PROGRESS REPORT
SEPTEMBER 1983

LTER: Micro and Macro Views of Succession, Productivity and Dynamics in Temperate Ecosystems

Cedar Creek Natural History Area

University of Minnesota

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Principal Investigators

1. SCIENTIFIC AND ORGANIZATIONAL ACCOMPLISHMENTS

OVERVIEW

This past year, the Long-Term Ecological Research program at Cedar Creek has continued the baseline sampling regime initiated last year (meterological, precipitation analyses, soil chemical analyses, primary productivity studies, vegetation dynamics, disturbance regimes, herbivore dynamics and plant and insect collections), and has now fully implemented the experimental studies which were a central portion of the LTER project. Specific accomplishments in various aspects of the LTER project are documentd below. We wish to stress at the outset that we view the LTER project at Cedar Creek as an integrated whole. While we do not elaborate, here, on the linkages we see among specific areas of scientific accomplishment outlined below, such linkages are a major reason for undertaking research exploring processes on many different organisms and trophic levels. Many of the scientific papers we have written and are writing do synthesize the work cited below.

A. OLD FIELD SOIL NUTRIENT ACCUMULATION

Recent theory of ecosystem succession and community development predicts a long period of nutrient accumulation during primary succession or following a disturbance that results in biomass and nutrient loss. To test this hypothesis as it relates to old field succession, in September, 1982 we surveyed 17 old fields to quantify the rates and amounts of nitrogen and soil organic matter (SOM) accumulation. The old fields ranged in age from 1 to 40 years post-agriculture. We hypothesized a gradual accumulation of N and SOM at a rate approximating atmospheric inputs. However, we found that SOM decreased from 1.5% at 1 year to 1.2% at 15 years before there was an accumulation to 2.2% at 40 years. Soil N showed the same trend, decreasing from 450 ug/g at 1 year to 350 ug/g at 15 years before increasing to 500 ug/g at 40 years. The decrease is thought to result from decomposition of agricultural crop residue and leaching of available N. We hypothesize the ratio of labile to resistant SOM initially decreased through time. At about 15 years, the SOM stabilized and N and organic matter began to accumulate. The N accumulation from years 15 to 40 was about 10 kg N/ha/yr, approximately equal to atmospheric inputs.

B. DECOMPOSITION

Nutrient accumulation and turnover in plant tissue is an important component in the N economy of an ecosystem. Thus a litter decomposition study was initiated in the fall of 1982. The objective of the study was to quantify and compare the rates of decomposition of little bluestem (Andropogon scoparius) in two old fields and at four levels of N fertilization. The first field was a 25 year old field dominated by little bluestem. The second field was 50 years old and similar to native tallgrass prairie, with big bluestem (Angropogon gerardii), little bluestem, Indian grass (Sorghastrum nutans), and Kentucky bluegrass (Poa pratensis) being the dominant grasses. Samples of little bluestem were collected before first frost and put in nylon mesh litter bags in the field. Six replicates were collected at 1 month, 4 months (immediately after snow melt), 6 and 8 months and will be collected at one year. Litter bag samples will be analyzed for C, N, and loss of biomass to estimate the rate of N turnover and decomposition. Additional litter samples are collected as part of the microplot sampling each summer. These data will allow us to determine the importance of the litter layer as a sink/source of N in our experiments. Chemical analyses of the samples are in progress.

C. LEACHING LOSSES OF NITROGEN

Leaching loss can be an important mechanism slowing rates of nutrient and organic matter accummulation in early stages of succession. Spring snow melt and rains combined with the sandy soils of Cedar Creek should promote nutrient loss from the root zone via leaching in soil water. To study this process, 66 porous cup lysimeters were installed in the macroplots during the fall of 1982. The macroplots are in old fields 15, 25, and 50 years old and in a fire maintained oak savanna. The lysimeters consist of porous cups attached to a reservoir containing access tubes. The reservoir was glued to the bottom of a 60 cm long and 15 cm dia. PVC tube containing an intact soil core. A few lysimeters were removed and repaired in the spring due to damage from freezing and thawing or gopher activity. Leachate samples were measured and frozen for N analysis.

D. NITROGEN AVAILABILITY

Available N is hypothesized to be a major control of ecosystem succession at Cedar Creek. Thus rates and quantities of available N are being characterized. An in situ buried bag study was begun on the macroplots in July 1982. Sieved soil samples from the top 10 cm of the soil were incubated in polyethylene bags for one month through Oct 14. The study was repeated following snow melt last spring. Available N was estimated as the difference between the initial inorganic N content of the soil (ammonium+nitrite+nitrate) and the inorganic N content after the one month incubation. Preliminary analyses suggest that Site A, the 15 year old field, had the greatest amount of available N through the fall incubation. This could be from the rapid decomposition and turnover of N in annual plant tissue in the younger field. The perennial grasses in the older fields have been shown to recycle N internally with storage in the roots, reducing the N that cycles through the litter component of the system.

E. LABORATORY IMPROVEMENTS

The large numbers of samples processed through our laboratory necessitated the upgrading of equipment. Early this year we purchased a Technicon AutoAnalyzer I. We found that the least expensive way to record data from the AA I was to record directly onto an Apple computer. With this equipment we were able to increase the number of samples analyzed each day to 150. We plan to further increase the efficiency of the laboratory by moving it to Cedar Creek as soon as the new laboratory addition is completed. This will allow researchers to process and perform chemical analysis on samples without the delays we now have and allow better supervision of the chemical procedures currently being used and being developed.

F. OLD FIELD SURVEY

To quantify the distribution and abundance of plant species along a successional gradient in old fields at Cedar Creek we sampled vegetation in 19 fields ranging in age from 1 to 50 years since cultivation. Plant species were identified and percent cover was estimated by species in 25 plots (1 x 1/2 m) on each of 4 transects in each field. In addition to the plant data a soil core was taken from each plot. We will use these data to examine changes in soils and plant species composition that occur with time, and to look for correlations between local soil nitrogen and plant species composition. Small mammal and grasshopper populations will be sampled this fall to examine successional changes in these faunas and for correlation with changes in soils and the plant community.

G. LONG-TERM STUDIES OF DISTURBANCE

An unusually violent summer storm caused extensive damage to the forest canopy in several localized areas at Cedar Creek. Hundreds of mature trees were destroyed by this major climatic disturbance. We have established permanent quadrats including extensive tree falls as well as relatively undisturbed vegetation in which to monitor responses of understory and overstory vegetation and the process of canopy replacement.

H. DEER BROWSING AND SUCCESSION

In the winter deer extensively browse woody vegetation along the forest-field margin. In fall 1982 we built replicate deer exclosures in two old fields to determine the extent and effects of this winter browsing. Invasion of old fields by woody vegetation is likely to be slowed significantly be deer. We predict that establishment and growth of woody species will increase within our exclosures relative to adjacent control plots.

A graduate student is studying the influence of insect damage on growth and establishment of sumac in other old fields at Cedar Creek. Deer browsing exclosures will be added to that study this fall.

I. AERIAL PHOTOGRAPHY

We are using aerial photography to make permanent records of our plots. These photographs provide excellent documentation of fertilization treatment effects. Taken at relatively low altitude, they may also be a non-destructive way of quantifying and recording gopher mound production on our plots. We are including in our aerial survey the 19 old fields in which we sampled vegetation this year; this will provide a permanent record of woody vegetation in those fields which can be referenced for future studies of succession at Cedar Creek.

J. MACROPLOT EXPERIMENTS

In 1983 we began experimental fertilization in our larger scale macroplots (20 x 50 m). Permanent pitfall traps for insects and for small mammals were installed. Additional trap stations for folding Sherman traps were also designated. Traps were placed along walkways of cement patio blocks laid across the macroplots to minimize the impact of frequent traffic.

We have documented significant changes in both beetle and small mammal populations in response to fertilization. Grasshopper samples suggest that the same is true for this group. The higher population densities of mammals this year have made possible verification of the effectiveness of herbivore removal treatments begun in 1982 on these plots.

K. SMALL MAMMAL STUDY

Because of the interesting data generated by snaptrapping done to clear small mammals from the fenced microplots (Inouye et al. ms) we established a new set of 3 microplot grids. Plots in two grids are fertilized with four levels of nitrogen (one grid disked prior to fertilization), and the third grid is unmanipulated. These are in a young field (Field E, 10 years since cultivation) and are unfenced. We have been live-trapping and marking small mammals, censusing gopher mounds, and censusing grasshopper activity on these grids. Thus far we have not caught *Microtus* on these plots; we expect that *Microtus* will eventually invade these plots, at which point we may see interactions between *Microtus* and *Peromyscus* similar to those we have observed by snaptrapping the fenced microplots. Because these plots are not fenced below ground we also hope to determine any effects gophers may have on patch use by *Microtus* and *Peromyscus*.

L. UNFENCED MICROPLOTS

Because we observed significant responses of several groups of mammals and insects to microplot fertilization in 1982 we initiated an additional set of microplots in each of fields A, B, and C. These plots are unfenced and will be sampled more intensively and more destructively than the original fenced microplots. The plots were established on undisturbed vegetation in an 8 x 6 grid containing 16 replicates of each of the 3 levels of nitrogen addition which were used on the macroplots. These plots are being used by graduate students from several departments for additional studies. These include studies of below-ground production (see below), population and physiological responses of the lichen flora, and nitrogen fixation by grasses along a nitrogen gradient.

M. SOIL MICROFAUNA

Recent literature suggests that nematodes may be the dominant consumers in grassland vegetation. We included removal of this group from small plots as one of our consumer experiments. This year we will sample the local nematode community in our study fields and screen for fertilization effects. We have discussed sampling methods at New Mexico State University and Colorado State University, and hope to develope comparative studies with Jornada and Central Plains Experimental Range sites. We will preserve samples of other soil microfauna at the same time for future screening.

N. GREENHOUSE STUDIES OF PLANT NUTRIENT REQUIREMENTS

This past year we performed a series of greenhouse experiments designed to determine the nitrogen requirements of the 10 most common vascular plants in our 4 microplot fields. Using seed collected at Cedar Creek, two types of experiments were performed. In one type, a rich Cedar Creek soil (ca. 1200 ppm N) was diluted with pure silica sand to give a series of 9 soils ranging from 50 to 1200 ppm N. Each species was grown singly in replicate pots in each of these 9 soils. This experiment determined plant growth rates as a function of total soil N and determined the ability of various plant species to extract N from soil. The other set of experiments was similar but used pure silica sand watered with solutions with different concentrations of NH_3NO_3.

O. OAK SAVANNA LONG-TERM BURNING EXPERIMENT

Spring burning has been used on 12 compartments ranging in size from 2.6 to 28.6 ha since 1964 in an attempt to reestablish oak-savanna at Cedar Creek Natural History Area. Complete protection from cutting, grazing and fire since the 1940's had allowed development of a dense understory dominated by Corylus americana and shade tolerant hardwoods. The experimental compartments have been burned at intervals of 1 to 8 years, and the effects of repeated burning are readily apparent.

As part of the LTER project, permanent 25 x 40 m quadrats were established in each compartment in 1983. Herbaceous, shrub and tree cover and selected soil parameters will be measured in these quadrats in sumer 1984 and periodically thereafter. We are especially interested in the response of prairie grasses and forbs to repeated fires. One of our micro-macro plot experiments is located in a compartment which is burned for 2 out of every 3 years, and will be next burned in 1984 and 1985.

P. OLD FIELD BURNING EXPERIMENT (In Cooperation with the Konza LTER)

A cooperative research project involving effects of controlled burning is underway between the Konza LTER site in Kansas and the Cedar Creek LTER site in Minnesota. Tall grass prairie constitutes the principle biome type at Konza and is an important component of Cedar Creek. Although woody plants invade fields very slowly at Cedar Creek, the long-term maintenance of prairie at Cedar Creek in the face of invasion by deciduous forest species may largely be a result of repeated fires. At Konza, burning is an integral part of their experimental design.

As a result of a visit by 6 Minnesota LTER scientists to Konza in September 1982, a cooperative burning experiment has been established at Cedar Creek. Sixteen plots, each 8 x 8 m, have been laid out in a 25-yr old abandoned field in which we are also doing other research. Composition and abundance of plant species were determined by clipping and sorting to species in August, 1983. Soil samples were also collected for analysis. In spring, 1984, burning will be initiated in a design using 4 replicates of each of 4 treatments. The treatments are (1) an unburned control, (2) burning once each year, (3) burning every other year, and (4) burning every fourth year. These treatments correspond with those already in use at Konza.

Many plant species characteristic of tall grass prairie are present at both Konza and Cedar Creek. We anticipate that we will have many areas for comparison between these and other aspects of our studies, including insect dynamics and gopher activity. We may also be able to determine effects of our differing climates on such processes.

Q. FORAGING BEHAVIOR OF PLAINS POCKET GOPHERS

A detailed study has been initiated on food habits and aspects of the foraging behavior of pocket gophers. The objectives are to determine the plant species which are preferred, to investigate factors which appear to influence the preferences observed, and to determine if altering the "quality" (i.e., nutrient content) of plants changes preference patterns. These objectives will be attained using captive gophers prior to evaluating foraging of free-ranging gophers. These findings will be integrated with other LTER data sets to help explain spatial and temporal relationships between gopher activity and vegetation patterns in old fields.

In April and May, 1983, laboratory feeding trials were conducted at the LTER greenhouse in Minneapolis. Although plant material was limited, valuable information regarding techniques and feeding preference trends was obtained. Results from a second trial conducted at CCNHA in June indicate strong preference by gophers for Tragopogon major and Poa pratensis. Another set of experiments will relate gopher food preferences to observed old field successional patterns.

In July and August, a set of fossorial mammal pens at CCNHA were prepared for "semi-natural" feeding experiments. Transplanting of 1600 plants into the pens was completed in early September. The experiment, which involves the release of pocket gophers into the pens and observation of their subsequent feeding behavior and spacing patterns, will continue through September 1983 and will be repeated in spring and summer, 1984.

R. GOPHER MONITORING SYSTEM

A telemetry system to monitor movements and behavior of pocket gophers has been developed. Temperature transmitters were implanted 26 times in 11 captive gophers. Test animals were mobile within 2 hours after surgery and no impairment of digging behavior was observed after 48 hours. Data from these gophers indicate that digging behavior correlates with rapid body temperature fluctuations.

Radio-tagged gophers will be monitored in the field using a 50 x 50 m grid of antenna wires spaced at 2 m intervals and monitored by a microprocessor-controlled receiving station. Installation of the antenna grid is planned for mid-September and we anticipate monitoring from 5 to 7 resident gophers.

To access data acquired by the antenna grid and receiving station, a microprocessor work station that transcribes field recorded data tapes to a microcomputer has been developed. The transcription runs at 12 times the speed of data acquisition. Programs to plot/display gopher movement patterns are partially completed.

S. PATTERNS OF BELOW-GROUND PRODUCTIVITY

The objective of this work is to examine root and foliage dynamics at the species and community levels as they relate to old-field succession. The studies are being conducted over the old-field successional sequence, using 4 x 4 m microplots and three levels of N fertilization. Soil moisture is being monitored bi-weekly with a neutron probe. Soil samples have also been collected for determination of chemical and physical properties.

The specific question being addressed is "How does above- and below-ground production shift both within and among species along the successional and nutrient gradients? This broad question leads to a number of contributing questions/answers. For example, does the root: shoot ratio of a specific major species shift along either gradient? Does nutrient absorption capacity or rate shift? Does foliage quality as defined by chlorophyll content change? Is a "plateau" or sustained level of root production and/or above-ground chlorophyll reached at some early point on either gradient, and are further shifts in species abundance within those boundary conditions?

2. PERFORMANCE AND PROBLEMS

The major problem we have had at Cedar Creek is lack of adequate space. There are two aspects to our space problem. First, we have inadequate laboratory and office space for all the technicians, graduate students, post-doctoral researchers and faculty researchers who work at Cedar Creek. Second, we have inadequate living space.

We have addressed these problems by submitting proposals to various agencies for funding to (1) build aditional laboratory space and (2) build additional living space. In March, 1982, we received a NSF grant for $100,000. which is being used at add ca. 2000 sq. ft. of laboratory/office space at Cedar Creek. The University is contributing an additional $20,000 to this project to cover various non-construction costs. After the usual University delays, construction is now about to start. It should be completed by February. This space will alleviate our present laboratory/office space problem.

The other major problem we have is housing space. We were able to obtain a grant of $25,000 from a private foundation and an additional $15,000 from the University to defray the cost of constructing a year-around two bedroom home. This home is almost completed, and will provide housing for two of our post-doctoral researchers. Another home at Cedar Creek will soon be vacated by its present occupant (a long-time Cedar Creek employee) and will be available for post-doctoral or graduate student housing.

However, we still have a housing problem at Cedar Creek. We have a dormitory which housed 14 student field assistants and researchers this past summer. A University housing inspector visited Cedar Creek recently and stated that we can house no more than 7 individuals in the dorm in the future. The inspector also stated that our kitchen facilities were inadequate for the number of people using them full-time (about 30), and that he would be forced to close those facilities if we did not seek to correct the problem immediately. We thus must solve our living and dining facility problem before the start of next field season. We are currently trying to obtain approximately $30,000 from private foundations to be used to upgrade kitchen facilities and to build a bath-house and campground facility. Such a facility would allow students and researchers to live at Cedar Creek in tents or trailers. Because many students have tents and enjoy camping and because government surplus trailers are often available at nominal cost, a campground may be the least expensive and most flexible way to solve our housing shortage.

3. SUMMARY OF PROJECT PLAN

We plan to continue all of the micro-plot and macro-plot experiments that we established in 1982 as well as the additional experiments we started this year. Sampling of soils and vegetation will continue at its present pace, as specified in our original plan. The macroplots, which were fertilized in early spring 1983, will be fertilized each year and all monitoring specified in our original proposal will be carried out. With the experiments we initiated this year, we have reached the limit of our ability to initiate any new experiments. All our efforts will now be spent collecting data from the existing studies and analyzing the results. Any new research efforts will have to be separately funded.

4. SUMMARY OF ACCOMPLISHMENTS

A. Contrary to the generalizations in the literature, old field soil nitrogen and organic matter decline for the first 15 years post-agriculture, and then increase. This may be caused by changes in the ratio of labile to resistant soil organic matter.

B. Fertilization of old fields and native, undisturbed vegetation has shown that N was the only limiting resource of N, P, K, Ca, Mg, SO_4, Cu, Mo, B, Fe, Co, Mn and H_2O.

C. Studies of both fertilized and unmanipulated vegetation in 4 different fields have shown that light availability at the soil surface is strongly inversely correlated with soil nitrogen. This means that nitrogen and light form a natural "resource ratio gradient".

D. Almost all of major plant species in all 4 experimental fields responded statistically significnatly to the imposed nitrogen graadient, suggesting physiological "tradeoffs" in their ability to compete for N and light.

E. Because plains pocket gophers were significantly more active in microplots and macroplots receiving high levels of nitrogen fertilization and because the soil disturbances caused by gophers were dominated by annual plants, this herbivore had a highly significant effect in reversing the normal secondary successional sequence.

F. Microtus and Peromyscus responded significantly to micro plot fertilization, demonstrating small-scale microhabitat specialization by these small mammals. Similar patterns were observed for various insects (membracids, grasshoppers, crysomelids).

G. In total, our experimental studies show a strong interplay of soil development, plant resource competition and herbivory in structuring the ecosystems at Cedar Creek.

5. PUBLICATIONS AND PRODUCTS

PAPERS PRESENTED

Inouye, R.S. and N.J. Huntly. 1983. Microhabitat selection by old-field small mammals in response to nitrogen fertilization and disturbance. American Society of Mammalogists Annual Meeting, Gainesville, Florida. June 1983.

Inouye, Richard S. and N.J. Huntly. Patch choice by insects and mammals: responses to fertilization of old fields. Ecol. Soc. Amer. Meeting, Grand Forks, North Dakota. August 1983

Stillwell, M.A. Nitrogen availability and organic matter accumulation during 50 years of old field succession in northern Minnesota. Ecol. Soc. Amer. Meeting, Grand Forks, North Dakota. August 1983.

Tilman, G. David. Plant succession: Experimental tests of a new theory of succession. Ecol. Soc. Amer. Meeting, State College, Pennsylvania. August 1982.

Tilman, G. David. Succession along an experimental nutrient gradient: gopher disturbances and other indirect effects. Ecol. Soc. Amer. Meeting, Grand Forks, North Dakota. August 1983.

Tilman, G. David and John R. Tester. Micro and macro views of succession, productivity and dynamics in oak savanna. Ecol. Soc. Amer. Meeting, State College, Pennsylvania. August 1982.

PAPERS IN PRESS OR SUBMITTED

Inouye, R.S., N.J. Huntly and G.D. Tilman. Microhabitat selection by small mammals in an old field in Minnesota. Submitted to Oikos.

Tester, J.R. Seasonal changes in activity of free-ranging animals. Submitted to Oecologia.

Tilman, G.D. Plant succession and gopher disturbance along an experimental gradient. Oecologia, in press.

Tilman, G.D. Plant dominance along an experimental nutrient gradient. Submitted to Ecology.

6. OTHER

None.

7. CHANGES IN SENIOR PERSONNEL

None.

8. EXTERNAL ADVISORY COMMITTEE

We decided that we could receive the best input from our external advisory commitee this year if the committee met at the end of the field season. We are thus scheduling our committee members to meet in late September or early October, as fits with their schedules. We have found that scheduling 4 scientists to meet simultaneously is often very difficult. Two of the individuals who were on our committee last year have said that they cannot attend any meeting this autumn. To diversify the types of advice we can receive and to maintain continuity on the committee, we are now contacting about 8 scientists who will serve as the group from which we draw on a subgroup of 3 or 4 advisors each year. This group will include our original 4 advisory committee members.

9. CURRENT AND PENDING SUPPORT

John R. Tester

Current: U.S. Fish and Wildlife Service, USDI-14-16-0009-80-016. Development of biotelemetry equipment for waterfowl research. 12/1/82 - 11/30/83. $25,523. With D. Siniff and V. Kuechle. Research conducted 5% of time spent on research.

National Science Foundation BSR-8304433 for $100,000. 5/01/83 - 10/31/84. Titled "Laboratory Addition for Cedar Creek Natural History Area." (With D. Tilman and D. Parmelee).

National Science Foundation BSR-8114302-A01 for $242,895. 1/15/83 to 1/14/84. Titled "Succession, Productivity, and Dynamics in Temperate Mixed Ecosystems in Minnesota." (With D. Tilman).

Pending: None.

G. David Tilman

Current: National Science Foundation BSR-8304433 for $100,000. 5/01/83 - 10/31/84. Titled "Laboratory Addition for Cedar Creek Natural History Area." (With J. R. Tester and D. Parmelee).

National Science Foundation BSR-8114302-A01 for $242,895. 1/15/83 to

1/14/84. Titled "Succession, Productivity, and Dynamics in Temperate Mixed Ecosystems in Minnesota." (With J. R. Tester).

National Sea Grant Program, NOAA, project R/F-9 of NA 82-AA-D-00039, for $29,160. 10/01/82 - 9/30/83. Titled "Nutrients, productivity, and water quality in Lake Superior: A mechanistic approach to an oligotrophic food web."

10. RESIDUAL FUNDS

We will have no significant residual funds as of the end of this period of funding (15 January 1984). Indeed, we are doing our best to assure that our funds last until that date.

11. COLLABORATIVE RESEARCH EFFORTS

Six LTER staff members visited the Konza Prairie LTER project in September 1982. As a result of this visit, we have initiated a cooperative project titled, "Old Field Burning Experiment" at Cedar Creek (see description in Item 1.P). Additional cooperative studies being planned with Konza involve nitrogen fertilization and the role of grasshoppers as foragers.

Three LTER staff visited the Central Plains Experimental Range, Niwot Ridge and Jornada sites in March 1983. As a result, cooperative projects on nitrogen fertilization and the role of soil nematodes are being established.

LTER staff participated in the following workshops: Disturbance regimes of ecosystems - J.R. Tester; Litter arthropods - M.A. Stillwell; Wood decomposition - M.A. Stillwell; Data base management - J.R. Tester and K.C. Zinnel.

A cooperative project is in progress with Dr. David Grigal, Department of Soil Science, with funding from the University of Minnesota Agricultural Experiment Station. Dr. Ed Schmidt, also in Soil Science, has expressed a strong interest in initiating cooperative research in the area of microbial decomposition.

Dr. James Reichman, Department of Biology, Kansas State University, spent 1 week at Cedar Creek conducting pilot studies for a research project on aspects of communication and spacing in pocket gophers. He plans to prepare a proposal to obtain financial support.

Our excellent relationship with CETA continued this year. These programs provided 10 field assistants for LTER projects at Cedar Creek this summer.

Non-Minnesota visitors to the LTER project this year included Drs. Per Lemnell, Environmental Protection Board, Sweden; Elizabeth Almgren, Sweden; Linda Whittaker, Brookfield Ecosystem Project, Australia; Don and Glennis Kaufman, Kansas State University; Mel Dyer, ORNL; Lucy Jacobs, Princeton University; Dave Behrends, SUNY- CESF; Don Waller, University of Wisconsin; Adam Lomnicki, Poland; Tom Williams, North Inlet LTER; Charles McClaugherty, VPI.