LTER Network News

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What is LTER?

The LONG TERM ECOLOGICAL RESEARCH program (LTER) is a network of field sites used to study structure and process in natural landscapes at temporal and spatial scales of decades or centuries. The ten sites now funded by the National Science Foundation's Division of Biotic Systems and Resources, include forest, prairie, desert, and aquatic environments. Major questions are addressed at each site related to patterns and controls of primary production, food webs, population abundance and distribution, organic matter accumulation and biogeochemical cycling, as well as questions related to disturbance frequency and affect. A base of common measurements and questions lay the groundwork for new analyses and generalizations across very different ecosystems relatively unencumbered by the unique character of each ecosystem. Problems more unique to each site are also under study (cover picture: log-decomp study conducted by Dr. Mark Harmon, Andrews Forest). The accumulating record and experience provides a temporal and spatial context for individual researchers needing such a base for their experiments. Institutions operating LTER sites encourage collaborative research by scientists at other institutions and the use of the sites by visiting investigators. LTER sites are regional and national research facilities. Interested researchers should contact the individual sites. -- by John Magnuson (North Temp. Lakes)

About the Newsletter

This is the first of what is planned as a continuing newsletter designed to present the latest efforts in the Long Term Ecological Research program. Each edition of the newsletter will contain a lead scientific article, news from LTER sites, an NSF column, upcoming events, opinions, and whatnots.

The organization of this newsletter was approached with a bit of scepticism! Where do we start? What will the potential readers want? etc., etc. The newsletter that you are now holding in your hand is what we came up with after considering the questions, and answers, provided by LTER participants. If you have any suggestions or helpful comments that might improve either the look or the content of this newsletter, please send them to us. We need your feedback, even if it's negative, if we are going to provide the type of newsletter that will meet the needs of its readers.

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Perspectives on LTER

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Preparation of this article is an opportunity to present an LTER synthesis from the point of view of the Foundation. In doing so I would like to order the article in approximately the following manner:

- What has LTER done during the first several years?

- How close do actual accomplishments come to what was envisioned in the beginning?

- Where might LTER go from here?

LTER may be "on the verge" of achieving a breakthrough in dealing with <u>pattern</u> - both spatial and temporal - in ecological systems. The active consideration of pattern appears in the large majority of report documents from the projects. Spatial scales run from the microtopographic (tenths of meters) to some approximation of the landscape (around a kilometer). Temporal scales under common consideration span days to a few hundred years for experimental work and up to a few thousand years for observational work. Ecological patterns are being reckoned with in terms of (1) how they appear and can be measured, (2) how parts of the pattern are distinct from each other, (3) how the array of distinguishable parts may change spatially over time, and (4) how the distinguishable parts of the pattern function internally. Less attention is being given to the conditions that give rise to the patterns in the first place or the processes that cause them to be maintained or to change. The least attention continues to be focused on how the parts of the pattern relate to each other at the level of process or function.

A few examples of parts of projects are pertinent to the consideration of pattern in ecosystems. CPER's latter day revision of their original catena paradigm to account for the organizing effects of wind on certain soils is important. Originating primarily from the ANDREWS group the updated concept of "biological legacies" holds promise for the unification of several lines of thought and study that appear at NIWOT, CEDAR CREEK, JORNADA, and NORTH INLET as well as others. The NORTHERN LAKES group's realization that their subjects are a "system" with emergent characters such as measurable linkages and time delays may provide part of the vehicle for reconciling historically very different approaches to lakes, streams and terrestrial components. Similarly, the RIVERS project's new views on "laterality" and "eddies" seem to suggest ways to unify some approaches to large and small streams as well as large rivers and marine systems. All of these examples contain major aspects of dealing with pattern, and all of them manifest the need to move to a level of effort that deals better with process and functional relationships among the parts of the pattern.

Some of the current LTER projects are contributing to a growing body of knowledge that challenges conventional thinking about the effects of acid deposition. Notably, the NORTHERN LAKES group have produced a synthesis that questions the relationship of acid loading to resultant changes, if any, in lake pH. The NIWOT group asserts that their soils and waters have historically received and continue to receive aeolian inputs that compensate for any acid deposition. These results jibe, at least conceptually, with observations from KONZA, JORNADA, CEDAR CREEK and others that things don't always (or even often?) end up as one might expect from the way they start out. Longer-term results may be counter to what short-term results would indicate. I suspect there is also a substantive connection with OKEFENOKEE's framework of theory having to do with "indirect effects." With continued existence the LTER projects should grow in importance in terms of predictive and early diagnostic capabilities deriving from continual measurement of variables and regular visual scrutiny of the ecosystems. This kind of value has been demonstrated at COWEETA in relation to their early perception of indicative ozone damage to foliage.

LTER sites and research groups have become important to other federal and state agencies with research mandates and responsibilities. Such was always the case with sites like ANDREWS, COWEETA, and CPER that have traditionally housed major research endeavors funded by their mission agency stewards. However, the utility of the sites and personnel have been recognized more broadly as in the cases of the NORTHERN LAKES collaboration with EPA for experimental lake acidification and the KONZA collaboration with NASA in a landscape-scale study of nitrogen dynamics called "FIFE."

Disturbance has from "day one" been a theme of LTER. Subsequent developments have refined the perception of disturbance to a degree that did not really exist in ecology before. Our view of disturbance is considerably more sophisticated than some analog of bulldozing an ecosystem. Disturbance comes in all shapes and sizes and with many kinds of timing. JOR-

NADA's small mammals operate at small scales but exert significant structural influences on the ecosystem as do gophers at NIWOT and CEDAR CREEK. KONZA's long-pending large herbivore experiment should have a major tale to tell that ought to fit with studies at CEDAR CREEK and CPER. Fire dominates experiments at KONZA and CEDAR CREEK and has the potential for doing so at many other sites. The view of fire has been largely revised in a fashion that says that it is really the absence of fire (a human imposition) that is the disturbance not the periodic occurrence of fire. Recently the NORTH INLET group had to begin to deal with the effects of the most significant storm (reinforced by a congruence of heavenly bodies and timed for the regular high tide) that has occurred since major research efforts began there. Meaningful data and syntheses should result because LTER was in place.

LTER has become known to other, separately funded scientists at the parent institutions as well as to scientists at other places. LTER has attracted a measure of national level attention that in one way may be exemplified by the continuing unresolved discussion about various types and levels of "lter" association including petitioning the ESA for a section on "long-term ecological research." LTER has become known internationally through many inquiries and contacts with the projects themselves and with NSF by non-US scientists, institutions, and research sponsoring agencies. Several scientists from LTER projects have spent major portions of sabbatical leave abroad pursuing research and synthesis projects initiated under or augmented by LTER support. Uncounted students, both graduate and undergraduate, have received LTER support for their educations as have post-docs and junior faculty members. The reputation continues to accumulate, and it is by a large proportion mostly positive even if that positivity remains a bit guarded.

To leave administrative/organizational aspects of LTER entirely untouched would be a disservice. In that context scientists, their students and technical personnel, and institutional officials now believe that the projects are not ephemeral or idiosyncratic occurrences. A degree of "institutionalization" has been conferred on the projects. They compete generally very well for institutional resources as a result of their relative stability. At one end of the spectrum the internal structure of institutions has changed to accomodate LTER. At the other end LTER has fitted into an empty niche.

How close <u>do</u> actual accomplishments come to what was envisioned at first? Such a question will always be a difficult one to answer, but under LTER the answer may be more tenable than it was, for instance, with respect to US/IBP. IBP was oversold from the beginning with regard to what could be delivered and in the <u>post mortem</u> analysis was predestined to come up short against any yardstick derived from the original promises. LTER's most significant promise was that "there exists a major family of ecological research that can only or best be accomplished by projects that are planned for and executed over long periods of time." This promise was, of course, predicated on the hypothesis that short-term projects run a large risk of yielding results that may differ significantly, both qualitatively and quantitatively, from results derived over much longer periods of time. This conservative hypothesis is now continually being supported by LTER project results.

What lies ahead? My own current classification of LTER-associated opportunities identifies three categories: (1) project specific or intra-project, (2) among network participants or inter-project, and (3) distributed or extra-LTER. In the project specific realm it will always be incumbent upon participants to perform the best, most technically sound research possible under the prevailing conditions. However, the LTER mandate (and its associated responsibility) goes well beyond that baseline level of performance. It embodies expectations of scientific aggressiveness and imagination, as well as the judicious exercise of opportunism while adequately tending the core research. It is also pertinent to remind ourselves that LTER core project support was never intended to provide all the resources necessary to study adequately any of the research sites. Please recall that LTER core support was originally intended to provide a "glue" to use in melding and integrating past, present and future research at the site supported from a diversity of sources. Support for such complementary research must be competed for aggressively from a diversity of funders.

At the inter-project level there are many miles to go during the foreseeable future. LTER has not achieved even a good approximation of mutuality of scientific interests among the funded projects. Although a sizable number of network workshops have been organized and conducted there is a notable lack of demonstrable results. It is probably reasonable to view the inter-project activities to date as part of the learning process.

Likewise, it is reasonable to expect that the time is at hand to actually achieve things that can provide solid evidence of a new level of synthesis and comparative ecosystem science having to do with regional-to-global-scale ecosystems. The network of LTER sites, projects and scientists represents the best opportunity for doing so. However, to do so will require that a critical number of LTER scientific leaders address themselves to creative thinking centered upon the secondary use of data and ideas that have accumulated in the pipeline. This does not say that such syntheses can be forced; however, it does say that LTER leaders must strive to create the conditions that will promote such syntheses.

With regard to extra-LTER associations and potential for accomplishment a start has been made by individuals, by projects, and by the LTER network. The task at hand now is to solidify and continue to expand those associations in a fashion that demonstrates growth in numbers of associates, complexity of thought, and quality of derivative scientific products. That can only be accomplished by demonstration through performance and the assurance that NSF, as well as other extramural funders, will be receptive to excellent proposals for meaningful research.

Finally, emphasis must be placed on the importance of aggressively pursuing some items that have received much discussion but little development or implementation so far. Of paramount importance is the actual computer-based linking of LTER projects, each with all the others, at the level of daily operations. All the hardware exists and so does nearly all the software. What is still missing is the will and the drive to incorporate the use of this form of communication as an ordinary method of doing business. New points of view must be adopted. Paradigms centering on "the system of definition" are now archaic and must be supplanted by paradigms that address landscapes, regions, and the ecosphere. Recognition and analysis of hierarchical organization in ecological systems is receiving increased attention. LTER seems to be ideal for testing hypotheses about hierarchies. Fractal geometry seems to possess many characteristics that may be tailor-made for hierarchical representation and analysis. New methods must be adopted, adapted, improved or invented to underwrite the new conceptual approaches. Remote sensing technologies and geographic information systems appear to have a lot to offer. Aggressive leadership must identify and act on opportunities as they are presented. IGBP and NSF's Global Change Initiative may be such an opportunity.

LTER represents a challenge to ecologists. The challenge is to sustain the growing momentum by seizing - or even creating - new opportunities.

NEWS FROM THE SITES

Cedar Creek LTER Program

Major personnel and program changes have occurred at Cedar Creek Natural History Area LTER project during the past 6 months. Richard Inouye (a post-doc who joined the project in June 1982, left in October), and Nancy Huntly (a post doctoral researcher since 1982) have accepted positions at Idaho State University. Both are planning to return to Cedar Creek for the 1987 summer field season. John Pastor is now full-time at the Natural Resource Research Institute, University of Minnesota, Duluth, and will no longer have part-time support on the LTER project; he expects to remain involved in the research program. Several members of the original Cedar Creek LTER team have left for new endeavors: graduate students M. Cowan, J. Brokaw, and K. Zinnel; data manager R. Buck, and soil chemist C. Maddox.

These vacancies have created opportunities for new scientists to join the LTER project or expand their LTER efforts. David Grigal (professor of soil science at UM) has initiated major research on soil and vegetation dynamics in upland, forested regions of the Cedar Creek landscape and become a co-PI. Eville Gorham (professor of ecology at UM) has also joined the project to begin studies of soil and vegetation dynamics along the wetland-upland ecocline this coming spring. A new post-doc interested in the controls of below-ground production, Scott Gleeson, will perform greenhouse and field studies to quantify relations between primary productivity and carbon allocation to roots, stems and leaves across the successional sequence at Cedar Creek. Another new post-doc, Don Zak (currently finishing at Michigan State) will join the project in March 1987. Don is interested in controls of the nitrogen cycle and in the possibility of competition for nitrogen between nitrifying bacteria and vascular plants. Abderrahman El Haddi joined the project in August to fill our data manager and soil chemist positions. He rings to the project skills in statistics, microcomputers, and soil science. New graduate students a Cedar Creek include: Martha Phillips (ecology of wetlands); Nancy Johnson (mycorrhizal fungi); and Anne Hairston (remote sensing to monitor forest production patterns).

We are delighted that two major papers have been accepted by Ecology (Succession on a Minnesota sandplain, by Inouye, Huntly, Tilman, Tester, Stillwell and Zinnel; and Secondary succession and the pattern of plant dominance along experimental nitrogen gradients, by Tilman). Moreover, papers on small mammal dynamics, on insects, on gophers and soil dynamics, on nitrogen mineralization, and on mechanisms of competition have recently been accepted by Ecology, Oecologia, Oikos, Holarctic Ecology, Journal of Mammology, and American Naturalist. Dave Tilman is excited and considerably relieved having just finished a book draft (possible Princeton Monograph) that combines Cedar Creek data and new theory to explore possible causes of some major patterns within plant communities and across biomes.

Central Plains LTER Program

Research at the CPER-LTER under the core topic of primary production is unique and broad in that we are addressing the production question over a range of spatial and temporal scales (Sala et al. 1987A, Lauenroth et al. 1986, Webb et al. 1983, Milchunas and Lauenroth 1987), as well as attempting to solve the very important belowground production problem (Lauenroth et al 1986, Milchunas et al. 1985, Sala et al. 1987B, Singh et al. 1984). During LTER-I, we developed a ^{14}C dilution technique that produced accurate estimates of belowground primary production under controlled growth-chamber experiments (Milchunas et al. 1985). This technique can provide estimates of other important belowground processes: root exudation, belowground herbivory, and root decomposition. A field experiment using this technique was initiate in 1985. Eight 16 m^2 long-term plots were labeled with a total of 75 mCi of ^{14}C as $^{14}CO_2$.

Experimental objectives are to examine the partitioning of carbon into labile and structural material, respiration, and exudates, as well as root turnover and production. Plots will be sampled for 10-20 years. We will monitor surface litter and belowground root decomposition and carbon dynamics in soil aggregates. Root production and turnover will be estimated by ^{14}C ^{12}C ratios, total ^{14}C decay, and harvest methods. These data will allow us to examine how herbivory, decomposition, exudation and sloughing, and respiration affect estimates of belowground net production obtained by various methods. The short-term phase of the experiment was completed in 1986.

Publications:

Lauenroth, W.K., H.W. Hunt, D.M. Swift, and J.S. Singh. 1986. Estimating aboveground net primary production in grasslands: a simulation approach. Ecological Modelling 33:297-314.

Mulchunas, D.G., W.K. Lauenroth, J.S. Singh, C.V. Cole, and H.W. Hunt. 1985. Root turnover and production by ^{14}C dilution: Implications of carbon partitioning in plants. Plant and Soil 88:353-365.

Milchunas, D.G. and W.K. Lauenroth. 1986. Three dimensional distribution of vegetation in relation to grazing and topography in the shortgrass steppe. (In prep).

Sala, O.E., W.J. Parton, L.A. Joyce, and W.K. Lauenroth. 1987A. Primary production of the Central Grassland Region of the United States: Spatial pattern and major controls. Ecology (submitted).

Sala, O.E., M.E. Biondini, and W.K. Lauenroth. 1987B. Bias in estimates of primary production: an analytical solution. Ecology (submitted).

Singh, J.S., W.K. Lauenroth, H.W. Hunt, and D.M. Swift. 1984. Bias and random errors in estimators of net root production: a simulation approach. Ecology 65:1760-1764.

Coweeta LTER Program

The Coweeta LTER site experienced a major drought during the past year. In 1986 precipitation totaled 124 cm, 57 cm below the average annual value. This is the driest year on record since establishment of the Laboratory in 1934 and probably is the driest year of this century. Much of the rainfall deficit occurred during the growing season, and, by autumn, hardwood mortality was apparent on ridges and other sites with shallow soils. In anticipation of the alteration of some ecosystem processes, research has been intensified to quantify drought effects. This research is being conducted with North Inlet as a cooperative intersite effort and is intended to supplement ongoing LTER activities at each site. The primary topics of intersite investigation include: (1) characterization of the drought event from a long-term climatic perspective, (2) examination of water budget components, (3) trends in precipitation and stream chemistry, (4) organic sulfur formation/mobilization, and (5) modeling studies to complement the field studies. The drought provides a unique opportunity to quantify system responses to a major natural, low frequency hydrometeorological event.

Two new projects which utilize or supplement LTER data bases are in progress by Forest Service scientists at Coweeta. The 4-year Integrated Forest Study on Effects of Atmospheric Deposition was started in 1985. The project involves 10 different localities or groups including Canada and Norway and 15 different forest ecosystems represented by both conifer and hardwood types. Coweeta is the only LTER site taking part in the project. The principal objective of the study is to evaluate the role of acid deposition in producing changes in forest nutrient cycling using a white pine plantation (WS 1) and a mixed hardwood forest (WS 2). The project is funded by the Electric Power Research Institute and administered through Oak Ridge National Laboratory. The second project is the Direct/Delayed Response Project funded by the Environmental Protection Agency through its Corvallis Environmental Research Lab. Coweeta staff are collaborating with scientists from EPA, Tetra Tech, University of Iowa, and University of Virginia in Level III analysis of this project. The objective of these analyses is to utilize existing models of surface water acidification to classify watersheds in two target regions of the east in terms of their long-term (50-100 years) response to current and hypothesized levels of atmospheric deposition.

Stations for routine monitoring of ozone were established in April 1986 with current measurements being taken at three locations on north- and south-facing slopes within the Coweeta basin. The long-term goal is to develop a network of bioindicator plots within the basin to document gaseous pollutents in remote locations.

Dr. Andrew Williams from Plymouth Polytechnic Institute in England will be at Coweeta on a 3-month sabbatical beginning in April. His research will deal with hillslope hydrology and the quantification of water and solute movement through a soil profile.

The Coweeta symposium volume is in the hands of the publisher (Spring-Verlag) and should be published in 1987. The volume contains 30 chapters by 49 contributors and is organized into the following topical sections: hydrology, geology, climate and water chemistry; forest dynamics and nutrient cycling; canopy arthropods and herbivory; forest floor processes; stream biota and nutrient dynamics; man and management of forested watersheds; and perspectives on long-term research.

H.J. Andrews LTER Program

The first sample of logs has been drawn from the long-term log decomposition study established during the last year of LTER-I (1985). The objective of this study is a detailed examination of the effects of time, log species, log size, and insect activity on patterns and rates of decomposition. Nearly 500 logs (60 cm in diameter and 6 m long) have been placed in 6 replicates in terrestrial environments and 180 smaller logs in Lookout Creek as part of a study of log decomposition processes in stream environments. Logs are to be removed and destructively analyzed for each of the first six years and at progressively greater time intervals, for a total estimated study duration of 200 years. Mark Harmon, leader of this component of the HJA LTER, has sawed up and is in the process of analyzing the first set of logs; additional information on insect, microbial, and fungal interactions in log colonization is being gathered using an NSF grant to Tim Schowalter.

A site has been selected for the LTER-II study on effects of organic matter levels on long-term site productivity. This study will involve several large scale (hectare) plot treatments (varying levels of logging residues, burn vs. unburned) with several small-scale treatments (e.g., total organic layer removal) superimposed. We invite inquiries from people who might like to participate or to utilize our experimental treatments.

The most noteworthy recent publication is the synthesis of information on the ecological role of coarse woody debris prepared by a large group of collaborators led by Mark Harmon (Ad. Ecolog. Res. 15:133-302, 1986).

The major personnel change involves Frederick J. Swanson's replacement of Jerry F. Franklin as Principal Investigator on the HJA LTER grant; Franklin will continue as a collaborating investigator, particularly on component 1 (terrestrial population studies). We currently have no professional or technical positions available.

Jornada LTER Program

The Jornada LTER added 3 principal investigators in 1987: Drs. Marsha Conley and Fred Fisher have moved from research associate to senior investigator status; Dr. Tim Ward of New Mexico State's Civil Engineering Department has joined the LTER research group.

Dr. Conley, who has been responsible for data collection on consumer populations, will be directing efforts to assess the role of consumers (i.e. ants, kangaroo rats, gophers, rabbits, etc.) in creating and maintaining disturbance patches. Results to date indicate that soil disturbance by consumers plays an important role in developing spatial heterogeneity, producing patches of enhanced primary production.

In the coming year Dr. Fisher will continue studying decomposition and nitrogen mineralization processes, and direct our assessment of the importance of belowground decomposition. The timing of ephemeral root decomposition in relation to moisture availability could dramatically affect the extent to which rainfall is able to stimulate primary production since this could produce either a N source or sink. These investigations are designed to develop predictive relationships for those critical water/nitrogen interactions.

Dr. Ward has previously investigated the effects of termite activity on infiltration, runoff, and sediment yield at Jornada. During 1987 he will be developing a simulation model of runoff. The model will be used to predict fluvial redistribution of organic matter along the watershed. We plan to combine this model with the point models of decomposition, nitrogen mineralization, and primary production being developed under the direction of Jim Reynolds (now at San Diego State) to predict spatial patterns of primary production.

Dr. Peter J. Wierenga (Soil Physics Laboratory, NMSU) has continued funding of a field study at Jornada from the Nuclear Regulatory Commission. With LTER funds a lysimeter facility was built to study chemical transport through 6 m deep caissons. This experience was used to design a trench study to monitor chemical transport through deep, unsaturated, arid soils. Results will be compared with predictions using a stochastic computer model developed by Dr. Lynn Gelhar at MIT. Further evaluation of this and other models will be performed for the NRC by Dr. Glendeon Gee at Battelle, Richland, WA.

Walt Whitford is on sabbatical leave in Australia during Spring '87. We look forward to his returning with new ideas and enthusiasm.

Konza LTER Program

Studies on the effects of burning, mowing, and fertilizer applications on belowground interactions were initiated in the spring of 1986 by an interdisciplinary group: David Gibson (primary productivity), Barbara Hetrick (mycorrhizae), Paul Schwab (soil chemistry), Tim Seastedt (arthropods, roots), and Tim Todd (nematodes). Eight plots, 25 by 50 m, were established in a split-split plot design. Main plots were unburned/annual burn, and these were split into two strips for unmowed/mowed three times per year treatments. The unmowed/mowed subplots were further divided into four annual fertilizer treatments of 10 g nitrogen/hectare, 1 g phosphorus/hectare, 10 g nitrogen plus 10 phosphorus/hectare, and a control with no fertilizer addition.

The overall goal is to add a statistically robust belowground component at Konza research using a system approach for three core areas of LTER--primary production, organic matter processing, and nutrient dynamics. Our interdisciplinary approach will allow observations of the interactions of imposed treatments while maximizing the use of time and resources. For example, burning is known to influence root growth and dynamics. To assess this, single root samples will be examined for primary production, level of mycorrhizal infection, impact of nematodes, arthropods in the rhizosphere, and nutrient dynamics in the roots.

Alan Napp (presently at the University of Wyoming) and Tim Seastedt recently examined the limiting effects of litter accumulation on primary productivity in the tallgrass prairie. Periodic fire is a natural component of prairies and alters the effect of litter accumulation (Bioscience 36:662-668).

In 1986, Don Kaufman became PI of Konza LTER. Dick Marzolf returned from his sabbatical and initiated research on the presence, source, and role of carbohydrates in the water of prairie streams. David Gibson began as the plant ecology research associate prior to the 1986 growing season. Dave Hartnett, new plant ecologist in the Division of Biology, initiated plant population studies at Konza and will assume some responsibilities for vegetation research in LTER. Also in 1986, the scope of studies in hydrology, belowground processes, and populations was widened by Barb Hetrick (Plant Pathology), Jim Koelliker (Civil Engineering), Paul Schwab (Agronomy), Buck Sisson (Agronomy), and Tim Todd (Plant Pathology) joining our research efforts.

Large River LTER Program

Some parts of the Upper Mississippi River are easily observed to be more productive than others, yet there are no obvious features which distinguish them from other broad, shallow river flats. Large scale eddies may offer one explantion.

For example, such an eddy is associated with high production of fingernail clams (*Musculium*) and mayflies (*Hexagenia*) near Keokuk, Iowa, a site where diving ducks have congregated since the 1960's to feed on these invertebrates. The eddy provides slow circulation which prevents stagnation and may transport detritus generated in plant beds to the invertebrate filterers and collectors. The eddy is 4.8 km long and 1.2 km wide and is relatively persistent. At a minimum, the travel time for water is 3 times that in the main channel, and the maximum replacement time could be as long as 20 days. Fifty-eight similar eddies are predicted for the 1078 km of the river between St. Louis and Minneapolis, based on analysis of river morphometry -- approximately 1 per 20 km. The formation or loss of eddies and other secondary circulation patterns in response to variation in discharge and channel morphometry (either natural or man-induced) may help explain yearly and longer term variations in biological production.

The Mississippi River is such a large system that collaboration is necessary to sample the entire river adequately. Richard Sparks collaborated with John Day and Rovert Costanza from Louisiana State University in a special symposium, "The Mississippi River as an Integrated System", at a Coastal Society meeting in New Orleans, 12-15 October 1986 which brought together scientists from the upper and lower Mississippi. There are shared concerns about problems created by man's redirection and redistribution of sediment in the system.

Positions available include an ecosystem modeler and data base manager/analyst, both for 8 to 15 months, on the LR LTER project, and 2 aquatic ecologists on permanent hard money at the Natural History Survey (one to be a lotic ecologist). For more information regarding these positions contact: (aquatic ecologists) Dr. Phil Ross (217)333-6897); (data base manager/analyst) Dr. Peter Bayley (217)333-6889/6890; (modeler) Dr. Richard Sparks (309)543-3105/3950.

Publications:

Adams, J. Rodger. 1986. Mechanics of a large eddy in the Mississippi River. Pages 645-652. In R.E.A. Arndt, H.G. Stefan, C. Farell, and S.M. Peterson (eds.), Proceedings of the Specialty Conference sponsored by the Aerospace Division, Engineering Mechanics Division, and Hydraulics Division of the Am. Soc. Civil Engineers, 3-6 June 1986, Minneapolis, MN.

Niwot Ridge LTER Program

A growing concern over whether or not mid-latitude, U.S. alpine regions will be susceptible to damage from acid deposition caused the U.S. Forest Service and other regional scientists to turn to the University of Colorado LTER program (CULTER) for help. The current hypothesis suggests that extant levels of acid deposition in the sensitive Colorado mountains will lead to soil acidification and adverse affects to the biota of the alpine within decades. The CULTER understanding of soil-water process chemistry, water and soils databases, and results from our long-term low-level, simulated acid rain experiments are in great demand by regional scientists. While common sense suggests acidification is likely, especially when the present acid deposition loading rates and the prevalence of granitic/gneissic parent rocks are considered, we now have good reasons to seriously doubt the conventional prediction of inevitable acidification.

During the summer of 1986 a new series of long-term experimental plots designed to link the Ridge and Valley continuation experiments (from LTER-I) were established. These manipulation plots, known as the Martinelli Slope Plots, are physically tied to the long-term and continuing micro-watershed studies of Dr. Nelson Caine. Monitoring of soil-water chemistry for nutrient flux will test our theories on the resistance and resilience of alpine communities to disturbance. Disturbances include a major anthropogenic impact, trampling, and a major natural impact -- gopher invasion. Complete denudation by cryogenic freezing as a control will separate the effects of vegetation removal from trampling compaction effects.

Important new long-term, climatic databases were discovered in 1986. The first, a climate record dating from 1910 at Silver Lake (3,115 m), a site near our current study areas, was uncovered in the U.S. Weather Bureau archives. This discovery resulted, in part, from Dr. Thomas Karl's attendance at the January 1986 Database Meeting at Jornada and his efforts following the meeting. The second discovery was a Soil Conservation Service database going back to 1938 for a snow course near our study area.

Dr. Donald (Skip) Walker, Institute of Arctic and Alpine Research Plant Laboratory has joined the CULTER team. Skip's expertise is in geographic information systems and landscape mapping and modeling, especially of Arctic regions.

"A Hierarchical Conceptual Model of the Alpine Geosystem" (French, N.R., Arctic and Alpine Research 18:133-149) presents CULTER's efforts to conceptualize the immense complexities of the alpine geosystem. The hierarchical model links spatial levels from the space required by a single organism to 100s of kilometers, the size of a watershed, and temporal scales from diurnal to 10,000s of years. Climate and hydrology plus geochemical processes are seen as driving variables linking all levels of the hierarchy. Modifications of this model would be applicable at all sites and reprints are available on request.

North Inlet LTER Program

At a workshop on ecosystem network analysis sponsored by the International Scientific Committee on Ocean Research (SCOR), H. McKellar presented data on North Inlet which were used to examine the utility of several approaches to flow analysis that have been recently developed by various systems ecologists.

The fauna group has been experimenting with relatively new statistical methods to better understand patterns in their data. The base now includes more than five years of biweekly samples, with abundance counts of hundreds of species per sample (for details write Don Edwards, Dept. of Statistics, University of South Carolina, Columbia, SC 29208).

Two papers have been prepared which summarize 11 years of continuous data on meiobenthic collections at 2 estuarine sites (one mud, one sand). One important finding is that there was no periodicity of greater than 1 year for any taxon, species, or physical variable measured. Seasonal and year-to-year variability was significantly greater in mud than in the sand. The mud fauna appears to be predator controlled, the sand fauna physically controlled. Apparently benthos in hydrodynamically active habitats are homogenized both temporally and spatially and biological agents increase the variability of the in situ fauna.

The major personnel changes involve the addition of Dr. Fred Sklar to the full time LTER staff replacing Dr. E. Blood who now is an Assistant Professor of Environmental Health, USC, but remains active in LTER. Dr.

Sklar joined us in February and will be heavily involved in landscape modeling.

Coull, B.C. 1985. Long-term variability of estuarine meiobenthos: an 11 year study. Mar. Ecol. Prog. Ser. 24:205-218.

Coull, B.C. and B.W. Dudley. 1985. Dynamics of meiobenthic copepod populations: a long-term study (1973-1983). Mar. Ecol. Prog. Ser. 24:219-229.

North Temperate Lakes LTER Program

Ecosystem parameters can be classified as "site specific" (varying among sites but not among years), "year specific" (varying among years but not among sites) or "stochastic" or "mixed" (varying among sites and years). Th classification allows inferences about factors controlling each parameter. Site specific parameters are influenced by factors intrinsic to each site; year specific parameters by conditions in a particular year, e.g. weather; and stochastic or mixed parameters by a complex interaction among site and year specific parameters. We are demonstrating the utility of this approach with 11 years of Birge-and-Juday zooplankton data on 5 lakes and analyses of our first 5-years of LTER data on a wide variety of hydrologic, geologic, and biologic variables, considering each of our 7 lakes as a site. The indices of spatial and temporal variation are not ecosystem specific and we believe they can be extended to form a new basis for intersite analyses and comparisons among aquatic and terrestrial ecosystems.

Primary production measurements on Crystal, Little Rock, Sparkling, and Trout Lakes are available since 1985 for comparative intersite analyses. We are using C-14 and laboratory incubation methods to generate daily and annual production of the entire water columns.

Groundwater input to a lake's hydrologic budget strongly influences the response of the lake to atmospheric deposition. Anderson and Bowser (1986, Water Resources Research 22:1101-1108) estimate significant time lags in lake acidification dependent on the extent that precipitation mixes with the groundwater before entering the lake and on the weathering reactions that occur in the groundwater.

Carl Bowser is on sabbatical working with Tom Winter at the USGS in Denver this year; Dave Armstrong has taken on his LTER responsibilities for the year. Tim Allen has joined our core of Wisconsin faculty committed to the LTER program and is interested in applying hierarchy theory to site and intersite analyses.

To Obtain Information

Please direct your requests for information to the following people: (Cedar Creek) Dr. David Tilman, Dept. of Ecology and Behavioral Biology, University of Minnesota, Minneapolis, MN 55455; (Central Plains) Dr. William Lauenroth, Dept. of Range Science & Natural Resource Ecology, Colorado State University, Fort Collins, CO 80523; (Coweeta) Dr. D.A. Crossley, Jr., Institute of Ecology, University of Georgia, Athens, GA 30602; (H.J. Andrews) Dr. Fred Swanson, Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, OR 97331; (Jornada) Dr. Walt Whitford, Dept. of Biology, New Mexico State University, Las Cruces, NM 88003; (Konza) Dr. Don Kaufman, Division of Biology, Kansas State University, Manhattan, KS 66506; (Large River) Dr. Richard Sparks, Illinois Natural History Survey, River Research Laboratory, Havana, IL 62644; (Niwot Ridge) Dr. Patrick Webber, INSTAAR, Campus Box 450, University of Colorado, Boulder, CO 80309; (North Inlet) Dr. John Vernberg, Baruch Institute, University of South Carolina, Columbia, SC 29208; (North Temperate Lakes) Dr. John Magnuson, Laboratory of Limnology, University of Wisconsin, Madison, WI 53706.

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