

Investigating the Social-Ecological Dynamics of Residential Landscapes: Insights from a Multi-Site Collaborative Workgroup

Final Report from Long-Term Ecological Research (LTER) Workshop
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WORKING GROUP OVERVIEW AND OBJECTIVES

On February 18-19, 2009, the Long-Term Ecological Research (LTER) Network Office (LNO) supported a workshop to develop a foundation for networked research among LTER sites. The workshop was aimed at understanding the coupled human-environment dynamics of residential landscapes and, more broadly, land use/cover systems across diverse ecosystem contexts. Hosted by the Central Arizona-Phoenix (CAP) LTER site within the Global Institute of Sustainability at Arizona State University, a total of 18 people representing 10 LTER sites (Table 1) participated in this intellectually fruitful event. Building on site-level research across the LTER network, our primary objectives were to:

- Share and coordinate approaches to current research on social-ecological dynamics of lawns, residential landscapes, and land use/cover patterns and processes across LTER sites.
- Identify and address opportunities and challenges associated with cross-site, long-term social-ecological research.
- Establish an information-sharing network and plans for future collaborations in comparative long-term social-ecological research.

In this report, we synthesize the insights and lessons learned from our working group discussions and activities in two parts. First, we summarize the social-ecological research underway at various LTER sites on land use/cover patterns and processes, with special attention to lawns, residential landscapes, and urban(izing) ecosystems. Second, we present the primary opportunities and challenges identified at the workshop, along with a 'wish list' of core datasets, protocols, and other capacities that were identified as central to furthering cross-regional comparative research. Other products of this workshop include:

- An information-sharing network for continued discussions and collaborations aimed at coordinating and advancing comparative research across the LTER network, specifically through the establishment of a Google Groups website.
- Planned session(s) at the upcoming LTER All Scientists Meeting focused on building the capacity for long-term, cross-regional research on the social-ecological dynamics of residential landscapes and land use/cover in diverse ecosystems.

The workshop also positions the LTER network to undertake explicitly comparative research through the development of cross-site proposals. Funding collaborative cross-site work is essential for fully supporting comparative studies of complex social-ecological systems across individual LTER sites while leveraging existing regionally-focused datasets and approaches. As we move forward with these cross-site initiatives, we plan to engage LTER scholars who did not participate in the workshop as well as those beyond the network. Involving a larger community of scholars is important as the insights gained from this event are pertinent to other comparative research initiatives being pursued across the network.

1. SUMMARY OF RESIDENTIAL LANDSCAPES AND LAND USE/COVER RESEARCH

Although urban environments occupy a relatively small portion of the Earth's surface, their ecological impacts are far-reaching in scope and diversity (Vitousek 1994). For example, the conversion of agricultural and forested lands to residential land use drives habitat fragmentation and ecosystem change in the US (Munroe *et al.* 2005). Although the management of agricultural lands has been well studied, far less research has focused upon urban or suburban areas where human choices affect ecological patterns and processes. Residential landscapes, including prevalent lawns, are increasing worldwide and are associated with high rates of water and chemical applications to terrestrial and, by extension, aquatic systems. Turfgrass in residential and other areas is now the largest irrigated crop in the US, covering 10–16 million hectares (Robbins *et al.* 2001; Milesi *et al.* 2005). Yet research is needed to understand the human ecological drivers, impacts, tradeoffs, and feedbacks associated with turfgrass management and residential landscapes in multiple locations with varying socioecological settings. The LTER network is uniquely poised to contribute to this key area of integrated social-ecological research, especially given on-going site-level research and emphasis on cross-site synthesis and comparisons (Redman *et al.* 1999). Specifically, socioecological research on *residential landscapes* is underway at several LTER sites, as briefly highlighted below:

- In the *Baltimore Ecosystem Study* (BES), Grove, Groffman, Jenkins, and colleagues are employing field surveys, land use/cover mapping, and other techniques to link lifestyle and demographic characteristics to ecological and built structure, ecosystem functions and services, and human outcomes and behaviors from the parcel to regional scales. These efforts are linked to long-term permanent plot monitoring and detailed research on actual residential lawns that aim to understand turfgrass productivity, carbon storage and nitrogen dynamics.
- At the *Plum Island Ecosystem* (PIE), Polsky, Pontius, Hopkinson, and others make use of parcel-scale lawn-mapping techniques to study of how land use/cover patterns in suburban Boston watersheds are related to land-use regulations, homeowner attitudes, hydrologic flows, and nutrient cycling.
- In *Florida-Coastal Everglades* (FCE), Chowdhury, Ogden, and others are combining geospatial and ethnographic analyses to uncover how zoning, sociodemographics, and climatic pulse events (hurricanes) interact to impact land use-cover at the household to regional scales.

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- At *Central Arizona–Phoenix (CAP)*, Larson, Hall, and others are using social and observation field surveys along with other data sources within a case study approach to examine the cultural, institutional, and social-structural drivers of residents' land-management practices and the ecological structure of yards, primarily at the household and neighborhood scales.
- In the *Jornada Basin (JRN)* vicinity, St. Hillaire and others are employing model plot experiments, analyses of metered water demand, and other methods to examine how residential landscape characteristics (e.g., grass lawns versus xeriscapes) in Las Cruces, NM affect plant physiology and water use efficiency under various climate scenarios as well as people's yard preferences and management practices.
- At the *Cedar Creek (CDR)* site, Hobbie and colleagues are utilizing social surveys, ecological models, and other methods to examine how norms, beliefs, and attitudes influence the magnitude and extent of nutrient fluxes (Carbon, Nitrogen, Phosphorous) in residential parcels along an urban-rural gradient (from St. Paul, MN out to the Cedar Creek environs).
- At *Hubbard Brook (HBR)*, Groffman and others are investigating the carbon and nutrient cycling implications of residential land use development in the area around the forested HBR site.

While workshop participants at these LTER sites are conducting research on the social-ecological dynamics of residential landscapes in relatively urban settings, each site varies in its theoretical and methodological approaches, geographic scope, and associated sampling methods. It is important to note that some of the above studies have been largely or partially supported with non-LTER resources and, in some cases, are not closely linked to their regionally situated or nearby LTER sites at present. Thus, although these studies present significant opportunities for collaborative, cross-site research, the different spatial boundaries of LTER sites do not always reflect the urban areas included in this cross-site comparison. For example, while CAP's lawns/landscaping research is co-located in select case study neighborhoods in urban Phoenix, which have been the focus of ongoing social and ecological research and long-term monitoring, complementary research at PIE is focused on study watersheds in the suburban outskirts of the greater Boston metropolitan region, which are outside of PIE's traditional research boundaries. This complicates comparative site-level LTER research, especially concerning the use of site-level data collection techniques and sampling designs (as outlined further below-see Table 2).

Several sites involved in the workshop (e.g., KNZ, LUQ, JRN, CWT) are situated in relatively rural or native ecosystems in which the notion of 'residential landscapes' does not apply quite as clearly as in urban(izing) settings. Perhaps the Jornada site illuminates this issue most clearly, since research on residential lawns and landscapes is underway in the broader region (in Las Cruces, NM), which is outside of the traditional boundaries of the LTER site. Nevertheless, similar research themes dominate all of the involved LTER sites, particularly in terms of understanding the driving forces of historic and modern land use/cover changes (whether in the Konza prairies or the forests of the Luquillo, Coweeta, or Hubbard Brook areas), along with the implications for ecological processes. At the Konza Prairie (KNZ) LTER site, for example, Harrington

and colleagues are examining land use and cover change patterns with Landsat imagery, along with the associated drivers and environmental implications, while documenting the ongoing conversion of grassland to woodland (as a function of disturbance frequency, predominantly the removal of fire) as well as the changing risk of rabies (in skunks) on the urban periphery of Manhattan, Kansas. Meanwhile, at the *Luquillo* (LUQ) LTER site, researchers are studying patterns and processes of urban expansion, urban stream ecology, the impacts of urbanization on carbon and nitrogen cycling, and the heat island effect. In the face of land development and changing use/cover patterns in and around these LTER sites, comparative research on environmental and ecosystem service change (especially due to urbanization and human settlement broadly) in broader regional contexts is an especially salient area of cross-regional LTER studies. Not only will moving toward similar spatial extents assist with comparative study designs, but broadening the geographic scope of LTER-related research (especially to include human settlements) will assist in further engaging social scientists in integrated long-term research. The Ecotrends social-demographic module, which defines an extended area for all the LTER sites, is an exemplary approach for addressing this challenge while developing a robust platform for cross-site coupled socio-ecological research.

2. INSIGHTS ON CAPACITY-BUILDING FOR COMPARTIVE SOCIAL-ECOLOGICAL LTER RESEARCH

Despite significant opportunities for comparative social-ecological research within the LTER network, a number of challenges exist to developing cross-site studies with existing network resources. While these challenges may pose difficulties for comparative studies based on previous and current site-level data and research, each challenge identified represents insights and opportunities for building upon the immense knowledge and capacity of the LTER network to advance cross-regional research. In Table 2, we outline the specific challenges identified at the workshop while highlighting how these present important capacity-building opportunities for cross-regional, long-term, coupled human-natural systems research in distinct geographic contexts. Following from our workshop discussions, we developed a 'wish list' matrix (Table 3) of the core datasets, protocols, and other research infrastructure with the most potential for moving toward comparative, networked research across LTER sites. In addition to highlighting these capacity-building resources, we note which of the participating sites currently have or are developing each of the resources identified as central to further cross-site studies of coupled human-ecological systems. As we move forward with our collaborations across the network, we hope the insights gained at our workshop will enhance and complement existing research activities as well as develop the infrastructure for comparative long-term studies of complex social-ecological dynamics across distinctive ecosystems. Through such research, scientific knowledge and theory will be advanced by considering the human-ecological patterns and processes common across diverse contexts while revealing the particularities of specific phenomena in unique geographic settings.

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TABLE 1. WORKSHOP PARTICIPANTS

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TABLE 2. INSIGHTS FOR CROSS-SITE SOCIAL-ECOLOGICAL LTER RESEARCH

CHALLENGE	OPPORTUNITY
<p>Data-driven process of long-term monitoring in the LTER may constrain the possible research questions addressed through social-ecological research, along with hindering the involvement of some scholars.</p> <p>Lack of involvement by certain disciplines or types of scholars, such as economists, psychologists, and at some sites, social scientists generally, hinders integrated scientific analyses to address long-term social-ecological dynamics.</p> <p>Varying boundaries of LTER sites and associated study units complicate cross-regional studies across (sub)urban, rural, and native ecosystem contexts at diverse spatial scales (e.g., neighborhoods, watersheds, forests) of interest.</p> <p>Use of diverse sampling designs, from study units, plots, and scales to populations of interests and how they are sampled, does not allow direct comparisons where similar methods exist.</p> <p>Application of ethical standards for the treatment of human subjects in research across sites may result in divergent approaches (e.g., with the use of incentives, recruitment procedures) due to institutional differences in how they are applied.</p> <p>Different resources and capabilities of local and regional government agencies and others entities potentially leads to difficulties in collecting similar datasets across sites and addressing particular questions through comparative research.</p> <p>Similar in-field studies of social-ecological dynamics across sites are difficult because of the lack of experimental control and other confounding factors.</p> <p>Difficulties comparing research findings result from different conceptual and operational definitions, study units, sampling designs, measurement protocols, etc.</p>	<p>Developing complementary, long-term datasets and research approaches at varying scales (especially the parcel-level) can enhance the research possibilities through comparative LTER studies.</p> <p>Engaging additional expertise in the LTER network may be possible by moving toward fine-scale data sources linked to human-environment interactions (e.g., at household scale) and broadening the geographic scope of LTER sites.</p> <p>Coordinating regional approaches (as with Ecotrends project) to study sites encompassing urban and suburban to rural and wildland places with a variety of land use/cover types will assist in the use of similar sampling and other methods to support comparative research.</p> <p>Moving toward common sampling approaches is readily possible given the use of similar data collection methods (e.g., social and field surveys, lawn mapping), especially in the areas outlined in Table 3.</p> <p>Sharing human subjects protocols and associated materials can assist in standardizing approaches to recruitment and research participation processes across study regions.</p> <p>Building relationships with stakeholders such as government agencies and non-profit organizations provides opportunities for the collection of novel data sources, recruitment of research participants, as well as applied project benefits.</p> <p>Developing mixed methods approaches including experiments and model landscaping plots will advance understanding of the causal processes linked to spatial patterns.</p> <p>Compiling synthesis papers will further comparative research by developing similar conceptual and methodological approaches that could emerge from collaborations.</p>

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TABLE 3. CORE CAPACITIES: DATASETS AND INFRASTRUCTURE TO SUPPORT CROSS-SITE NETWORKED RESEARCH

Information Wish List		BES	CAP	PIE	FCE	LUQ	KNZ
DATA: Parcel & Household Scale	Assessed Property Values	1	1	2	1	2	3
	Full Census Data (Community Survey)	1	1	2	1	1	3
	Market-derived Lifestyle Data (PRIZM)	1	1	1	3	3	3
	Resident Ecological Knowledge	3	2	2	3	2	1
	Resident Values & Preferences	3	2	2	3	2	1
	Water & Energy Consumption	3	1/3	2	2	2	3
	Parcel/Household GIS Shapefiles	1	1	1	2	3	3
	Land-use & Land-cover Maps over Time (<1 meter, with land use history)	1	3	1	2	2	1
DATA: Neighborhood & Regional Scale	Network of Permanent Soil & Vegetation Sampling Plots	1	1	2	3	3	3
	Neighborhood-level Nutrient & Water Budget (input-output)	1	2	2	3	2	3
	Neighborhood-level Shapefiles (e.g., HOA Boundaries)	1	3	2	3	3	3
	Zoning & Land-use Regulations & Historical Variances (With Locations)	1	2	2	2	2	3
	Land Use History	1	1	2	2	1	1
	Transportation & Energy Consumption	1	1/3	3	3	2	3
	Septic & Sanitary Infrastructure	1	1	3	3	2	3
	MODELS	Validated Residential Preference Model	2	3	2	3	3
Validated Residential Biogeochemistry Model		2	3	3	3	3	3
PROTOCOLS	Survey Clearinghouse (Social & Ecological) Methods & Implementation Protocols	1	2	2	3	3	3
	Residential Landscape Mapping (<1m) Protocol & Classification	1	1	1	2	3	3
	Residential Landscape Mapping (<1m) Protocol & Classification	1	3	1	2	3	3
	Core Set of Social Survey Questions & Standard Sampling Approach	1	3	2	3	2	3
	Privacy Assurance for Household Data	1	1	1	3	3	3
	Metadata Documents	1	1	2	3	3	3
1 - Developed /collected already 2 - Currently under development 3 - Not developed or underway							