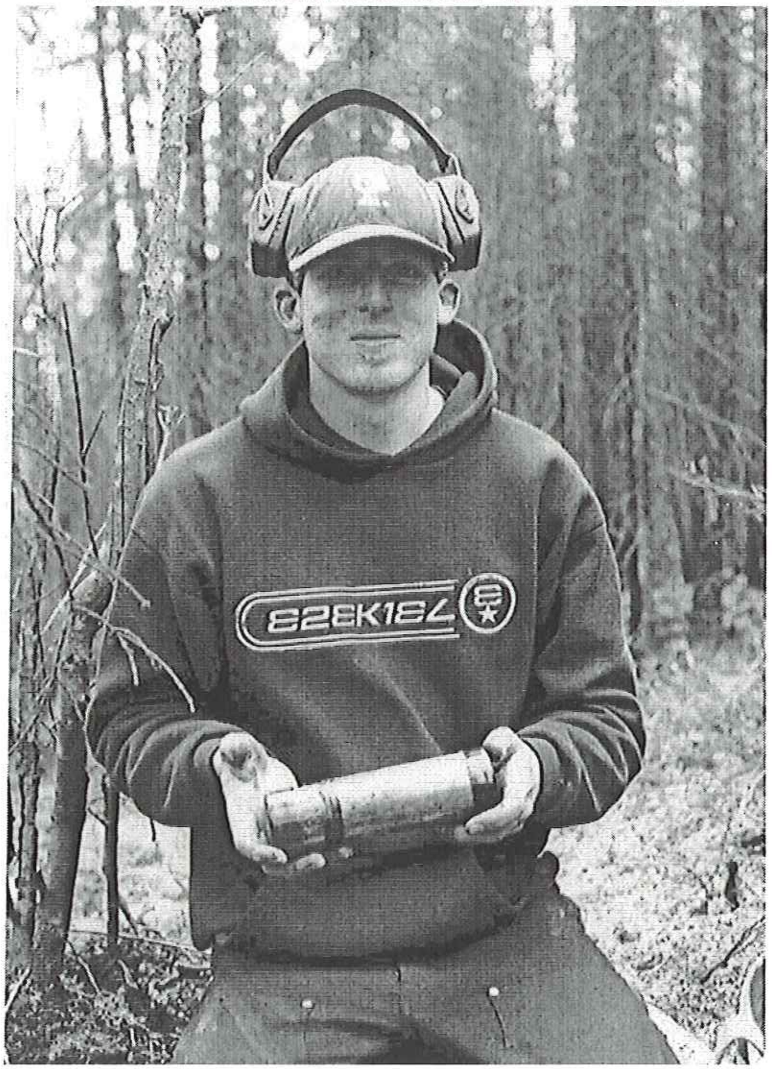
A SUMMER INTERNSHIP IN ALASKA



A PROJECT BY NILS LUNDER
HUMBOLDT STATE UNIVERSITY
ENVIRONMENTAL SCIENCE

For

Dr. Richard Hansis

The plane began its descent through thick clouds that had obscuring my view of the interior of Alaska. Below the plane the Tanana River meandered its way through forests of dwarf black spruce; the river transported a load of material that had been scoured from the mighty Alaska Range by the relentless forces of alpine glaciation.

The river's surface reflected a faint light that had made its way through the high clouds, the land surrounding the river seemed dark and foreboding. "This is it", I uttered to myself, central Alaska awaited and appeared anxious to reveal itself to me during the next 12 weeks--'the last frontier' was about to become another place that was open to my explorations. The Fairbanks International Airport was still 200 miles away and the clusters of light were emitted from the scattered communities interrupted the seemingly never-ending interior plains of central Alaska.

I had known that Alaska was going to be my summertime destination for months. Although the logistics remained hazy and the leads that I had pursued had only made me feel more apprehensive about how I was going actually achieve my goal, I knew that I would make it somehow. Right before our spring break all Environmental Science students had received an email from Dick Hansis, the coordinator of the Humboldt State University Environmental Science Program. This message informed us of a number of positions that were available for research assistants working through the University of Alaska Fairbanks

(UAF). I read through the announcement and quickly updated my resume, shortly after receiving the announcement I submitted an application.

In early May, I received a phone call from a graduate student from the UAF named Susanne who was about to start her field research. She was going to extract soil samples from a study site north of Fairbanks in an attempt to analyze how nitrogen and carbon was cycled in the boreal forest and how fire altered the natural concentrations of these essential plant nutrients. I was very intrigued and after a phone interview conducted by both Susanne and her professor Richard Boone, the position was offered to me. Shortly after the interview a fax was sent to me regarding the plane ticket, after filling in the departure date and the return date I sent back the fax. I was going to Alaska.

The terrestrial ecosystems found in the boreal region cover a little less than 17% of the earth's land surface, yet they contain over 30% of all carbon present in the terrestrial biome (Kasischke 2000). Much of the boreal region is underlain by permafrost, soil that has been below freezing point for long periods of time. Permafrost is commonly associated with the soil order called Gelisols. According to the University of Idaho, Soil Science Division, Gelisols are soils of very cold climates that contain permafrost within 2 meters of the surface. These soils are limited geographically to the earth's northern and southern Polar Regions and localized areas at high mountain elevations. Gelisols store almost 40% of the total soil organic carbon mass of all soils in Canada (Tarnocai 1999).

It has been predicted that a change in global temperatures will alter surface summer temperatures by 4°C and winter temperatures by between 4°C and 10°C. This warming may cause a northward shift of the current temperature zones (Woo et. al 1992). It is commonly agreed that there will be a significant northward movement of the permafrost zones if the global climate warms (Kettles et al., 1997; Zoltai, 1995; Vitt et al., 1994; Koster and Nieuwenhuijzen, 1992). The northward movement of the permafrost zones will reduce the land area that is currently storing carbon (carbon sinks) and this may lead to a net increase in the amount of carbon that is released into the atmosphere.

Is this happening?

Boreal forests are set apart from other biomes by the amount of carbon that they store in their soils. This is a result of a number of environmental factors Due to their northern latitude[1] they are usually subject to extremely cold temperatures. These cold conditions reduce the rates of decomposition and result in deep, un-decomposed organic soils. The presence of permafrost severely impedes the drainage of water from the land's surface. The precipitation in many boreal regions is less than 300mm/yr, but many soils remain saturated throughout the year. Saturated soils lead to anaerobic conditions and this further slows the decomposition of organic matter (Kasischke 2000).

Van Cleve et al. (1983) determined that the boreal forest floor exerts a dominant influence on the soil thermal and chemical regimes, and that its removal dramatically

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[1] Boreal forests are usually found 50° north or south of the equator

increases pH and the concentration of nutrient ions that are in solution. The agent that removes the greatest volume of the forest floor is fire. Fire is ubiquitous in the boreal region. During the summer months, daylight air temperatures are generally greater than 20°C and temperatures greater than 30°C are not uncommon. Although the soils tend to remain saturated all summer, the surface lichens and mosses become desiccated. High temperatures paired with low precipitation leads to favorable conditions for wild land fire. It has been estimated that between 5 and 12 million hectares of boreal forest burn each year (Kasischke 2000).

Fires are extremely important as a mechanism that directly transfers carbon from the earth's surface to the atmosphere in the boreal forest ecosystem. Studies show that the amount of carbon released during a fire varies a great deal. This depends on the type of vegetation, the moisture/temperature conditions of the ground layer, and the timing of a fire during the growing season (Brown 1983).

In general the lowest level of vegetation consumption during a fire occurs on forests occupying the warmest and/or driest sites. In boreal forests these sites are dominated by aspen and white spruce. On the other hand, the highest levels of vegetation consumption occur in the forests occupying the coldest and/or wettest sites that are dominated by black spruce and willow. Conversely, ground-layer biomass is more rapidly consumed by fires occurring within warmer/drier sites than on the moist/cooler sites. (Kasischke 2000). Thick organic soils take hundreds of years to form. Fires that burn deep into these accumulated masses of organic carbon can create a long-term net loss of carbon form the surface of the earth.

In the summer of 1998 an anthropogenic fire burned in the permafrost-dominated watershed at the Caribou-Poker Creek Research Watershed (CPCRW) north of Fairbanks. This watershed contains a permanent stream and the major forest types of the Alaskan boreal forest. The experiment was designed to cause a gradation of burn intensities that represent those that are observed in fires occurring on boreal forests. The burn occurred on permafrost-dominated black spruce, muskeg[2] ecosystems, and on permafrost-free deciduous forest ecosystems. An adjacent unburned control watershed was monitored for a comparison to the burned watershed.

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[2] Muskeg= Area dominated by dense populations of mosses, lichens, liverworts, and shrubs. Soil is usually saturated year round causing anaerobic conditions that lead to the sequestration of organic mater.

The name of this particular Long Term Ecological Research (LTER) project was FROSTFIRE. Prior to the burn, the carbon and nitrogen stocks in the vegetation and soils were analyzed and fuel classes were established based on classes of materials that differ in probability of combustion. Bore holes were created to monitor the permafrost thermal regime, nitrogen deposition was measured as was carbon, water, and energy exchange by hydrologic monitoring of the carbon and nitrogen outputs in the streams. Decomposition of organic matter, root growth, tree establishment and growth are also being monitored for at least six years following the fire.

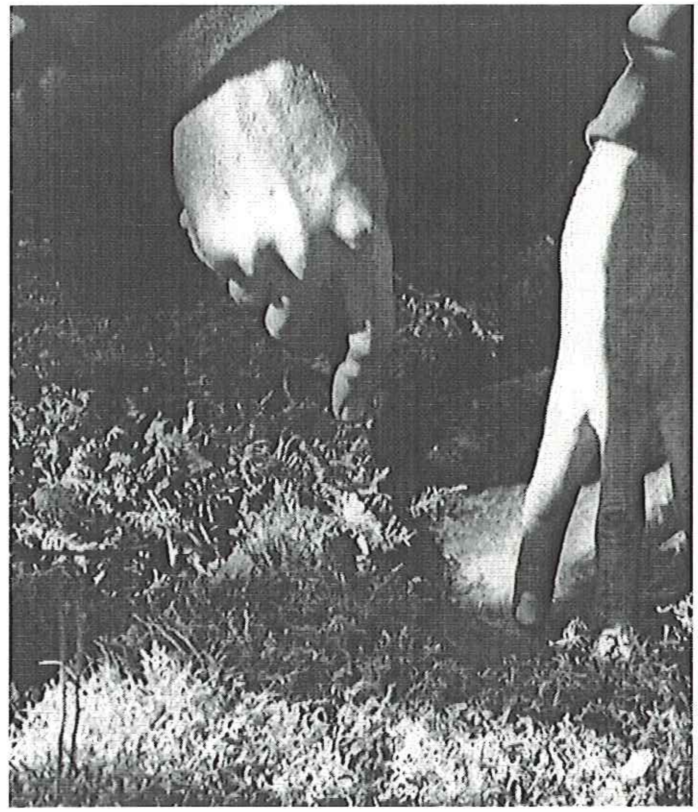
The UAF is involved with the ongoing FROSTFIRE project and the work that I helped out with took place on the CPCRW form May 28-August 15. Working under a soil ecologist named Richard Boone, Susanne was interested in the effects of fire on soil nitrogen dynamics. We had a total of eight experimental plots; two were located in mixed hardwood stands that had been burned by the 1998 fire, two were located in mixed hardwood stands that had not been influenced by the burn, two were located in black spruce that had been burned by the fire and the final two were in unburned black spruce.

METHODS

We used plots that had been established before the burn by David Valentine (a forest soils ecologist) and by Richard Boone; each plot was 30 meters by 30 meters. The boundaries of the plot were marked with white steaks that had orange flagging (see appendix 1). The lower left hand corner of the plot was treated as (0,0), the lower right corner was considered (30,0), the upper right corner was treated as (30,30), and the upper left corner was considered (0,30). The plots were located on both sides of Helmers Ridge, on which a firebreak had been cut along its axis. This fire break not only acted as the access road that led us to our sample plots, but it also separated the control plots from those that had burned (see appendix 2).

From the university in Fairbanks we would drive northeast on the Steese Highway past the town of Chatinika. From there we took a five-mile dirt road that made its way up the Poker Creek drainage. There was a base camp at the end of the road and this was where we kept two 4X4 four wheelers. We use these machines to get across a thick swamp of deep mud and up the ridge to our eight study plots. Theses carried the equipment that was needed to extract the soil cores from the plots and bring them back to the lab for analysis.

At each plot we would use a random number generator to create eight separate points within our 30meter X 30meter plot, each point was marked with a flag that listed the plot, the coordinates of the point, the date of extraction, the experiment name, and the condition of the forest floor. Using a Cartesian coordinate system based on the center of the plot (15X15) and with the aid of the 7.5meter distance markers that had been established around the perimeter of the plot (see appendix 1), we would find the newly generated random point. A 20cmX20cm plastic template and a serrated knife were used to cut away a square of the surface material.



A diagonal was cut from one corner of the square to the opposite corner; one half of the organic material was then placed into a labeled bag and taken for analysis in the lab. The other half was inserted into a similar bag and set aside. After probing for rocks a plastic sleeve was inserted into a 20cm steel corer and the corer was driven into the earth. This method of soil extraction worked well; the plastic sleeve allowed the core to be transported without disrupting the horizonation of the sample.

Two cores were taken from each of the eight points on each plot. One of the cores was taken back to the lab for analysis and the other was inserted into a polystyrene bag (allows CO_2 out while excluding the entrance of O_2 into the sample).

The bagged core was then inserted into a mesh bag to protect the bag and the whole unit was reinserted into the hole from which it had been extracted. The organic matter sample and the core were left at the site for one month, after that time they were collected and analyzed in an attempt to understand rates of nitrogen mineralization[3]. By comparing the amount of ammonium and nitrate within the sample that was taken into the lab and frozen with the amount found in the sample that remained in the ground for one month shows the rate at which nitrogen is being mineralized in the area of analysis.

The process of soil extraction is a labor-intensive undertaking and on a good day Susanne and I could cover three plots in one day. Since there are a total of 16 cores per plot, on a day when we covered three plots a total of 48 cores were extracted. We worked in all types of weather conditions; it rained, it hailed, it snowed, the sun roasted us, and regardless of the weather of the minute, we could always count on the numerous insects to keep us on our toes. Throughout the summer there were many lessons learned by both Susanne and I. Over time we developed an efficient method of fieldwork that allowed us to minimize the amount of time that was required to do our monthly collection of soil cores.

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[3] Nitrogen mineralization= the process of converting atmospheric organic nitrogen (N_2) to a plant available inorganic nitrogen compound such as ammonium or nitrate

I was involved with three separate field sessions and each of these required the extraction of 128 soil cores. Being outdoors doing scientific research is what I envisioned for my summer and that is precisely what happened. Even though Susanne and I did spend a lot of time outside, we spent more time in the lab than we did out in the field.

Returning from a long day in the field, we would carry the ice chests full of soil samples to a walk-in freezer. The samples from each plot were placed into a large plastic bag labeled with the date of removal, the plot name, and the name of the experiment. Theoretically, this will cause all of the biological processes occurring within the samples to cease and by doing so we are able to see the condition of the carbon and nitrogen cycling as they were occurring when the core was removed from the earth.

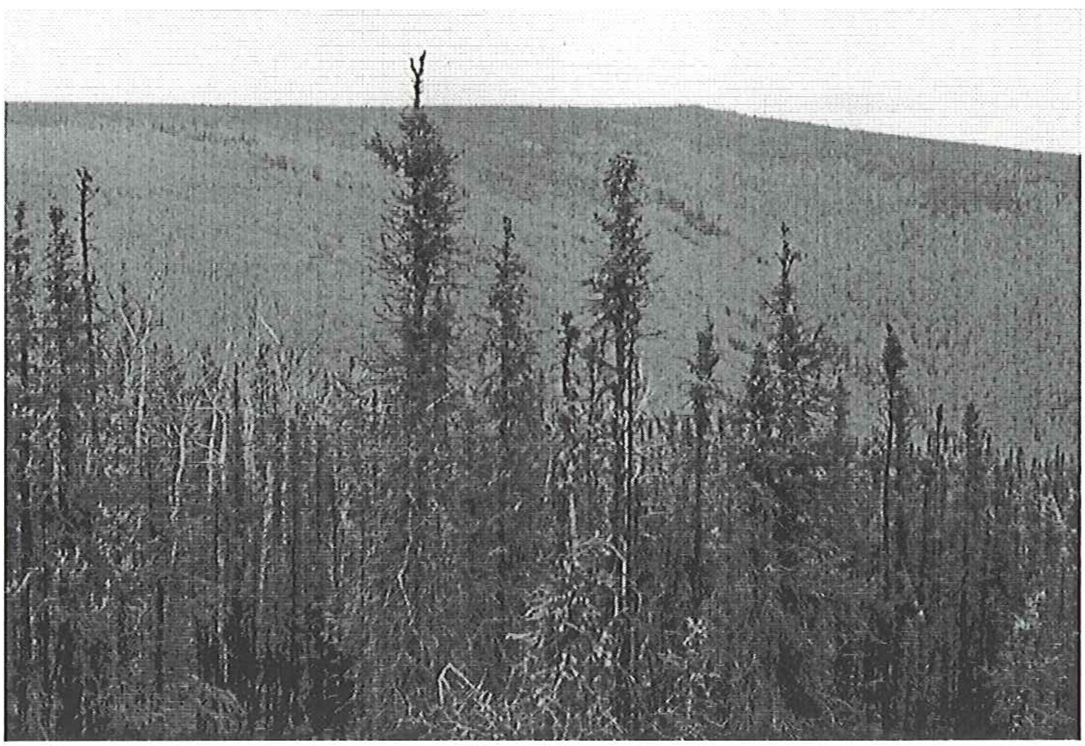
Using a coarse sieve to remove the larger woody debris, roots, rocks, worms, and live vegetation, we would attain as much soil from the sample as possible. There were a total of three categories for this process: the organic matter sample (O horizon), the 0-5cm of the core (A horizon), and the 5-20cm (B-horizon). Each category was sieved, and 10 grams of the sieved material was added to an individual plastic cup. 75ml of potassium sulfate ($K^+SO_4^-$) was added to the sieved material and a lid was screwed on. This concoction was shaken and allowed to sit for 24 hours. Another 10 grams of each category of the sieved soil samples was placed onto an aluminum-massing cup. These were then weighted on a digital scale and placed into a soil drying kiln for 24 hours @

105°C, removed from the kiln and weighed again. This procedure let us calculate the % water content of each soil sample.

After the soil had been in the $K^+SO_4^-$ solution for 24 hours, each sample was passed through a suction filter. The soil was collected on the filtration paper and the soil solution was collected in a test tube. So, we had a test tube of soil solution for each category of our soil sample. Each tube was labeled appropriately and frozen until further analysis could be performed. The $K^+SO_4^-$ solution functions as an extractant that dislodges the ammonium (NH_4^+) and the nitrate (NO_3^-) from the soil colloid, thus it extract as much of the nitrogen-based compounds from the soil as possible. This process is ionic, K^+ binds to the NO_3^- and the SO_4^- binds to the NH_4^+. Since the soil samples are being collecting for the analysis of their nitrogen dynamics, the $K^+SO_4^-$ acts as a key component in the analysis of the soils.

During the three months that I spent in Alaska we spent about six days a week collecting samples, planning for the next field session, fixing tools, processing our soil samples, entering data into a large spreadsheet, and finding ways of being more effective and professional. I really enjoyed being exposed to this type of research project being involved with many of the aspects of a master's thesis without actually being in graduate school. I feel that I was provided a very real glimpse of what advanced field science academia entails without having to actually having to commit to such a 3-6 year project. Susanne and I got along very well and we managed to keep our tasks fun while being focused. Even during the numerous all-day lab tedium we would pass the time with interesting political discussions, music, stories of our past adventures, and with healthy doses of green tea.

Being in the scientific environment of the UAF Institute of Arctic Biology taught me more about ecological studies and experimental design than I could have learned by attending school. I was surrounded by many intense scientists, all that I had to do was ask them a few questions about what they were currently studying and they would share a lot of insight. It was a phenomenal opportunity for a young scientist.



abrupt ending - More evaluation of your experience would be useful

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University of Idaho, Soil Science Division

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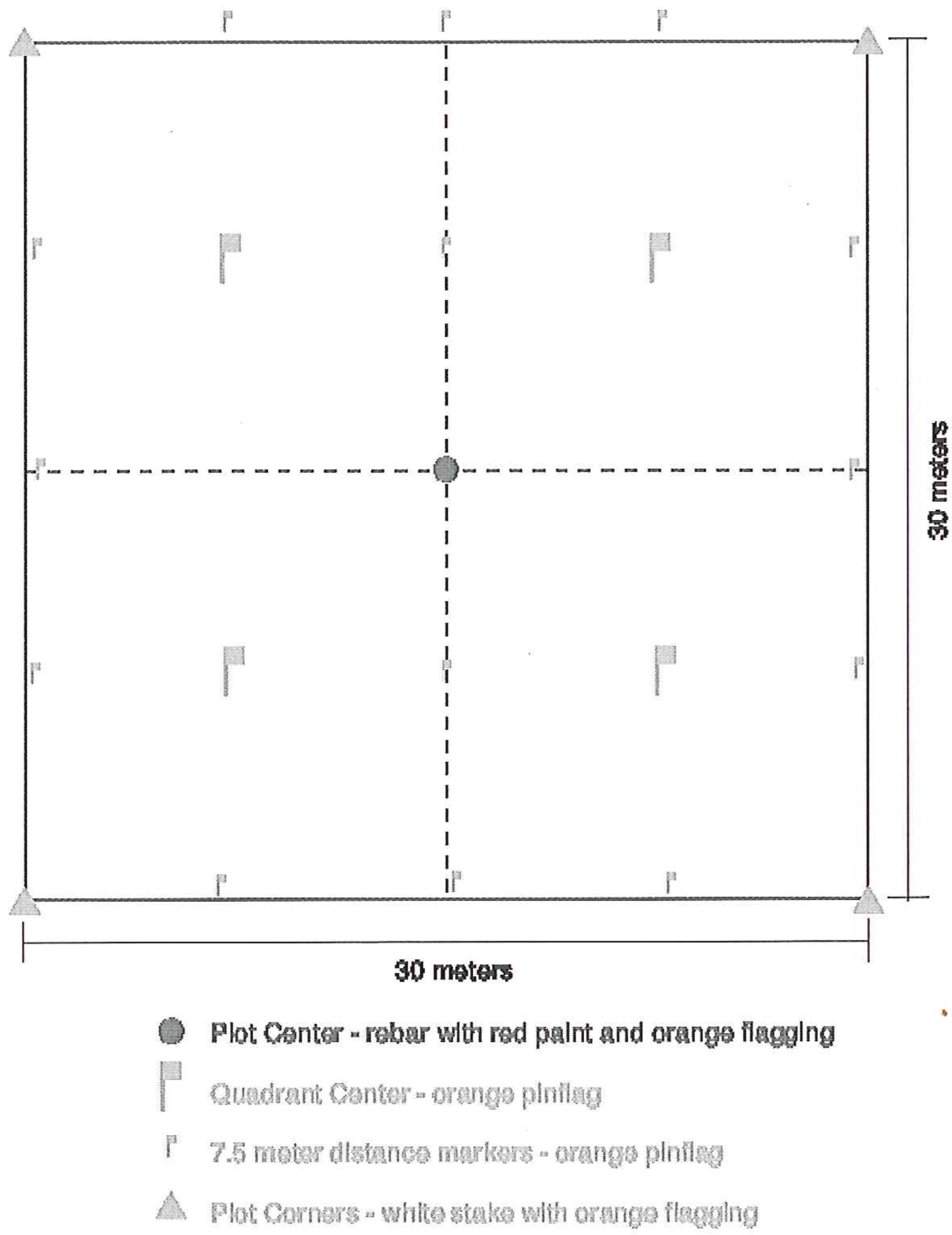
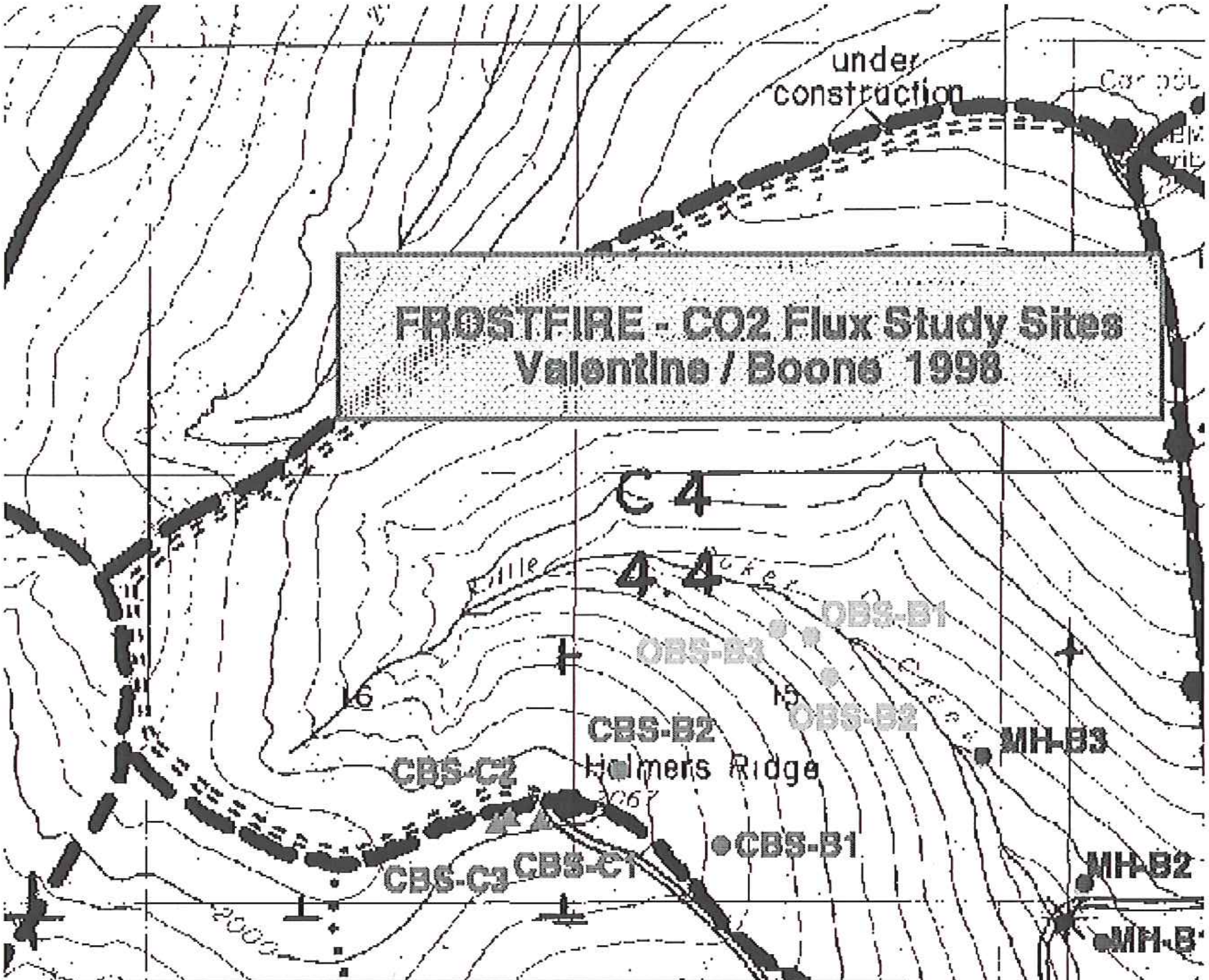
APPENDIX I

Frostfire CO2 Flux Study
Valentine / Boone 1998
- SITE LAYOUT -



APPENDIX 2



SITE	COVER	TREATMENT	LOCATION Easting, Northing, Elev.
CBS-B1	Closed Black Spruce	Burn	475256, 7227232, 546
CBS-B2	Closed Black Spruce	Burn	474872, 7227615, 598
CBS-B3	Closed Black Spruce	Burn	
CBS-C1	Closed Black Spruce	Control	474579, 7227333, 629
CBS-C2	Closed Black Spruce	Control	474460, 7227342, 626
CBS-C3	Closed Black Spruce	Control	474410, 7227317, 620
OBS-B1	Open Black Spruce	Burn	475598, 7228022, 346
OBS-B2	Open Black Spruce	Burn	475668, 7227868, 377
OBS-B3	Open Black Spruce	Burn	475488, 7228048, 368
OBS-C1	Open Black Spruce	Control	477078, 7225331, 235
OBS-C2	Open Black Spruce	Control	476985, 7225313, 251
OBS-C3	Open Black Spruce	Control	476871, 7225312, 260
MH-B1	Mixed H.wood/Conif.	Burn	
MH-B2	Mixed H.wood/Conif.	Burn	476819, 7227080, 300
MH-B3	Mixed H.wood/Conif.	Burn	476231, 7227565, 313
MH-C1	Mixed H.wood/Conif.	Control	477642, 7227237, 308

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April 30, 2001

To Whom It May Concern:

Nils Lunder worked as a research assistant in my laboratory in the summer of 2000. Nils worked mainly with my graduate student Susanne Trillhose, who is examining the effects on fire on soil nitrogen dynamics in a forested watershed about 35 miles northeast of Fairbanks. Nils assisted Susanne with all aspects of her field and laboratory work. His duties included soil sampling, sample processing (sieving and oven-dry conversions), and extraction of samples for exchangeable ammonium and nitrate. He also helped with the logistics of transporting field gear and samples and traveling within the watershed on 4-wheelers.

Nils's performance on the project was outstanding. He was extraordinarily hard working and conscientious and showed great attention to detail. He asked good questions and helped streamline procedures. He was willing to work long hours when necessary and always saw work through to completion.

Nils made a significant contribution to Susanne's (and my laboratory's) research. Because of his help, Susanne had a successful field season that will provide perhaps the first information on post-fire soil N dynamics in an interior Alaska boreal forest watershed. This information will be used in conjunction with parallel streamwater carbon and nitrogen studies to predict watershed-level nitrogen and carbon export after fire. I would readily hire Nils again for a position in my laboratory.

Sincerely,

Richard D. Boone

Richard D. Boone
Associate Professor of Ecosystem Ecology
Institute of Arctic Biology, and
Department of Biology & Wildlife