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# Introdution

# Social Science in the Context of the Long Term Ecological Research Program

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*This special issue of* Society and Natural Resources *brings the results of long-term ecological research with an explicit social dimension to the attention of the social scientific research community. Contributions are from the Baltimore Ecosystem Study LTER, the Central Arizona-Phoenix LTER, the Coweeta LTER and the Northern Temperate Lakes LTER. The range of practice represented at these four sites serves to identify commonalities and differences in the results as well as the experience of integrative research. The objective of this special issue is to extend a call to social scientists of all kinds to engage with the LTER program in long-term research and synthesis to help answer the urgent and intriguing questions of our day.*

**Keywords** LTER, long-term research, synthesis, integrative research, regional science

A special issue of *BioScience* (Hobbie 2003) recently addressed contributions of the Long Term Ecological Research (LTER) program to the intellectual progress of ecological and environmental sciences. Statistics of the program alone are impressive: more than 1200 scientists affiliated with one or more of the 26 U.S. LTER sites; thousands of online data sets available for download; 12,000 journal articles published between 1980–1995 as well as seven synthesis volumes with 13 more in preparation; educational programs ranging from kindergarten through postdoctoral fellows; and cooperative international programs with at least 20 countries. But what is the LTER program and what does it mean for social scientists?

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Most ecological scientific research has focused on biological and physical systems in isolation from human influence, or considered humans and their activities as external perturbations to the functioning of biophysical systems. Most social scientific research has focused on social, economic, and political systems in isolation from their biophysical surroundings, or considered the environment as a backdrop for the functioning of social systems. It is generally true that most research continues to be disciplinary in nature or integrated only in the narrow sense across related fields in the biophysical, social, behavioral, or engineering sciences (Kinzig et al. 2000). A 1997 article by Vitousek et al. challenged this received view on scientific practice by noting that "most aspects of the structure and functioning of Earth's ecosystems cannot be understood without accounting for the strong, often dominant influence of humanity" (1997, 494). Such an admission has enormous implications for the practice of science as usual and how LTER research is overcoming the constraints that limit the ability of scientists to address transcendent issues (Jasanoff et al. 1997).

In this special issue of *Society and Natural Resources* we bring the contributions of long-term ecological research with an explicit social dimension to the attention of the social scientific research community. Our objective is to extend a call to social scientists of all kinds to engage with the LTER program in long-term research and synthesis. Your participation would contribute to the intellectual and analytical research needed to help answer urgent and intriguing questions of our day.

## The LTER Approach to Understanding

The first six LTER sites began operating in 1980 (Callahan 1984; Franklin, Bledsoe, and Callahan 1990). Subsequent requests for proposals by the National Science Foundation (NSF) resulted in funding for the current network of 26 sites. The most important aspect of LTER research is the long-term nature of observations and experiments: LTER projects are funded for 6-year periods. Based on scientific progress, quality of publications and management, and the development of human resources including graduate student mentoring, site funding can be renewed for additional 6-year periods. Long-term funding has a qualitative impact on the kind of research possible at LTER sites from the types of questions asked to the level of interest shown by the central administration of the institutions where individual programs are based.

Conceptual unity among sites with relative autonomy in the specific focus of their research is ensured by a set of core research topics—one ecological, one social (Callahan 1984; Redman, Grove, and Kuby 2004). Each core reflects the intellectual heritage and overarching goals of the two disciplinary traditions. Their purpose is to guide the discovery and explanation of processes in LTER site-based research and orient long-term research projects toward question-driven science rather than simply monitoring. Beyond the general guidance provided by the social and ecological cores, the more fundamental objective of long-term research is to examine the degree to which systems in their broadest possible definition are organized, and the role played in this organization by internal versus external influences (Pickett 1991; Pickett et al. 1997). The present challenge is to understand so-called coupled human–biophysical systems.

Research from the four LTER sites in this special issue represents a range of practice that serves to identify commonalities and differences in results and experience

in integrative research. The four sites are the result of two models for how the social and ecological sciences have developed within the LTER Network. Northern Temperate Lakes LTER (NTL) and Coweeta LTER (CWT) incorporated a human dimension into existing ecological research that had been ongoing in excess of 70 years. The Central Arizona–Phoenix LTER (CAP) and the Baltimore Ecosystem Study LTER (BES) were established de novo in 1996 with the express purpose of conducting research on the relation between social and ecological systems in urban settings. We briefly describe the setting and programmatic nature of research at the four sites before focusing on the individual studies.

The Northern Temperate Lakes LTER builds on over a century of limnological research on Lake Mendota by researchers at the University of Wisconsin–Madison. After obtaining supplemental funding from NSF in 1994 to incorporate a regional human dimension, the NTL research program expanded (a) to the watershed of Lake Mendota in the Southern Lake District, and (b) to consider landscape-level processes on multiple lakes in the Northern Highlands Lake District of Wisconsin. (There is one article each in this special issue on the Southern Lake District and the Northern Lake District.) The NTL research program is centered on the study of human-dominated landscapes surrounding northern temperate lakes using a watershed approach. In recognition that the boundaries of the lakes do not accurately reflect the boundaries of their ecological systems, the research is organized into three general initiatives: (1) the human dimension of NTL-LTER lakes, (2) monitoring the North, and (3) anticipating the future. Additional information on all aspects and products to date of the Northern Temperate Lakes LTER is available at http://lter.limnology.wisc.edu.

The human dimension of the Coweeta LTER Research Program, analogous to that of NTL, was first incorporated into ongoing ecological research with supplemental funding from NSF in 1994. At that point, the research also expanded from the confines of the USDA Forest Service Experimental Forest of the Coweeta Hydrologic Laboratory to the southern Appalachian region. The Coweeta LTER objective is to advance scientific understanding of the spatial, temporal, and decision-making components of land use and land-use change in southern Appalachia over the last 200 years, and forecast patterns into the future 30 years. The research is conducted at site, watershed, river-basin, and regional levels and is organized into three initiatives: (1) characterization of the socionatural template, (2) ecosystem responses to the socionatural template, and (3) forecasting ecosystem responses to changes in the socionatural template. Additional information on all aspects and products to date of the Coweeta LTER is available at http://coweeta.ecology.uga.edu.

The Baltimore Ecosystem Study LTER was first funded in 1996 to carry out research on metropolitan Baltimore as an ecological system. This urban complex is home to 3 million people, and the BES research strategy is to balance intensive measurements in focal watersheds with extensive measurements throughout the metropolitan region. The central research questions are: How do the spatial structures of socioeconomic, ecological, and physical factors in an urban area relate to one another and how does this relationship change through time? What are the fluxes of energy, matter, capital, and population in urban systems, and how do they change over the long term? And how can people develop and use an understanding of the metropolis as an ecological system to improve the quality of their environment and reduce pollution loadings to downstream air- and watersheds? Additional

information on all aspects and products to date of the Baltimore Ecosystem Study is available at http://beslter.org.

The Central Arizona–Phoenix study, like the Baltimore project, was first funded in 1996 to study a human-dominated ecosystem. In this case, the focus is on Phoenix and its surrounding agricultural and desert lands where over 3.5 million people reside in more than 20 municipalities. Research is conducted at 206 quadrats, $30 \times 30$ m, randomly distributed across a sampling grid blanketing Maricopa County where the city of Phoenix is located. The central research question is how patterns and processes of urbanization alter the ecological conditions of the city and its surrounding environment, feeding back to the social system and generating future changes. Three interpretive themes are used to link field projects to the central research question: (1) scales and periodicities of ecological and human phenomena, (2) extent of human control of ecological variability in space and time, and (3) characterization of urban ecosystem resilience. Additional information on all aspects and products to date of the Central Arizona–Phoenix project is available at http://caplter.asu.edu.

While there are rules of thumb for encouraging interdisciplinary and/or transdisciplinary research within and beyond LTER, there are no concrete guidelines that unambiguously ensure success (Klein 1996; Peterson 1993). As such, the sociology of teamwork is an issue of some significance when addressing *how* knowledge about coupled human–biophysical systems is to be developed. The progress of integration is evidenced by incremental changes in the practice of research rather than revolutionary change in the LTER program from one year to the next. Any one of the various social science projects presently underway across the LTER network could be done without reference or connection to the biophysical setting of the research. However, the five examples presented in this special issue explicitly focus, although in different ways, on the relationship between humans and their biophysical setting. They also represent a gradient of intellectual and practice issues that bear directly on achieving integration.

Hope et al. outline their intent as one of distinguishing biophysical from human factors affecting plant diversity in Phoenix, AZ. Their method is to analytically relate plant diversity to 13 variables ranging from latitude/longitude position of a $30 \times 30$ m quadrat through median income of the Census Block Group in which a quadrat is located. There is no explicit social theory at test, but rather a search for patterns that demonstrate the likelihood that human-specific variables are related to floristic diversity in a human-dominated setting. To be noted, the ecological study of human-dominated systems is even shallower in time than the participation of social scientists in LTER research (Pickett et al. 2001). As such, Hope et al. are fully cognizant that their conclusions are limited to the scale at which the study was carried out and some of the independent variables tested are really surrogates for specific human processes. This study, however, opens the way to future studies that more closely examine the effects of changing human attitudes, behavior, and institutions.

Grove et al. discuss new kinds of data and methods for examining the relationship between social and vegetation structure in urban areas using their research from Baltimore, MD. They note that there are at least two significant questions that emerge from the rapid urbanization of the United States in recent years and the importance of vegetation to this change: (1) Does vegetation structure vary among urban neighborhoods, and (2) do the motivations, pathways, and capacities for vegetation management vary among households and communities? Grove et al. discuss how to increase categorical resolution of social area analysis beyond what is possible

with Block-Level Census data by using market research data and methods, in this case, PRIZM data. They also address advances in remotely sensed data designed to characterize urban areas in terms of their vegetative and built covers using, in this case, HERCULES data. This article demonstrates how the ability to pose hypotheses designed to advance our understanding of human-dominated urban settings must not only rely on long-term social and biophysical data, but also adapt existing methods to the complex, fine-grained heterogeneity of urban areas.

Stedman and Hammer examine how aggregate individual perceptions relate to measured water quality in a rapidly growing rural area of the Northern Highlands Lake District of Wisconsin. Moving from mass socioeconomic measures as contained in the U.S. Census or PRIZM categories to individual response measures reflects a trade-off that must often be made between scale and resolution, given the research objective. The significance of focusing on individuals in this case is captured by Stedman and Hammer's discussion of how people often couch their opposition to rapid development in language that emphasizes protecting the environment. They unambiguously demonstrate how access to high-quality lake amenities is related, but not equal to, changes in the physical environment. It may seem obvious to social scientists that perception differs from observation, but this view is not equally widespread among biophysical scientists. Furthermore, the degree to which it is true that perception differs from observation has not been nearly as well established by either social or biophysical scientists as the strength of the opinions either group holds about the relation of perception and observation.

Nowak et al. extend the examination of the relation between social and biophysical variables into new territory by applying the concept of disproportionality to *within*-group variation. In effect, these authors examine outlying individual responses of managing phosphorous in Pheasant Branch Creek Watershed, Wisconsin, to distinguish between the performance of a unit of social organization relative to the performance of its member individuals. Nowak et al. then proceed to demonstrate how the behavior of outliers can either be benign or consequential depending on the location of those behaviors and buffering capacity of the biophysical system. This reveals how the search for the normal or essential in studies of society can easily miss what is of most consequence to a society's future viability.

Gragson and Bolstad synthesize several completed studies from the Coweeta LTER project, rather than relate human subjects to their biophysical setting through a unitary study at a moment in time. Noting the challenge of moving historical insight to the practical needs of regional planning, they present evidence for how land-use legacies are manifest and continue to affect contemporary terrestrial and aquatic systems. Like Nowak et al., they emphasize that answering the *where* question is often just as important as answering the *why* question when it comes to making the results of research useful to fulfilling the needs of decision makers. Beyond the truism that past land-use practices are expressed in the structure and function of contemporary ecosystems, Gragson and Bolstad show how the coincidence of evidence in particular situations often has surprising results with important implications for the understanding of process.

## Lessons Learned

Social scientists are trained to ask *why* questions, but theoretically significant and practically important research on *where* and *when* humans occur received decreasing

attention as the post-processual movement led to ever more nuanced critiques of humanity's place in nature. The understanding of process that underpins these two aspects of social behavior is central to the final engagement of social scientists not only with their biophysical science peers, but also with constituencies outside the traditional realm of the practicing researcher. Recognition has grown in all parties over the last 10 years that neither human nor biophysical systems can be studied autonomously if the issues Vitousek and others have identified are to be addressed. This recognition is the impetus for determining how LTER research will study the dynamics of complex and interdependent social and biophysical systems.

Our collective experience is that explanation will not fall neatly into the domain of either traditional ecological theory or traditional social theory. To varying degrees, selecting sites, identifying questions, and developing theory, experiments, and models have provided each group of collaborators in this set of articles with the capacity to understand systems in novel and important ways. A common theme to the research presented in this special issue is moving understanding about humans from stereotypes toward process and explanation. From this common theme emerges the recognized need to base explanation on the examination of variables in combination or in a multiplicative sense, rather than to attempt explanation using bivariate or additive approaches.

This raises two issues about the practice of research in general that bear directly on LTER research. The first issue is that we can never reduce error to zero. Recognizing that we must live with error is liberating, because instead of avoiding action in lieu of perfection we can distinguish kinds of error and determine their relative utility to some purpose. In this set of articles, Hope et al. address sampling error by using a 206-point sampling framework; Grove et al. rely on PRIZM categories, which reduce the U.S. Census values to factors with a known relationship to variance; Stedman and Hammer evaluate the differences between perception and measurement to demonstrate their points of commonality and difference; Nowak et al. define the concept of disproportionality to examine behavioral outliers traditionally excluded as either mistakes or simply uninteresting; and Gragson and Bolstad assess the contribution of past land use to contemporary systems so as to discriminate background from human effects.

The second issue is that different constituencies differ in their expectations about the resolution, accuracy, and precision of results. Knowing more and more about less and less is a risk in question-driven research, but trying to sell the need for more research when our current knowledge might be sufficient for decision making satisfies no one. Social scientists, traditionally reticent about offering counsel or advice based on their results, are being called to participate in what Cronon (1993) calls the whirlpool of prophecy of making policy decisions. If social scientists fail to participate, others will do so in their stead yet may lack the skills and expertise required to address the coupled nature of human–biophysical systems.

In our experience, research success in addressing the coupled nature of human–biophysical systems begins with *trust*. Trust in the context of an LTER project is premised on a mutual appreciation of what each disciplinary member can contribute professionally toward answering a question or solving a problem of common interest. Collaborations depend on collaborators recognizing that each discipline—including their own—has blind spots (Freudenburg and Alario 2000). The difficulties of building trust are not unique to the LTER, since the practice of science as usual is as much a challenge within as across disciplines. It is the recognition of

this difficulty that underlies various calls to raise the next generation of scientists differently.

The stakes for building trust in time or through a generational shift include direct participation in developing effective and efficient policy in which the marginal rates of return on environmental benefits exceed what is currently the case. Nowak et al. in this special issue discuss the tendency to judge a policy as ineffective when the cumulative impact of the behavioral changes it induces through implementation does not significantly change the environmental impact the behavior is associated with. The example they provide is that of the U.S. EPA use of TMDL. The question is whether it is useful to pass legislation on the basis of the sum total of all behavior in a watershed when output may merely reflect the extreme behavior of a small number of individuals. To address the critical issues faced by society as it confronts the challenges of modernity, we must go beyond storytelling to distinguish between mass behavior and outliers, perception and observation, and why, where, and when of human behavior.

## Conclusion

The unique features of the LTER program are the emphasis on long-term patterns and processes, long-term funding, data sharing, and site comparison. The long-term record already available in the LTER program makes it a unique observatory for assessing the ecological effects of numerous external and internal forces from climate to land use. Social scientists might do well to emulate ecological scientists in systematically collecting long-term data on beliefs, attitudes, and behaviors. This will serve in part to capture the "shifting baseline" (Pauly 1995) in how humans view and relate to their surroundings, which will help overcome the traditionalism in policies that result from overreliance on single-point-in-time measures as if socioeconomic systems were adequately characterized as static.

Interdisciplinary LTER opportunities for social scientists exist at both site and network levels. The goals for the Decade of Synthesis we are currently in will be achieved to the extent that new perspectives from other scientific disciplines now participating or expected to participate in LTER research are incorporated. The range of potential topics is broad, from intensive multidisciplinary analyses of patterns and processes in individual ecosystem types to comparisons of the interaction of human populations with ecosystems across a wide range of abiotic and biotic circumstances. As the record continues to lengthen, standardization is agreed on, and synthetic efforts with other disciplines increase, the intellectual contributions of the LTER program to understanding the relation between humans and biophysical systems and the ability to forecast future scenarios will be without par. The first of these contributions are presented in the following set of articles.

## References

Callahan, J. T. 1984. Long-term ecological research. *BioScience* 34:363–367.

Cronon, W. 1993. The uses of environmental history. *Environ. Hist. Rev.* 17:1–22.

Franklin, J. F., C. S. Bledsoe, and J. T. Callahan. 1990. Contributions of the long-term ecological research program. *BioScience* 40:509–523.

Freudenburg, W. and M. Alario. 2000. What ecologists can learn from nuclear scientists. *Ecosystems* 2:286–291.

Hobbie, J. E. 2003. Scientific accomplishments of the long term ecological research program: An introduction. *BioScience* 53:17–20.

Jasanoff, S., R. Colwell, M. S. Dresselhaus, R. D. Goldman, M. R. C. Greenwood, A. S. Huang, W. Lester, S. A. Levin, M. C. Linn, J. Lubchenco, M. J. Novacek, A. C. Roosevelt, J. E. Taylor, and N. Wexler. 1997. Conversations with the community: AAAS at the millennium. *Science* 278:2066–2067.

Kinzig, A. P., J. Antle, W. Ascher, W. Brock, S. R. Carpenter, F. S. Chapin, III, R. Costanza, K. L. Cottingham, M. Dove, H. Dowlatabadi, E. Elliot, K. Ewel, A. Fisher, P. Gober, N. Grimm, T. Groves, S. Hanna, G. Heal, K. Lee, S. A. Levin, J. Lubchenco, D. Ludwig, J. Martinez-Alier, W. Murdoch, R. Naylor, R. Norgaard, M. Oppenheimer, A. S. P. Pfaff, S. T. A. Pickett, S. Polasky, H. R. Pulliam, C. Redman, J. P. Rodriguez, T. Root, S. Schneider, R. Schuler, T. Scudder, K. Segersen, M. R. Shaw, D. Simpson, A. A. Small, D. Starrett, P. Taylor, S. van der Leeuw, D. H. Wall, and M. Wilson. 2000. *Nature and society: An imperative for integrated environmental research.* Phoenix: Arizona State University.

Klein, J. T. 1996. *Crossing boundaries: Knowledge, disciplinarities, and interdisciplinarities.* Charlottesville, VA: University of Virginia.

Pauly, D. 1995. Anecdotes and the shifting baseline syndrome of fisheries. *Tree* 10:430.

Peterson, B. J. 1993. The costs and benefits of collaborative research. *Estuaries* 16:913–918.

Pickett, S. T. A. 1991. Long-term studies: Past experience and recommendations for the future. In *Long-term ecological research: An international perspective*, vol. Scope 47, ed. P. G. Risser, 71–88. New York: John Wiley & Sons.

Pickett, S. T. A., W. R. Burch, S. Dalton, T. Foresman, J. M. Grove, and R. Rowntree. 1997. A conceptual framework for the study of human ecosystems in urban areas. *Urban Ecosyst.* 1:185–199.

Pickett, S. T. A., J. M. Cadenasso, J. M. Grove, C. H. Nilon, R. V. Pouyat, W. C. Zipperer, and R. Costanza. 2001. Urban ecological systems: Linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. *Annu. Rev. Ecol. System.* 32: 127–157.

Redman, C., J. M. Grove, and L. H. Kuby. 2004. Integrating social science into the long-term ecological research (LTER) network: Social dimensions of ecological change and ecological dimensions of social change. *Ecosystems* 7:161–171.

Vitousek, P. M., H. A. Mooney, and A. Lubchenco. 1997. Human domination of Earth's ecosystems. *Science* 277:494–499.