Musser. 1994 Short-grass ecosystem responses to elevated atmospheric CO_2: whole system carbon balance. *Climate Change Biol*. *In preparation*.

Project reports/ papers in progress/ papers submitted

Responses of moist and dry arctic tundra to trampling and warmer temperatures

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[3] Aldo Leopold Wilderness Research Institute, Missoula, MT.
[4] Natural Resource Ecology Lab, Colorado State University, Fort Collins, CO

Project Description Summary

A two year study was initiated to evaluate the consequences of trampling and elevated summer temperature due to climate change on moist and dry tundra. Field manipulations of trampling were applied in $0.75m^2$ plots and small, temporary greenhouses were erected to warm the soil and air temperatures. Immediately after and two months following trampling, plots were evaluated on the basis of plant species composition, morphological characteristics, relative vegetation cover, relative durability, and soil compaction. Similar measurements will be conducted in August 1995 to examine the resilience of the vegetation. Experimental findings will be compared to existing areas where long term recreational impacts can be identified. Our goal is to quantify and understand the response of these tundra systems to trampling disturbance particularly in the light of potential climate change. We hope to develop low-impact backcountry travel recommendations, provide the BLM and other agencies with additional information for the continued development of management strategies, and assist in the U.S. contribution to the International Tundra Experiment (ITEX).

Introduction

With the increased popularity of outdoor recreation over the last 25 years, visitor impact has been identified as a significant component of degradation in many areas, particularly in relatively pristine regions (Hammitt and Cole, 1987). Significant impacts to soils and vegetation in many wildland ecosystems have been observed (Cole 1987; Kuss et al., 1986). In addition, increased visitation has also led to decreased water quality in some areas (Hammitt and Cole, 1987) and negative affects on the wilderness experience of users (Kuss et al, 1990). This body of knowledge has helped us gain some insight into recreational effects, but many questions remain. In addition, many responses to impact are highly system-specific (Marrion, 1991). As a consequence, site-specific research and monitoring is essential for the development of the most appropriate management strategies.

The arctic-alpine vegetation of the central Brooks Range is typical of the dominant vegetation in northern Alaska. These ecosystems provide unique aesthetic values and have been of great interest to researchers. The area remained largely unglaciated during the Pleistocene and was a refuge for plants during that time (Hultén, 1973). Plant species in the region have origins in the Rocky Mountains, circumpolar Arctic, and Eurasia, and current speciation is hypothesized to be analogous to that of the late Wisconsin and nearly Holocene vegetation in the area (Cooper, 1989).

Currently, there is little specific information on the relative resilience, resistance and tolerance of Arctic tundra ecosystems to recreational use, though the impacts of industrial development (Oechel, 1989; Walker, et al. 1986) and impact induced thermokarst (subsurface soil thawing) (Truett and Kertell, 1992) have been investigated. Cooper (1986) identified the Arrigetch Peaks Region of Gates of the Arctic National Park as an area of high visitor appeal and ecological importance. His vegetation studies, conducted from 1976-1981, provide a baseline assessment in this region as well as an early identification of some recreational impact. Cooper also established permanent strip transects in 1978 in the main camping area in the Arrigetch creek valley for impact monitoring, but to our knowledge, no follow up studies have been done since that time (D. Cooper, personal communication). Some trampling studies have been conducted on *Dryas octopetala* mats in alpine tundra regions of Waterton lakes National Park, Canada (Nagy and Scotter, 1974) but little other information on recreational impacts on tundra exists. Human -induced thermokarst has been observed with industrial impacts (Truett and Kertell, 1992; Walker, et al. 1986 and others), but it is not clear if trampling will have the same result.

Moreover, in northern Alaska, mean summer temperatures are predicted to rise as a consequence of global climate change (Maxwell, 1992) leading to significant effects on plant production and soil nutrient availability (Holland, et al. 1992; Wookey, et al. 1993, Welker, et al. 1993). Low summer temperature is one of the main constraints to plant and soil processes in Arctic environments (Billings and Bliss, 1959; Nadelhoffer et al. 1991). The resilience, or ability to recover after trampling, of these systems with warmer summer temperatures has not been investigated. Consequently, an examination of the combined disturbance effects of recreational use impact and the response of the vegetation to a changing climate may have important long term management implications in these regions.

Approach and Objectives

Site Selection

Our experimental site is located in the BLM managed “utility corridor” land accessible along the Dalton Highway at the Galbraith Lake Camp. This area is typical vegetation of the tundra communities found in the region, including areas of Gates of the Arctic National Park and the Arctic Reserve (formally ANWAR).

Trampling and warming treatments

The objective of this study is to; 1) compare and determine the resistance, resilience and tolerance of moist and dry tundra to trampling; 2) investigate the vegetation response to elevated temperature; and 3) examine the combined effects of trampling and elevated temperature on the dominant species in each ecosystem type.

Methods-trampling

Experimental design for the trampling treatments follows the standard protocols described by Cole and Bayfield (1993). Four replicates of experimental trampling lanes (1.5m x 0.5m) were established in each of the two vegetation types. Each replicate consists of 8 lanes; control (untreated), 25, 75, 200 and 500 trampling passes; and control, 75 passes, and 500 passes with warming treatments. A pass is a one way walk at a natural gate along the lane with tramplers weighing 60-70 kg and wearing a lug sole boot. Treatments were applied in early summer conditions after leaf-out.

Methods-warming treatments

The temperature of the air and soil is warmed in these plots by using small temporary fiberglass greenhouse cones. This design is standard in the ITEX program and has been used successfully in the high Arctic on Ellesmere Island and in alpine tundra at Niwot Ridge, Colorado. The cones are 30 cm high and 1m in diameter and are designed for high solar transmitance, humidity control, and optimal gas exchange.

Response variables

The following parameters are standard indices of trampling effects (Cole and Bayfield, 1993). Measurements are taken in each lane in one 30 x 50 cm subplot both before and after trampling:

- Percent cover of vascular plant species, lichens and mosses
- Percent bare ground
- Mean vegetation height
- Soil penetration resistance

Initial Results

Initial vegetation resistance to trampling results are represented in Fig. 1. Dry tundra plots were dominated by the mat-forming *Dryas octopetela* while the moist tundra plots contained a variety of sedges in the genus *Eriophorium.* . Species identification of the sedges was problematic due to lack of flowering, so these will be refered to as *Eriophorium. spp.*

Percent bare ground increased significantly in both vegetation types at the 200 pass level (fig 1). 500 passes resulted in nearly 100% die-back in moist tundra and nearly 90 % die-back in dry. Lower levels of travel (25 and 75 passes) had little effect on both vegetation types.

Discussion

Evaluation of initial resistance of vegetation to disturbance is important since trail formation, campsite selection and ecosystem effects can be governed by this initial response. Both of these sites seem to fall in the "moderately sensitive" range , since only 200 passes resulted in significant disturbance.

The Dry tundra site had a greater relative increase in bare ground compared to the moist tundra and appears more sensitive. At the 200 pass level, dry and moist sites increase 93% and 32% respectively compared to the control.

Continued data analysis this fall and subsequent follow up measurements will allow us to evaluate other parameters including species composition, site resilience (grow-back), soil compaction, vegetative response, and species richness.

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Response of five native plant communities to trampling in the Wind River Range, Wyoming, USA.

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Abstract

The response of five native vegetation types to two years of applied trampling was investigated. Sites were located between an elevation of 2800 and 3200m in the Wind River Range in central Wyoming, USA. Plant communities included both woody and herbaceous forest understories, a subalpine meadow dominated by graminoids, an alpine grass community and an alpine fellfield. Experimental plots (0.5m x 1.5m) were subjected to trampling mid growing season at the rate of 25, 75, 200 and 500 passes, with the exception of the alpine fellfield and the alpine grass community that, instead of 25 passes, received 800 and 1000 passes respectively. Alpine communities exhibited the least decrease in plant cover while both forest understory communities showed significant decreases with as little as 25 passes. Intense trampling (500 passes) resulted in nearly 100% vegetation loss in some forest understory plots. Soil penetration resistance increased significantly with 200 passes in both forest understory sites, but did not respond to trampling at the other sites. Species richness tended to decrease in all plots with increasing trampling intensity. Canonical discriminant analysis revealed significant changes in plant community structure in all vegetation types, with low levels of trampling (75-200 passes) affecting forest understory communities and higher levels affecting the subalpine meadow and alpine communities.

Introduction

With the increased popularity of outdoor recreation over the last 25 years, visitor impact has been identified as a significant component of degradation in many areas, particularly in relatively pristine regions (Hammitt and Cole, 1987). Significant impacts to soils and vegetation in many wildland ecosystems have been observed (Cole 1987; Kuss et al., 1986). In addition, increased visitation has also led to decreased water quality in some areas (Hammitt and Cole, 1987) and negative affects on the wilderness experience of users (Kuss et al, 1990). This body of knowledge has helped us gain some insight into recreational effects, but many questions remain. In addition, many responses to impact are highly system-specific (Marrion, 1991). Land managers need a better understanding of the relationship between use and impact and the relative durability of different vegetation types in order to minimize disturbance (Cole, 1993). As a consequence, site-specific research and monitoring is essential for the development of the most appropriate management strategies.

The effects of trampling on vegetation have been investigated extensively in many systems (Kuss et al., 1990) These responses are largely site specific and as a consequence, there is value in examination of trampling in the many systems subjected to this potential disturbance. With the recent development of standard methodologies for applied trampling (Cole and Bayfield, 1993), direct comparisons across varying vegetation types will now be possible. In this approach, controlled, short term trampling is applied to a designated plot and pre and post assessments are made.

In this study the effects of trampling have been evaluated in five unique plant communities in the Wind River Range in Wyoming. Currently, we have no information regarding the response of these systems to trampling. Moreover, there is little information regarding the response of plant-species assemblages in any system to trampling disturbance. We evaluated the community structure changes using recently developed canonical ordination techniques (ter Braak, 1988) and examined the response of overall site characteristics in these communities.

Methods

Trampling

Experimental design for the trampling treatments will follow the standard protocols described by Cole and Bayfield (1993). Four replicates of experimental trampling lanes (1.5m x 0.5m) were established in each of the 5 vegetation types. Each replicate consisted of 5 lanes; control (untreated), 25, 75, 200 and 500 trampling passes. A pass is a one way walk at a natural gate along the lane with tramplers weighing 60-70 kg and wearing a lug sole boot. Treatments were applied in mid summer at a time approximating peak biomass. Follow-up measurements were conducted two weeks after trampling was applied.

Response variables

The following parameters are standard indices of trampling effects (Cole and Bayfield, 1993). Measurements were taken in each lane in two 30 x 50 cm subplots both before and after trampling:

- Percent cover of vascular plant species, lichens and mosses
- Percent bare ground
- Mean vegetation height
- Soil penetration resistance

Statistics

ANOVA's were performed on overall site characteristics using SYSTAT software (SYSTAT, Inc., 1992). Plant species assemblage responses were evaluated using canonical correlation analysis (ter Braak, 1992).

Results and Discussion

Site Descriptions

- GERO. Alpine Fellfield dominated by *Geum rossii, Carex,spp., Deschampsia cespitosa, Calamagrostis purpurascens.*

- ARCO Mixed forest understory dominated by *Arnica cordifolia, Epilobium angustifolium, Achillea milefolium.*

- TURF Alpine grassland dominated by *Elymus trachycaulus, and Festuca idahoensis.*

- PHAL Subalpine (moist) meadow dominated by *Caltha leptosepala, Carex nigricans, Antennaria corymbosa.*

- VASC Pine forest understory dominated by *Vaccinium scoparium* .

Site Characteristics

Overall responses of general site characteristics such as percent bare ground, species richness, and soil penetration resistance are represented in Figs. 1-5. Sites differed widely in responses, with the forest understory sites (ARCO and VASC) being the least resistant to trampling, and the alpine grassland (TURF) and alpine fellfield (GERO).

Percent bare ground increased significantly with as little as 25 passes yr^{-1} in the ARCO site, and increasing to over 80% in the VASC site with just 75 passes yr^{-1}. *Vaccinium spp.* seems particularly sensitive to trampling, perhaps largely due to the woody, brittle perennial stem . The two alpine sites required the application of additional trampling to obtain the “standard” 50% dieback in vegetation (Cole and Bayfield, 1993). In these resistant sites, significant increases in bare ground were only seen above 500 passes and nonetheless, the sites remained over 80% covered.

Species richness was largely unaffected by trampling in the two alpine sites (GERO and TURF) and in the subalpine meadow (PHAL). In the ARCO site, species richness declined significantly with as few as 75 passes yr^{-1}. In VASC, *V. scoparium* was largely eliminated by 500 passes yr^{-1} with *Arnica cordifolia* seedlings being the only green material present.

Soil penetration resistance, and index of surface compaction, was largely unaffected by trampling in the two alpine sites (GERO and TURF) and in the subalpine meadow (PHAL). In both the forest understory sites, penetration resistance increased significantly, with 200 passes yr^{-1}.

Ordination

Ordination results of canonical correlation analysis (CCA) of the ARCO site and the PHAL site are represented in figures 6 and 7 respectively. For both sites Monte Carlo test of significance of the first canonical axis reveals significant differences in vegetation as a consequence of disturbance (ARCO $P \leq 0.01$; PHAL $P \leq 0.07$). First canonical axis accounted for 43.0% of the species-environment relation in the ARCO site and 72.9% in the PHAL site.

Conclusions

• The Forest understory sites in this study are the most sensitive to trampling disturbance with significant increases in bare ground, soil penetration resistance and decreases in species richness with minimal trampling.

• Alpine grasses seem particularly resistant to trampling, with 1000 passes yr-1 being required to induce a 50% dieback in vegetation cover.

• Ordination of vegetation reveals significant shifts in plant communitiy structure as a consequence of trampling.

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Fragile rivers: current knowledge regarding minimum impact use and identification of significant research gaps.

Jamie Williams[1] and Christopher Monz[2*]

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Abstract

We investigated the known ecological impacts of river recreation on western river systems and current state-of-the-art practices used to minimize those impacts. This study integrates a review of current literature, interviews with resource managers, and a survey of major western river outfitters. Recommendations are made on the best minimum impact practices for river runners. Resource management needs and significant research gaps are identified.

Camping is considered to have the greatest impact of all river recreation activities and consequently, field research has focused on the biophysical ramifications of these impacts in riparian areas. Soil compaction, vegetation loss, and accelerated bank erosion are problems correlated with the amount of use. Proper campsite selection on beaches or established sites and avoidance of important sensitive riparian plant communities is recommended. Existing research does report the relative resistance of different sites to impact, but there is currently little work on the ecological implications of impacting various riparian communities.

Out of 37 outfitters surveyed 92% carried out all fecal waste, 84% used fire pans, and 97% camped in designated sites. Use of these low impact camping techniques can help resolve the major resource management issues, but many basic ecological questions such as recreational use impact on water quality and wildlife remain. More research is needed in order to develop specific management strategies.

Perspectives on the integration of Wilderness research and education

Christopher A. Monz*, Chad Henderson and Richard A. Brame

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Abstract

Continued social and ecological research is vital to the sustainability of wilderness systems. Since land use is shifting from resource-based to recreational-based activities in many areas, recreational user education has become an increasing priority. This paper provides preliminary results from on-going wilderness research and examples of the use of this information for wilderness stewardship purposes. Direct integration of research into wilderness education programs such as Leave No Trace (LNT) can provide an essential mechanism for applying research findings at the user level. The LNT public-private national educational initiative establishes a framework to provide the user with the most complete minimum-impact skills and information. LNT also directly involves land management professionals as “master trainers” and thus provides and important feedback into identifying research priorities. We describe an approach that integrates current research into a user-based education program. An example of current research findings of vegetation impact is used to describe the use of scientific research to modify minimum-impact practices.

Introduction

Assessment of recreational impacts in Wilderness has received considerable attention in recent years, with several excellent recent reviews (Kuss, et al 1990, Hammitt and Cole, 1987). As a consequence of increases in the popularity of outdoor recreation over the last 25 years, visitor impact has been identified as a significant component of degradation in many areas, particularly in relatively pristine regions (Hammitt and Cole, 1987). Significant impacts to soils and vegetation in many wildland ecosystems have been observed (Cole 1987a; Kuss et al., 1986). In addition, increased visitation has also led to decreased water quality in some areas (Hammitt and Cole, 1987) and negative effects on the wilderness experience of users (Kuss et al, 1990). This body of knowledge has helped us gain some insight into recreational effects, but many questions remain. In addition, many responses to impact are highly system-specific (Marrion, 1991).

Appropriate user education has been cited as a primary mechanism for mitigating user impacts (McCool and Lucas, 1990). The majority of impact can be avoided through proper behavior (Cole, *et al.* 1987) and apparently, visitor behavior can be modified (Roggenbuck and Berrier, 1982). Wilderness users tend to be well educated (Roggenbuck and Lucas 1987) and it has been suggested that education leading to voluntary behavioral change is preferable to regulation and enforcement (Doucette and Cole, 1993).

It is unclear as to the early development of educational strategies to minimize user impacts. By the late 1960's agencies had adopted the "pack-it-in, pack-it-out' slogan (Doucette and Cole, 1993) and a formal educational program to promote minimum-impact use was initiated by the National Outdoor Leadership School (Petzoldt, 1974). These initiatives have evolved over time to reflect increased visitation and knowledge. Currently, information on appropriate minimum-impact techniques has been published (Cole 1989, Hampton and Cole, 1988) and conceptual approaches to Wilderness education investigated (Roggenbuck and Manfredo, 1990). More recently, the *Leave No Trace* Program (LNT), a national public-private education program to promote minimum-impact recreation practices has been initiated. The U.S. Forest Service, National Park Service and Bureau of Land Management are the principal federal agency partners of this program.

In light of the current state-of-knowledge on recreational impacts, LNT seems particularly poised to be the primary vehicle to disseminate practical user information. As a consequence of this initiative, Wilderness user behavior could be influenced and the concomitant management requirements altered. In this paper we will examine the application of research results in LNT curriculum and discuss the potential feedbacks of the LNT program to research.

Approach

The philosophy of the LNT program is not a dogmatic one, rather a conceptual framework of minimum-impact techniques that is suitable for broad application (Leemon *et al.* , 1992). The key to minimizing back-country related impacts is in the development of sound judgment and an experience base to allow for the most appropriate decisions for a given situation. Despite this lack of a "cookbook" approach, many specific questions must be researched in detail to increase the minimum-impact knowledge base and significant gaps in our knowledge remain (Cole 1987b). Consequently, continued LNT curriculum development can not only dispense current information, but also assist in continued identification of these "gaps".

An example of the need for scientific research and its ability to inform and modify techniques is found in an ongoing NOLS-USDA Forest Service research project. Previous backcountry minimum-impact teaching frequently recommended avoidance of alpine areas since these were "the most fragile of all" (Hampton and Cole, 1987) and generally directed users to forested areas for camping and travel. Recent results from applied trampling experiments (fig. 1) in the Wind River range (Monz *et al.* , 1994) indicate that the best practices could be contrary to this. The alpine areas examined in this study proved to be resistant to trampling, even at high rates, while forest understory plots were very susceptible to trampling. These areas are exemplified by the two sites shown (fig. 1). Although these results are preliminary and the resilience (grow-back) of these sites is still being investigated, these initial (2 yr) responses are dramatic. If these initial results remain consistent, they will be integrated into LNT curricula. Social impact concerns and management considerations will also play a role in the actual practices promoted.

Research findings such as these are vital to the continued improvement of LNT curricula and ultimately may prove significant at the user level. A conceptual model for how these results can be distributed to the user level is described (fig. 2). Research results are integrated into the LNT curricula through the close interaction of LNT staff and researchers. Results could initially be represented in scientific form, much as in fig. 1, and included in LNT training materials for LNT masters, providing scientific "backup" for LNT practices. Information in this form is also helpful to agency management professionals.

"How to" information is the vital link in the LNT program. Here, the basic scientific results are distilled to the practical user information and practices that can be directly distributed to the user. The LNT program will also take advantage of industry and agency channels to further distribute this information. Hopefully, through education, user behavior can be influenced leading to a sustainable level of environmental quality. Monitoring user behavior can also lead to further modifications of the program, in order to increase efficacy.

Important aspects of this model are the feedbacks into research. LNT is constantly identifying practical information gaps in minimum-impact knowledge, many of which cannot be answered by simple literature review. Field observations also lead to further hypotheses and new research.

Conclusions

The LNT program can be utilized as an important mechanism for distributing current research findings applicable to the continued improvement of minimum-impact backcountry techniques. By utilizing research, LNT can develop appropriate training materials for managers and "how to" publications for Wilderness users. Of equal importance, is the continued feedback of LNT to researchers to assist in the development of research projects with immediate user application. Ultimately, these efforts can further the goal of integrating responsible recreational use and Wilderness preservation.

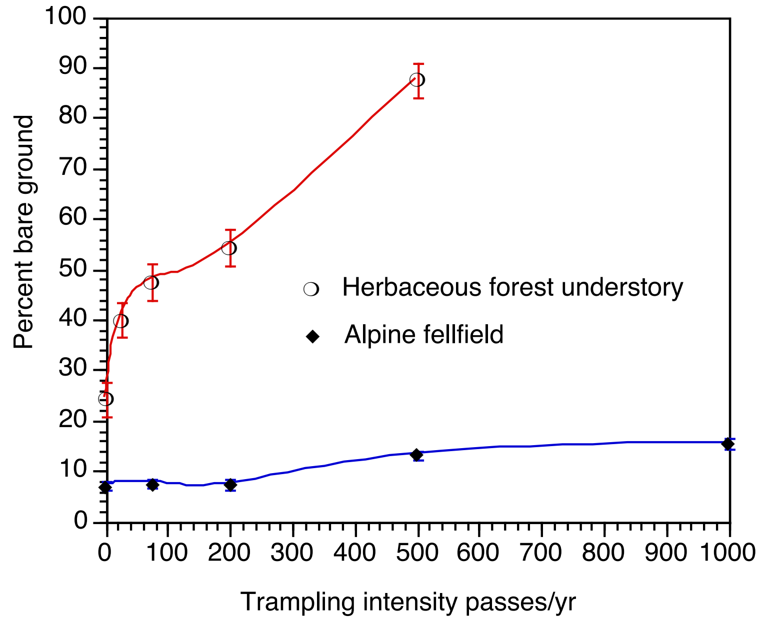

Fig. 1 Response of an alpine fellfield and a forest understory site to two years of trampling. Values are means ± pooled SE. Adapted from Monz, *et al.* (1994)

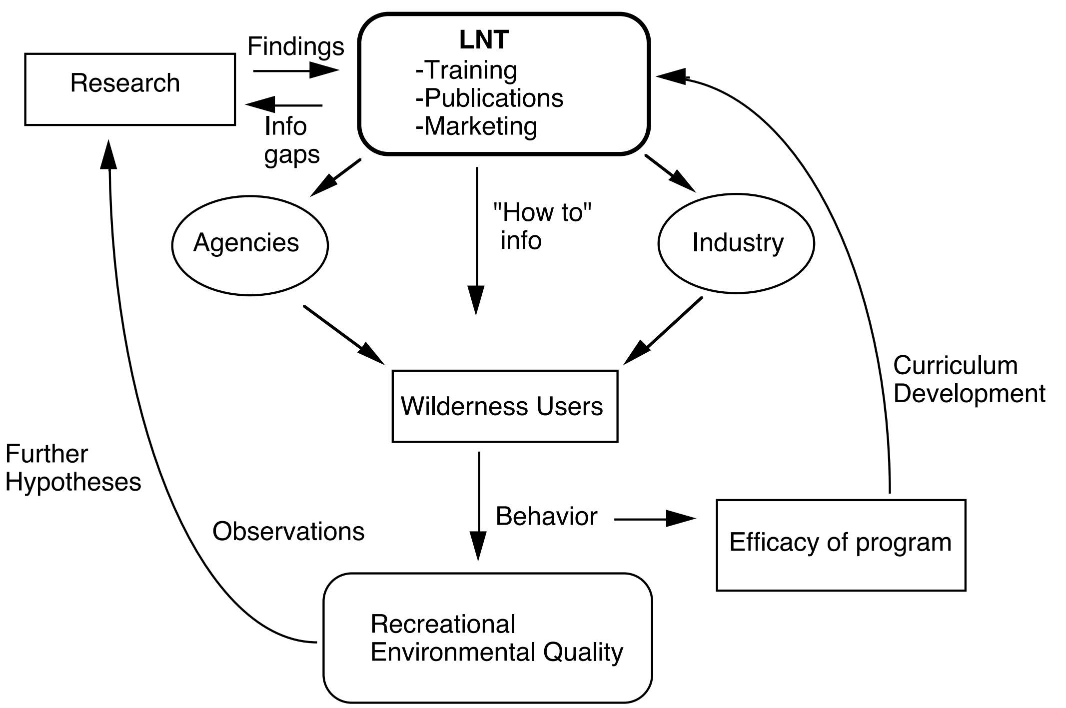

Fig. 2 LNT model for utilizing research information.

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Effects of NOLS' Wind River Wilderness Course on Responsible Environmental Behavior of Students

J. Porter Hammitt[1], Wayne Freimund[1], Alan Watson[2], Rodney Brod[1], Christopher Monz[3]

[1] University of Montana, Missoula, MT
[2] Aldo Leopold Wilderness Research Institute, MT
[3] National Outdoor Leadership School, Lander, WY.

Summary

In recent years, there has been significant growth in the popularity of outdoor adventure programs. Various desirable outcomes are associated with such pursuits and many of the purported effects have been closely studied. One area, however, that has been the subject of little research (although much conjecture) is the effect of these programs on responsible environmental behavior.

A collaborative study involving NOLS, the Aldo Leopold Wilderness Research Institute, and the University of Montana is now underway that addresses these questions. The specific objective of this study is to determine the effects of participation in a wilderness experiential education program on behavior, attitudes, and intentions as they relate to the environment.

Research was conducted out of NOLS headquarters in Lander over the past summer and involved a sample selected from the population of NOLS 1994 Wind River Wilderness students. A survey instrument designed to measure the stated concerns was administered to 277 students immediately before and immediately after their 30-day course, and this fall, a follow-up mail survey will be conducted three months after completion of the course. The responses of each individual student will be compared across time to produce meaningful results.

Hines et al. (1986/87) conducted an exhaustive search of empirically based research reported since 1971 on responsible environmental behavior (REB), recording the characteristics and findings of each study to serve as data for a meta-analysis. Results of the meta-analysis were integrated with the current thinking on the subject to produce a theoretical model that served as a foundation for the design of the survey instrument.

Results from the first two surveys are now being entered into a data base, with those of the mail-out soon to follow. Analysis will commence later this fall, and with an expected publication submission date of spring 1995. This research project promises to make a substantial contribution to the body of knowledge in our field.

Literature cited

Hines, J.M.; Hungerford, H.R.; Tomera, A.N. (1986/87). Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. Journal of Environmental Education, 18(2): 1-8.

Proposals

How Much Does NOLS Training & Leadership Reduce Impacts of Wilderness Travel?

R. Buckley and C. A. Monz

Summary. Snapshot study of historical impacts at all main NOLS course sites cf. nearby public-use areas; jointly between NOLS Research Group, David Cole and other university research associates in USA, and Ralf Buckley of ICER[1] in Australia, who will be on a year's sabbatical from July 1995.

Aim. Compare campsite trampling impacts in areas used only by NOLS groups with those in equivalent areas subject to a similar level of use by other groups and general public.

Rationale. NOLS' mission is to be the best source and teacher of wilderness skills and leadership that protects the user and the environment. Quantitative comparisons between NOLS and non-NOLS groups are needed to evaluate how well this goal is achieved. This may also be important in demonstrating NOLS' first-rank competence for, e.g., permitting, accreditation, LNT etc.

Scope. Changes in student attitudes and behaviour following a NOLS course are valuable indicators; but the only reliable way to determine how these affect actual impacts on the environment is to measure those impacts directly. Different impacts may be more or less critical in different ecosystems and for different activities, but for comparisons, a single indicator parameter with a standardised measurement technique is needed. Measuring impacts relative to spatial controls and historical baselines estimates NOLS' impacts, but to measure the effectiveness of the NOLS program, the critical issue is the comparison between NOLS and other groups. For such comparisons, breadth across all relevant ecosystems is more significant than precision at one site.

Limitations. This program is critically dependent on the availability of paired field sites with similar levels of use by NOLS and others respectively. The results will not distinguish between the effects of student training as such, and the effects of instructors' control and group ethics in the field.

Sites. Sites are currently under selection by Chris Monz. If possible they should include sites in the Wind River Range, Brooks Range, Prince William Sound and Baja coast. The principal constraints are availability and access to control sites used by other groups or the public at similar intensities, with historical data on visitor numbers and permitted use.

Scale. Part of the NOLS minimum-impact approach is to disperse campsites in low-use areas. Hence comparisons between a rarely-used individual NOLS

[1] International Centre for Ecotourism Research, Griffith University, Australia

campsite and a heavily-used public campsite will not be enough. What is required is a measure of aggregate impacts at all sites in a broader area under NOLS and non-NOLS use. The appropriate area may vary with the ecosystem but should have a radius approximately equal to a day's travel.

Methods. The impacts of campsite trampling on plant height and cover, plant species assemblages, percent area of bare ground, vegetation recovery rate, and soil compaction will be measured using standard techniques developed by Cole *et al.* [2] and used in current NOLS research.

Personnel.
Overall supervision: NOLS Research Advisory Board
Experimental design: Cole, Marion, Monz, Buckley
Measuring impacts: Monz, Buckley
Visitor numbers and behaviour, NOLS sites: instructors (consult as necessary)
Visitor numbers and behaviour, control sites: research associates in land management agencies; ?volunteer field assistants with equipment and subsistence provided by NOLS.
Analysis of results: Monz, Buckley.

ICER Collaboration. ICER is conducting research on wilderness impacts overseas that is directly comparable to NOLS' current research program in the USA.[3] For example, it has a current grant from the National Ecotourism Program in Australia to measure environmental impacts of recreation at wilderness campsites, and an extended program of research on backcountry impacts on water quality. Professor Ralf Buckley, Director of ICER, is expected to be on 12 months' sabbatical leave from July 1995 and is keen to spend this period at NOLS. This project is not dependent on collaboration with ICER, but if Buckley is available, this would provide the NOLS research group with a full professor for at least 6 months, at no salary cost. ICER would pay Buckley's international airfare and NOLS would cover only Buckley's travel, field and maintenance costs in the USA in association with this project.

Logistics. Each site would require a total of about 6-10 days fieldwork, half in the NOLS area and half in the control area. The precise time would depend on area, weather, number of campsites in the area, etc. Access time would be additional. Equipment is already available. Travel requirements would include air &/or ground travel for Monz and Buckley to each NOLS branch and field site. A separate project on the effects of group size on noise generation will be carried out in parallel with linked field periods.

How Does Group Size Affect Noise Produced by Backcountry Users?

R. Buckley and C. A. Monz

[2] see, e.g., *63 Biol. Conserv.* 209-215 [1993]
[3] see *ICER Research Report 1993;* copy with Chris Monz.

Summary. Test whether two small backcountry groups make more or less noise than one large one; whether NOLS groups make less noise than others, and how much less; and whether one large NOLS group makes less noise than 2 small non-NOLS groups. Test by field measurements without knowledge of subjects, using a real-time 1/3-octave spectral frequency analyser to distinguish human from background noise. Joint project between NOLS Research Group and Ralf Buckley of ICER[4] in Australia, who will be on a year's sabbatical from July 1995 and has an appropriate sound level meter.

Aim. To compare noise produced during different activities and at different times of day by backcountry users in groups of different sizes; both NOLS groups and control groups from the general public and other guided groups

Rationale. Party size is a critical and controversial issue in management of public lands for wilderness use at present, particularly with regard to permitting for educational and commercial operators. For most impacts, distinguishing the effects of party size is difficult because large and small parties use the same trails, campsites and water sources. One impact where discrimination is feasible is noise. Noise is also a critical issue both in regard to impacts on wildlife and impacts on other users. Hence it provides a good indicator parameter for analysing party-size effects. This may be an important issue for future permitting and accreditation.

Sites & Scope. The project will be carried out in conjunction with a separate project on the effects of NOLS training & leadership in reducing the impacts of wilderness travel. The same sites will be used. Noise measurements on NOLS groups will be carried out by prior arrangement with instructors for particular courses. Measurements on control groups will be made in cooperation with land management agencies' campsite booking records, and opportunistically on the trail.

Methods. Noise will be measured using a hand-held battery-operated CEL-593 sound level meter, which can provide real-time 1/3 octave spectral resolution of noise from 4dB to 130dB. This enables sounds from different sources to be distinguished and recorded in the field. The instrument weighs a few pounds and can be carried in a backpack.

[4] International Centre for Ecotourism Research, Griffith University, Australia

Personnel.
Overall supervision: NOLS Research Advisory Board
Experimental design: Monz and Buckley
Measuring impacts: Monz and Buckley

ICER Collaboration. This project is only feasible with an appropriate sound measuring device. The instrument described above costs about $15000. ICER has one. Professor Ralf Buckley, Director of ICER, is expected to be on 12 months' sabbatical leave from July 1995 and is keen to spend this period at NOLS.

Logistics. Project would be carried out in conjunction with with a separate project on the effects of NOLS training & leadership in reducing the impacts of wilderness travel. Additional logistic requirements would be minimal.

Challenge Cost Share proposal Submitted to the Chugach National Forest

A "Limits of Acceptable Change" study in the Nellie Cuan, College Fjord Wilderness Study Area (WSA) was implemented in 1992 and 1993. In order to continue and improve upon that study, the National Outdoor Leadership School (NOLS) is proposing to study recreation impacts in Prince William Sound in partnership with the Forest Service. Using monitoring and assessment techniques specifically designed for the backcountry (Cole 1983; Marrion 1991; Cole and Bayfield, 1993), NOLS and the Forest Service would conduct an overall evaluation of recreation sites in the WSA.

We propose a 3 year study with two overall objectives: 1) to inventory and monitor visitor resource impacts on recreation sites and 2) to quantify the resistance, resilience and tolerance of the three predominant ground cover vegetation types to applied trampling. In year one, initial site identification, assessment and application of trampling treatments will be conducted. The subsequent 2 years (funding dependent) will consist of follow-up monitoring and assessment. Conclusions, data analysis and publication by NOLS would be supplied at the end of the study. Data received from this study would be very pertinent to Chugach Forest Plan revision which begins in FY-95.

Health and safety is a factor in this project because by studying recreational impacts in the WSA, we will gain knowledge about possible health and safety hazards that exist at the recreation sites. More knowledge of the sites will help the Forest Service reduce those hazards for the future recreation user. Rather than restoring capital improvements, this project will assist in the rehabilitation of overused recreation sites by making recommendations for improved on-the-ground management.

Rural development/economic diversity: the project provides opportunity to diversify or strengthen communities economic base by planning for recreation sites in the WSA that can be used by private users and outfitter/guides that pass through the towns of Whittier, Cordova, or Valdez. This project ensures accessibility to the disabled public along with ensuring gender equality because recreation sites to be studied would be accessible to all individuals and groups. The study may increase accessibility by designating recreation sites that would be barrier free. This project is in a Congressionally Designated Wilderness Study Area. Trail systems adjacent to communities within National Forests are maintained and increased with this project because many of the "trails" within the WSA are water trails used by kayaker, sailors, and power boaters. By studying and monitoring recreation sites, plans can be made to improve water trail systems that connect to recreation sites.

<u>Cost Breakdown Year 1:</u>

Site Inventory

30 sites would be inventoried in 1995. Trampling experiments would be conducted where appropriate. We estimate a minimum of 25 days for a crew of 4-5 persons would be required for this study including field time, outfitting and transportation.

NOLS Contribution Year 1

Field			
	Senior Scientist	$25.00/hr x 25 d =	$5000.00
	2 Technicians	10.00/hr x 25 d =	$4000.00
	Per diem	$20.00/d/person =	$1500.00
	Airfare WY to AK	3 people	$2000.00
	Supplies		$1000.00
Analysis			
	Data entry		$1000.00
	Senior Scientist	$25.00/hr x 20 d	$4000.00
	Computer support		$1000.00

Total NOLS Contribution = $19,500

Forest Service Contribution Year 1:

GS-5 Seasonal Recreation Tech	$4,500
GS-5 Seasonal Recreation Tech	$4,500
2 kayaks, supplies, materials	$2,500
Boat support/shuttles to WSA	$1,500
Total CCS Allocation	$13,000

Baja conference details

November 5, 1994

address

Dear <fname>:

As we discussed recently, I would like to detail some of the aspects of our meeting in Baja this January. With some of the recent developments in the region, a costal monitoring and assesment project seems timely. I'm very encouraged by the enthusuasm this has generated, and am confident this will be a productive and successful gathering.

We are planning on meeting January 12-14, 1995 at the NOLS Mexico campus, near Mulege, BCS. The campus is located on Coyote Bay and basic accomodiations and meals during the meeting will be provided there. I will be developing a specific meeting itinerary in the next several weeks, but our general goals for the meeting are as follows:

- define the parameters, structure and scope of the research project
- set up advisory committee for project
- appoint people for grant writing, identify likely supporters
- create a formal project link with the Universidad Autonoma de Baja California Sur, Secretariat of Social Development, Aldo Leopold Wilderness Institute, NOLS

Enclosed you will find an initial, tentative list of attendee's and information on NOLS and the Coastal Mexico LNT program. Please feel free to offer comments and suggestions regarding invitees and agenda items, where appropriate.

I hope that you will be able to participate in this meeting as I am sure your imput will assure our success in developing this project. If you have any questions or comments, please feel free to contact me.

Sincerely,

Christopher Monz
Program Scientist

Conference invitees

Dr. Ray Turner
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Wes Henry,
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Enriqueta Velarde
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Richard Brame
Leave No Trace Program
NOLS

Chris Monz
Program Scientist
NOLS

David Kallgren
NOLS Mexico Branch Director

Group Size letter

July 25, 1994

Bill Sherman
Special Assistant to the Assistant Secretary for Policy,
Management and Budget
U.S. Department of the Interior
1849 C St., NW
Washington, DC 20240

Dear Bill:

Thanks for your interest in the group size issue. I look forward to working with you and the Interior Department to address this issue that has such a direct impact on both private and commercial recreational use of our nation's public lands.

It is a daunting prospect to tackle group size. Land managers seek an objective method to determine the best group size but they find themselves in the unenviable position of making decisions based on insufficient factual or scientific grounds. While various models do exist, each has its drawbacks. The Forest Service's Limits of Acceptable Change planning methodology (LAC) is a terrific model but its practical application is hindered by woefully inadequate resource inventories and mostly non-existent monitoring programs. The National Park Service uses LAC and the Visitor Education and Resource Protection concept (VERP) to replace the outdated concept of "carrying capacity." But you still hear managers justify group size on the basis of "It seems to be the best size" or "It's the least controversial size" or "This is what they're doing at that other park."

We may come up with more questions than answers at first, but it will be a service to land management if we start the ball rolling on this one. If you have questions regarding our research program, please contact Chris Monz, NOLS research manager, at (307) 332-1272.

Thanks again and let's keep in touch.

Sincerely,

Chad Henderson
Public Policy Manager