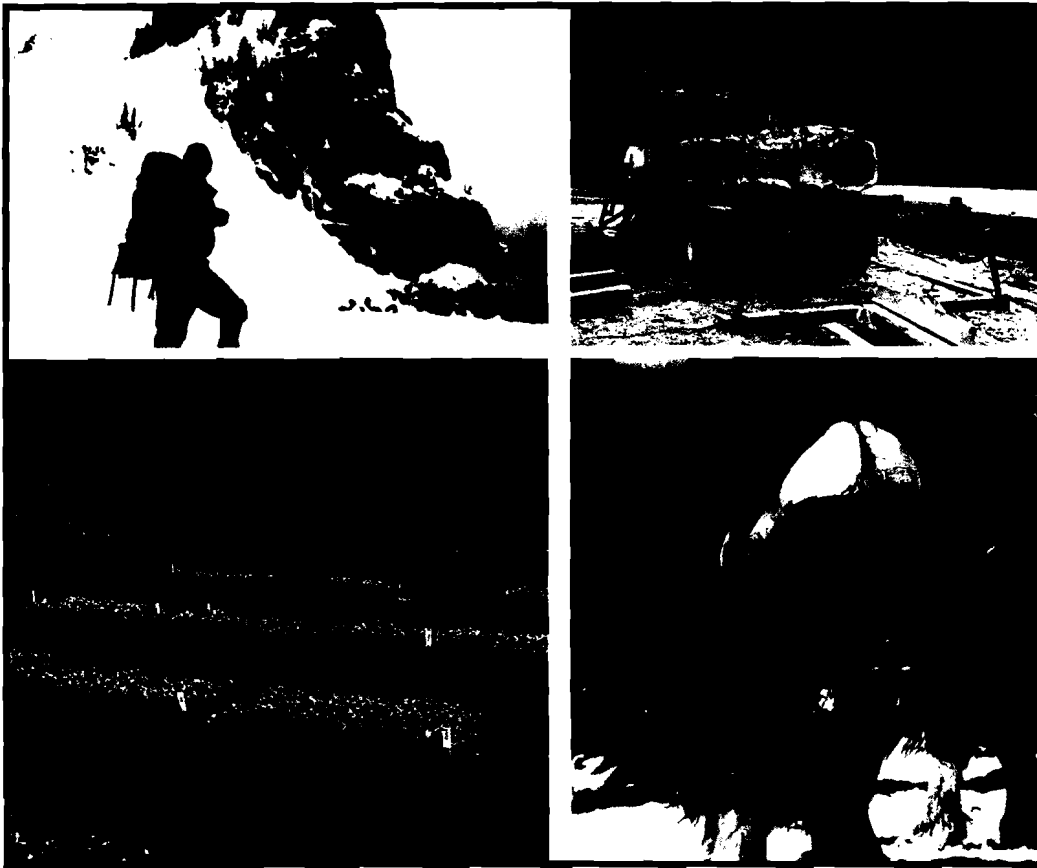


**Research opportunities
for undergraduates
at the School of
Natural Resources
& Agricultural Sciences**



Introduction

In keeping with the hallmark of land-grant universities, the University of Alaska Fairbanks integrates teaching and research with learning and public outreach. Interestingly, agriculture as we define it here at the School of Natural Resources and Agricultural Sciences (SNRAS) and the Agricultural and Forestry Experiment Station (AFES) encompasses energy, biotechnology, rural education—and much more. Our unit is the only one at the University of Alaska and one of few among land-grant universities nationwide in which research, teaching, and outreach encompass the social sciences as well as the biological and physical sciences. Program experience also includes written and oral communication, which are important skills in our students' chosen fields.

Our current students and our graduates are wonderful examples of the benefits of an education that includes a breadth of perspectives and the opportunity to pursue specific interests of their own. This would not be possible without our

involved and dedicated faculty who mentor natural resource management students as they complete their required senior thesis projects. Without their incredible efforts and broad perspectives in resource management, the results you see in the section featuring senior thesis projects would not be possible.

Students majoring in natural resource management choose a concentration of courses in either forestry, resources management, or plant, animal and soil science. Our graduates bring their knowledge into a variety of careers.

At SNRAS, along with the senior thesis, students often gain research experience through our internship program, and in some cases, student employment is also research-related.

Carol E. Lewis, Dean

School of Natural Resources and Agricultural Sciences

Note: The following material on our senior thesis program is reprinted from the summer 2005 issue of *Agroborealis*.

SNRAS Internship Program

College credit, work income, and experience with professional mentors are all part of the picture for students who enroll in NRM 300, Internship in Natural Resources Management. This supervised, pre-professional experience is open to students majoring or minoring in natural resources management.

Students can take the internship course for one to three credits during the summer or fall and spring semesters. It can be repeated for a maximum of six credits. The prerequisites for the course include completion of NRM 101, junior standing with a minimum 3.0 grade point average, permission of the instructor, and an approved internship plan.

The internship is an apprentice-type experience, structured and supervised. A well-designed internship provides the student intern with opportunities to apply concepts and techniques learned in previously completed coursework to a professional setting.

Becoming actively involved in the internship program is an excellent opportunity for prospective employers to screen the abilities and potential of students within the Natural Resources Management program. After sponsoring several internships, the sponsoring organization has insight into the general quality and capability of NRM graduates as it pertains to the function of that particular agency or business. Likewise, our faculty gain from maintaining direct contact with the agencies and businesses, keeping abreast of the most recent and relevant information in the field.

Internship objectives are designed specifically for each student intern, depending upon the internship topic and the student's occupational goals and interests. The topic varies with the individual and may involve any aspect of natural resources management. As in an independent study course, individualized instruction aims to accomplish established objectives written specifically for that internship experience. The intern is supervised throughout the experience by a

cooperating supervisor (an appropriate representative of the sponsoring agency or business) and a SNRAS faculty member with expertise related to the internship topic. Experiences gained during the internship should be practical, emphasizing hands-on and involvement-oriented learning.

A minimum of four contact hours per week is recommended per credit hour of internship. Thus, for a three credit hour internship, the student intern arranges to work approximately twelve clock hours per week. A student may take as many as six credit hours of internship, but no more than three credit hours during any given semester. Internships are letter graded.

An internship may be a paid or unpaid position. These arrangements depend on the sponsor's willingness and ability to pay for the services to be rendered by the student intern. The depth of previous experience the student intern brings to the situation may affect whether the position is paid or unpaid. Regardless of whether pay is received or not, the university does charge the intern the standard fee per credit hour.

An internship can be a rewarding and beneficial experience for Natural Resources Management students. Over the last several years the internship program has grown and the opportunity for an eligible student to participate greatly has expanded. Internship sponsors have included the U.S. Department of Interior Bureau of Land Management and National Park Service; U.S. Department of Agriculture Natural Resource Conservation Service; U.S. Forest Service; Alaska Department of Natural Resources (divisions of Land and Water Management, Forestry, Mining, and Parks and Outdoor Recreation); Alaska Department of Fish and Game; the university's Agriculture and Forestry Experiment Station; Cooperative Extension Service; Office of Land Management; Toghothele Native Corporation; City of Fairbanks; and Fairbanks North Star Borough. Internship topics are as varied as the sponsorships.

Creativity and Independent Thought

Resources management seniors tackle rewarding thesis projects

by Doreen Fitzgerald

The assertion that the quality of the question determines the value of the answer was one of the most interesting I encountered as an undergraduate. During their senior year, undergraduates majoring in Natural Resource Management (NRM) at UAF spend two semesters working to define a good research question, develop appropriate methods, carry out the research, and present their findings orally and in writing. They are enrolled in NRM 405 and 406, Senior Thesis in Natural Resources Management, a course required for all NRM majors, an optional one for students with minors in NRM. Their work covers a wide range of topics, reflecting the three areas in which the students concentrate their coursework: forest sciences, or resources management, or plant, animal, and soil sciences.

"The process itself is as important to students as the end product," said professor Patricia Holloway, the thesis course coordinator. "This is the first time many students work on an independent research project. They learn how to work with a committee, three professionals in their field. This is an opportunity that's seldom available to undergraduates. Although this is a lot of work for the faculty, they get to see the students develop in remarkable ways."

To complete the course, students draw on the collective knowledge they have acquired through past coursework, internships, and work experience to formulate a natural resources management research question. During the research and thesis presentations, they demonstrate their competency in problem solving, analysis, and written and oral communication.

"The thesis program was a great opportunity to pursue a line of natural resource related research I was interested in," said 2004 graduate Michael Gibson. "I was able to come up with my own idea and find the university professors and professional staff that would help me turn my idea into a finished research project. No doubt it was a challenge. I had to draw upon what I learned in my classes as well as the skills I had gained outside the classroom." Gibson is now a recreation technician for the Bridger-Teton National Forest in Afton, Wyoming.

A review of qualifications listed in natural resource management job advertisements quickly reveals that effective communication is one the most important skills a student should master. Regardless of the area of specialization, the ability to write and speak clearly in one's field of expertise is essential.

"As well as determining what to do and how to do it, senior thesis students gain experience writing in the natural resources field and experience in presenting their findings," said Holloway. She noted that students often use their theses later, when applying for jobs, as an example of their written communication skills.

The project's three major components are identifying and defining a research question; attempting to answer the question by conducting an experiment, gathering survey data, analyzing existing

literature; discussing or defending conclusions and supporting them with existing literature; and sharing findings with others. Creativity and independent thought are important to the value of the projects, which go far beyond the research paper concept of reporting what others have done. A thesis project is judged both on content and the student's ability to effectively communicate with peers and faculty during presentations and in writing.

"The experience adequately prepared me for the professional-level projects I'm required to complete as a U.S. Forest Service employee," said Gibson. "It was by far the most useful and rewarding class I participated in."

In the fall, students first attend an introductory workshop conducted by the course coordinator. They must formulate an acceptable thesis topic, find a thesis advisor, and assemble a thesis committee. After the first two weeks of class, the coordinator meets with students as needed to answer questions and solve any problems that have arisen. Along with conducting workshops, she also schedules presentations and facilitates functions of the advisory committee. When necessary, the coordinator may help a student find a thesis advisor.

Before any research is conducted, a draft thesis proposal and a final proposal is presented and approved. "The most amazing thing to watch is how in the beginning, many students are at a loss," Holloway said, "and their proposal presentations are often rough. But by the time they finish and make their final presentations, the students are polished and professional."

The thesis advisor is a SNRAS faculty member who is selected based on how their expertise coincides with the student's research interests. During the two semesters, the advisor is the student's major contact, providing guidance in defining the topic, designing the project, preparing drafts and final products. They work with students to ensure that the selected project is feasible given time and economic constraints.

Three faculty serve on the thesis committee: the advisor and two others who have an interest or expertise in the student's chosen topic. The committee approves the topic and grades all written and oral projects during the two semesters. When approved by the course coordinator and advisor, one committee member can be other than a SNRAS faculty member (faculty from another department, agency personnel, or a private researcher), although this member cannot chair the committee. Technicians and graduate students from SNRAS, other university departments, agencies, and public organizations may be included as additional, nongrading members, but cannot replace a faculty member. UAF graduate students and technicians may participate and often lend support on a voluntary basis. Students meet with their committee and advisor within the first three weeks of each semester so that all committee members can have input at one time into the topic area and can help with methods.

"Students who really involve themselves in their thesis projects

can gain a lot from the experience,” said Peter Fix, a faculty member who specializes in outdoor recreation management. “Probably more so than with conventional courses, the outcome depends on what the students expect of themselves and the work they’re willing to do.” Fix was Michael Gibson’s thesis advisor.

“I think the most important thing a student gets from the course is the opportunity to make a specific project their own, of taking ownership of it and responsibility for it,” said professor Milan Shipka (animal science). “They have to work independently and be professional; it’s an introduction to what many of them will be required to do in the workplace.”

Milan’s thesis advisee, Jennifer L. Miller, this year developed a proposal that led to funding by the UAF Office of Sponsored Programs. Funding for the award was donated by Williams Alaska Petroleum (now Flint Hill Resources). Miller is researching differences in quiviut quality between wild and domestic muskoxen and, in domestic muskoxen, the variation in quiviut samples from shoulder, side, and rump samples. She has already collected the wool. The funding supports the collecting work and purchase of the quiviut and supplies. Samples will be analyzed by the Texas Wool and Mohair Laboratory. Miller will complete her thesis before her expected graduation next spring.

To develop a research question, students are advised to use their classroom discussions and work experience to identify a topic, then talk with other students, their academic advisor, and other faculty members about their idea. The faculty advisor helps the student refine the idea, and makes sure it is feasible to complete the project within the two-semester time frame.

The thesis project may or may not involve an experiment or laboratory research. Also, it may or may not represent original research. However, the topic should have a level of complexity that distinguishes the senior thesis from a term paper. The topic should be one that provides for independent thought and critical analysis. For example, a paper reviewing the published methods of germinating white spruce seeds is a good term paper, but it is not acceptable as a senior thesis. A paper based upon an experiment comparing several methods of germinating white spruce seeds at different temperatures could be a good thesis.

A comprehensive review of the literature on a particular topic is appropriate if it contains an analysis or critical review of the literature. For instance, an outline of the literature relating to land use practices in the Tanana Valley would not be sufficient for a senior thesis. However, a critical comparison of land use practices on public and private lands could be appropriate, as long as the topic can be formulated as a hypothesis or question.

All of the students prepare an annotated bibliography with a minimum of fifteen references, eight being primary sources. At least two of the sources are historical, and at least two written within the past three years. Each citation is followed by a short paragraph, outline, or notes describing how the article will be important to the student’s research.

After the middle of the second semester, the student presents the thesis to the faculty and other students, giving a 25-minute formal presentation that includes a short summary of their objectives, methods, results, and conclusions. Presentation must include visual aids and are followed by a short question

and answer period. The presentation is a formal university seminar, with an audience that may consist of all faculty, the student’s peers, guest lecturers and scientists, agency personnel, and other members of the university community.

Holloway said the idea of a thesis project for NRM majors was first presented to the faculty by Tom Gallagher, who at the time was a professor of regional and land use planning at UAF. The program began in 1993.

Selected Abstracts

Electrical Stimulation of Reindeer Carcasses during field slaughter and the Effect on Meat Tenderness

by George Aguiar. Submitted May 2005 in partial fulfillment of the requirements of the B.S. degree in natural resources management (plant, animal, soil science option).

Abstract: Field-slaughtered reindeer out on the Seward Peninsula, Alaska, must be frozen immediately in the field after dressing in order to meet State of Alaska regulations. This abrupt freezing may inhibit subsequent muscle tissue processes that influence meat quality. Low voltage electrical stimulation (E.S.) has been used in the beef industry to avoid undesirable meat characteristics due to flash freezing. Twenty-six reindeer steers were field slaughtered during February and allowed to abruptly freeze. Thirteen animals were stimulated prior to field dressing. Front shoulder meat from E.S. carcasses was statistically more tender (54% to 46%, $p < .05$, $n = 203$) than control carcasses using a paired comparison consumer evaluation test. Electrical stimulation prior to abrupt freezing in the field improves tenderness of fore shoulder reindeer meat.

The author acknowledges his senior thesis committee: professors Greg Finstad, chair, Christy Long, and Norman Harris.

Public Involvement in Situk River Land-Use Proposals, Yakutat, Alaska

by Nathaniel Endicott. Submitted November 2003 in partial fulfillment of the requirements for the B.S. degree in natural resources management (plant, animal, soil science option).

Abstract: The Hubbard Glacier is currently in position to block the entrance of Russell Fiord, just outside the small fishing community of Yakutat, Alaska. The potential destruction of trail system and river access provided the foundation for case study of public involvement in land use decision-making. The purpose of this study was to describe local Situk River users and their opinions concerning access and management options. This study consisted of a mail survey of the Yakutat community, along with personal interviews. The response rate for the survey was 30%, with 64 responses from the sample population of 212. Differences were found between the user groups of commercial fishers and sport fishers, in areas such as trail access and management quality. This data, along with trends found in content analysis, led to management suggestions such as: public participation education programs, increasing boat launch access quality, and changing public participation practices.

The author acknowledges his senior thesis committee: professors Peter Fix, chair, John Fox, and Stephen Sparrow.

Opportunities for a Small Portable Sawmill in Eastern Washington

by Cody Burgess. Submitted May 2005 in partial fulfillment of the requirements for the B.S. degree in natural resources management (forestry option).

Abstract: Technology has made portable sawmills efficient for cutting logs of various sizes and producing lumber of all dimensions. Portable sawmills can be used to custom cut lumber, taper saw for increased lumber recovery, and to minimize labor costs. A case study was done using a Log-Master Model 5 portable sawmill in eastern Washington. The sawmill is owned and operated by Burgess Logging Inc, which is attempting to expand their business. Eastern Washington forests contain highly valuable species of timber, including ponderosa pine, Douglas fir, western red cedar, and others. From June through August 2004, 6230 board feet of lumber were produced. Orders, stock material, and chunks were sawed, which created a lumber recovery overrun of 511 board feet. The results show that the Log-Master is efficient sawing logs between 8 inches and 24 inches in diameter. Log scaling and lumber grading rules and techniques were also studied in order to become more familiar with the sawmilling business.

The author acknowledges her senior thesis committee: professors Edmond C. Packee, chair, John D. Fox, Jr. and T. Scott Rupp.

Slash Decomposition Following Thinning

by Christopher Swisher. Submitted May 2005 in partial fulfillment of the requirements for the B.S. degree in natural resources management (plant, animal, soil science option).

Abstract: Boreal forest management prescriptions commonly require thinning with pruning of overstocked spruce stands. A major concern with the prescription is the remaining slash. Objectives were to determine the amount of slash remaining after two different thinning regimes and to sample the fuel load on a treated site to see if an increased fire hazard still exists 22 years later. Slash removal from treated sites is expensive and currently seen as necessary to reduce fire hazards in treated areas. Nine plots were measured for fuel loading and compared to a control plot and a treated plot with the slash removed. The thinned plots contained 5 to 27 more tons per acre of coarse woody debris than the control plot and 12 to 34 more tons per acre than the cleared plot. The thinned area still poses an increased fire hazard after 22 years. This project demonstrates the need for slash treatment.

The author acknowledges his senior thesis committee: professors Edmond C. Packee, chair, John D. Fox, Jr. and T. Scott Rupp.

Possible Hybrids Between White Spruce (*Picea glauca* (Moench) Voss) and Black Spruce (*Picea mariana* (Mill.) B.S.P.) in the Tanana Valley, Alaska

by Heide Lingenfelder. Presented May 2004 in partial fulfillment of the requirements for the B.S. degree in natural resources management (plant, animal, soil science option).

Abstract: Many *Picea* species in North America hybridize. Reports of hybridization between black spruce, *P. mariana*, and white spruce, *P. glauca*, are rare and disputed. The isolating mechanism preventing hybridization between these species is

flowering time. White spruce has been shown at lower latitudes to flower earlier than black spruce. Trees showing intermediate characteristics between these species have been observed in the Tanana Valley in Alaska. The Tanana Valley is located in the interior of Alaska, and has climate constraints that might cause flowering times to coincide. Genetic analysis using PCR (polymerase chain reaction) was performed on six trees growing throughout the Tanana Valley. PCR was performed using both mitochondrial and chloroplast DNA. Mitochondrial DNA has been shown to be maternally inherited in spruce, and chloroplast DNA has been shown to be paternally inherited. Three of six trees displayed both white and black spruce chloroplast DNA. The results of this study are inconclusive. The preliminary results of this study warrant further investigation.

The author acknowledges her senior thesis committee: professors Jenifer McBeath, chair, Edmond C. Packee, and John Alden (retired).

Avalanche knowledge, experience, and behaviors among winter backcountry users in Turnagain Pass, Alaska

by Michael Gibson

Submitted May 2004 in partial fulfillment of the requirements for the B.S. degree in natural resource management (resources option). The author acknowledges his senior thesis committee: professors Peter Fix, chair, Joshua Greenberg, and David Valentine.

Editor's note: In this abridged version of Michael Gibson's thesis, several sections and illustrations are omitted, along with the related citations. Omitted text is indicated by an ellipsis or an editor's note.

Since 1950, 693 people in the United States have died from avalanche-related incidents (Colorado Avalanche Information Center)... Nearly half of these deaths have occurred since 1990 [and] this disquieting trend is occurring simultaneously with an observable rise in participation of winter recreation throughout the United States.... There is strong evidence to support the notion that nationwide, participation and participation intensity in winter recreational activities will continue to rise (Bowker 1999). State-level outdoor recreation participation estimates for Alaska suggest that the number of residents participating in backcountry skiing and off-road vehicle use, including snow machining, will increase by 35 percent and 29 percent respectively by the year 2020 (SCORP 1997). This is particularly important in Alaska, where in recent years a large percentage of avalanche fatalities have occurred....

As demand continues to grow, it will become progressively more difficult for land managers to provide safe winter recreational opportunities while concurrently meeting the need for increased

user capacity. This is especially true on national forests lands which are “established and shall be administered for outdoor recreation” under the Multiple Use Sustained Yield Act of 1960 (Coggins et al. 1993)....

Land managers faced with meeting increased demand along with rising avalanche fatality rates could benefit from information concerning winter backcountry users. It has been suggested that the more land managers know about factors influencing a decision to perform or not to perform a given behavior, the better their ability to develop effective messages to influence these decisions (Fishbein and Manfredi 1992). Specifically, information linking avalanche knowledge, experience, and behaviors in the backcountry would be extremely useful in developing effective education campaigns that consider what messages to utilize and how to disseminate those messages.

Such information would also be useful to avalanche professionals and educators. Avalanche educators have long recognized that education has the potential to reduce the relative risks taken by winter backcountry users. Fredston et al. (1994) suggest that good avalanche training and experience are fundamental to making good decisions. To assess these risks, past research related to avalanche awareness, experience, and behaviors has relied on [after the fact] avalanche accident reports, media reports, and interviews collected and compiled by the Colorado Avalanche Information Center (Atkins 2000, McCammon 2001, 2002)....

This...study complements past research by investigating the relationships between levels of avalanche knowledge, experience, and behaviors of winter backcountry users [prior to an incident]....to: 1) obtain some generalizable information about backcountry users; 2) examine the relationships between avalanche knowledge, experience, and behavior of motorized and non-motorized users; and 3) to determine if avalanche knowledge and experience interact to affect behavior.

Methods

Sampling and Data Collection: Use of human subjects in this study was approved by the University of Alaska Fairbanks Institutional Review Board (IRB Protocol No. 03-69). My target population for this study was winter backcountry users visiting Turnagain Pass in the Glacier Ranger District of the Chugach National Forest in Alaska during winter 2004. Sampling occurred between December 31, 2003 and February 1, 2004. I stratified my population of interest into two user groups, motorized and non-motorized winter backcountry users. For sampling purposes, this was easily accomplished as the Forest Service restricts motorized use to west of the Seward Highway in Turnagain Pass. I randomly sampled backcountry users at three roadside pullouts: Turnagain-West (motorized), Sunburst, and Tincan....
[Editor's Note: the Questionnaire Design, Knowledge Measurement, and Data Analysis sections of this thesis are omitted here.]

Results

Questionnaire Response: Of the 101 individuals approached with a questionnaire, 40 motorized and 53 non-motorized users completed the questionnaire. A total of 93 people completed the questionnaire for an overall response rate of 92 percent.

Only 1 non-motorized user and 7 motorized users refused to take the survey....

Table 1. Mean knowledge of avalanches for motorized and non-motorized users.

Category	X	t
Motorized	5.85	-6.44
Non-motorized	6.4	-6.44

n = number in sample; X = mean knowledge score; SD = standard deviation; t = t score; p = probability of attaining a value of t as great or greater than the value that was obtained

Knowledge Among User Groups: The mean knowledge score for the 93 backcountry users who responded to the 10 knowledge items was 5.3 out of a possible 10 (SD=2.29), indicating an intermediate level of knowledge about avalanches when all user groups were pooled. Avalanche knowledge significantly differed among user groups.... Non-motorized users had a greater mean knowledge-of-avalanche score than motorized users. That is, non-motorized users scored significantly higher on the knowledge-of-avalanche quiz than motorized users.

Relationship Between Avalanche Knowledge/Experience and Behavior: Avalanche knowledge was significantly correlated with behavior.... Respondents with higher levels of avalanche knowledge were more likely to have higher mean behavior scores. Results of the regression analysis show that 36.8 percent of the variance in mean behavior scores is dependent on knowledge (R²=0.368).

Experience was also significantly correlated with behavior in this study.... Respondents with higher levels of experience generally had higher mean behavior scores. Approximately 20 percent of the variance in mean behavior scores can be attributed to experience (R²=0.195).

Interaction Effect of Avalanche Knowledge and Experience on Behavior: Using univariate analysis of variance, the interaction of avalanche knowledge and experience did not significantly affect behavior in this study (F=1.76, p=0.145). Results did show however, that knowledge and experience interact to affect behavior (Figure 3). Respondents with high levels of avalanche knowledge and experience had the highest mean behavior scores. The lowest mean behavior scores were observed in users with the low levels of avalanche knowledge and experience.

Using linear regression analysis the interaction of avalanche knowledge and experience on mean behavior scores was significant in this study (F=35.34, p=0.01). Results show that 44 percent of the variance in mean behavior scores is related to the interaction of knowledge and experience (R²=0.44).

Discussion

.... My results confirm the observation that the two greatest risk groups are novices who do not recognize that a hazard exists and experienced travelers whose skill levels lead them to take greater risks (Fredston et al. 1994). In this study, high, intermediate, and low experience groups with low knowledge all had similar low mean behavior scores. This implies that experienced people with low levels of avalanche knowledge are just as likely to make unsafe decisions as low experience people with little knowledge.

This identifies the high-experience, low-knowledge group as particularly dangerous. This is because less experienced group members regularly disregard their own judgments and rely on a more experienced partner without recognizing that most peoples' traveling skills far exceed their avalanche hazard evaluation skills (Fredston et al. 1994). In any case, it is not ideal to make decisions about how to travel through avalanche terrain predicated upon experience or knowledge alone.

Conclusions

My results demonstrate that avalanche knowledge has a greater influence upon behavior as experience level increases. The interaction of knowledge and experience accounts for a larger percentage of the observed variance in mean behavior scores than looking at these variables independently. Looking at the interaction effect of knowledge and experience on behavior provides much more insight than looking at experience or knowledge independently. For example, just focusing on knowledge, one may falsely conclude that knowledge is the only factor posited to positively influence behavior. This does not explain why more than once a person has attended an avalanche workshop and been caught and killed in an avalanche not long after. This is not meant to belittle the importance of education, but rather to illustrate that knowledge and experience interact at some basic level to influence the decision-making process. Knowledge and experience only partially substitute for one another. Therefore, the safest users are those with both avalanche knowledge and practical experience. Indeed, the results of this study clearly show that significantly reducing the persistence of unsafe behaviors among winter backcountry users will take a combination of both.

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Avalanche Questionnaire

The questionnaire Michael Gibson used for his thesis contained the following questions. (Answers are on page 28)

- Human-triggered avalanches are most likely to occur at which of the following slope angles?
 - 25-34 degrees
 - 35-45 degrees
 - 46-55 degrees
- Weak layers within the snowpack generally persist longer at which aspect?
 - North-facing aspect
 - South-facing aspect
 - East-facing aspect
 - West-facing aspect
- Avalanches can happen on any snow-covered slope?
 - True
 - False
- Which of the following weak layers is responsible for most human triggered avalanches?
 - Facets
 - Buried surface hoar
 - Depth hoar
 - Ice Crust
- Which of the following terrain variables are most important when determining whether or not it is possible for a given slope to avalanche? (**Choose 3**)
 - Elevation
 - Aspect
 - Slope angle
 - Path history
 - Vegetation
 - Terrain roughness (anchoring)
 - Slope Shape
- Most natural avalanches occur when?
 - During or immediately after storms
 - During periods of warming
 - During periods of cooling
 - During periods of high winds
- Which of the following slope shapes is responsible for more avalanches? (Circle one)



- A heavy amount of new snow in a short period results in which of the following?
 - Erosion of the bonds between snow grains
 - Loose snow avalanches
 - Increased stress on the snowpack
 - Deposition of a slab over a weak layer
- Rainfall is more likely to produce an avalanche when it encounters which of the following types of snow?
 - Wet snow
 - Dry snow
 - Old melt-freeze snow
- Shooting cracks, "whoomping" noises, and propagating fractures are associated with which of the following

types of avalanches?

- A) Ice avalanches B) Loose snow avalanches
C) Cornice collapses D) Slab avalanches

11. Which of the following best describes your ability level in the winter backcountry recreational activity you participate in the most?

- A) Expert B) Expert/Intermediate
C) Intermediate D) Intermediate/Novice
E) Novice

12. How long have you been winter recreating in the back country?

- A) Less than 1 year B) 1-3 years
C) 4-6 years D) 7 years or more

13. On average, how many days do you spend winter recreating in the backcountry per year?

- A) 1-7 days B) 8-14 days
C) 15-21 days D) 22 or more days

14. What types of avalanche education have you participated in? (Check all that apply)

Avalanche experience table

Types of avalanche education	Put an "x" in the appropriate squares
Watched a video/program or read literature about avalanches	
Attended an avalanche safety lecture	
Level I (field intensive) avalanche training or equivalent	
Level II (field intensive) avalanche training or equivalent	

15. On average, how many times a year do you practice using an avalanche beacon?

- A) Never B) Once a year C) 2-3 times a year
D) More than 3 times a year

16. Did you take an instrument to measure slope angles with you today? (If Yes, indicate the type of instrument)

- A) Yes _____
B) No

17. Which of the following items did you carry on your person while traveling in the backcountry today? (Circle all that apply)

- A) Avalanche beacon B) Shovel C) Probe

18. Did you make sure that each member of your party was equipped with a beacon, shovel, and probe today?

- A) Yes B) No

19. Did you conduct any snow stability tests today? (If Yes, indicate which types)

- A) Yes, _____
B) No

20. What is the weather forecast for today?

Temp (write in) _____

Precipitation (circle one)

rain snow none

Wind Direction (circle one)

N NE E SE S SW
W NW Variable

21. Where do you obtain information on snow and weather conditions? (Circle all that apply)

- A) TV weather B) Internet C) Radio
D) Avalanche information center/hotline
E) Other (please indicate) _____

22. You would like to descend a 24° west-facing slope. Approaching the slope you hear "whoomping" noises and observe shooting cracks. The weather is clear and cool. You observe that moderate winds from the east have transported snow onto west-facing slopes. Which of the following would you choose to do?

- A) Travel the slope B) Avoid it and find another way

23. You would like to travel on a 35° south-facing slope. It is early spring and the snowpack has just begun a wet, melt-freeze cycle. The sky is clear with prevailing light winds from the southeast. You are sinking in the snow up to your calves. You notice several sets of new tracks on the slope. Which of the following would you choose to do?

- A) Travel the slope B) Avoid it and find another way

24. The weather is sunny after two days of storms, and you head to "The Super Bowl" to enjoy the powder on your favorite 35° line. The shovel shear tests you conducted on a representative slope yielded easy shears. Approaching the bowl you watch a group of three people descend a 29° slope to the right of the line you intend to descend. Which of the following would you choose to do?

- A) Travel the slope B) Avoid it and find another way

End

Answers to the knowledge questions:

- 1-(B), 2-(A), 3-(B), 4-(B), 5-(B, C, G), 6-(A), 7-(convex), 8-(C), 9-(B), 10-(D), 22-(A), 23-(B), 24-(B).

Can lettuce growers profitably use smaller containers for seedlings?

Cody Edwin Peterson

Excerpted and condensed from "Lettuce Seedling Growth in Flats with Different Cell Size and Shape," a senior thesis presented to the faculty of the School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks, and the senior thesis committee (professors Meriam Karlsson, chair, Stephen Sparrow, and Mingzhu Zhang) in partial fulfillment of the requirements for the first degree of Bachelor of Science in natural resources management (the plant, animal, and soil science option) by Cody Edwin Peterson, Fairbanks, Alaska, May 3, 2004.

Introduction

A common practice in vegetable production is the use of containerized transplants. This propagation technique provides producers with many benefits such as earlier yields, improved field establishment, and use of a controlled environment to optimize growing conditions for seedling production (Dyremple and Paul, 1988; Ivanhoff et al., 1960; Nettles, 1963; Norton, 1968). To increase efficiency, producers often use transplant flats with a small cell volume. A smaller rooting volume reduces inputs such as growing media, required handling, and increases transplants per greenhouse space, which subsequently reduces cost to the grower (Weston and Zandstra, 1986). Zimet and Vavrina (1995) suggest doubling the number of muskmelon transplants in a Florida greenhouse reduces pre-plant cost by 30 to 40 percent of estimated fixed and variable cost. Dufault and Waters (1985) stated the cost of cabbage transplants produced in a 3.8 mL container is \$.019 compared to \$.075 for a 23.2 mL container. Cabbage seedlings in 33.7 mL container volumes cost twice as much as seedlings in 7.5 mL container volumes (Csizinszky and Schuster, 1993).

While smaller containers may improve efficiency of transplant production, a small rooting volume can induce root restriction (NeSmith and Duval, 1998). Plants undergo many physiological and morphological changes in response to reduced root volume, which can affect transplant performance, and subsequently yield. Root and shoot growth, biomass accumulation and partitioning, photosynthesis, leaf chlorophyll content, plant water relations, nutrient uptake, respiration, flowering, and yield are all affected by root restriction and container size (NeSmith and Duval, 1998; Marr and Jirak, 1990; Weston and Zandstra, 1986). In tomato transplants, height, leaf area, flowering, and stem diameter increased with a larger rooting volume (Weston and Zandstra, 1986; Marr and Jirak, 1990; Kemble et al., 1994). Smaller container volumes reduced growth, stem length, and leaf diameter of marigold seedlings (Latimer, 1991). Similar results were observed from broccoli and cauliflower (Dufault and Waters, 1985), peppers (Weston, 1988), and cabbage (Marsh and Paul, 1988).

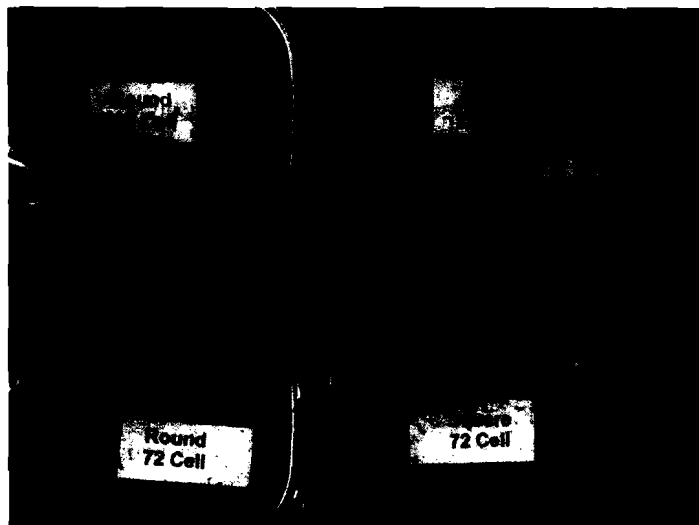


Figure 1. Effect of container cell size and shape on root volume and hypocotyl thickness X.

In many crops, transplant rooting volume affects yield. Pepper (Weston 1988), sweet corn (Waters et al., 1990), and tomato (Kemble et al., 1994; Weston and Zandstra, 1986; Marr and Jirak, 1990) yields were earlier with increased container size. Using a larger container resulted in higher yield for cabbage (Marsh and Paul, 1988) and tomatoes (Kemble et al., 1994; Weston and Zandstra, 1986).

The response to seedling root volume, especially in terms of harvestable yield, also depends on cultivar, environmental and field conditions, and location. Yields differed in response to container size for watermelon cultivars 'Charleston Gray' and 'Crimson Sweet' (Hall, 1989; Vavrina et al., 1993). Days to first harvest, central, cull, and lateral yields of 'Southern Comet' broccoli were not affected by container size in St. Paul, Minnesota (Dufault and Waters, 1985). While at the Becker Sand Plains Research Farm, Minnesota, 'Southern Comet' in 3.8 mL containers matured a week later than 30.5 mL and 23.2 mL containers (Dufault and Waters, 1985). Contradictory evidence and variable results among species and cultivars suggest a need for further experimentation to determine the response to rooting volume (NeSmith and Duval, 1998).

My objective was to determine the effect of container size and shape on the growth and development of lettuce (*Lactuca sativa* L.) seedlings. Results of this study will assist in selecting a transplant container size and shape that could potentially enhance quality of lettuce transplants. Characteristics of higher quality lettuce transplants include increased dry mass, high root to shoot ratio, reduced height, lower specific leaf area, leaf length to leaf width ratio, and hypocotyl length (Kitaya et al., 1998). These results could allow growers to produce quality transplants that will improve field performance and increase yields.

Methods

The lettuce cultivar 'Alpha' is commonly grown by commercial producers in the Matanuska Valley (Leiner, 2003) and was therefore selected for this study. The seeds were planted in plug flats filled with a commercially available peatlite medium (Premier ProMix BX, Premier Brands, Red Hill, Pennsylvania).

The experiment was initiated at the planting of seeds. The lettuce was grown in a controlled greenhouse environment. The temperature during the course of the experiments was maintained at 20 ± 2°C using aspirated thermometer sensors and a Wadsworth step control system (Arvada, Colorado). The seedlings were watered throughout the study with a fertilizer solution of 100 ppm nitrogen using Peters' 15-16-17 peatlite special fertilizer (Scotts Co., Marysville, Ohio). Sixteen hours of high-pressure sodium (HPS) light was provided to all treatments with light intensity at 130–150 mmolxm-2s-1.

The effect of container size and shape on the development of lettuce seedlings was studied using four treatments. The plug trays with individual cells of square or round shape in two sizes were selected. The volumes of the square cells were 10 mL or 50 mL while the volumes for the round plug trays were 9.5 mL or 48 mL. Lettuce seedlings were grown in treatments for a period of four weeks. The experiment had three replications. Each replication was separated by one week. Treatments were randomly placed in the greenhouse.

At the end of four weeks, I collected data from lettuce in the four treatments. The outer rows of the flats were disregarded to eliminate a source of variance in my results. Height was measured from the surface of the growing medium to the top of the leaf canopy and hypocotyl length was from the media surface to the node of the lowest leaf. The roots of transplants were washed free of growing media and separated into root and shoot tissue. Dry weights were recorded following three days at 65–70° C and the ratio between root and shoot dry weights was

determined. Visual evaluations of transplant quality were made before and after the growing media was washed off the roots. Data were analyzed by analysis of variance (ANOVA) using the computer software SPSS (SPSS Inc, Chicago, Illinois). Following ANOVA, means were compared using bonferroni method (SPSS Inc, Chicago, Illinois).

Results

Lettuce transplants from large container volumes, 50 mL and 48 mL, had more leaves, increased height, and larger root, shoot, and total weights compared to the smaller container volumes, 10 mL and 9.5 mL (Table 1). Hypocotyl length was significantly shorter from large square containers compared to small square containers. However hypocotyl length in large round containers was not significantly shorter than small containers. Effect of container cell shape was less evident than container cell size. Fifty mL square cells increased height, root, shoot, and total weight compared to 48 mL round cells. Ten mL square cells increased hypocotyl length and decreased height from 151.7 to 141.6 cm and leaf number by 1 compared to 9.5 mL round cells. Root to shoot ratio was not significantly affected by container cell size and shape.

Aspects of transplant quality not represented in data analysis were visually evaluated (figures 1 and 2, on page 32). Leaf area appeared to increase in the 48 mL and 50 mL cell sizes compared to 9.5 mL and 10 mL container cells. The volume of roots was larger in the large container cells compared to the smaller container cells. Hypocotyl diameter was observed to be larger in 48 mL and 50 mL cells compared to 9.5 mL and 10 mL

Table 1. Effect of container cell size and shape on growth of 'Alpha' lettuce seedlings. Data recorded 35 days from seeding.

Square							
10 mL	10.8 ^X	9	141.6	0.032	0.180	0.211	0.173
50 mL	7.8	11	172.0	0.110	0.584	0.694	0.198
Round							
9.5 mL	8.8	8	151.7	0.032	0.193	0.225	0.165
48 mL	8.1	11	166.0	0.084	0.472	0.556	0.182
Significant effects^Y							
Volume							
10 mL vs. 50 mL	*	*	*	*	*	*	NS
9.5 mL vs. 48 mL	NS	*	*	*	*	*	NS
Shape							
10 mL vs. 9.5 mL	*	*	*	NS	NS	NS	NS
48 mL vs. 50 mL	NS	NS	*	*	*	*	NS

^X Each mean is the average of 120 plants

^Y Mean separation by Bonferroni test, significant at P ≤ 0.05 (*), or nonsignificant (NS), respectively



Figure 2. Effect of container cell size and shape on leaf area x. 200 Cell = small containers, 72 cell = large containers

cells. Majority of the root growth in all treatments was observed at the outer edge of the root mass next to the container wall.

Discussion

Kitaya et al. (1998) defined higher quality lettuce plug transplants as having higher dry mass, higher root to shoot ratio, decreased height, lower specific leaf area, leaf length to leaf width ratio, and hypocotyl length. The results of my study conclude 'Alpha' lettuce transplants in large containers (48 & 50 mL) were of higher quality than small containers (9.5 & 10 mL).

Although transplants grown in smaller containers were shorter compared to larger containers, this was a result of root volume restriction, which had an overall negative effect on transplant quality. Impacts of root restriction may be alleviated by cultural practices, producing a higher quality transplant. Csizinszky and Schuster (1993) indicated that increased fertilization rates reduced effects of root restriction of cabbage transplants grown in small containers. Horticultural practices applied to transplants in larger containers may also increase quality by reducing height. In addition, if seedlings were capable of being transplanted prior to five weeks, total height would possibly also be reduced.

Dry weights, height, and leaf number of lettuce transplants increased in larger containers as did previous studies of lettuce (Nicola and Cantliffe, 1996), broccoli and cauliflower (Dufault and Waters, 1985), muskmelon (Maynard et al., 1996), and cabbage (Csizinszky and Schuster, 1993; Marsh and Paul, 1988).

Container cell size and shape did not have a significant effect on root to shoot ratio (Table 1), however a trend indicated that larger containers had a higher root to shoot ratio. Previous research indicates differences in root to shoot ratio response to rooting volume. Root to shoot ratio of watermelon (Liu and Latimer, 1995) and muskmelon (Maynard et al., 1996) were not responsive to rooting volume. However root to shoot ratio of tomatoes (Peterson et al., 1991; Nishizawa and Saito, 1998) and salvia (Van Iersel, 1997) increased with increasing root volume.

Visual evaluations here suggested greater root growth at the medium-cell interface. These observations are consistent with earlier studies on tomato (Liptay and Edwards, 1994). A higher leaf area was observed from 48 mL and 50 mL cell size. Leaf area of lettuce (Nicola and Cantliffe, 1996), broccoli and cauliflower (Dufault and Waters, 1985), muskmelon (Maynard et al., 1996), salvia (Van Iersel, 1997), and cabbage (Csizinszky and Schuster, 1993; Marsh and Paul, 1988) increased with increasing rooting volume. A thicker hypocotyl was observed from 48 mL and

50 mL container cells. Larger stem size was reported for cabbage seedlings with increasing cell size (Marsh and Paul, 1988).

Effect of cell shape on transplant quality was less evident. Significant differences were obtained between round and square containers however differences did not produce a definitive trend. Significant differences were obtained between small, square and round cells for hypocotyl length, leaf number, and total height but differences were not significant for dry weight. Differences between large, square and round cells were significant for total height and dry weights but not significant for hypocotyl length and leaf number.

However, growers prefer square containers for lettuce transplant production. Roots in round containers tend to grow in a circular direction. Following transplanting, roots continue growing in this direction instead of out into the soil. Growers state that this can prevent adequate anchorage and reduces field performance.

The results of this experiment indicate container cell volume of 48 mL and 50 mL would enhance field establishment of lettuce transplants compared to 9.5 mL and 10 mL containers. Due to poor contact with field soil, smaller root systems are more subject to desiccation when transplanted (Dufault and Waters, 1985) compared to transplants with larger root systems, which generally suffer less from transplant shock (Weston and Zandstra, 1986). Stress to transplants caused by root restriction (NeSmith and Duval, 1998) can reduce seedling vigor, which can decrease establishment in field. Lettuce seedlings subjected to less root restriction during transplant production could potentially increase field establishment, uniformity, and higher and earlier yields. Larger container cell volumes increased hypocotyl thickness and decreased hypocotyl height, which could provide more structural support during transplanting. However compatibility of container cell size with transplanting methods is essential.

Although transplants from larger containers were of higher quality, studies evaluating transplant growth, field performance, compatibility, and cost are needed to fully analyze container size and shape on lettuce production pertinent to Alaska. Additional transplant studies to include a wider range of container size, shapes, and depths would be beneficial to evaluate how transplant quality is effected by root restriction and container type. Increasing data collected on transplants to quantify visual evaluations and other aspects of transplant quality would provide a

more complete evaluation of container type in respect to transplant quality. Data collection throughout the course of the study could provide continuous relationships of transplant growth and quality. With this information a clearer understanding could be established to determine when root restriction occurred in each container, and the impacts on transplant growth and quality.

Although container size and shape affected transplant growth, field studies are essential to evaluate post-transplanting performance of seedlings. Past research has indicated post-transplanting performance and subsequent yields vary in response to rooting volume. Post transplant performance of vegetable seedlings are dependent upon location (Dufault and Waters, 1985; Maynard et al., 1996), cultivar (Hall, 1989; Graham et al., 2000; Dufault and Waters, 1985; Vavrina, 1995; Liu and Latimer, 1995; Maynard et al., 1996), field conditions (Nicola and Cantliffe, 1996), and environmental conditions (Nicola and Cantliffe, 1996; Graham et al., 2000; Marsh and Paul, 1988). In addition, container type during transplant growth may alter lettuce head size and shape, which would ultimately affect consumer acceptance.

In some cases, larger containers are reported to provide benefits such as increased total and early yields. This benefit may be especially critical to lettuce production in Alaska due to a short production season. Dufault and Waters (1985) stressed the importance of an early market and the high demand and price achieved for early produce. However, larger containers must be compatible with current production methods for growers to profit from potential benefits. Further comparisons of yield potential and cost of establishment need to be considered in selecting transplant container cell size and shape (Maynard et al., 1996; Dufault and Waters; 1985; Hall, 1989; NeSmith and Duval, 1998).

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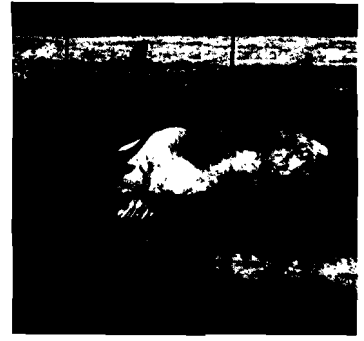
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- Pigors, Rochelle. Throw all experiments to the winds"—practical farming and the Fairbanks Agricultural Experiment Station, 1907–1915. Advisors: Dr. Pat Holloway and Dr. Terrence Cole.
- Swor, Rhonda. Comparison of hullless barley and naked oats in early weaned pig diets in interior Alaska. Advisor: Dr. Fred Husby.
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- 1996 Adams, Scott. A preliminary analysis of solid waste and wastewater pollution in the Fairbanks North Star Borough. Advisor: Dr. Susan Todd.
- Barnard, Colin. Polyphosphate sequestrants as a source of supplemental phosphorus. Advisor: Dr. Charlie Knight.
- Burke, Toby. The bryophyte and lichen flora of interior Alaska's boreal forests with reference to species at risk from forest management in areas with similar flora. Advisor: Dr. Glenn Juday.



Gibby, Stephanie. Forage quality for ensiled fireweed and bluejoint. Advisor: Dr. Mike Panciera.

Kern, Christine. Canola residue and its potential as a natural herbicide. Advisor: Dr. Charlie Knight.

Sarringer, DeeDee. Comparison of Canadian and U.S. wetland delineation systems. Advisor: Dr. Charlie Knight.

Schoening, Franz. A legal analysis of the "intent requirement" for criminal prosecution of violations of the Migratory Bird Treaty Act. Advisor: Mr. Harry Bader.

1995 Sampson, Jennifer. The Arctic Circle site plan and its relation to the Bureau of Land Management planning process. Advisors: Dr. Susan Todd and Dr. Alan Jubenville.

Grover, Raymond. Identification of alkaloids in Alaskan *Lupinus* spp. with reference to crooked calf's disease. Advisors: Dr. Lyle Renecker and Dr. Fred Husby.

Hollingsworth, Jamie. Survival and growth of late-summer planted conifers in interior Alaska. Advisor: Dr. Ed Packee.

Russo, Robert. Salmon oil as a moose deterrent in Alaska gardens. Advisor: Dr. Charles Knight.

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