### US-IALE 2001 Abstracts for All Sessions

<table>
<thead>
<tr>
<th>NO.</th>
<th>Email</th>
<th>Session Type</th>
<th>Author/Address/Title</th>
<th>Full Abstracts</th>
<th>Session Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td><a href="mailto:siwaa@cc.usu.edu">siwaa@cc.usu.edu</a></td>
<td>Oral/Regional Planning</td>
<td>Adair, William A., and John A. Bissonette. USGS Utah Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Utah State University, 5210 Old Main Hill, Logan, UT 84322-5210, USA. Spatially explicit models and landscape planning: A case study with the endangered Newfoundland marten (Martes americana atrata).</td>
<td>Wildlife ecologists have long recognized that for most wildlife species, habitat quality depends on both the quantity of resources and their spatial configuration. However, few wildlife habitat models have attempted a spatially-explicit approach to assessing habitat quality, and only a handful of these have been used for landscape planning. Because 1) Newfoundland marten favor old growth forests and avoid openings and 2) spatial configuration is the most flexible aspect of timber harvest planning in western Newfoundland, the Newfoundland marten provides an ideal case study for examining the costs and benefits associated with spatially explicit modelling. We developed a suite of spatially explicit models that assess habitat quality by directly linking den sites with foraging patches, thereby mimicking the marten's habitat selection process. We compared these spatially explicit models with conventional aspatial models in terms of 1) their ability to accurately depict Newfoundland marten habitat quality at several scales and 2) their utility as decision-making tools for landscape planners. We conclude with guidelines for determining when spatial explicit modeling is a requirement for effective decision-making.</td>
<td>Landscape Management: Approaches and Practices</td>
</tr>
<tr>
<td>2.</td>
<td><a href="mailto:jfa@larp.umass.edu">jfa@larp.umass.edu</a></td>
<td>Top 10</td>
<td>Ahern, Jack. Department of Landscape Architecture and Regional Planning, University of Massachusetts, Amherst, MA 01003, USA. Full Circle: challenges for the integration of the science and the application of landscape ecology.</td>
<td>From its beginnings in Europe, landscape ecology has held the promise to fully and seamlessly integrate ecological science with applications in landscape planning, design and management. The reality has been one of mixed success. While significant progress has been made in articulating first principles and fundamental theories, few widely-accepted successes can be cited as model applications of landscape ecology. The promise remains to be more fully realized. The following questions are useful to frame, to lead, and to integrate future investigations and applications: What are the main knowledge gaps which limit the effective application of landscape ecology in planning, design, and management of landscapes? Can these gaps be addressed through empirical research? Which adaptive strategies are appropriate to gain new knowledge through application? Can monitoring protocols be established to collect and analyze long term data from decisions made? How can the methods of case study-based research be formalized to articulate and document knowledge gained through application (and comparative applications)? Can the scope of these case studies be focused on accepted indicators of landscape structure, function and change? What is the appropriate pedagogy to inspire and support a fuller integration of landscape ecological science and application? What is the role of the universities? of IALE? Of other agencies or entities?</td>
<td>Top 10 List</td>
</tr>
<tr>
<td>3.</td>
<td><a href="mailto:jfa@larp.umass.edu">jfa@larp.umass.edu</a></td>
<td>Special: Ahern's</td>
<td>Ahern, Jack. Department of Landscape Architecture and Regional Planning, University of Massachusetts, Amherst, MA, USA. Future Landscape Scenarios in Urban Watershed Planning.</td>
<td>A fundamental precept of landscape ecology is the reciprocal interrelationship of landscape pattern and process. Much research has explored this dynamic with respect to flows of energy, materials and movement of species across heterogeneous rural and agricultural landscapes. Less work has been done with respect to these flows, and other flows which are prevalent in human-dominated urban environments. Future landscape scenarios engage the landscape pattern:process dynamic over time</td>
<td>Landscape Ecology Comes to Town: An exploration of concepts, issues, strategies and case studies of applied urban landscape ecology</td>
</tr>
</tbody>
</table>
into the future. As planning activities, they make assumptions and proposals which define trajectories of landscape change based on best-available knowledge and data. Scenarios are most useful; to inform comparative discussion among stakeholders and decision makers regarding planning and policy decisions. This paper reviews several contemporary approaches to alternative future landscapes and proposes a method for the application of scenarios in urban watershed planning.

4. Vivek Shandas & Chicka de@uwashington.edu
   Oral/Reg
   Alberti1,2, Marina and Paul Waddell1,3, 1Department of Urban Design and Planning, University of Washington, Seattle, WA 98195 USA; 2Urban Ecology Research Lab, University of Washington, Seattle, WA 98195, USA; 3Daniel J. Evans School of Public Affairs, University of Washington, Seattle, WA 98195, USA. Urbansim: An Integrated Urban Development and Land Cover Change Model.

   This paper presents an integrated strategy to model the urban development and land cover change dynamics in the Central Puget Sound Region. This project is part of the Puget Sound Regional Integrated Synthesis Model (PRISIM)—an interdisciplinary initiative at the University of Washington aiming to develop a dynamic and integrated understanding of the environmental and human systems in the Puget Sound. We focus on UrbanSim, a new software architecture for spatial simulation to develop a behaviorally integrated model for operational use by policymakers and planners faced with the complex trade-offs between urban growth and preserving ecological conditions. This paper presents the specifications of the urban development and land cover change models and discuss the status of the implementation and empirical application of these models to the Puget Sound region. We build on several modeling traditions—urban economics, landscape ecology, and complex system science—each offering different perspective on modeling urban dynamics. We choose to link human and ecological processes through a spatially explicit representation of the land. Our hybrid model structure combines a microsimulation of actor choices (location, housing, travel, and land development) and a spatially-explicit, grid-based model structure which represents the dynamics inherent in land use and land cover change.

5. Vivek Shandas & Chicka de@uwashington.edu
   Poster
   Alberti1,2, Marina, Derek Booth3, Kristina Hill4, John Marzluff5, Stefan Coe1,2, Roarke Donnelly6, Vivek Shandas1,2, and Daniele Spirandelli2,4. 1Department of Urban Design and Planning, University of Washington, Seattle, WA 98195. USA; 2Department of Landscape Architecture, University of Washington, Seattle, WA 98195. USA; 3Department of Civil and Environmental Engineering, University of Washington, Seattle, WA 98115, USA; 4Department of Landscape Architecture, University of Washington, Seattle, WA 98195, USA; 5Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA; 6Department of Landscape Architecture, University of Washington, Seattle, WA 98195, USA. The Impacts of Urban Patterns on Ecosystem Dynamics.

   Consideration of urban patterns is critical to the successful use of ecological research in urban planning and design. Urban ecology does not yet have an established, proven set of pattern metrics to describe urban landscape patterns. To study the relationship between urban patterns and ecological conditions we need to describe these patterns quantitatively. We examine across a broad range of scales, several pattern metrics which we hypothesize are linked to ecological processes in urbanizing landscapes. We select metrics to quantify urban form, land use intensity, land cover heterogeneity and land cover connectivity. We seek correlations with two biological metrics: (a) nest predation rates of corvid bird species (crows, ravens) on songbird species, and (b) aquatic macroinvertebrate biodiversity (measured using the Index of Biotic Integrity, or IBI). Using data on bird communities and aquatic macroinvertebrates we test formal hypotheses about what factors determine and maintain an urban gradient in the Puget Sound region. We investigate three categories of hypotheses: (1) relationships between urban patterns and various spatial pattern metrics; (2) relationships between spatial scale (defined first as resolution and then as a real extent) and the correlation between a pattern metric and an ecological variable; and (3) relationships between spatial pattern metrics (each defining one aspect of an urban-rural gradient) and an ecological variable. Together, these allow us to address both the direct relationship between urban pattern and ecological conditions, and the sensitivity of pattern measurements to measurement scale.

6. Vivek Shandas & Chicka de@uwashington.edu
   Poster
   Alberti1,2, Marina, Erik Botsford1, and Alex Cohen1,2. 1Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA; 2Urban Ecology

   Ecologists have suggested that ecological conditions in urbanizing landscapes can be described by a
<table>
<thead>
<tr>
<th>#</th>
<th>Email/Username</th>
<th>Type</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td><a href="mailto:tallen@odu.edu">tallen@odu.edu</a></td>
<td>Poster</td>
<td>Conceptual vision for integrating wetland restoration and tourism development at the Montezuma Wetlands Complex in New York State. This landscape design proposal creates a conceptual vision for the 50,000+ acre Montezuma Wetlands Complex (MWC) that seeks to enhance habitat integrity and accommodate visitors. The MWC is a major stopover on the Atlantic migratory flyway, in upstate New York. The draining of wetlands during construction of the Erie Canal, subsequent muckland farming, and the development of a major interstate highway have profoundly modified the MWC landscape. Plans are now being developed to restore the area to a wetland condition and manage it for wildlife habitat. The reversion of agricultural fields to wetlands will greatly reduce the county and municipal tax base. Consequently, local communities have expressed interest in developing tourism to support the economy. Our analysis and interventions seek to integrate the restoration of wetland habitat with the development of ecologically sensitive tourism.</td>
<td>Allen, Thomas, and John Kupfer. &quot;Department of Political Science &amp; Geography, Old Dominion University, Norfolk, VA 23529, USA; and &quot;Department of Geography and Regional Development, University of Arizona, Tucson, AZ 85721, USA. Scales of Pattern and Process in Fraser Fir Forest Disturbance and Regeneration, Great Smoky Mountains, USA. Southern Appalachian Spruce-Fir (Picea-Abies) forests have undergone widespread damage and mortality since the introduction of the balsam woolly adelgid in the 1950's. We integrated field observations, topoclimatic models, and 1988-1998 satellite imagery to analyze spatial and temporal patterns of Fraser fir and spruce-fir ecosystems in Great Smoky Mountains National Park. Spectral changes in Landsat TM digital data were statistically modeled by topographic variables. Change vector analysis (CVA) and spherical geometry were applied at multiple scales; individual sites, local ridges, and east-west across the study area. Meaningful relationships were found between elevation and spectral change within and between sites. CVA vectors revealed differential spectral evidence of mortality and regeneration pathways. Geographic variations of these vectors also detail the scale of east-west and finer scale patterns suggesting upslope progression of fir mortality. The application of CVA provided the ability to summarize variation in spectral changes in space and time and to ascribe these to forest mortality and regeneration.</td>
</tr>
<tr>
<td>8</td>
<td><a href="mailto:tse4@cornell.edu">tse4@cornell.edu</a></td>
<td>Poster</td>
<td>Conceptual vision for integrating wetland restoration and tourism development at the Montezuma Wetlands Complex in New York State. This landscape design proposal creates a conceptual vision for the 50,000+ acre Montezuma Wetlands Complex (MWC) that seeks to enhance habitat integrity and accommodate visitors. The MWC is a major stopover on the Atlantic migratory flyway, in upstate New York. The draining of wetlands during construction of the Erie Canal, subsequent muckland farming, and the development of a major interstate highway have profoundly modified the MWC landscape. Plans are now being developed to restore the area to a wetland condition and manage it for wildlife habitat. The reversion of agricultural fields to wetlands will greatly reduce the county and municipal tax base. Consequently, local communities have expressed interest in developing tourism to support the economy. Our analysis and interventions seek to integrate the restoration of wetland habitat with the development of ecologically sensitive tourism. Through spatial analysis, our inquiry focused on restoring and enhancing patch diversity and connectivity in a fragmented landscape, exploring edge dynamics, and creating interior space conditions. Design interventions include project areas that interpret ecological processes at different temporal and geographic scales, including geologic and human-induced landscape transformation, engineered wetlands serving as a stopover for millions of migratory birds, and various stages of wetland succession. Proposals also include the creation of a new visitor center acting as a gateway into the entire complex.</td>
<td>Anderson, Linda, and Theodore Eisenman. Landscape Architecture Department, Cornell University, Ithaca, NY 14853, USA. Conceptual vision for integrating wetland restoration and tourism development at the Montezuma Wetlands Complex in New York State.</td>
</tr>
<tr>
<td>9</td>
<td><a href="mailto:andison@bandaloop.ca">andison@bandaloop.ca</a></td>
<td>Oral/Poster</td>
<td>Landscape-Ecosystem Services, 3426 Main Ave., Vancouver, BC, Canada, V3H 4R3. Fire in riparian zones: The perfect hierarchical model. As we get our hands dirty with the natural disturbance model of forest management in the boreal forest,</td>
<td>Andison, David W. Bandaloop Landscape-Ecosystem Services, 3426 Main Ave., Vancouver, BC, Canada, V3H 4R3. Fire in riparian zones: The perfect hierarchical model.</td>
</tr>
</tbody>
</table>
4R3. Fire in riparian zones: The perfect hierarchical model.

things are not as clear-cut as we hoped. For instance, riparian zones are particularly sensitive areas both socially and ecologically. Ironically, our improving understanding of how fire affects these special areas is not making the task of managing them sustainably any easier. At landscape scales, there is evidence that fires burn through riparian zones on a regular basis. Fires form edges more often than expected at creeks and rivers, but not significantly so. At intermediate scales, we begin to see more subtle shifts in fire severity across riparian zones, but again, not commonly so. Survival of individuals increases through riparian zones for selected combinations of vegetation-types and topography, but the majority of riparian zones burn as often, and as hot as the adjacent upland forests. At stand scales, fire controls forest invasion, maintains lower vegetation communities, keeps fuel-loads low, changes the temperature profile of the aquatic system, and creates snags and woody debris. Finally, at the micro-site scale, fire is a chemical process that exposes mineral soil without compaction, converts and transports nutrients, and creates a new hydrological balance. Understanding and accepting that these functions are “natural” is difficult enough, but using all of this new knowledge to design a management strategy which maintains the integrity of the system is another, much more difficult mission. Ultimately, the difficulty lies in our inability to think, plan, manage, and monitor in a hierarchical manner.

[4R3. Fire in riparian zones: The perfect hierarchical model.

Andison, David W. Bandaloop Landscape-Ecosystem Services, 3426 Main Ave., Vancouver, BC, Canada. Practical Science using the LANDMINE Landscape Fire Simulation Model.

Despite all the talk about "natural range of variability", examples of exactly what that entails are few and far between. We are universally having difficulty grasping the potential implications of embracing variability in land management. LANDMINE is a stochastic, landscape disturbance model that was designed to fill this void. The cellular automaton spread algorithm in LANDMINE allows disturbances such as forest fires to be calibrated for shape as well as amount, spacing, and sizes of residual islands. Disturbance sizes and frequencies are selected stochastically from empirical data. Stochastic ignition probabilities are based on spatial ignition tendencies. Vital attribute species responses to disturbance drive successional shifts on individual pixels. Although not a proper fire behaviour model, LANDMINE can use topography, fuel-types, and even wind direction to spread fires according to observed or hypothesized burning tendencies. The transparent, conceptual simplicity of LANDMINE has proven valuable for practical applications over the past several years. The most obvious application has been to run the model several times to measure a temporal range of variation in patterns. For instance, Weldwood of Canada Ltd. has used LANDMINE output to establish multi-scale seral-stage ranges for long-term planning. The model has also been used to test the ability of different management scenarios to create more “natural” landscape patterns. Not surprisingly, the most powerful application of the model so far has been to demonstrate how, and in what way natural landscapes have been, and will continue to be dynamic.

[4R3. Fire in riparian zones: The perfect hierarchical model.

Anthony, J.A., and G.A. Bradshaw. "Department of Fisheries and Wildlife, 104 Nash Hall, Oregon State University, Corvallis, OR 97331, USA; USDA Forest Service- PNW Research and Rogue-Siskiyou National Forest, Applegate Ranger District, 6941 Upper Applegate Road, Jacksonville, OR 97530-9341, USA. Wavelet analysis as an approach to investigate the reciprocal relationship between ecological pattern and process.

Two-dimensional wavelet analysis characterizes complex ecological data to increase our comprehension of the reciprocal relationship between pattern and process across scales. Integrating individual features at one scale as a texture at multiple scales translates ecological patterns as a multi-dimensional volume. Visualizing complex relationships as a space-time volume captures a closer approximation of the way ecological relationships exist in nature - nonlinear, multi-scalar, uncertain. As a pattern analysis method that accommodates and preserves non-stationarity, wavelet analysis provides novel visualization and analytical capabilities for increased insight into the interactions between multi-scalar pattern (heterogeneity) and sampling design. Wavelet analysis is presented as an analytical and modeling tool for optimizing sampling efficiency and accuracy, such as in the context of designing large-scale monitoring plans. Effective monitoring must involve sampling designs sufficiently detailed to detect ecologically significant patterns at multiple scales, yet logistically tractable and resource-efficient for sustained execution. For this reason, methods that help optimize these objectives and contribute to the design of more efficient sampling prior to implementation are important for successful large-scale monitoring. We
present an approach that uses two-dimensional wavelet analysis in tandem with simulation modeling to select optimal sampling designs for large-scale spatio-temporal ecological phenomena. The sampling properties and behavior of wavelet analysis are described and illustrated in a comparison of spatio-temporal patterns in species range data and statistical simulations of varying distributions to emulate natural patterns.

<table>
<thead>
<tr>
<th>12.</th>
<th><a href="mailto:marc.antrop@rug.ac.be">marc.antrop@rug.ac.be</a></th>
<th>Top 10</th>
<th>Antrop, Marc. Department of Geography, University of Ghent, Belgium. Top 10 list for landscape ecology. (Conveyed by J. Wu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Search for norms or standards for the landscape metrics</td>
<td>Antrop, Marc. Department of Geography, University of Ghent, Belgium. Top 10 list for landscape ecology. (Conveyed by J. Wu)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The use of indices is becoming increasingly important in environmental assessment and policy making. Unlike the more ‘technical’ environmental compartments such as air, water, soil toxicity and noise, no numerical standards or norms are available for indicators related to landscape and ecology. Many indicators about the technical compartments are legally regulated, which is not the case for landscape indicators. Landscape metrics are numerical indicators that are widely used for descriptive and comparative purposes, but are difficult to be used as standards in a legal assessment procedure. It might be worthwhile to focus some fundamental research upon this.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Integrate or link landscape metrics (indices) to holism</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Many landscape metrics try to describe properties of the landscape that are surpassing the characteristics of the composing elements. Some of these properties have clearly a holistic meaning, such as the ones dealing with complexity, diversity, heterogeneity and order. They might offer a possibility to bridge the experimental-scientific method of research with the phenomenological-humanistic methods. As both approaches are used in the study of landscape, this can only broaden and enforce the understanding of landscape and the practical application of the results coming from it.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Design and apply integrated monitoring at the landscape level</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The speed and magnitude of landscape change is still increasing and general inventory data are rapidly out of date. Many actions in spatial and environmental planning are interfering with each other and have no or a poor follow-up in many cases. Monitoring programs focus upon a specific issue, such as biodiversity assessed by the occurrence of some indicator species or the measurement or immissions by sampling networks. Interaction with other processes in the landscape as well as the landscape structures are seldom integrated. Integrated monitoring at the landscape level is multifunctional and is more appropriate to understand the driving forces – pressures – state – impact - response model (DPSIR).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Consider man as a particular species</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Man should be regarded as a particular species because of the way he interacts with the environment and the magnitude of his impact upon the creation and change of the landscape. His behavior is hardly predictable and billions act simultaneously but in a largely non-concerted manner, resulting in a rather chaotic pressure and impact upon the environment. An important aspect in understanding man’s behavior in relation to the landscape is the way he is valuing the land and the landscape, as well as the elements it contains. Values of landscape (and elements) are not absolute, but are assigned and affected by culture. Values may change in time and this affects the way the land is used and thus how the landscape will be (re)shaped. The success of programs to sustain landscape ecological functioning depends upon the way humans, as individual and as society, considers it being important. Also, most valuing by humans in the past resulted in the creation of unique cultural landscapes that are considered of ecological importance today, such as the enclosed hedgerow landscapes. Understanding the way man evaluates the landscape might offer new opportunities to implement the results of landscape ecological research.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Give more attention to the quality of the data generally provided for spatial analysis and use in a GIS</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spatial analysis and the use of GIS became extremely important in landscape ecological research. More and more geographical map data become generally available. Many of these are secondary data derived from other data sets or digitized or interpreted from analogue data. Data from different scale, accuracy, precision and quality are often combined, affecting in various, but not always transparent ways the outcome. Little information is given about the quality of the data used (for example in scientific publications) and the metadata accompanying the data sets is rare and not always complete. Critical data evaluation should become more important in the reporting of scientific research, in particular when</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
dealing with spatial and dynamical issues.

6. **Apply theories from landscape ecology to other domains of landscape research and translate the results from landscape ecological research for planning and policy making**

Fundamental research and theory are important in landscape ecology and the research is organized accordingly. This makes landscape ecology still strongly an academic discipline (although not always recognized as such). Many results are considered too abstract and theoretical for many planners and policy makers that are also dealing with the landscape in a more practical sense and thus are important in the changing and shaping of the landscape as well. Landscape ecologists should make more efforts to translate their theories, concepts and results for practical applications and link them to concepts and theories used in spatial (physical) planning and environmental planning.

7. **Broaden the research for landscape perception**

‘Landscape’ differs from ‘land’ by its holistic character that implies also a perceptive dimension. Landscape always refers also to the scenery. The visual aspect is emphasized here and other forms of landscape sensing receive less attention. Recent research by acoustics is achieved in the field of soundscapes for example. However, these researchers have no background in landscape research. Landscape ecology as a transdisciplinary discipline should try to embrace these new fields of research as well and set up links to broaden and integrate its concepts with those in the field of environmental psychology, sociology, acoustics, etc.

8. **Apply landscape ecology in dynamic and chaotic landscapes**

Much landscape ecological research is focusing upon specific landscape types (wetland, riparian landscapes, deserts, mountains, forests, etc). Recently the interest for the complex and dynamical (sub)urban landscapes has been increasing as well as the impact of urban sprawl upon the countryside. However, really chaotic and extremely dynamical landscapes, such as the ones formed by large industrial complexes, third world urbanization and war and zones of conflict are rarely studied. Of course, many practical difficulties exist, but also many opportunities are missed as well to see the landscape functioning in extreme situations. Thinking about a methodology to study such landscapes might be a first step.

9. **Set up a common language**

English has become the common international language in landscape ecology as in most other sciences. For non-native English speaking researchers this is clearly a handicap to express the results of their work. The problem in landscape research is particularly important as the concept of landscape has also a perceptive, cultural and social dimension. In many languages there is no one-to-one translation for ‘landscape’ as well as for many related concepts such as ‘(geographical) space’, environment, ‘scale’, etc. For example, in many languages, ‘landscape’ has an intimate connotation of the ‘beauty’ or ‘symbolic’ value of the perceived or imagined land. Associations are made often with ‘home land’ and ‘heritage’. In the common use of the word ‘landscape’ no association is made with a hierarchical structured system or a scale of complexity of organization. The multiple meanings of the term ‘landscape’ and related terms is the most important factor in misunderstanding, also amongst scientists.

10. **Stimulate education and training in landscape ecology**

Landscape ecology is still marginal in educational programs, in particular in higher education. However, landscape as a central holistic concept for many different research disciplines offers many opportunities to initiate and train young future researchers in transdisciplinary working in a broad field of applications. A base course of landscape ecology (‘thinking landscape ecology’) might essential before any later specialization in (one of the branches) of landscape ecology that is added to any other more traditional and recognized discipline.

---

13. **oralreg**

Arge1, Lars, Jeff Chase1, Laura Toma1, *Jeffrey Vitter1, Rajiv Wickremesinghe1, Pat Halpin2, and Dean Urban1.

1Levine Science Research Center, Computer Science Department, Duke University, Durham, NC 27708, USA; 2Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. Digital terrain analysis for massive grids. Analysis of digital elevation models (DEMs) is central to a range of applications concerned with the effects of topography on hydrologic flow and soil water accumulation. Topographic convergence indices. **Landscape Mapping and Characterization: Methods and Applications**
Landscape ecologists in two decades have developed a body of theory and empirical findings that has reshaped ecology and influenced many other disciplines, yet significant challenges remain. Twenty-first Century landscapes will be more developed and humanized than are landscapes today, because of continuing population growth and expansion of the global economy. In the Rocky Mountains, for example, a rising population is creating distinct problems in landscapes dominated by urbanization, energy development, logging and grazing, agriculture, recreation, and wildlands. Landscapes characterized by sustainability have not yet emerged, because of continuing population growth and because the region remains under the influence of shifting global and national forces and priorities (e.g., shift to natural gas as an energy source, expanding urban and ex-urban development). A continuing boom-and-bust economy leaves landscape legacies that constrain future options. New theory and principles are needed, tailored to particular kinds of landscapes, to absorb population growth and economic development while maintaining critical landscape functions and future options. In fossil-fuel energy landscapes, for example, there is a need for new models for development that will minimize short-term adverse impacts and facilitate restoration of landscape structure and function after resource depletion. Logging landscapes can be re-designed to minimize adverse effects of fragmentation while harvesting continues. Landscape ecology will remain important during the 21st Century if it can provide practical solutions as well as new theory relevant to the short-term pattern of land transformations accompanying growth, with the long-term goal of transitioning to landscapes of sustainability.
<table>
<thead>
<tr>
<th>Page 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>17.</strong> gbarrett@sparrw. ecol.ogy.uga .edu</td>
</tr>
<tr>
<td><strong>18.</strong> bascompt e@ab d.csic.e s</td>
</tr>
<tr>
<td><strong>19.</strong> mbatist e@indian a.edu</td>
</tr>
<tr>
<td>20.</td>
</tr>
</tbody>
</table>

| 21. | dbean@interchange.ubc.ca | Poster | Bean, David A., and Greg H.R. Henry. Department of Geography, University of British Columbia, Vancouver, BC, Canada, V6T 1Z2. | The Spatial Pattern of Vegetation in a High Arctic Oasis. | Environmental changes resulting from global warming are predicted to be most intense at high latitudes and this has considerable implications for the distribution of vegetation in the High Arctic. The relationships among plant community structure, diversity, vegetation phenology, and abiotic factors including snowmelt pattern, temperature, soil moisture and soil nutrients are being studied at the Alexandra Fiord lowland (78° 53' N, 75° 55' W), a high arctic oasis on the east coast of Ellesmere Island, Canada. Digital aerial photographs were used to map the vegetation and the pattern of snowmelt. At each of 28 sampling points, vegetation was surveyed, soil was sampled, temperature was recorded by dataloggers and phenological observations were made on four plant species throughout one growing season. A geographic information system is being used to analyze the data from the discrete sampling points and relate it to the observed distribution of plant communities. From these data are anticipated insights on the spatial interrelationships between vegetation and the abiotic environment with a view to improving predictions of vegetation response to climate change in this region. |

| 22. | mbeaty@psu.edu | Oral/Reg | Beatty, R. Matthew and Alan H. Taylor. Department of Geography, The Pennsylvania State University, University Park, PA 16802, USA. | Stand and Landscape Scale Variability of Fire Effects and Vegetation Dynamics in a Mixed Conifer Forest Landscape, Southern Cascades, California. | Disturbance and Vegetation Pattern and Dynamics |
Fire is an important force that shapes landscape diversity by influencing vegetation composition and structure at multiple scales. We examined stand and landscape scale patterns of fire effects on vegetation in a mixed-conifer forest landscape. Fire regimes (i.e., return interval, season, extent, rotation, severity) were reconstructed with dendroecology. Repeat aerial photography (1941 and 1983) and stand structural analysis was used to determine patterns of fire effects and successional changes since fire suppression. Slope aspect, potential soil moisture, forest composition, and fire regime parameters in our study area covary. Median composite and point fire return intervals were shorter on ponderosa pine dominated, south-facing slopes (9 years, 19 years), intermediate on mixed species, west-facing slopes (14-17 years, 34-37 years), and longest on white fir dominated, north-facing slopes (34 years, 54 years). Fire severity also varied by species composition, slope aspect and slope position. At the landscape scale, differences in fire return interval and severity promoted fine-grained vegetation patterns on south-facing slopes and coarse grained patterns on north-facing slopes. At the stand level, variable fire regimes created vegetation structures ranging from even-aged, monospecific stands of white fir to multi-aged, multi-species stands dominated by pines. Fire frequency declined dramatically after 1905, and stands have infilled with fire intolerant species. This study suggests compositional and structural diversity within the mixed conifer zone is related to spatial variation in fire regimes. Fire suppression has homogenized fire regimes with the apparent result of homogenizing vegetation composition and structure at both stand and landscape scales.


Landscape planning and management decisions should incorporate key ecological processes and the associated spatial patterns, particularly as development pressures increase upon a limited land base. In Nova Scotia, several species are in decline and at risk of extirpation due to habitat conversion, degradation and fragmentation. Thus, to conserve these species it is important to understand the ecological process of population viability over time, as well as the spatial patterns (size and configuration) of critical habitat on the landscape. Selection and delineation of critical habitat includes considerations of viable population size, density, home-range area, dispersal patterns, and habitat characteristics. The habitat requirements of viable populations of lynx (Lynx canadensis), American moose (Alces alces), American marten (Martes americana) and river otter (Lontra canadensis) help to define key landscape-level parameters in Nova Scotia. Geospatial Information System (ArcInfo; ArcView) analyses of various land-cover and forest-inventory data sets are used to select and delineate appropriate habitat, including both core and connectivity zones. If sufficient habitat for these species is conserved, it should go a long way toward maintaining viable populations of many species in Nova Scotia. Population viability of species over time is a key ecological process and is intimately bound up with the landscape. Critical spatial patterns for the survival and evolution of focal species should be understood, delineated and maintained.

Bennett, Elena and Stephen R. Carpenter. Center for Limnology, 680 N. Park St., Madison, WI 53706. Phosphorus distribution along an urban-rural gradient.

Phosphorus (P) is a key pollutant causing lake eutrophication, a critical problem for freshwater resources in the United States. P is accumulating in upland soils of many watersheds around the world, increasing the potential P runoff to surface waters. However, we know little about the spatial pattern of P accumulation, the causes of this pattern, or its effects on P runoff to surface waters. We hypothesized that, at the watershed scale, changes in P accumulation and storage may be best understood along a gradient from urban to rural land uses. Our urban-rural gradient is not represented by a linear transect; instead, we used a functional gradient definition based driving time to the urban center and population density to map the urban-rural gradient across Dane County, Wisconsin. We examined soil P concentrations at over 500 sites along this gradient to determine the spatial pattern of hot spots of P accumulation and the land management factors driving the relationship between hot spots and location. We found that, while the mean soil test P values were similar across the gradient (mean of 43 ± 22 ppm in urban areas and 74 ± 51 ppm in rural areas), the spatial variation increased significantly along the gradient from urban to rural sites. Current land use (e.g., agricultural or residential) and house age (r²=0.25, p<0.000) rather than land use history or fertilizer application rates (r²=0.064, p<0.001), appears to be the dominant factor influencing this relationship.
Multilevel Statistical Modeling for Generalizing from Case Studies.

Case studies, which are the bread and butter of environmental research, are too often faced with a very difficult “So what?” criticism: just because certain findings apply to a given study site does not necessarily mean that they apply to any others. Yet, the goal of such research commonly is to arrive at broadly relevant conclusions. In this paper, we employ a generalization of multilevel statistical modeling to consider the degree to which one can draw credible conclusions across a set of case study sites. Multilevel modeling allows one, within a regression analysis framework, explicitly to consider how statistical summaries vary systematically over a set of sites. As a result, the degree to which findings can be applied beyond a single site is addressed directly. Our contribution is to provide a generalization of multilevel modeling, and the necessary software, so that one may work with the generalized linear model and include such features as spatial and temporal dependence, inherently nonlinear relationships, and latent variables. For example, outcomes can be categorical and sites closer to one another in space may be treated systemically as more alike. The emphasis in our paper is on technique, with the data used as an illustration. The data come from a Regional Environmental and Monitoring Assessment Program (R-EMAP) project, US EPA Region 9, undertaken in conjunction with UCLA Environmental Science and Engineering Program. The research is spatially intensive stream bioassessment monitoring study for Calleguas Creek Watershed, Ventura County, California. The effort includes sampling of riparian habitat and streams for two seasons between 1999-2000. Data are collected at 70 sites. Field assessment in the watershed includes water quality, physical habitat assessments (e.g., measures and/or visual estimates of channel cross-sectional dimensions, substrate, fish cover, bank characteristics, and riparian vegetation structure) and benthic and fish community sampling. The project seeks to assess the current ecological condition of coastal Southern California streams and to examine the impacts of land use on water quality and aquatic ecosystem integrity.

In order to project future urban growth, it is necessary to identify the predominant factors and processes that drive urbanization. In the past decades, many urban growth models have been developed, but few offer any ecological or social explanations. In this presentation, we describe a spatially explicit urban growth model that is used to simulate the historical land use change and its social and ecological driving forces in the Phoenix metropolitan area. The Phoenix urban growth model is a modified version of HILT, a rule-based urban growth model originally developed for the San Francisco Bay Area. The modeling framework is a modified cellular automaton that applies growth rules and allows for self-modification during execution of controlling variables. Using land use and other data collected for the Phoenix area, existing growth rules have been selectively modified, and new rules added to help examine key ecological and social factors that affect urbanization. FRAGSTATS, a landscape analysis package, is used to compute landscape indices to compare simulated and empirically mapped land use patterns. Preliminary results show that there are relatively few factors that have significantly influenced the urban growth in the Phoenix metropolitan region. These include growth/density values, land ownership, and dispersal growth that is so elusive to model, and significantly contributes to landscape fragmentation.

When species compositions for sites with low species richness are largely proper subsets of compositions for sites with higher species richness, the distributional pattern of species across sites is structurally nested. To date, the application of nested subset analysis has primarily focused on extensions of the
Quebec, Canada K1A 0H3 (KEF). Nested species subsets in a regional context: effects of landscape structure, scale and error.

The theory of island biogeography, while largely ignoring explicitly spatial and landscape scale factors that potentially contribute to the generation of this class of non random pattern. In this study, two separate designs were used to compare the effects of patch size, isolation, landscape structure and scale on species specific and assemblage level nestedness patterns. We used a dataset comprising a total of 144 forest fragments with complete bird surveys in the form of presence/absence data in a 125 km square region and representing a gradient of decreasing forest cover and increasing fragmentation. Nestedness varied greatly across ranking variables for both patch clusters and landscapes and increased with scale. Individual forest bird responses differed for landscapes ranked by independent measures of forest composition and configuration and was not evident at the species level. In general, only a small proportion of species was significantly nested. Because measurement error led to increases in statistical ties between sites for a given ranking variable, effect size and absolute nestedness scores declined with increasing error. Nested subset analysis may help identify species likely to exhibit threshold responses to landscape structure in a study region, which could lead to coarse scale rules for more detailed modeling in conservation management.

28. bbestelm@jornada.nmsu.edu  Poster  Bestelmeyer1, Brandon, Joel Brown1, Kris Havstad1, Robert Alexander2, and George Chavez3, and Jeffrey Herrick1. 1 USDA-ARS Jornada Experimental Range, New Mexico State University, Las Cruces, NM, 88003, 2 Bureau of Land Management, 1474 Rodeo Rd., Santa Fe, NM 87502; 3 USDA Natural Resources Conservation Service, 6200 Jefferson, Albuquerque, NM 87109. An integrated approach to managing landscape pattern and dynamics in southern New Mexico.

Bestelmeyer1, Brandon, Joel Brown1, Kris Havstad1, Robert Alexander2, and George Chavez3, and Jeffrey Herrick1. 1 USDA-ARS Jornada Experimental Range, New Mexico State University, Las Cruces, NM, 88003, 2 Bureau of Land Management, 1474 Rodeo Rd., Santa Fe, NM 87502; 3 USDA Natural Resources Conservation Service, 6200 Jefferson, Albuquerque, NM 87109. An integrated approach to managing landscape pattern and dynamics in southern New Mexico.

The ecological site concept of the USDA Natural Resource Conservation Service provides a hierarchical framework for classifying and distinguishing landscape units that differ in the processes that determine plant and animal community dynamics within and that determine interactions among units. Ecological sites are based upon important differences in landscape position and inherent soil properties as defined by the respiration in climate and management. Dominant plants, in turn, regulate several ecosystem attributes including dynamic species pools. State-and-transition models are used to represent theories about the positive feedbacks between plant populations and ecosystem processes and the consequences of irreversible changes in plant and animal composition. An understanding of these causes is needed to avoid ecosystem degradation, to fairly evaluate and manage current approaches to community and landscape ecology with the historical perspectives and practical experiences of land managers and ranchers. Our approach emphasizes an increased understanding of patterns of dispersal, establishment, and growth of dominant plants along landscape and climatic gradients.

29. kab4@duke.edu  Oral/Re g  Bickel1, Kathryn A., Laura C. Philips2, and Dean L. Urban3. 1 Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708-0328, USA; 2 Department of Biology, University of North Carolina at Chapel Hill, Box 3280, Chapel Hill, NC 27599, USA; 3 Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708-0328, USA. Land use, Disturbance, and the Spread of Non-native Plant Species in a Piedmont Forest Ecosystem.

Bickel1, Kathryn A., Laura C. Philips2, and Dean L. Urban3. 1 Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708-0328, USA; 2 Department of Biology, University of North Carolina at Chapel Hill, Box 3280, Chapel Hill, NC 27599, USA; 3 Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708-0328, USA. Land use, Disturbance, and the Spread of Non-native Plant Species in a Piedmont Forest Ecosystem.

Non-native plant species are increasingly invading forest ecosystems and creating considerable ecological problems by altering ecosystem structure and function. A number of explanations for this trend have been offered, one of which pinpoints the interaction between habitat alteration from land use and the opportunistic life histories of invading species. This study investigates the hypothesis that land use and natural disturbance mediate the spread of non-native species in forests of the Piedmont region of North Carolina. The Piedmont is characterized by a long history of widespread habitat alteration resulting from agricultural practices in the early part of the twentieth century. Pine forests have since regenerated on abandoned agricultural fields and are now actively managed for timber. Piedmont forests are undergoing additional modifications in response to increasing development pressures. Forests in this region are therefore continually subjected to alteration and fragmentation. This study takes advantage of a unique set of permanent sampling plots in Duke Forest, a 3260 hectare private research forest, to measure changes in herbaceous communities over the past twenty-five years. Changes in native and non-native species richness and composition are related to environmental, topographic, and land use variables. Land use variables include the proximity of sites to roads and streams and the density of neighboring
development and vegetation cover. Our findings indicate that proximity to streams and surrounding vegetation densities are important variables in explaining changes in herbaceous communities of the Piedmont.

| 30. | mbinfor d@geog .ufl.edu | Oral/Re g | Binford 1, M.W., C. Leslie 1, R. Britts 1, G. Barnes 1, H. L. Gholz 2, S.E. Smith 3. 1Department of Geography; 2Geomatics Program, Department of Civil Engineering; 3School of Forest Resources and Conservation, University of Florida, Gainesville, FL 32611. Decadal-Scale Spatial Dynamics of Land Cover, Land Ownership, Land Management in Industrial and Non-industrial Forests in the Southeastern Coastal Plain Region of the U.S. | Land Use and Land Cover Change: Pattern and Process |

Urban, agricultural, and plantation forestry landscapes are all dominated by human activities, and each has its own temporal and spatial dynamics. We are studying how climate variability and land ownership and management practices have altered forested ecosystems in the southeastern United States between 1975 and 2000, using an integrated approach of satellite remote sensing, in situ measurement of ecosystem processes, and compilation of land-record archives to define land-ownership patterns. Our focus is on private and state-owned industrial and non-industrial forests. Small (14.4 km x 14.4 km) sample areas are being studied intensively to determine the spatial and temporal patterns of changing land cover and land ownership and management practices. Land-cover change processes are estimated with remote sensing methods calibrated by long-term (20+ years) ecosystem measurements. This paper describes how spatial patterns, measured by various landscape indices, have changed over the period of study, and outlines specific hypotheses that explain the influence of land ownership, natural environmental variation, and their interactions. Preliminary results suggest that the size of the land parcel, but not land ownership, is a good predictor of land-cover change patterns. Large parcels, whether owned by private individuals, commercial forestry companies, or holding companies, are managed as industrial forests and have shown specific patterns as they have been clear-cut and regrown over 25 years. The transfer of land from one commercial enterprise to another, with some conversion from commercial to private ownership (urban development), were the predominant changes in the later part of the time period.

| 31. | thomas. blaschke@sbg. ac.at | Oral/Re g | Blaschke, Thomas. Department of Geography and Geoinformation, University of Salzburg, Hellbrunner Str. 34 A-5020 Salzburg, Austria. Hierarchical patch dynamics and object-oriented image analysis: Multi-scale exploration of a cultural landscape. | Landscape Pattern Analysis: Theory and Methods |

Hierarchical patch dynamics (HPD) has been suggested as a conceptual framework for research into landscapes, which incorporates the issues of heterogeneity, scale, connectivity and non-linearity. Due to theoretical and technological short-comings, much traditional landscape monitoring has been limited to uni-spatial snapshots of the continuums of landscape, and to a focus on the pixel as a surrogate for landscape process or pattern. In this paper, the hierarchical patch dynamics framework is juxtaposed with the concept of a multiscalar methodology of image segmentation. It is argued that segmentation-based methods of object-oriented image processing will overcome some limitations of the pixel-centred approach and allow for the integration of semantic rules within the classification process. The fractal net evolution approach is introduced which uses a local mutual best-fit heuristics to find the least heterogeneous merge in a local vicinity, following the gradient of the best-fit. The potential of this approach is illustrated by reporting on an ongoing research program in a traditional cultural European landscape dominated by extensive grazing over centuries and undergoing recent changes. The concept of multiscalar segmentation is applied to a classification of different types of meadows and pastures according to their texture. Some pastures exhibit characteristic textures while they show at the same time similar reflection values per pixel in an infrared aerial photography. It is argued that the exploration and understanding of these spatial patterns opens new ways to explore and understand changes of the driving processes and will enable landscape planners to design grazing schemes to preserve the cultural landscape.

| 32. | jbolliger @facstia ff.wisc.e du | Oral/Re g | Bolliger 1, Janine, Erik V. Nordheim 2, and David J. Mladenoff 3. 1Department of Forest Ecology and Management, University of Wisconsin-Madison, Madison, WI, 53706; 2Department of Statistics and Department of Forest Ecology and Management, University of Wisconsin-Madison, Madison, WI, 53706; 3Department of Forest Ecology and Management, University of Wisconsin-Madison, Madison, WI, 53706. A probabilistic and spatially explicit method to assign individual tree species to ambiguously identified | Landscape Mapping and Characterization: Methods and Applications |
Given the increasing rate of landscape change, researchers have realized that managing natural resources sustainably requires knowledge about ecosystems over more than one temporal and spatial scale. Monitoring ecosystem integrity implies sampling over long periods of time and space to identify any significant changes. Nonetheless, there remain aspects related to scaling which limit the ability to detect landscape change with a maximal amount of inference. While successive analyses can be used to estimate errors, it is not clear how spatial reorganization resulting from scaling has diluted the signal of the processes embodied within the observed patterns. This is particularly of import for the case of aquatic networks such as streams. To achieve a maximal amount of inference, it is first necessary to match three scales: spatial heterogeneity, the scales of the ecological processes creating landscape heterogeneity, and the spatial and temporal resolutions of the image used in the analysis. We discuss the relationship between scale of spatial pattern, image analysis, and scale of process and how their interactions affect large-scale monitoring quality for the case of aquatic networks. We assert that the interactions between pattern and process need to be considered explicitly when designing large-scale monitoring to accurately describe ecological change. This study and others further support the suggestion that monitoring be coupled with spatio-temporal models to elucidate the mapping from pattern to process across scales. It is
inhabiting the FEMS. I hypothesized that the population responds of species differentiating by evolutionary strategies will have bell shape function. I found that a R-selected species mainly respond to changes in the amount of resources in the patches and it population density increases due to increase of survival rate. To the other extreme, a K-selected species have demonstrated overall little response to the treatment. Two other species with intermediate characteristics have demonstrated mixed respond which included both an increase in survival rate and an increase in migration rate that was correlated to the amount of water in the patches and to the relative amount of water between them. These results indicate a matching rule between the spatio-temporal activity scale of the individuals and the scale of the newly created patches.

This project examines the implications of land use and management policies proposed by the National Marine Fisheries Service to protect and restore stream and associated uplands habitat for endangered salmon species. Focusing particularly on proposed stream buffer zones, we examine the conflicts between current land use patterns and desired habitat configurations. In addition, we estimate the costs of achieving these habitat conditions under differing sub-watershed development conditions. We employ Geographic Information Systems (GIS) and ancillary technologies to study a sample of sub-watersheds in the Puget Sound (Washington USA) Basin, stratified by Scheuler's watershed 'degradation' categories. Using information on hydrological features, habitat/land cover, parcelization and other data, we analyze the current status of habitat in these sample watersheds, focusing particularly on the proposed stream buffer areas. We then compare proposed buffers, and current and desired habitats, with parcel and ownership patterns to assess the costs and feasibility of implementing proposed protection measures. Further, we analyze costs for restoration of habitats to desired conditions as they vary amongst the watershed degradation categories. These analyses highlight 'conflicts and costs.' They provide a basis for suggestions regarding the proposed policies in terms of the extent of current-use conflicts with the desired conditions, and the costs of meeting these conditions. Examination of suggested buffer sizes in relation to parcelization patterns facilitates development of suggestions regarding the 'takings' aspects of the proposed policies. Overall, this project develops a basis and methodology for discussing the potential and problems of implementing these habitat protection and enhancement measures.

50. Bunn's, Andrew G., Dean L. Urban", Lisa J. Graumlich'. "Mountain Research Center, Montana State University, Bozeman, MT USA; "Nicholas School of the Environment, Duke University, Durham, NC USA. Fine Scale Variability in the Physical and Biotic Templates of 3 Alpine Treelines. "

Previously ongoing research into landscape modeling of ectocenes indicates the need to account for fine scale drivers. Understanding the patterns at fine spatial scales is a critical step if we are to derive
<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Author(s)</th>
<th>Title</th>
<th>Presenting Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.</td>
<td>Poster</td>
<td>Jan Butaye, Jan Hans Jacquemyn, and Martin Hermy</td>
<td>The biotas of fragmented habitats often have been found to exhibit non-random patterns of species composition. An example of such non-random distribution pattern is a nested subset pattern. At both the community and the individual species level we investigated whether a nested community pattern could be found in 84 isolated recent forest fragments. Next the hypothesis that nestedness was generated by isolation and differential colonization was tested. Alternative hypotheses formulated in the past, such as nested habitats and patch area dependent species relaxation, were verified. Individual species colonization probabilities were derived with a logistic regression analysis. Species occurrence in suitable target patches was related to the degree of isolation from occupied source patches. Habitat suitability of each target patch was determined with a habitat space model based on the actual species composition. Albeit the stochastic factor involved in the colonization process, the observed non-random community structure resulted primarily from different colonization probabilities and isolation. At the individual species level the degree of nestedness is highly correlated with isolation sensitivity. Based on the results we recommend the use of colonization probabilities to quantify effects of isolation in heterogeneous landscapes. Although the dynamic rates may be superior to study migration within homogeneous forest systems. The consciousness of the importance of geographic isolation on species composition forces us to change our perception on forest conservation and to integrate landscape planning into conservation efforts.</td>
<td>Department of Land and Water Management, University of Leuven, Vital Decosterstraat 102, B-3000 Leuven, Belgium. Differential colonization causing non-random forest plant species community structure in a fragmented agricultural landscape.</td>
</tr>
<tr>
<td>39.</td>
<td>Oral/Regional</td>
<td>Cadenasso1, M.L., S.T.A. Pickett1, and W.C. Zipperer2</td>
<td>A guiding question of the Baltimore Ecosystem Study, Long-Term Ecological Research (LTER), is: “How do the spatial structure of socio-economic, ecological, and physical factors in an urban area relate to one another and how do they change through time?” A first step to address this question is to define socio-economic, ecological, and physical patches within the study area. This presentation will demonstrate an approach we are using to describe, delimit, and quantify ecological patches in four regions of the Gwynns Falls Watershed, Baltimore, Maryland. The four regions span the gradient of urbanization present in the watershed. Specifically, we have focused on 1) how can structural patches, based on ecological factors, be described, delimitated, and quantified? and 2) how does patchiness of ecological factors differ among the four regions? Digital air photos of submeter resolution, taken during the leaf season of 1999, were used in an ArcView system to create a data layer of delimited patches. The ecological patches were described hierarchically by three broad categories: forests, open areas, and built structures. Forests are further resolved into patch types based on canopy size. The open area patches represent combinations of non-forest and non-built areas. Patches of built structures are described using a matrix of the type and density of built structures and the types and densities of associated vegetation. We will compare the frequency distributions of patch types in the four regions as well as the degree of spatial heterogeneity that is found in these regions.</td>
<td>Institute of Ecosystem Studies, Millbrook, NY 12545, USA. and USDA Forest Service, Syracuse, NY 13210, USA. Spatial Heterogeneity in an Urban Watershed: Baltimore, Maryland.</td>
</tr>
</tbody>
</table>
40. ernesto. castro@asu.edu Poster Camelo-de-Castro, Ernesto. Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA. Landsat MSS and TM Data Preparation for Vegetation Cover Change Analysis: Evaluation on a Cerrado Environment in Mato Grosso, Brazil.

Camelo-de-Castro, Ernesto. Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA. Landsat MSS and TM Data Preparation for Vegetation Cover Change Analysis: Evaluation on a Cerrado Environment in Mato Grosso, Brazil.

The main objective of this work is to evaluate the preparation of two Landsat images, of different dates and resolution, for a vegetation cover change analysis. The data tested is compound of an MSS scene from August, 1986 and a TM scene from August, 1992 which were obtained from the Tropical Rain Forest Information Center / Basic Science and Remote Sensing Initiative (TRFIC/BSRSI) at Michigan State University. The steps necessary to prepare the data to be used in this kind of analysis are described and discussed. Particularly with regards to issues like: quality of metadata, the radiometric and atmospheric correction, geometric correction and scale definition for the analysis. The results show that, with certain precautions, a combination of NDVI and Change Detection techniques can be used to perform vegetation change analysis using the two different scaled images. A reclassification process is also described with the intention to produce a map of land cover suitable for the evaluation of the vegetation change, in case that a vegetation map is not available. The major achievement of this study is a demonstration of how to control for the resolution in the analysis of vegetation cover change using regular quality MSS and TM images.

41. carmelia@yorku.ca Oral/Research Poster Canzonieri, Carmela. Faculty of Environmental Studies, York University, Toronto ON, Canada. Reinforcing the ecological structure to artificial infrastructure ratio in suburban/rural landscapes.

Canzonieri, Carmela. Faculty of Environmental Studies, York University, Toronto ON, Canada. Reinforcing the ecological structure to artificial infrastructure ratio in suburban/rural landscapes.

The paper looks at the relation between the pattern of an ecosystem upholding its ecological structure and the scale of the artificial infrastructure imposed upon it. When the difference in scale is substantial, for example a small vegetation patch and an isolated road in a desert, chances are that the ecosystem might escape the effects of the infrastructure, or in a opposite example, that a far ranging ecological structure might be not significantly affected by an infrastructure of a much lower scale. When the scale of the artificial infrastructure is similar to that of the ecological structure, conflicts start to occur at higher and higher frequencies. The effect of a standard infrastructure is then different over different landscapes. The paper presents a case of applied landscape ecology in which the primary goal is to set up concomitant measures to reinforce the ecological-structural/artificial infrastructure ratio within the ecosystem, rather than to manage for harvesting resources. The paper looks at: 1) The effects of arbitrarily placed infrastructure over the functions of components and over the larger ecological processes, 2) Mechanisms which have a positive influence on the strength of the system, 3) A spatial scenario capable of reinforcing ecological structure by reducing redundant infrastructure while accommodating a necessary level of it. Key issues are road effects, connectivity, network, ecological-structure to artificial infrastructure ratio, strategic infrastructure downsizing.

42. cardille@students.wisc.edu Special: Jones' Cardille¹, Jeffrey A., Jonathan A. Foley¹, Marcos Heil Costa². Center for Sustainability and the Global Environment, University of Wisconsin, Madison, WI 53706.¹ Department of Agricultural Engineering, Federal University of Viçosa, Viçosa, MG, Brazil. Scaling Down Successfully: A New Method For Integrating Census and Satellite Data

Cardille¹, Jeffrey A., Jonathan A. Foley¹, Marcos Heil Costa². Center for Sustainability and the Global Environment, University of Wisconsin, Madison, WI 53706.¹ Department of Agricultural Engineering, Federal University of Viçosa, Viçosa, MG, Brazil. Scaling Down Successfully: A New Method For Integrating Census And Satellite Data.

As part of our effort to develop long-term, historical datasets of land cover in the Amazon River basin, we have developed a new method for merging satellite-based imagery and ground-based agricultural census information. This method allows us to scale down polygon-based census data by simultaneously considering satellite-based land cover data for the same area. We began by developing a spatially explicit agricultural census data set for each of the countries of the basin and produced a new map of county-level agricultural activity for the mid-1990s. We then developed a new technique to integrate this census map with satellite-based land cover classifications, and produced a new, 5-minute (9 km) gridded data set with attributes of both the census and satellite data. The method uses regression trees to represent the statistical relationship between the county-level agriculture density data and the categories of the relatively fine-grain satellite classification. We then use this relationship to determine the most likely agriculture density in each cell of a regular grid of intermediate spatial scale. The net result is a fused map that preserves the overall amount of spatial scale of the satellite imagery. We believe that this method is a generally applicable approach to problems of scaling down data in a way that is consistent with other information sources. This presentation will introduce the problem, the regression tree method, and criteria for selecting among candidate solutions.
<table>
<thead>
<tr>
<th>#</th>
<th>Authors</th>
<th>Poster/Regional</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.</td>
<td>Charpentier, M., C. Wigand, R. McKinney, M. Chintala, G. Thursby, and J. Kiddon.  OAO Corporation, 27 Tarzwell Drive, Narragansett, RI 02882, USA;  EPA, NHEERL, 27 Tarzwell Drive, Narragansett, RI 02882, USA. A geographic information system (GIS) analysis of water transit through watersheds of subestuaries in Narragansett Bay, RI.</td>
<td>Poster</td>
<td>A watershed approach was used to examine the integrity of ten salt marshes of similar geomorphology and hydrology in Narragansett Bay, RI. The integrity of salt marshes is described as the capability of a salt marsh to provide key ecosystem services including water quality maintenance, wildlife habitat, food production, erosion control, and recreation/cultural use. Indicators of these services are being developed from measures of ecosystem structure and function in marshes of varying anthropogenic stress based on watershed land use (i.e., percent residential, industrial, agricultural, and natural lands). As part of this study a GIS analysis was utilized to examine patterns of water transit and how various natural lands act as nutrient sinks. A topographic model for each watershed was developed which integrated the surface hydrology of the respective watershed. Using the topographic model, a surface flow network was determined for each watershed. The surface flow network models the surface flow of water for all locations in each watershed. Land use information was then draped over the surface flow network so that the contribution of flow from any particular land use type could be determined for any location in the watershed. Summary values of the contribution of flow from land use types was determined at several sampling locations within each watershed for comparison to field measurements. By adjusting the surface flow network such that flow was intercepted by natural lands, it was possible to examine the effects of natural lands acting as sinks for nutrients.</td>
</tr>
<tr>
<td>44.</td>
<td>Chen, Chang-Jui. Department of Landscape, Chinese Culture University, 100.2F, 125, Chung-Hua Rd., Sec.2, Taipei, Taiwan. Landscape spatial patterns of three kinds of irrigation areas in Taoyuan Terrace, Taiwan.</td>
<td>Poster</td>
<td>The agricultural landscape is a mosaic of natural and human-managed patches that vary in size, shape and arrangement. Therefore, the analysis of landscape spatial patterns is an important component of understanding ecological dynamics. Traditional paddy farming villages in Asia used to have various important parts to play among urban, rural and natural areas. Those paddy fields with waterway networks and hedgerows among farming villages were functioning as: 1) habitat of species, 2) ecological networks for traveling among urban, rural and natural areas, 3) buffer zones that repress human influences flowing from cities into natural areas, 4) flood control, water quality improving and revitalizing ground water. However, as urbanization, industrialization advances, biodiversity existing there has been getting largely damaged and ecological orders among urban, rural and natural areas are also about to collapse. The focus of the first part is to research and analyze the change of culture landscape of the Taoyuan terrace</td>
</tr>
<tr>
<td>45.</td>
<td>Chen, Chang-Jui. Department of Landscape, Chinese Culture University, 100.2F, 125, Chung-Hua Rd., Sec.2, Taipei, Taiwan. Landscape spatial patterns of three kinds of irrigation areas in Taoyuan Terrace, Taiwan.</td>
<td>Poster</td>
<td>The agricultural landscape is a mosaic of natural and human-managed patches that vary in size, shape and arrangement. Therefore, the analysis of landscape spatial patterns is an important component of understanding ecological dynamics. Traditional paddy farming villages in Asia used to have various important parts to play among urban, rural and natural areas. Those paddy fields with waterway networks and hedgerows among farming villages were functioning as: 1) habitat of species, 2) ecological networks for traveling among urban, rural and natural areas, 3) buffer zones that repress human influences flowing from cities into natural areas, 4) flood control, water quality improving and revitalizing ground water. However, as urbanization, industrialization advances, biodiversity existing there has been getting largely damaged and ecological orders among urban, rural and natural areas are also about to collapse. The focus of the first part is to research and analyze the change of culture landscape of the Taoyuan terrace</td>
</tr>
</tbody>
</table>

**Landscape-Scale Ecological Assessment**

**Landscape Pattern and Ecosystem Processes**

**Land Use Change and Urban Ecology**
in Taiwan and to find out the special agricultural development mode and social formation of three kinds of irrigation areas before 1980s. The focus of the second part is to analyze the landscape ecology structure change complexity and diversity of landscape elements in composition, structure and function over three kinds irrigation areas of the Taoyuan Terrace in Taiwan throughout urbanization and industrialization processes in the last two decades by using landscape ecology theorem and geographic information system (GIS). Due to the need of special geographical environment and irrigation the type and size of irrigation pond and waterway form the typical agriculture ecological and geographical landscape of Taoyuan Terrace before 1980s. Throughout the individual period (1982-1988-1994). G.I.S data study the areas of rice field in three kinds of irrigation rapidly decreased by urbanization and industrialization. The study establishes a set of systematic research methods and theorem from landscape ecology – including various spatial pattern indices such as fractal dimension, fragmentation, diversity, dominance, evenness index of landscapes, and shape index in combination with characteristics of patches lick total numbers, mean size, size ranges, corrected perimeter-area ratio, compactness, patch elongation index, grain shape index and patch edge. were then applied to detect and analyze the changes of landscape elements, classifications and the relative arrangement of patch type within landscape mosaic over the study period. Finally propose sustainable development strategies that will cater to future changes.

46. grace-chen@u iowa.ed u  Special: Jones'  Chen, Grace F. Department of Geography, The University of Iowa, Iowa City, IA 52242, USA. Relating Landscape Patterns to Hydrological Processes in a Watershed Hierarchy.

A watershed-based approach is required to address the cumulative impacts of nonpoint source pollution that occurs across the landscape, and links the terrestrial and aquatic environments through hydrological cycles. According to the principles of hierarchy theory, which suggests that spatial patterns, processes, and their interactions vary with scale, relationships between land and water need to be discerned at characteristic scales. To explore the effects of scale on landscape properties, hydrological processes, and pattern-process interactions, an Iowa watershed encompassing some 11,000 km² is first decomposed into three hierarchical levels, within which various numbers of subwatersheds are contained, using GIS techniques. Watershed processes and landscape properties are then quantified for each subwatershed using hydrologic modeling and pattern analysis techniques. Based on the simulated results and chosen indices of landscape pattern, relationships between landscape patterns and hydrological processes are established at each hierarchical level. How dominant factors controlling pattern-process interactions change with scale and errors resulting from scaling are finally evaluated across the watershed hierarchy. This case study reinforces the importance of identifying characteristic scales for particular nonpoint source problems and exemplifies how the effects of scale on spatial patterns, processes, and their interactions can be explored through a hierarchically structured framework using GIS techniques and hierarchical ANOVAs.

47. jiq@mtu .edu Poster  Chen, Jiquan1, Eugenie Euskirchen1, Tom Hayes2, Siyan Ma1, Treneice Marshall1, and Sari Saunders1. 1School of Forestry & Wood Products, Michigan Technological University, Houghton, MI 49931. 2University of California, Berkeley, CA 94720. Are Edge Effects More Pronounced at Edges?

Edges and areas-of-edge influence (AEI) created by natural or human-induced disturbance account for a large proportion of many landscapes. Vertical flows of materials and energy within the AEI differ from those within the same area prior to the disturbance. Some direct alterations related to edge creation include changes in light levels, precipitation, seed/pollen rains, deposition, and outgoing radiation. Horizontally, there will be a series of mixing processes because of the differences between the two adjacent communities (E₁ and E₂). These horizontal mixing processes are described by employing two differential equations based on the diffusion rate between the edge and the adjacent communities: \( \frac{\Delta A_{E_1}}{\Delta A_{E_2}} = K_{E_1} \) and \( \frac{\Delta A_{E_2}}{\Delta A_{E_1}} = K_{E_2} \), where \( D_{E_1} \) and \( D_{E_2} \) are distance from the edge in \( E_1 \) and \( E_2 \), respectively, and \( K_{E_1} \) and \( K_{E_2} \) are the diffusion rates. Through model simulations of varying \( K_{E_1}, K_{E_2}, E_1 \), and \( E_2 \) we found that edge influences do not always peak at edge (i.e., 0 distance). This phenomenon is further supported by field data of several empirical studies examining understory vegetation, stand structure, physical environment, litter, and other ecosystem processes (e.g., decomposition) at the edge and its adjacent communities. We emphasize that edge effects are a result of complex vertical and horizontal mixings. Depending on the variable of interest and timing of the event, various gradients between \( E_1 \) and \( E_2 \) can be predicted. In addition to the empirical-based edge studies, a more process-based approach is critical in terms of understanding the horizontal mixing processes associated with the AEI.
<table>
<thead>
<tr>
<th>Page 20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>48.</strong></td>
</tr>
<tr>
<td><strong>49.</strong></td>
</tr>
<tr>
<td><strong>50.</strong></td>
</tr>
</tbody>
</table>

1. Northern China by lacunarity analysis.
2. A simulation system has been developed to provide for the interaction of fire and insect and disease disturbance processes within a spatial pattern of vegetation communities. The probability of disturbance process occurrence by individual plant communities is determined by using a combination of vegetation attributes, past processes and treatments, and the conditions and past processes of adjacent plant communities. The predicted probabilities are used to create multiple simulations that provide arcover maps for the frequency of occurrence for both disturbance processes and vegetation attributes. Landscapes can be simulated in yearly or decade time steps. Vegetation input layers can be irregular polygons or uniform, rectangular polygons of a size specified by the user. Vegetation treatments can be scheduled. The system is being used for landscapes ranging from a few thousand acres to millions of acres. The system is one of a number of models currently being compared at a number of geographic locations across the United States in a Joint Fire Science study. The systems' behavior for predicting fire spread and intensity is compared to a large wildfire occurring in the summer of 2000 on the Bitterroot National Forest.

The Natural Resource Analysis Center at West Virginia University and the Canaan Valley Institute are developing an ArcView GIS extension to evaluate the impacts of landscape changes using indicators related to water quality, wildlife habitat, and overall landscape condition. Users of the extension will be able to interactively incorporate changes to the landscape to predict where changes might occur from urban expansion. The will be accomplished within the major components which include the ability to define a study area location, summarize existing landscape condition, perform landscape related water quality analysis, perform wildlife habitat analysis, and model the effects of land use change. Land use change may be implemented in one of two methods. The first method will be an interactive model of potential land development. The model is based on topography, existing development (urban or residential areas), and existing land uses. The user will have the ability to specify likelihood of conversion to developed land uses for different existing land uses, as well as restrictions to development such as zoning or parcel boundaries. The second method of specifying land use change is actual delineation of changes using either on-screen digitizing and within ArcView or incorporation of digital map data files from other sources. For example, a new digital map data might indicate the location of a proposed mine outline. This effort is expected to result in the development of improved methods that support policy development, community decision-making, and agency.
<table>
<thead>
<tr>
<th>Page 21</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>51. mcole @cressa.rutgers.</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The top ten landscape ecology issues for the next millennium are: (1) Land-use change - understanding the causes and implications of land use and land cover changes at local and regional scales; (2) Environmental changes - developing the ability to understand and predict effects of climate and other environmental changes at local and regional scales; (3) Data - developing the means to handle the large amounts of data that are becoming available; (4) Communication - developing the language, repertoire, and means to communicate what landscape ecology has to offer to decision makers. These decision makers include individuals, private companies, environmental organizations, elected officials, and agency employees. (5) Models - using the best available technology to appropriately understand and predict key landscape processes. (6) Resource management - addressing how patterns in space and time affect resources and their management. (7) Scaling - developing and testing methods for translating information across scales. (8) Experiments - building a body of landscape experiments that use scientific methods to test ideas about landscape ecology. (9) Interdisciplinary research and approaches - building the firm bridges to other disciplines that are necessary to address landscape issues. (10) Sustainability - developing an understanding of what sustainability means for landscape ecology. This understanding will involve consideration of ecological, social, cultural, aesthetic, and economic components of sustainability over a region. |

| 56. mark.dale@ualberta.ca | Oral/Regional | Dale, Deborah W., Division of Landscape Architecture, University of Oklahoma, Norman, OK, 73019, USA. Eco-Revelatory Design: A Cautionary Tale of Two Designs in the City.

Between 1997 and 1999, the author was co-designer for two landscaping projects that emphasized a native plant palette and expressed visually the qualities of the local native landscape. Both projects were of such small scale that it was not possible to include ecological function as a workable goal. However, the designers believe that it is important to try to create expressions in the landscape that reflect or recall the native landscape of the area as a means of re-educating people about the native landscape. This more ecologically expressive approach represents a different aesthetic than is normally expected or

| 57. dalton@ou.edu | Oral/Regional | Dalton, Deborah W., Division of Landscape Architecture, University of Oklahoma, Norman, OK, 73019, USA. Eco-Revelatory Design: A Cautionary Tale of Two Designs in the City.

Between 1997 and 1999, the author was co-designer for two landscaping projects that emphasized a native plant palette and expressed visually the qualities of the local native landscape. Both projects were of such small scale that it was not possible to include ecological function as a workable goal. However, the designers believe that it is important to try to create expressions in the landscape that reflect or recall the native landscape of the area as a means of re-educating people about the native landscape. This more ecologically expressive approach represents a different aesthetic than is normally expected or |
accepted in urbanized settings, and carries with it a number of conflicts with typical cultural aesthetic values. The "Oklahoma Canyon Garden", used the canyon landscapes found in the state as a model for re-landscaping a two-story deep 30' x 125' lightwell in the University of Oklahoma Library Plaza in Norman, Oklahoma. The other project, "Bluestem Stream", used the metaphor of a stream to create an undulating swath of native prairie plants and stone in a matrix of little bluestem grass on the Oklahoma City campus of the University of Oklahoma Health Sciences Center. While these two projects were installed, neither of them was completed totally as the designers originally intended. The proposed presentation, supported extensively by slides, will describe the projects, discuss some of their theoretical and philosophical underpinnings, and discuss the problems associated with trying to design in a more ecologically expressive way.

58. jarnagin.taylor@epa.gov  Special: Jones’ Jennings, David B. and S. Taylor Jarnagin*. U.S. Environmental Protection Agency, NERL/LEB, Environmental Photographic Interpretation Center, Reston, VA 20192, USA. Impervious Surfaces and Streamflow Discharge: A Historical Remote Sensing Perspective in a Northern Virginia Subwatershed. David B. Jennings and S. Taylor Jarnagin*. U.S. Environmental Protection Agency, NERL/LEB, Environmental Photographic Interpretation Center, Reston, VA 20192, USA. Impervious Surfaces and Streamflow Discharge: A Historical Remote Sensing Perspective in a Northern Virginia Subwatershed. Impervious surfaces are a leading contributor to non-point-source water pollution in urban watersheds. These surfaces include such features as roads, parking lots, rooftops and driveways. Aerial photography provides a historical vehicle for determining impervious surface growth and, with concurrent daily streamflow and precipitation records, allows the historical relationship of impervious surfaces and streamflow to be explored. Impervious surface area in the upper Acotolink Creek subwatershed was mapped from six dates of geo-registered historical aerial photography ranging from 1949 to 1994. Impervious surface cover has grown from approximately 3% in 1949 to 33% in 1994. Analysis of historical concurrent daily mean streamflow and daily precipitation records (1948 - 1998) shows a statistically significant increase in normalized discharge rates (per 1 in. of precipitation) for precipitation events >= 0.25 in., while the amount of precipitation per event shows no statistically significant change over the same time period. Historical changes in streamflow in this basin appear to be related to increases in impervious surface cover as determined by aerial photography and not to changes in precipitation patterns. The use of historical remote sensing data to reveal changes in landscape characteristics shows promise as a tool in understanding long-term changes in ecosystem function. Notice: The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), funded this research and approved this abstract as a basis for an oral presentation. The actual presentation has not been peer reviewed by EPA.

59. ebo@eagle.west.asu.edu  Poster, Project de-Camino-Beck, Tomas and Jianguo (Jingle) Wu. Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA. Toward Developing a Hierarchical Patch Dynamics Modeling Platform. David, John (EBo) and Jianguo (Jingle) Wu. Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069 and Department of Plant Biology, Arizona State University, Tempe, AZ 85069, USA. Toward Developing a Hierarchical Patch Dynamics Modeling Platform. Many of the ecological questions posed today are by their very nature multi-scale and, interdisciplinary, and spatially extended. Historically, the effects of spatial pattern were often assumed to have little or no effect on the dynamics of ecological systems. In these instances problems were decomposed only vertically (as in hierarchy theory). In other cases, the importance of spatial relationships were recognized and the models were spatially explicit, but were “flat” to avoid the added complexity inherent in hierarchical models. The arbitrary separation of system complexity into these distinct camps was in part the motivation behind the integration of Theory of Patch Dynamics into Hierarchical Patch Dynamics. In addition to the theoretical and epistemological framework, there are numerous ways that sub-models can be represented that have profound consequences to model performance in terms of computational time, numerical stability and error characteristics. We are developing a Hierarchical Patch Dynamics Modeling (HPDM) platform for integrating multi-scale heterogeneous models. As such, the HPDM platform is intended to function as a framework from which multi-sale ecological models can be developed and integrated in an efficient and coherent manner. Here we demonstrate how the HPDM platform works through a series of examples. These include: 1) a forest stem map simulator to be used in modeling fire risk assessment and the effects of fire reintroduction in ponderosa Pine forests; 2) a simple model of land use change utilizing ownership, domains of influence and local rules; and 3) a model of native plant recruitment as a function of managed dam releases and water availability as indicated by global process indicators.

60. tomasd Oral/Re de-Camino-Beck, Tomas and Arturo Sanchez-Azofeifa. Earth and Atmospheric Science Department, University West, Phoenix, AZ 85069 and Department of Plant Biology, Arizona State University, Tempe, AZ 85069, USA. Toward Developing a Hierarchical Patch Dynamics Modeling Platform. Landscape Pattern

Scaling Issues Related to Ecological and Hydrological Landscape Analyses
<table>
<thead>
<tr>
<th>Email</th>
<th>ORCID</th>
<th>Institution</th>
<th>Affiliation</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>@ualberta.ca</td>
<td>g</td>
<td>Arturo Sanchez-Azofeifa</td>
<td>Earth and Atmospheric Science Department, University of Alberta, Edmonton AB, Canada T6G 2E3</td>
<td>A critical review of landscape fragmentation measures using cellular automata.</td>
</tr>
<tr>
<td><a href="mailto:mh@mu.edu">mh@mu.edu</a></td>
<td>bb</td>
<td>DeFee II, Buren B., Douglas Wunneburger, Department of Landscape Architecture and Urban Planning, Texas A&amp;M University, College Station, TX 77840-3137, USA</td>
<td>Integrating Stakeholder Concerns Into Open Space Planning Decisions.</td>
<td></td>
</tr>
<tr>
<td><a href="mailto:ehecker@aalberta.ca">ehecker@aalberta.ca</a></td>
<td>g</td>
<td>Decker, E. H., B. T. Milne, F. A. Smith, and S. M. Elliott</td>
<td>Department of Biology, University of New Mexico, Albuquerque, New Mexico, 87131, USA; Division of Earth and Environmental Sciences, Los Alamos National Laboratory, Los Alamos, New Mexico, USA</td>
<td>General Patterns in The Spatial Structure of Urban Networks.</td>
</tr>
</tbody>
</table>

In the past, the behavior of landscape fragmentation measures have been analyzed using simulated neutral landscapes, with a small set of unrealistic random patterns that do not represent, in general, realistic landscapes. In this paper we argue, using four simulated landscapes created with cellular automata rules (anneal, ortho, blocks, and patches) plus random generated landscapes, that current measures used by the landscape ecology community are not enough to understand landscape fragmentation. Our results show that different types of landscapes, resulting from different dynamics expressed in the cellular automata rules, have similar values in many measurements, leading to misinterpretation of how a fragmented landscape would appear in reality. Our results also indicate that percolation thresholds and total percolation values for non-random landscapes differ from theoretical values when compared against random generated maps, and that landscape measures do not have unique solutions as previously believed. We also show that values such as lacunarity, landscape division, spatial entropy, mass entropy and percelation thresholds are more robust measures of landscape structure and fragmentation that the common used by the community (e.g. patch density and fractal dimension). In this paper, we suggest that non-random landscapes created with cellular automata can be used to establish a general landscape classification scheme to estimate critical values for landscape fragmentation. Finally, we suggest that a concise definition of landscape fragmentation, accounting for both, temporal and spacial dynamics of land use/cover and meta-population properties, must be established.

Urban ecosystems are gaining attention as important sites for ecological research. While substantial modeling and fieldwork is being conducted on the ecology in cities, little is known about processes that govern the distribution of urban areas around the world, i.e. the ecology of cities. Here we analyze the spatial structure of inter-urban networks globally using satellite, census, and traffic data. We examine size-specific nearest neighbor distances, rank size distributions, and measures of spatial arrangement to quantify patterns of urban distribution. We then describe how these patterns are governed by ecological and energetic constraints on the flow of material and energy through and among urban areas. We find that hierarchical patterns of city distribution are general and global, which suggests that socioeconomic details are unnecessary for understanding macroscopic patterns of human settlements.

Substantial population growth in Texas is contributing to the spread of urban areas into the surrounding countryside. Two nearby major metropolitan areas, Houston and Austin, and one smaller metropolitan area within the COG, Bryan/College Station, provide centers for high growth potential within the counties under the jurisdiction of the Brazos Valley Council of Governments (BVCOG), a seven county regional planning organization located in central Texas. In preparation for urban growth into its rural areas, the Environmental Subcommittee of the BVCOG has called for the creation of an Open Space Plan. The first step in open space planning is creating an inventory of land that is currently used as or could be preserved as open space. Several problems have been identified as central to this process: (1) Open space is poorly defined and largely dependent on local values. (2) Appearance of outside experts with answers to your problems will alienate many stakeholders within the COG. (3) A mechanism for delivering information is as important as the open space inventory database, itself. To address these issues as well as to develop the open space inventory database, the Geoinformatics Studio is developing an Internet-based open space decision support system. This system will identify potential open space areas through physical and ecological characteristics, yet include local citizen values when determining what areas to consider for conservation. Ultimately, the system will rank areas within the COG quantitatively for desirable open space characteristics based upon existing resources, identified needs, and expressed
63. desimone@uw.edu | Oral/Poster | Desimone, Steven M., Brian L. Cosentino, Joseph B. Buchanan, D. John Pierce, and Timothy Quinn. Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia, WA 98501, USA. Riparian Buffers as Habitat for Northern Goshawks: A Spatial Assessment at Three Scales on Managed Forest Landscapes in Western Washington.

Recent changes in State Forest Practices standards will result in wider riparian buffers along most streams in Washington. Although forest landowners hope to meet multiple species habitat requirements in the buffers, their value for most wildlife species is unknown. We wanted to assess whether riparian areas in managed forests will meet specific area thresholds of the Northern Goshawk (Accipiter gentilis) at three spatial scales: nest site, post-fledging family area (PFA), and home range. A spatially explicit model using a grid cell-based “moving window” assessment determined if threshold area amounts (75, 40, and 40% of 48 [nest], 170 [PFA], and 2200-ha [home range] “windows”, respectively) occurred at each spatial scale. Using GIS-generated buffer widths (24.4, 30.5, and 39.0 m) that reflect a likely range of riparian protection, we mapped buffer areas on a randomly selected township of lowland forest in western Washington. Our results suggest the new riparian standards may be inadequate for goshawks because moderate (30.5-m) buffers and moderate stream density did not meet area thresholds at any of the spatial scales. Analysis using 39.0-m buffers indicated that thresholds were met for the two larger spatial scales on part of the moderate density landscape. Results from analyses in landscapes with higher and lower stream densities will be presented and discussed. Where area thresholds were not met, either increasing buffer width in localized areas, extending the length of harvest rotations, or parsimonious designation of adjacent uplands as goshawk habitat met area threshold goals.

64. mdixon@zoology.wisc.edu | Oral/Poster | Dixon, Mark and Monica Turner. Department of Zoology, University of Wisconsin, Madison, WI 53706, USA. Modeling the Effects of Flow Variation on Recruitment Dynamics of Riparian Trees.

Plant communities are influenced by the timing of disturbance relative to species-specific demographic processes. Using a combination of field sampling and simulation modeling, we examined the influence of temporal flow variation on the recruitment of riparian tree seedlings on Wisconsin River sandbars. Field data for 1997-2000 showed high variation in flows, seedling abundances, and species composition among years, with mid-summer flow pulses exerting strong influences on the composition and density of new germinants in 3 of the 4 years. Based on these results and data from the literature, we developed a rule-based model to link variation in river flow with annual seedling recruitment of riparian species. Key relationships in the model include (i) the effect of water level and sandbar topography on dispersal and deposition of seeds and (ii) the importance of the timing of sandbar exposure/inundation relative to seed dispersal. We predict that strong recruitment years will be episodic and will occur when flows are low, stable or declining during the growing season. For particular tree species, we predict that recruitment success in a given year will also be related to the timing of flows in relation to the dispersal phenology of that species. Possible uses of the model include projecting the impacts on riparian vegetation dynamics of flow regime changes due to regulation or climate change.

65. madrummond@usgs.gov | Poster | Drummond1, Mark A., Raymond D. Watts2, Roger Compton3, 1 USGS, MESC, 4512 McMurry Ave., Fort Collins, CO 80525; 2 USGS/CIRA, Colorado State Univ. Foothills Campus, Fort Collins, Colorado 80525; 3 USGS, RMCC, Box 25046, MS516, Denver, CO 80225. Temporal Effects of Human Influence on Riparian Habitat in Teton County, Wyoming.

Fragmentation of wildlife habitat has been cited as the number-one strategic concern of Park Service, Fish and Wildlife Service, and Forest Service managers in the Greater Yellowstone Area (GYA). Comprehensive measurement of fragmentation in the GYA is, however, lacking - in part because of limitations of available geographic data and in part because of the lack of a consensus methodology for measuring fragmentation. Our study assessed the effect of various data sets (including maps of roads and clear-cuts) on the development of fragmentation maps and statistics, working in a study area between the Gros Ventre and Teton Wilderness Areas in Teton County, Wyoming. The quality and currency of road maps used in the analysis makes a discernible difference in the outcome, as does the seasonal opening and closing of National Forest roads. Our results indicate that comprehensive mapping and measurement of habitat fragmentation will be reliable only with a consistent, recent data set that is
augmented with information about seasonal administrative closure of roads. Our results also suggest that traffic-density information for open roads will have a discernible effect on measures of fragmentation.

### Disturbance and Vegetation Pattern and Dynamics

| 66. | Electrode@uwyo.edu | Oral/Reg | Ehle, Donna S. and William L. Baker, Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. Influence of the Spatial Distribution of Pre-European Disturbance Events on Ponderosa Pine Age Structure in Rocky Mountain National Park, USA.

Supporters of historic stand structure restoration advocate fuel reduction to return ponderosa pine landscapes to a pre-European settlement state. We mapped and aged live and dead trees and mapped dated fire scars in 9 plots in the ponderosa pine zone in Rocky Mountain National Park, USA. The historic ponderosa pine landscape in Rocky Mountain National Park was likely shaped by beetle epidemics and a mixture of fire regimes. Before European settlement, some stands were burned by crown fires, some stands were burned by surface fires that torched some trees, and some stands were burned by both crown and torching surface fires. Fire spread over the landscape was inferred from approximate death years of live and standing dead trees. Crown fires led to simultaneous tree recruitment. Torching of trees during surface fires resulted in a patchy spatial distribution of mortality and resulting regeneration. Regeneration resulting from surface fires did not always occur at the locations of trees killed by the same fire and may represent areas favorable for regeneration in the absence of competing vegetation. Dating of dead wood in some plots allowed temporal reconstruction of pre-European stand-initiating and stand-replacing events. Missing cohorts (no dead wood) between these events may indicate beetle epidemics or other events that would cause wood to decay especially quickly. Results from this study indicate that temporal and spatial events that shaped pre-European ponderosa pine landscapes in Rocky Mountain National Park were more heterogeneous than previously thought.

| 67. | eseuskir@mtu.edu | Oral/Reg | Euskirchen, Eugenie1, Jiquan Chen1, Harbin Li2, and Eric Gustafson3, Michigan Technological University, Houghton, MI 49931, USA; 1USDA Forest Service Center for Forested Wetlands Research, Charleston, SC, 29414, USA; and 3USDA Forest Service Center for Forested Wetlands Research, Charleston, SC, USA; and 3USDA Forest Service Center for Forested Wetlands Research, Charleston, SC, 29414, USA; and 3USDA Forest Service Center for Forested Wetlands Research, Charleston, SC, USA; and 3USDA Forest Service Center for Forested Wetlands Research, Charleston, SC, USA. Modelling net carbon across a hypothetical landscape under alternative harvesting strategies.

Forests have been considered as the major carbon sink within the global carbon sink. However, the amount of carbon sequestered by a fragmented landscape, which varies significantly in its composition and age structure, generally remains unknown to the scientific community. The temporal dynamics and spatial distribution of net ecosystem production (NEP) in a mosaic are dependent on patch type and its chronosequence in the landscape. In light of this, we have devised a model, LandNEP, to follow the change in NEP by patch type and chronosequence. Three different scenarios have been simulated within a 10000 ha hypothetical landscape. Over a period of 300 simulation years, the biomass of the landscape ranged from 41900 Mg to102200 Mg, and the cumulative area harvested ranged from 783500 to 134300 ha. Based on these scenarios, we are able to demonstrate that theoretically, timber harvest strategies requiring rotations at the time of a patch’s maximum NEP will ultimately yield the greatest cumulative NEP value. These results suggest that carbon losses within a managed landscape could be mitigated by permitting the ecosystem to reach its maximum as a net carbon sink, and harvesting timber directly at the point. Therefore, alternative management scenarios play a leading role in determining to what extent a landscape sequesters carbon.

| 68. | Joseph.Ewan@asu.edu | Oral/Reg | Ewan1, Joseph M., and James P. Burke2. 1School of Planning and Landscape Architecture, Arizona State University, Tempe, Arizona, USA; 2Parks, Recreation and Library Department, City of Phoenix, Phoenix, Arizona, USA. The Sonoran Preserve Master Plan: Integration of Landscape Ecology with the Design and Planning of

In Metropolitan Phoenix, Arizona, over an acre of open desert land is cleared for development every hour. The Sonoran Preserve Master Plan (1999) presents a vision for how 21,500 acres can be set aside for public open space and wildlife habitat within the city. This presentation addresses how both aesthetic and scientific perspectives informed the planning and design process for this urban preserve. Development of this plan differs from the city’s prior open space planning efforts. The planning methods combine traditional planning and design techniques such as inventory and analysis, with public input and landscape ecological theory. University contributions through research (wildlife and vegetation | Landscape Pattern and Ecosystem Processes

### Land Use Planning and Landscape Architecture
inventories, habitat suitability analysis, GIS modeling, and land value analysis) and collaborative planning practices (charrettes and symposia) helped integrate cultural and ecological needs and concerns into the plan. As a result of a planning process that embraced ecological landscape design, the Sonoran Preserve incorporates a diversity of desert biotic communities and landforms, and includes culturally significant features. It protects desert tortoise habitat and preserves undisturbed xeric-riparian corridors—both threatened and declining members of the regions natural ecology. It nearly doubles the amount of preserved desert land in the city and plays a significant role in the shaping of future urban form. The Sonoran Preserve Master Plan provides a model for reconciling human and non-human nature in the biggest city in the fastest growing county in the nation. More directly the plan provides important urban open space so future generations can, through direct contact, learn to love and respect a place of fragile beauty.

Conservation is largely affected by socio-economic imperatives. Various levels of human landscape development represent a co-evolutionary process between a social system and an ecosystem. We examined the distribution and abundance of bird species across two southern African development gradients using bird census data in KwaZulu-Natal Province, South Africa. The region represents a gradient of African rural to Western first world commercial agriculture and urban land-use running from relatively undisturbed to highly developed and includes nature reserves, subsistence farming, commercial farming, exotic plantations, small holdings, residential and industrial areas. In an effort to understand avian community temporal dynamics, pattern and scale, it is instructive to consider these in a hierarchical fashion, from the broadest to the most localized. Broad environmental and landscape-scale pattern factors are examined as contributions to regional and the influences of physical environment, biotic factors, and human disturbance processes are explored. Different environmental factors assume varying degrees of importance among localities within a region, and landscape pattern or land-cover proportion are likely to dominate in importance in a similar manner. The hypothesis that topographic, temperature and moisture factors assume the greatest importance of explaining variation in bird diversity at coarser scales, and landscape pattern and land-cover proportion explains the remaining variation in diversity, based on the type of development model, in a hierarchically scaled manner is confirmed. The analysis places crucial questions on the roles of establishing isolated nature reserves and their ability to preserve bird diversity persistence in the developing landscape.

Acting in Landscape Ecology means to have an integrated vision of the real world, means to understand better and deeply how ecosystems are functioning and how humans change the functions and behavior of the natural systems. After at least 20 years of impressive action in theoretical as well as in applied fields Landscape Ecology is now facing a dilemma to maintain an independent position inside the Ecology by evolving new theories and practical tools or, to restrict the action to the applied field with the risk to be incorporated into the plethora of reductionistic ecological approaches. I strongly believe that Landscape Ecology can and must pursue the challenge (1) to develop itself into an independent field. To achieve this goal (2) Landscape Ecology should contribute more to the integration between the different “environmental and economic sciences” according a common framework that is based on (3) System General Theory, (4) Environmental Complexity, (5) Hierarchy Theory, and (6) the Multiscalar Perception of Complexity. (7) Ecosystem Approaches should be integrated with the Landscape Ecology approach in land evaluation, restoration procedures and protection activity; (8) field experiments that are actually rare and restricted to some categories of organisms should be expanded in space an time, from organisms to processes; (9) a new General Theory on the Mosaic should be developed; (10) Educational programs should be strongly encouraged and developed in academic curricula.
| u | Environment, University Of Michigan, Ann Arbor, MI 48109-1115, USA. Modeling the Agents of Tropical Deforestation: Integrating Social Survey Data into Spatial Models of Land Use Change on the Atlantic Coast of Nicaragua (1959-1996). | Spatial Models of Land Use Change on the Atlantic Coast of Nicaragua (1959-1996). Deforestation in Nicaragua is increasing primarily by economically marginalized peasant-colonist farmers using swidden agricultural practices. Efforts to study deforestation dynamics have primarily focused on modeling approaches that use remotely sensed data at regional scales. There have been few efforts that integrate household level social data with regional scale spatial models. I present results from an ongoing study that examines causes and patterns of deforestation using an integrative approach that combines spatial regression analysis, social science methodologies, and agent-based land use modeling. The study focuses on the lowland fore-regular lagoon, Nicaragua. The objectives of this study are to 1) identify eco-physical and aggregate socio-economic variables and their effects on the pattern of land use change using logistic regression analysis. 2) determine key peasant decision factors in land selection through social surveys, and model key decision factors in an agent-based landuse change model. 3) determine strengths and shortcomings of the these two approaches and develop a new integrative framework that combines the advantages of each. A main hypothesis of this study is that an integrated approach, which combines the power of remotely sensed data with the more culturally accurate community level data, provides more accurate results in multi-cultural developing regions with mobile ethnic populations. I present results of the regression analysis compared to, and integrated with, social data for Fonseca village in eastern Nicaragua. The study results describe regional historical land use patterns and illustrate the value of including community level data into deforestation and land use models. |
| 72. | Findlay's Special: Dent's | Findlay², Stuart, Nina Caraco¹, Jonathon Cole¹, William Nieder², and David Strayer². Institute of Ecosystem Studies, Box AB, Millbrook, NY 12545, Hudson River National Estuarine Research Reserve, Annandale, NY 12504. Functioning of submersed vegetation patches in the tidal freshwater Hudson River. Patches of submersed aquatic vegetation (SAV) are a conspicuous feature of most aquatic ecosystems and have been shown to serve a variety of quantitatively important functions ranging from habitat to sediment trapping. In the tidal freshwater Hudson River SAV can occupy as much as 20% of the river bottom area and plant biomass is as high as 500 g dry mass/m². In a 60 km stretch there are nearly 400 plant beds ranging in size from 20 to 1.2 million m². We have evaluated several of the ecological functions including primary productivity, sediment trapping, and habitat for invertebrates and fishes. We are exploring the extent to which patch characteristics or landscape variables help explain among-patch variability in these functions. Maintenance of super-saturated oxygen concentrations in the water column appear to be a simple function of patch size suggesting larger patches are buffered from exchange with the generally under-saturated water in the river main channel. In contrast, suspended sediment concentrations are higher in the patches than in the main channel and were not related to patch size. This suggests that even large patches are incapable of decreasing water velocities sufficiently to enhance sediment trapping. Our ability to extrapolate from site-specific studies to the whole ecosystem depends upon finding relationships between function and simple predictor variables such as patch size, shape or landscape position. Such tools would also help efforts to manage and preserve these important habitats. |
| 73. | ctfisher @asu.e du | Fisher, Christopher T. Archaeological Research Institute, Department of Anthropology, Arizona State University, Tempe, AZ 85287, USA. 2000 years of landscape change in the Lake Pátzcuaro Basin, Michoacán, Mexico. The "Columbus polemic" debate seeks the cause of modern degradation in the Americas by determining the sustainability of indigenous and European-style land-use. This paper reports on a program of landscape research examining socio-political processes underlying 2000 years of land-use within the Lake P’tzcuaro Basin, Michoacn, Mexico. First patterns of erosion and settlement are integrated identifying how and with what impact indigenous and Hispanic land-managers modified past landscapes. Second, the impact of Conquest is evaluated focusing on the unintended consequences of disease and landscape abandonment. |
| 74. | s.fisher @asu.e du | Fisher, Stuart G., Julia Henry, John Schade, and Jill Welter. Department of Biology, Arizona State University, Tempe, AZ 85287. Challenges of Applying the Concepts and Approaches of Landscape Ecology to Running Waters. | Challenges of Applying the Concepts and Approaches of Landscape Ecology to Running Waters. |
### Poster 75. Richard Fleming, Alexander Smith, Suzanne Tarr, Susan Jacobson, Sampreethi Aipanjiguly

**Poster Title**: Running Water Ecosystems Can Be Better Understood If They Are Viewed Through the Disciplinary Eyes of Landscape Ecology

**Authors**: Richard Fleming, Alexander Smith, Suzanne Tarr, Susan Jacobson, Sampreethi Aipanjiguly

**Affiliations**: Florida Marine Research Institute, University of Florida, Gainesville, Florida, USA; Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Florida, USA

**Abstract**: Running water ecosystems can be better understood if they are viewed through the disciplinary eyes of landscape ecology. However, several decisions must be made to define the domain of study and to properly frame research questions. Examples will be presented from studies of Sycamore Creek in Arizona, which has been studied for two decades, first as an ecosystem and more recently as a landscape. The first decision is whether to view the stream as one of many patches within a larger landscape to resolve it as itself a landscape consisting of many patches. The latter approach has been used by stream ecologists. The second decision is identify the scale(s) of the study to be aware of the effect of scale on answers to research questions. Stream ecologists have traditionally decomposed streams based on geomorphology in a manner which is sometimes hierarchical. Scaling decisions will ultimately depend on the dimensional resolution of the system. The third decision therefore will determine whether the stream will be viewed as a one-dimensional line, a planar surface, or a three-dimensional whole. Interecalary fractal descriptions may also be useful, for example in describing drainage networks. The fourth dimension time is required to reveal patterns of material movement, processing and retention in the landscape and the disturbance regime which alters these dynamics.

### Poster 76. Fleming, Richard A., Jean-Noël Candau

**Poster Title**: The Dominant Natural Disturbances in Canada’s Boreal Forests Are Wildfire and Outbreaks of Spruce Budworm

**Authors**: Fleming, Richard A., Jean-Noël Candau

**Affiliations**: Great Lakes Forest Research Centre, Canadian Forest Service, Sault Ste. Marie, ON, P6A 5M7, CANADA; Ontario Forest Research Institute, Ontario Ministry of Natural Resources, Sault Ste. Marie, ON, P6A 5N5, CANADA

**Abstract**: The dominant natural disturbances in Canada’s boreal forests are wildfire and outbreaks of spruce budworm, Choristoneura fumiferana (Clem.). Our research focuses on the spatial and temporal patterns of the interaction of these disturbance regimes at landscape scales and on some of the underlying ecological processes. As a prerequisite to developing models for forecasting, and as a baseline for future monitoring, we present early results from a retrospective analysis of Ontario’s historical records over the past 60 years. These results begin to quantify the interaction between SBW outbreak and wildfire monitoring, we present early results from a retrospective analysis of Ontario’s historical records over the past 60 years. These results begin to quantify the interaction between SBW outbreak and wildfire disturbance regimes.

**First result**: The proportion of 61 x 10^6 ha defoliated by SBW at least once since 1941, the proportion burnt was greatest in areas that suffered moderate frequencies (9-11 years) of disturbance regimes. Spatiotemporal analyses suggest that fires burned less than 10 x 10^6 ha while SBW caused whole tree mortality within 33 x 10^6 ha. Within the 41 x 10^6 ha defoliated by SBW at least once since 1941, the proportion burnt was greatest in areas that suffered moderate frequencies (9-11 years) of SBW defoliation (P=0.00021). Randomization tests revealed that fires over 200 ha occurred 3-9 years after a SBW outbreak more often than would be expected by chance alone (P<0.05), and that SBW
outbreaks generally occurred less often than expected by chance alone (P<0.05) between 1 year before and 16 years after fire. This 'time-window' of disproportionately high fire prevalence appears to have started longer after SBW outbreak and to have been wider in western than in eastern Ontario. Climatic explanations for such differences are investigated.

Foltete, Jean-Christophe, and Didier Josselin. THEMA, 32 rue Megevand, 25030 Besancon Cedex. Using spatio-temporal co-occurrence matrices to delineate spatial patterns about vole swarming.

The goal of our research is to identify spatial patterns involving the vole swarming phenomenon. Because of this phenomenon complexity, which evolves cyclicly, and whose ecological factors are not yet really explained, we are in charge, in a multidisciplinary research team, to study the relationship between landscape structure and the swarming scores of rodents measured in space (at French communes scale) and time (every year). First, we describe the available data, their accuracy, their limits and the spatial entities they are attached to. We also assume a few hypothesis from expert assessment and ecological observations. Two sets of different data are used in a supervised way: (1) from a vectorial map: the swarming scores described yearly upon ten years for every French communes; this is our phenomenon to explain, (2) from raster images, the landscape characterization, described by land cover, slope and elevation; these are the explicative variables. Then, we explain the involved methods. Our choice is to keep strongly the different spatial structures within co-occurrence matrices, instead of computing synthetic indicators. It is also to cross two different approaches to build our knowledge: (i) using an automatic filtering algorithm in order to extract local spatio-temporal co-occurrence matrices about vole swarming and landscape structure, (ii) upstream and downstream, exploring and validating delineated patterns by an Exploratory Data Spatial Analysis. We developed these methods in a freeware computational environment (Delphi and XlispStat). Finally, we show our results on a French set of communes (Doubs county) and discuss the involved methods efficiency in the landscape ecology research field.


These fall into three bulging bins. (1) SIGNIFICANT LACUNAE in today's landscape ecology include: ecological flows across the land; adjacencies and neighborhood configurations; the matrix; stream/river corridor width and design; cluster of small patches versus a corridor; importance of plants and vegetation; ecologically optimum network forms; the roles of spatial patterns produced by nature, planning/design, and lack thereof. (2) NEW FRONTIERS evolve naturally from landscape ecology. "Spatially meshing nature and culture" seems still shrouded. However, "road ecology" emerges, including: traffic disturbance/noise effects on natural communities; the road-effect zone; development of theory; and shaping ecological flows/biological diversity with safe/efficient transport. (3) WE THE PEOPLE highlights how landscape ecologists might work. Ponder the transition from how we spend our time to how we got and get inspiration. Look beyond our colorful land-use-and-ownership models to see topographic variations, little-road systems, hedgerow habitats, groundwater flows, changing forms guiding our movement, and actual animal routes across heterogeneous land. Spend more time with colleagues in landscapes outside North America. Outline visions for the future, in addition to improvements for the present. Write rather than edit concise books on landscape ecology, its major areas and applications. Make sure that both solid long-half-life empirical insight and promising short-half-life quantitative models move forward arm-in-arm. Imagine the end of the aughts in landscape ecology.

Fortin, Marie-José, Mathieu Philibert, Tarmo Remme and Ferenc Csillag. 'School of Resource and Environmental Management, Simon Fraser University, Burnaby, B.C., Canada V5A 1S6; Department of Geography, Simon Fraser University, Burnaby, B.C., Canada V5A 1S6; Department of Geography, University of Toronto, Mississauga, Ontario, Canada L5L 1C6. Sensitivity analysis of boundary detection on spatial features of heterogeneous landscape.

Boundaries are inherent features of all landscapes. The definition, description, identification and interpretation of boundaries, however, depend on (1) the context within which landscapes are analyzed, and (2) the data models and data types that are used to represent those landscapes. Most methods of handling boundaries are arbitrary in some fashion and are specific to certain applications and/or data
A spatially explicit landscape model of disturbance and vegetation succession, LANDIS, was used to examine the effect of fire regime on succession in the plant communities of the southern California foothills and mountains. The model was tested using an artificial dataset representing an initial random distribution of six plant functional groups on an even-aged landscape. Three fire cycles, frequent (35 yr), moderate (70 yr), and infrequent (1050 yr), were applied for 500 yr (ten replicates). These fire cycles were simulated within 7% of the intended values. Thus, LANDIS, originally developed for northern temperate forests, can be calibrated for the higher-frequency fire regime in this region. The infrequent fire regime resulted in an old landscape dominated by the shade tolerant functional groups while under the moderate and frequent fire regimes all functional groups persisted. The model is being modified to simulate fire-cued germination from a seed bank because "obligate seeders" form an important functional group in the region. It will then be applied to a dataset comprising 25 species and 11 landtypes (landscape site classes) developed for ~3900 sq. km of San Diego County. Landtypes were modeled by unsupervised clustering of climate and terrain variables. Maps of species occurrence by age class were simulated using predictive models of species distributions combined with fire history data. I hypothesize that a 70-yr fire cycle will result in infrequent but high severity fires in the montane zone (where fire suppression has lead to fuel build-up) causing a decline in low-elevation conifer species.

A landscape index for “Metapopulation Viability” that has been extracted from a spatially realistic metapopulation model allows dissimilar habitat networks to be assessed, compared and ranked according to their ability to maintain a viable metapopulation. Moreover, the effect of changes in the network structure can be assessed in a spatially differentiated way. By taking this information as a basis, land use activities with the highest positive or the lowest negative effect can be identified. The predictive power and the practical value of the presented index are demonstrated for the Glanville Fritillary butterfly (Melitaea cinxia) system on the Aland Islands (SW Finland). Finally, some general conclusions concerning the benefits of extracting landscape indices from spatial population models are drawn. We show that a number of problems in the realm of decision support in conservation management (evaluating landscapes through the eyes of an ecological process; providing understanding; managing ecological uncertainty; linking ecology and socioeconomy) are captured.

Landscape fragmentation and habitat loss are common phenomena in human-dominated areas. They result in networks of remnant habitat patches with the well-known effect of an increased risk of species extinction. In this case, harmonizing humanity and nature means looking for activities that effectively counteract or at least do not further amplify this negative effect. This task, however, can only be met if tools are available that enable the relationship between the spatial structure of habitat networks and the viability of spatially structured populations or metapopulations to be uncovered. We present a simple landscape index for the “Metapopulation Viability” that has been extracted from a spatially realistic metapopulation model. This index allows dissimilar habitat networks to be assessed, compared and ranked according to their ability to maintain a viable metapopulation. Moreover, the effect of changes in the network structure can be assessed in a spatially differentiated way. By taking this information as a basis, land use activities with the highest positive or the lowest negative effect can be identified. The predictive power and the practical value of the presented index are demonstrated for the Glanville Fritillary butterfly (Melitaea cinxia) system on the Aland Islands (SW Finland). Finally, some general conclusions concerning the benefits of extracting landscape indices from spatial population models are drawn. We show that a number of problems in the realm of decision support in conservation management (evaluating landscapes through the eyes of an ecological process; providing understanding; managing ecological uncertainty; linking ecology and socioeconomy) are captured.

A landscape index for “Metapopulation Viability” that has been extracted from a spatially realistic metapopulation model allows dissimilar habitat networks to be assessed, compared and ranked according to their ability to maintain a viable metapopulation. Moreover, the effect of changes in the network structure can be assessed in a spatially differentiated way. By taking this information as a basis, land use activities with the highest positive or the lowest negative effect can be identified. The predictive power and the practical value of the presented index are demonstrated for the Glanville Fritillary butterfly (Melitaea cinxia) system on the Aland Islands (SW Finland). Finally, some general conclusions concerning the benefits of extracting landscape indices from spatial population models are drawn. We show that a number of problems in the realm of decision support in conservation management (evaluating landscapes through the eyes of an ecological process; providing understanding; managing ecological uncertainty; linking ecology and socioeconomy) are captured.
Due to demographic and economic pressures, the predominantly forested matrix that characterized many areas of slash-and-burn agriculture is being replaced by a cultivated matrix with areas of younger forest in various stages of recovery. The more rapid turnover of plots and the altered spatial context of the fields and forests within the landscape may have ramifications for the long-term fate and restoration of tropical forests. For example, it could be hypothesized that the adjacency and diversity of seed sources for regeneration on fallow fields has been altered as a result of the changes in landscape structure, and this altered spatial context may subsequently influence the rate and trajectory of succession. We examined this hypothesis by collecting vegetation data from thirty-two milpas (slash-and-burn fields) that varied in their age (fallow > 3 years, fallow < 3 years, in use >3 years, in use < 3 years) and their distance to older forest (> 100 m or < 100 m). Species composition of both the woody and herbaceous strata were found to be significantly different between near and distant milpas. Further, Shannon’s diversity index values for woody vegetation were greater in the milpas near old growth than distant milpas currently in use. One implication that could be drawn from these results is that regenerating fields marked by lower diversity may be less resilient and recover more slowly from cultivation because of greater soil leaching brought about by the less efficient uptake and cycling of soil resources (e.g., nitrogen).

Land-use scenarios are an approved tool for studying the influence of possible changes on natural processes, such as flood generation. The model land-use change modelling kit (LUCK) provides a method for the spatial transformation of overall trends concerning land-use changes into spatially distributed land-use patterns. Making use of gridded spatial information on topography, soils and present land-use, the technique takes the topology into account in a true position mode. The conversion is realized pixelwise, based on an evaluation of the site characteristics of each pixel as well as its neighbourhood relationships. Both criteria form the potential of each pixel to become subject to changes. Three main land-use categories are considered within LUCK by different modules for urbanization, agricultural and forestal land-use changes. The results are altered land-use maps which can directly be used as an input for flood simulation with distributed hydrological models such as WaSiM-ETH. Study areas are three mesoscale tributaries of the Rhine basin in Germany which represent different characteristic land-use patterns with either dominantly urban, agricultural and forestal structure. Referring to these area types, different land-use trends with certain driving forces come into operation that are considered for the land-use scenario generation. The avails and the limits of the tool will be presented by applying the different tools to the three areas. Main focus is on the urbanization module, which has been validated for all three catchments on the dynamics of historical settlement development.
Understanding changes in the distribution of an organism requires information on its habitat requirements and dispersal capability in a landscape context. We are studying the distribution, habitat suitability, dispersal and genetic structure of Hexastylis arifolia, a common myrmecochorous forest herb of the Southeastern US. The study is done in Whitehall Forest, near Athens, GA, a mosaic of forest patches of different type, age, and successional stage. Major changes in the landscape in the last 60 years have been delineated using aerial photographs. In the study area, Hexastylis arifolia is found in a range of deciduous forest seral stages, but rarely further than 50 meters from patches that have been forested continuously for at least 60 years. This distribution pattern implies dispersal limitation, a hypothesis that is tested in this study. Direct observations of ants dispersing seeds indicate dispersal distances are typically 2m or less, but occasionally exceed 10 m. These direct measurements are compared to maximum likelihood estimations of dispersal curves based on the distribution of seedlings. The spatial scale of the genetic structure measured by allozyme variation is consistent with the observed dispersal distances. We assess habitat suitability by correlating distribution to environmental factors, and by studying habitat-specific demography. We test our assessment of habitat suitability by introducing plants of various life stages into different habitat types and following their subsequent survival and reproduction. Our goal is to develop a model that uses field estimations of dispersal and habitat suitability to predict changes in the distribution of Hexastylis arifolia, and to test these predictions with current distribution and historical changes in the landscape.

The invasion of BC's grasslands by douglas-fir has been a concern for range managers and conservationists. Land managers dispute the relative effects of fire suppression and grazing regimes on tree encroachment. In addition, the limits of their ranges may be sensitive indicators of changes in climate that are difficult to detect statistically. I examined patterns of encroachment of douglas-fir in relation to climate records of the 1900's. There was not a clear trend in average annual or growing season rainfall or temperature that corresponded to Douglas-fir establishment. Since 1934, the northern limit of grasslands in central British Columbia has had fewer hot/dry summers and more cool/wet summers than previously. This unexpected change in climate has reduced potential evaporation in this area. It is hypothesized that this change in climate extremes could reduce desiccation of tree seedlings, and also alter the natural fire regime. If seedling desiccation is a major factor limiting encroachment, then seedling survival should be most successful where shade from nearby trees protects the seedling. However, in a preliminary study in a relatively cool, wet summer, I found significantly higher proportions of seeds germinated and survived in open grassland areas than in areas shaded by trees. Small mammal consumption of seeds was reduced in open grasslands where there was less cover from predation for the voles and mice. The relaxation of the climatic constraint of high potential evaporation may have made the small mammal role in tree encroachment apparent.

It is presented here, the case of loss of hydric supplying and the agricultural productivity decurrent of the extreme modification in the landscape of the County of Visconde of Rio Branco, Minas Gerais State, Brazil. During the 80's, when the ground, worn out by the intense culture of coffee and sugar cane, caused the reduction of the harvests, and the producers invested in cattle. In the 90's, however, in extensive areas of the region, not even grass germinated any more. Erosive processes had installed, leading to the loss of the land. The cutting of the woods of the heads of the springs and margins of the rivers, led to the deposit of sediments in the stream-beds and to the decrease of the outflow. This modification in the landscape was so intense that, today, the estimate hydric supplying for the region is calculated in ten years. Through ge mathematic and ecological studies, data about the last landscape and the current one had raised, as well as of the urbanization processes. These information, have made possible to understand the context and to offer to the population a program of Ambiental Education, facilitated by the demand of some brackets of the society. As an incentive method, valuation and
approach of the community, a didactic material was elaborated, telling the history of the region. Here, joining the scientific data and the popular knowledge, recovered through oral information, that made possible its integration to regional history. The program, hopes to collaborated in the resetting of the current landscape as much as the remaining original landscape, rescuing the value of the environment in the supported development of the region.

88. gomide@nesc.ufrj.br Poster Gomide¹, Marcia, Roberto Medronho², and Heinrich haasenack². "Núcleo de Estudos de Saúde Coletiva - NESC/UFRJ/ Rio de Janeiro, Brasil; and "Departamento de Ecologia/UFRGS/Porto Alegre, Brasil. Precarious Urbanization and Transmission of the Hepatitis A in a Poor Area of Rio de Janeiro, Brazil.

The modification and the inadequate use of the space cause environmental problems that may affect the population's health. The area of the study has a short drain extension, poor garbage collect and water supply, leading part of the population to make use incipient cesspools and hollow wells as alternatives of water supply (precarious sanitation conditions). This situation favors the occurrence of several waterborn diseases as hepatitis A, a viral etiological disease. There was an attempt as to identify the factors that could determine the occurrence of hepatitis A, through a group of environmental and socio-economic variables. Geographic Information Systems were used so as to identify the risk areas and logistic regression to identify the explanatory variables for the occurrence of the hepatitis A. Areas with higher risk for hepatitis A were identify as well as two decisive socio-economic factors for occurrence: the familial monthly income average and the housewives' number of years of study. It is ended that the occurrence of the hepatitis A is strongly influenced by environmental and socio-economic conditions, being, the adoption of basic, educational and improvement of the socio-economic level steps, necessary for its appropriate control.

89. gong@nature.berkeley.edu Oral/Reg Gong¹, P., Y. Sheng¹, B. Xu¹, L. Wang¹, G. S. Biging², Y. Wang¹, Y.-P. Hsieh³, Center for Assessment and Monitoring of Forest and Environmental Resources, University of California, Berkeley, CA 94720, USA; ²Department of Geological Sciences, Florida State University, Tallahassee, FL 32306, USA; ³Wetland Ecology, Center for Water Quality, Florida A&M University, Tallahassee, FL 32307, USA. Photo-ecometrics for landscape characterization.

Our recent attempt toward the development of the field of photo-ecometrics has lead to a number of new developments in digital photogrammetry and its applications. We advocate the use of digital surface model (DSM) that contains the elevation of all surface features such as buildings and trees rather than digital elevation model (DEM) that has been traditionally used only for the terrain. We illustrate in this presentation our methods for deriving DSMs and orthophotos generated with digital photogrammetry in landscape characterization. Using 1:40,000 aerial photograph as ground truth, we evaluated the potential of Landsat Thematic Mapper imagery in crown closure estimation of California’s hardwood rangeland. Using 1:2,400 and 1:12,000 aerial photographs, we developed new image matching algorithms to extract tree crown morphology and tree heights for both broadleaf and conifer species in California. Using 1:12,000 aerial stereopairs acquired in the summers of 1970 and 1995 of a hilly savanna in California and scanned at 1000 DPI, we derived DSMs and subsequently orthophotos for each year to measure gully encroachment. Using 1:23,000 aerial stereopairs acquired over a coastal marshland area in Florida in 1951 and 1997, we produced a digital orthophoto for each year.

Through measurement, we found that the lower boundaries of the salty sandy zones on the marshland displaced toward the land for approximately 3-10 m from 1951 to 1997. Since it was unlikely that the sand type had changed over the 46-year period, the only possible explanation is that either the annual average sea level or the evaporation rate over the observation period in this area, leading to a conclusion that climate had changed over the 46-year period. There is no doubt that aerial and digital photography are getting more popular than before. Digital photogrammetry is a helpful tool for us to extract accurate DSM data from stereopairs. As high resolution data from airborne and space-borne remote sensing become more and more available, DSMs can be easily obtained. DSMs allow us to study changes not only about topography but also about canopy closure and tree heights. The potential of DSMs opens many opportunities for improving the accuracy of landscape change monitoring.
of Institutions, Population, and Environmental Change (CIPEC), Indiana University, Bloomington, IN 47408, USA. Control of forest distribution by bio-geophysical and social/institutional factors: Does conservation management make a difference?

This paper analyzes the relative contributions of bio-geophysical and social/institutional factors in determining the distribution of forest. We examine landcover for Indiana, from Landsat TM images and data gathered by surveys in the early 1800s. Topographic relief values were calculated from digital elevation models (DEM) and compared to landcover on private lands vs. lands managed by government agencies. Forest, which once covered 85% of Indiana, now covers 20%. Deciduous forest cover increases from 10% of flat land to more than 65% on slopes greater than 10%. While the aerial extent of land in Indiana drops off rapidly with increasing slope, the proportion of land under non-private management increases sharply with increasing relief. Land managed by government agencies makes up only about 4% of the State. Land managed by different agencies is distributed differently with respect to relief, with some agencies' holdings concentrated on flatter land and some on topographically steep terrain. Do institutions determine landcover, or do they simply inhabit particular kinds of lands - lands that would have the same landcover regardless of ownership and management? A test of proportions evaluates whether or not landcover under these government agencies is significantly different from privately managed lands at the same slope values. This analysis can be helpful in evaluating the types of habitats that are being preserved both on public and on private lands. This information can aid forest policymakers attempting to evaluate current conservation policies and craft new legislation to promote conservation of particularly threatened types of forest habitat.

Approaches and Practices

Pattern and Process in Urban Landscapes

Movement models as tools for analyzing the effect of landscape structure on population processes.

Developing options for a sustainable land use requires a good understanding of the effect of landscape structure on ecological processes. But in order to fully understand the effect on population processes, for instance, the individuals' specific response to the landscape structure (e.g. movement behavior) has to be taken into account. Hence, tools for linking individual with population processes are needed. We present an individual-based, spatially explicit model that allows the individual probability of meeting a partner (and therefore the rate of fertilized females) to be assessed and analyzed in terms of the consequences of both different landscape structures and different (sex-specific) movement types. We demonstrate to what extent the movement type of a species influences the ranking order that results from comparing alternative landscape structures regarding their effect on the individual mating success and discuss the consequences for landscape evaluation and management. Finally, we show that a landscape index "Individual Mating Success" can be derived that contains the whole essence of the presented simulation.
model and provides a tool for analyzing a given landscape through the eyes of the considered species. This index only depends on the landscape structure and the movement rules and can directly be calculated, without having to resort to the underlying model itself. The presented model-based approach was tested and validated in a case study, using a long-term data set of a population of an arboreal Gecko (Geihyla variegata) in Australia.


A natural catchment (30 by 40 kilometres) delineated using WMS is used to test the assumption that landscape connectivity is a threshold phenomenon and its exact value of the threshold depends upon the spatial arrangement of habitat and the perceptions of organisms. The valley is characterized by rapid development by clearing forest for dairy and residential purpose since a century ago. The spatial arrangement of remnants is critical in nature and biodiversity conservation in the area. Based on the ecology and their connectivity requirements, critical threshold scales associated with abrupt changes in landscape connectivity for four State-wide listed species (each uses a different type of habitat based on vegetation) have been identified using GIS and simulation modeling. The suitable scale to investigate landscape connectivity for *Petrogale penicillata* is about 100 meter, and that for *Petaurus australis* is 400 meter, for *Tyto tenebrosa* is 800 meter and for *Dasyornis brachypterus* is 1000 meter. Consequently specific high value remnants (keystone patches) were located for each species, which if properly conserved or revegetated can significantly increase the connectivity for those species. To test the effect of landscape composition and spatial arrangement on landscape connectivity, Modified Cluster Method (Saura and Martinez-Millaan, 2000) is used which can separate the control of fragmentation and habitat abundance. Our results answered some key questions concerned local community in vegetation target setting; How much vegetation do I need? Where should they be left? How should they be arranged? These results could be easily integrated into the design guidelines for sustainable landscape.

94. Guo, Qinghua, Wei Luo*, Ye Qi. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA, 94704, USA. Semivariance techniques in point pattern analysis: A comparison with Ripley K.

Spatial point pattern analysis has always been an important issue in ecological analyses. Most popular point pattern analysis methods such as Ripley K and TTRQ assume that the spatial process is isotropic, which means the covariance of a pair of points depends only on the scalar distance between them. But in nature, isotropy is really an exception. And often, understanding the anisotropy nature of the spatial pattern is crucial in our understanding of ecological process behind. We propose to introduce semivariance technique into spatial point analysis. We found that the semivariance method can better detect the anisotropic and heterogeneous nature of spatial point patterns. We first simulated artificial point data to measure the effectiveness of this method and then applied it to the mangrove forest in the Los Haitises National Park. We compared the effectiveness of semi-variance method with results by Ripley K. Semivariance method proved to be able to not only detect spatial deviation from random distribution, but also can detect spatial variations along different directions (anisotropy). Ripley K was not able to detect anisotropy. In case of random distribution, the semivariogram exhibited a pure nugget effect; in regular distribution, it also had a similar pattern with a lower sill. In clustering distribution, the semivariogram exhibits a clear structure with the range corresponding to the average cluster size. The effects of the grid size used in semivariance calculation are discussed. And gaps (defined as low density area around patches) in the point pattern on the shape of semivariogram are investigated.

95. Haire, Sandra L. USGS-Biological Resources Division, Fort Collins, CO 80525, USA. Landscape ecology as an integrative science: An application in the Greater Yellowstone Ecosystem.

Human activities change landscape patterns and processes, even in areas we are inclined to think of as "wild". How have our activities changed the look of the landscape, and what do we want the landscape to look like in the future? One way to explore these questions is to bring together knowledge of historical landscapes, plant and wildlife ecology, and cultural values to predict landscape change. These changes can be visualized in images that contain landscape elements that are predicted to vary with changes in

<table>
<thead>
<tr>
<th>Page 36</th>
<th>Landscape Pattern Analysis: Theory and Methods</th>
<th>Landscape Pattern and Population Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>93</td>
<td>Guo, Linhai Larry, John Morrison, and John Marthick. Environmental Research Institute, University of Wollongong, NSW 2522, Australia. Multi-scale Analysis of Landscape Connectivity in Kangaroo Valley, NSW Southeastern Australia in the Context of Landscape Ecology.</td>
<td>A natural catchment (30 by 40 kilometres) delineated using WMS is used to test the assumption that landscape connectivity is a threshold phenomenon and its exact value of the threshold depends upon the spatial arrangement of habitat and the perceptions of organisms. The valley is characterized by rapid development by clearing forest for dairy and residential purpose since a century ago. The spatial arrangement of remnants is critical in nature and biodiversity conservation in the area. Based on the ecology and their connectivity requirements, critical threshold scales associated with abrupt changes in landscape connectivity for four State-wide listed species (each uses a different type of habitat based on vegetation) have been identified using GIS and simulation modeling. The suitable scale to investigate landscape connectivity for <em>Petrogale penicillata</em> is about 100 meter, and that for <em>Petaurus australis</em> is 400 meter, for <em>Tyto tenebrosa</em> is 800 meter and for <em>Dasyornis brachypterus</em> is 1000 meter. Consequently specific high value remnants (keystone patches) were located for each species, which if properly conserved or revegetated can significantly increase the connectivity for those species. To test the effect of landscape composition and spatial arrangement on landscape connectivity, Modified Cluster Method (Saura and Martinez-Millaan, 2000) is used which can separate the control of fragmentation and habitat abundance. Our results answered some key questions concerned local community in vegetation target setting; How much vegetation do I need? Where should they be left? How should they be arranged? These results could be easily integrated into the design guidelines for sustainable landscape.</td>
</tr>
<tr>
<td>94</td>
<td>Guo, Qinghua, Wei Luo*, Ye Qi. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA, 94704, USA. Semivariance techniques in point pattern analysis: A comparison with Ripley K.</td>
<td>Spatial point pattern analysis has always been an important issue in ecological analyses. Most popular point pattern analysis methods such as Ripley K and TTRQ assume that the spatial process is isotropic, which means the covariance of a pair of points depends only on the scalar distance between them. But in nature, isotropy is really an exception. And often, understanding the anisotropy nature of the spatial pattern is crucial in our understanding of ecological process behind. We propose to introduce semivariance technique into spatial point analysis. We found that the semivariance method can better detect the anisotropic and heterogeneous nature of spatial point patterns. We first simulated artificial point data to measure the effectiveness of this method and then applied it to the mangrove forest in the Los Haitises National Park. We compared the effectiveness of semi-variance method with results by Ripley K. Semivariance method proved to be able to not only detect spatial deviation from random distribution, but also can detect spatial variations along different directions (anisotropy). Ripley K was not able to detect anisotropy. In case of random distribution, the semivariogram exhibited a pure nugget effect; in regular distribution, it also had a similar pattern with a lower sill. In clustering distribution, the semivariogram exhibits a clear structure with the range corresponding to the average cluster size. The effects of the grid size used in semivariance calculation are discussed. And gaps (defined as low density area around patches) in the point pattern on the shape of semivariogram are investigated.</td>
</tr>
<tr>
<td>95</td>
<td>Haire, Sandra L. USGS-Biological Resources Division, Fort Collins, CO 80525, USA. Landscape ecology as an integrative science: An application in the Greater Yellowstone Ecosystem.</td>
<td>Human activities change landscape patterns and processes, even in areas we are inclined to think of as &quot;wild&quot;. How have our activities changed the look of the landscape, and what do we want the landscape to look like in the future? One way to explore these questions is to bring together knowledge of historical landscapes, plant and wildlife ecology, and cultural values to predict landscape change. These changes can be visualized in images that contain landscape elements that are predicted to vary with changes in</td>
</tr>
</tbody>
</table>
ecosystem management and cultural influence. We attempt to integrate scientific knowledge and cultural value components in our study of the Jackson Valley, Wyoming, USA, where a long history of ungulate management is under scrutiny in a fascinating and controversial situation. Jackson bison and elk herds winter on the National Elk Refuge; attracted by the feedlines established in the early 1900's when high elk mortality roused public sympathy. Currently, ungulates are an economic resource for the area in terms of hunting and tourism, as well as a source of concern; feeding practices exacerbates the transmission of brucellosis. Of equal concern to ecologists is the alteration in vegetation patterns and underlying processes resulting from high ungulate population levels. This study uses a visual perspective as an integrative approach to aid management decisions in the Jackson Valley.

Human developments in rural landscapes clearly have had negative impacts on many species. However, for some exploited species, rural development may actually have positive impacts by creating defacto refugia from hunting pressure. For instance, in Illinois, state regulations prohibit firearms hunting for white-tailed deer (Odocoileus virginianus) within 274 meters of any occupied structure without the permission of the occupant. Therefore, it is likely that exclusion of hunters from areas around rural structures may reduce hunter-caused mortality in exploited species. Moreover, as the amount of high quality habitat in juxtaposition to rural structures increases this effect may be enhanced. To investigate these questions, we examined the impacts of rural development on the distribution and success of deer hunters in Illinois. Specifically we measured the distribution of hunters through both aerial and ground surveys and then compared this distribution with that of rural developments. We also examined the quality of habitat within the legal exclusion of hunters and how that impacted hunter success. Home density within deer habitat was not found to be significantly correlated with harvest efficiency. However, harvest efficiency was found to have a slight negative correlation with the percent of the exclusion areas consisting of deer habitat. Other contributing factors are also presented and discussed.

A series of statistically-derived ecoregionalizations of the conterminous United States based on 25 environmental variables will be presented. Multivariate clustering based on high-resolution maps of elevation, temperature, precipitation, soil characteristics, and solar inputs at several specified levels of division result in a spectrum of objective ecoregion maps for the United States. Coarse divisions reflect intuitively-understood regional environmental differences, but fine divisions highlight local condition gradients, ecotones, and clines. Because the technique is quantitative, several valuable ecological derivatives can be generated. Principal Component Analysis (PCA) of ecoregion centroids after clustering forms the basis for a red-green-blue visualization which indicates the relative contribution of each PCA factor to the environment within that ecoregion. Similarity of any ecoregion to any other ecoregion can be quantified and displayed as a "representativeness" map. Borders between ecoregions can be characterized as gradual or sharp, or can be shown to change character along their length. The technique can also be applied simultaneously to multiple maps through time.

This study focuses on valuing the loss of open spaces that accompanies new residential development in urban fringe areas. Open space is valued for a number of reasons, including for its views, recreational opportunities and in maintaining water quality and species habitat. Public parks and forest preserves, private golf courses, and agricultural land are different types of open space, which may have different values for a community. This paper develops a model that estimates the value of open space in a community, allows policy simulations of alternative preservation strategies, and applies the model to a
## Hawks, Michelle M., Helene H. Wagnar, Jonathan M. Bossenbroek, John A. Wiens, and Beatrice Van Horne.

**Department of Ecology, Evolution and Natural Resources, Rutgers University, New Brunswick, NJ 08901, USA.** Discontinuities in habitat features inhibit the spread of exotic species.

### Abstract

Stream and riparian habitats function as corridors for organisms to move through the environment. At the scale of the watershed, the configuration of streams provides a network of interconnected habitats that potentially determines habitat extent and accessibility for organisms dependent on the stream or riparian environment. The goals of this study were to examine the potential for stream and riparian habitats to function as corridors for exotic plants at the scale of the stream network. I examined how exotic species distribution varied with riparian plant community composition, position within the network and the local environmental. The study stream network was a relatively undisturbed 4th order stream system in northern New Jersey where the riparian vegetation community was sampled along the main channel and all tributaries. Variation in stream gradient and channel morphology defined five different riparian vegetation types that were intermixed along the main channel and tributaries. Overall species diversity and exotic species richness varied by riparian vegetation type with four of the five vegetation types supporting exotic species. Most exotic species present in the riparian zone were also common in the adjacent upland hampering the ability to determine the source of initial introduction. However, distributions of exotic species were not continuous along the stream network suggesting that riparian habitats do not function as continuous habitats. The non-continuous nature of the riparian vegetation types throughout the stream network appears to retard the spread of riparian-dependent exotic species.

### Methods and Case Studies

The scale we use to collect data on animal communities influences our ability to explain species distributions using environmental variables. Analysis of data at multiple scales can help identify which scales might be appropriate for further data collection and analysis. We collected butterfly community data along three 2-km transects at Konza Prairie LTER. Environmental data gathered along these transects included fire frequency, grazing treatments, vegetation composition and plants flowering at time of survey. We analyzed these data by causal modeling of resemblance matrices at various scales. The explanatory power of the environmental variables changed with scale. Our analyses indicated the appropriate scales for data collection. We demonstrate how this approach can be used to determine that appropriate scale for a particular study.

---

## Hay’, G.J., P. Dubé’, D.J. Marceau’, A. Bouchard’, ‘Geocomputing Laboratory, Department of Geography, University of Montreal, Montreal, Que, Canada, H3C 3J7,’ IRBV, University of Montreal, Jardin Botanique de Montreal, Montreal, Que, Canada, H1X 2B2.

**Scale-Space for Landscape Ecologists: A Novel**

In this paper we describe a novel approach based on scale-space theory for extracting multi-scale landscape structure within a high-resolution remote sensing scene. Analysis is performed on an IKONOS image (acquired in September, 2000), that represents a highly fragmented agro-forested landscape in the Haut-St-Laurent region of south-western Québec. Scale-space originates from the computer vision community, where it was developed to analyze real-world structures with no apriori information about the scene being assessed. Its basic premise is that a multi-scale representation of a signal (such as a remote sensing image of a landscape) is an ordered set of derived signals showing structures at coarser scales.
that constitute simplifications of corresponding structures at finer scales. In practice, gaussian filters are applied to the image at a range of kernel sizes resulting in a scale-space cube, where each layer in the cube represents convolution at a specific scale. The primary objective of our study is to link structures at different scales in scale-space to higher-order objects, called "scale-space blobs", and to extract significant features based on their appearance and persistence over scales. Blobs-like structures, which persist in scale-space, are likely candidates to correspond to significant structures in the image, and thus in the landscape. Spatial statistics are used to describe the spatial heterogeneity of these emergent landscape structures, and 3-D tools have been developed (in IDL-interactive data language) to visualize and describe their multi-dimensional morphology. These patterns are then related to their underlying processes in order to better understand the multi-scale dynamics of this landscape.

The need for an integrated approach to water resources management and the linking of water management to land use has been stressed in many fora in recent years. Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. A study was conducted to determine the effects of land use practices on water quality and quantity in the Hope River watershed, Jamaica. Geographical information systems was utilized to evaluate changes in land use over the decade 1989-1998; while Participatory Rural Appraisal was used to determine the local people's perceptions and practices. Water balances for the watershed and the reservoir were determined to better understand the limitations and scope for management options. The water quality study revealed that there is high spatial and temporal variability in rainfall, which decreased from 250 mm monthly in 1933 to less than 150mm in the 1990s. Subsequently, the available water from runoff as well as peak flows have also decreased. There has been an increase of over 2˚ in temperature in the watershed over the study period. The water balance showed that the hydrological cycle is dominated by evapotranspiration, which is greater than rainfall for 75% of the year. At the Mona Reservoir, which receives water from the Hope River, there was a negative balance in storage for at least 1/3 of the decade. Water quality analysis showed that there is deterioration in both spatial and temporal dimensions. Not only have nutrients increased but conductivity, total dissolved solids and fecal coliform levels have also risen. Fecal coliform levels exceed the maximum allowable limits for health and recreational use over 90% of the time. These all tend to increase downstream. GIS overlays showed a 55% increase in agriculture, 24% in settlements and a decrease of 18% in forestland. Conversion of the land is of major concern as 85% of the land is on steep slopes of over 25˚. A study of people's perceptions revealed that most problems stem from the current economic conditions. People's perceptions were different from those of the Government but sometimes showed similarities with the scientific data. An integrated management framework is needed which involves all stakeholders with specific focus on pollution prevention, maximizing storage and improving efficiency of water use.

Aggregations of raster data based on the majority rule have been typically used in landscape ecological studies. It is generally acknowledged that through the aggregation process 1) dominant classes increase in abundance, while minor classes decrease in abundance or even disappear; and 2) the spatial patterns are changed. In this paper, we examine an alternative, random rule-based aggregation and its effects on cover type abundance and landscape patterns using a classified TM imagery. We aggregated the image from 30 m to 990 m resolution, a range sufficient for most data aggregations. To assess the effects of data aggregation on spatial patterns, we use aggregation index (AI), fractal dimension (FD), and average patch size. Our study assures that the majority rule-based aggregation distorts cover type percent areas, with the most common and contagious classes and the least common and dispersed classes distorted the most, while the random rule-based aggregation maintains cover type proportions of all classes within this.
Patterns Using Landsat TM Satellite Imagery. broad range (30-900 m). The two aggregation methods alter spatial patterns in opposite ways. Majority rule-based aggregation filters out minor classes and produces clumped landscapes, while random rule-based aggregation tends to make disaggregated spatial pattern. Overall, we find that with the classified TM satellite image, the random rule-based aggregation maintains spatial pattern better than the majority rule-based aggregation. A map from random rule-based aggregations appears to have finer resolutions than the one from majority rule-based aggregation, while the spatial resolution is actually the same.

104. phelmu
nd@co
costate.e
du Oral/Re
g

105. ehelmer
@fs.fed
.us Poster

106. ghenebr
y@calm
lt.unl.ed Poster

Landscape Pattern and Biodiversity Conservation
Landscape Characterization and Pattern Analysis
Landscape Pattern and Population Dynamics and
### 107. julia.henry@asu.edu

**Special: Smith's Dent's**

*Henry, Julia C., S.G. Fisher, J.D. Schade, and J.R. Welter.*  Department of Biology, Arizona State University, Tempe AZ 85287, USA. **Periphyton-sandbar edge interactions in an arid-land stream.**

Ecosystem ecologists are interested in the relationship between spatial patterns and ecosystem processes. Recent research in Sycamore Creek, a nitrogen limited desert stream, has focused on the influence of sandbars on nitrogen cycling. Sycamore Creek is unregulated and characterized by flash floods that rearrange alluvial material. Depending on time since a flood event, sandy runs contain from 0 to >20 sandbars that vary in size, shape, and arrangement in the channel. Stream water flows downstream, enters sandbars along "inwelling" edges and moves along flowpaths through the sandbar. Microbial processes occurring in the interstices of sandbars cause non-linear increases in nitrate along flowpaths, and high nitrate water re-enters the surface stream at sandbar termini or "outwelling" edges. We have observed distinct spatial patterns of different types of periphyton associated with sandbar inwelling and outwelling edges. This study was designed to answer, What causes upstream sandbar inwelling edges to be dominated by nitrogen fixing cyanobacteria and downstream outwelling edges to be dominated by non-fixing algae? We hypothesized that algae grows preferentially at locations where high nitrate water outwells from sandbars while cyanobacteria, which can fix nitrogen from the atmosphere, inhabit inwelling edges with low nitrate concentrations. We tested the hypothesis descriptively (measuring hydrology, nutrients and periphyton biomass) and experimentally (periphyton transplants). In general, the hypothesis was supported by our results. Sandbars are important to stream nitrogen cycling because they influence the distribution of n-fixing (direct N input to stream) and non-fixing (which retain 60-98% of outwelling nitrate) periphyton along their edges.

### 108. gthess@ncsu.edu

**Special: Smith’s Dent’s**

*Hess, George.*  North Carolina State University, Forestry Department, Raleigh NC 27695-8002, USA. **Measuring Suburban Sprawl.**

Between December 1999 and May 2000, articles about sprawl appeared in several popular magazines, including *Time, US News and World Report, The New Yorker, Atlantic Monthly,* and Sierra.  Search for "urban sprawl" on the World Wide Web and you will be inundated.  Most of these articles and web sites focus on purported negative social, economic, and environmental effects of sprawl. Yet, in all of this, the term "sprawl" is rarely defined and quantified.  In order to assess sprawl's ecological impacts, we must be able to define and measure it. I define sprawl from a landscape perspective, present a number of simple quantitative sprawl indexes based on US Census data for urbanized areas (e.g., population size, population density, road connectivity), and use these indexes to compare sprawl among the urbanized areas in the mid-Atlantic United States. The indexes will be used to develop quantitative profiles of urbanized areas with similar characteristics.  The indexes will be useful for examining trends for a single urbanized area through time, and comparing trends among urbanized areas at city, state, and regional scales. In the longer term, I will examine correlation among sprawl indexes and measures of environmental quality and degradation.

---

### Species Distribution

**pattern and process in aquatic ecosystems: how patches and networks affect ecosystem function**

**Assessing Current and Future Regional Vulnerabilities**
Dead trees are important to forest ecosystem function and biodiversity and their distribution is sensitive to the history of wildfires and logging. Patterns of dead wood have been examined at stand scales but infreqently and cursorily at landscape and regional scales. In this study, we asked: 1) What is the amount and distribution of snags and down wood in the Coastal Province of Oregon? and 2) What is the relative importance of environment and forest history in explaining the regional patterns of dead wood? We compiled a series of regional plot databases to describe the current amount and distribution of dead wood. We used multivariate techniques to evaluate relationships between dead wood, environment, and history. We used the Gradient Nearest Neighbor approach to model the spatial patterns of dead wood across the Coastal Province. Dead wood levels were higher on some ownerships, and size distributions of down logs and snags were spatially highly variable. Both environment and stand history played a role in the abundance and distribution of dead wood, with higher dead wood levels found at lower elevations and in areas that had not experienced repeated fire events. Ecological relationships explaining dead wood patterns at stand scales also operate at regional scales but with greater variation. Regionally, dead wood amounts and piece sizes are sensitive to management history. Current forest management practices and continued fire suppression will likely diminish the amount of dead wood present on some ownerships and lessen the spatial variability and temporal pulses of wood inputs.
How do the relationships between organisms and environments vary with scale? How do patterns of beetle species richness relate to heterogeneity in vegetation? To answer these questions, we analyzed variation in the distribution of beetle species richness and vegetation coverage at multiple scales on the short-grass steppe of Colorado. Four 2-km transects were selected to traverse a gradient of habitat types. We systematically trapped beetles and performed vegetation surveys along each transect during the summer of 1998. We used semivariance analysis to assess similarity between the scales of variation in beetle species richness and vegetation attributes. Although semivariance analysis has been used to quantify the spatial heterogeneity of many organismal and environmental variables, there have been few attempts to use semivariance to relate spatial variance in species richness at a particular site to environmental features. Similarity between the scales of variation in beetle species richness and vegetation attributes may indicate ways in which beetles perceive and respond to habitat features. Overall, we found few instances in which semivariograms of beetle species richness were similar to those seen in vegetation coverage, although in some instances patterns...
of variability in beetle species richness coincided with those seen in bare ground coverage and shrub coverage. Overall, beetle species richness exhibited multiple scales of variability, whereas environmental variables appeared to vary at dissimilar scales.

Hollister, Jeff W., John F. Paul, Jane Copeland, Randy L. Comeleo, Mike Charpentier, Peter V. August, Mike Mark Brush. 1 University of Rhode Island, Department of Natural Resources Science, Kingston, RI, 02881; 2 United States Environmental Protection Agency, Atlantic Ecology Division, Narragansett, RI 02882; 3 OAO Corporation, Narragansett, RI 02882; 4 OAO Corporation, Corvallis, OR 97333; 5 University of Rhode Island, Graduate School of Oceanography, Narragansett, RI 02882. Landscape Structure and Estuarine Condition in the Mid-Atlantic Region of the United States: II. Assessing the Accuracy of the National Land Cover Dataset at Multiple Extents. It has been hypothesized that land use and land cover patterns are strongly correlated with estuarine condition. In order to effectively evaluate this hypothesis, we need accurate measures of landscape structure and an understanding of the functional scales of land use/land cover data. Robust site-specific accuracy assessment methods allow for fine scale assessments of overall land cover/land use classification accuracy and also describe misclassification error between classes; however, they provide little insight into the accuracy of the data at the broad spatial scales at which landscape structure is often measured. We have developed a method, which addresses this shortcoming. We assessed the accuracy of the National Land Cover Dataset (NLCD) using photo-interpreted land use/land cover data from Rhode Island (RIGIS) and Massachusetts (MASS-GIS). Within randomly distributed areas, we were able to calculate Pearson and Spearman rank correlations between the classified (NLCD) and reference (RIGIS and MASS-GIS) data along a gradient of extents (30ha to 3000ha). Forest, water, urban and agricultural lands were accurately depicted at extents greater than approximately 3000 ha. Due to potentially non-unique spectral signatures and rarity, barren lands, wetlands, non-natural woody, and rangeland were consistently misclassified and the NLCD poorly depicted these at all extents. These analyses allow us to identify a minimum spatial extent at which we may reliably measure landscape structure. This method is not presented as a replacement for site-specific accuracy assessment but as an important additional source of information regarding the accuracy and utility of broad scale land use/land cover data.

Hooten, Mevin B., David R. Larsen, and Christopher K. Wikle. 1 Department of Forestry, University of Missouri, Columbia, MO 65211, USA; 2 Department of Statistics, University of Missouri, Columbia, MO 65211, USA; 3 Department of Forestry, University of Missouri, Columbia, MO 65211, USA. Modeling and mapping the distribution of legumes in the Missouri Ozarks: A Bayesian Approach. Understory vegetation composition is an important factor influencing biodiversity, animal forage, nutrient dynamics and other crucial processes in most forested ecosystems. This holds true for the Ozark highlands section of Southeast Missouri where most of the upland soils are highly weathered and underlying geology is quite variable. The topographic complexity of the area adds to the variation in quantity and quality of ecological niches defined by environmental characteristics such as: soil order, geology, slope, aspect, slope position and landform. It has been documented that several of the 500+ plant species found in subsections within the Missouri Ozark highlands have fairly high correlations with these environmental variables. In these subsections, leguminous ground flora has been found to be highly abundant when compared to other forested ecosystems. Speculation suggests that this abundance may be due to the exploitation of a nutrient poor substrate by these nitrogen-fixing legumes. It is the purpose of this project to demonstrate a robust spatial modeling methodology that will describe abundance patterns for organisms on a landscape. This research is focused on spatially modeling relationships between certain understory legumes and the aforementioned terrain-derived and substrate defining variables. Using ground flora data collected as part of the MOFEP pre-treatment project, and a series of conditional spatial regression models within a hierarchical Bayesian framework it is possible to successfully model leguminous plant distributions on a landscape.

Howe, Elisabeth Bartlett and William L. Baker. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. Disturbance Interactions and Severe Blowdown in a Rocky Mountain Subalpine Forest Landscape.
Western Oregon. Environmental Data in Inventory Plot and to Map Forest Structure from Oregon State University.

118. Poster
Pacific Northwest Research Station, U.S. Forest Service; and Department of Forest Science, College of Forestry, Oregon State University. Comparison of Two Methods to Map Forest Structure from Inventory Plot and Environmental Data in Western Oregon.

The Forest Service and other agencies maintain a national network of inventory plots where forest structural parameters are measured and monitored at roughly decadal intervals. Our objective was to produce contemporary, regional maps of forest structure from these data, for the benefit of forest managers. We summarized tree basal area, height, and density data at the species level for over 1300 inventory plots systematically gridded across western Oregon at 1.7-5.5 km intervals. We also compiled continuous environmental data layers (climatic, topographic, geologic, and spectral) for the same region. We then used two methods, Gradient Nearest Neighbor (GNN) and Most Similar Neighbor (MSN), to relate the plot-level data on species and stand structure to the continuous environmental data extracted for the inventory plot locations. The similarity functions in GNN and MSN are based on canonical correlation analysis and canonical correspondence analysis, respectively. Both methods use nearest-neighbor imputation to predict the response variables at all inter-plot locations, based on their respective
Are invasive plant species a threat to oak-hickory forests of the Eastern United States? Invasive plant species are often characterized by early successional traits, including small seeds that are wind and animal dispersed, vegetative growth, and shade-intolerance, all of which enable the plants to take advantage of disturbed areas and spread rapidly. One may conclude that these traits do not lend themselves to easy invasion of a forest and the apparent low impact of invasive plant species on forests, compared to riparian and rangeland sites, may support this. However, oak-hickory forests are unique because their canopies are relatively open compared to other hardwood forests, and the native species respond well to openings caused by various disturbance types. In fact, management regimes to maintain oak-dominated forests include clear-cutting and fire, both of which may promote exotic invasion. Moreover, eastern forests may be described as patches within an urban and agricultural matrix; i.e., the sink of invasion is embedded in its source. While there are over 180 potential oak-hickory forest invaders, we found the following species of most concern: Alliaria petiolata, Microstegium vimineum, Lonicera japonica, Celastrus orbiculatus, Rosa multiflora, L. maackii, L. tatarica, L. morrowii, and Allanthus altissima. I compared each species’ traits (physical, reproductive, and physiological), competitive ability, control measures, and known impacts on succession and ecosystem processes. I then related the distribution of these species to patterns of forest fragmentation and land use. I used this information to predict future impacts of invasive plant species on oak-hickory forests.

Recently, attention has been given to developing landscape indices to quantify spatial pattern. However, it is not well known which, if any, of these indices describe aspects of pattern relevant to organisms. One study has investigated the ability of landscape indices to predict the results of simple dispersal on fragmented old growth landscapes. However, many species follow more complicated dispersal rules, some of which may alter the effect of pattern. The relative success of indices may also depend on the range of patterns investigated. To explore these considerations, we examined relationships between a variety common and new landscape indices and the results of a simulation of pheremone-mediated congregative dispersal, such as that of mountain pine beetles and other aggressive bark beetles. We used a simple fire model to generate forest landscape patterns, which allowed us to vary landscape composition (habitat/non-habitat) and configuration independently over a wide range, while still ensuring that the cohesion and size distribution of our patches remained within a natural range. We used a balanced multifactorial experimental design to test for effects of patch characteristics and percent habitat, with ten replicates of each pattern type to control for stochastic variation in pattern and dispersal success. We found that both composition and configuration affect beetle success. Connectivity indices that are insensitive to small patches and small changes in patch perimeter performed best. This result is consistent with the findings for simple dispersal on real landscapes, suggesting that the relative merit of landscape indices may be fairly robust to details of pattern and species.

In integrating biophysical and socio-economic aspects for analysis of land use problems, one is always confronted with the problem of combining data from different spatial scales. Land use decisions involve choices on at least two spatial scales. At one level, the regional level (macro level), a policy maker is...
aggregation and scaling for land use planning: methodology and application.

Trying to decide what policy may bring about the desired developments. At the other level, the farm level (micro level), farmers have their own production decision problem. In order to solve the macro-level decision problem, the uncertainty about farm responses has to be reduced. Ideally this can be done by grouping individual farms and aggregating them to be able to estimate their responses. In land use planning, scaling up analysis from farm level to regional level is the source of the aggregation problem. Developing procedures for solving this problem is one of the main challenges in land use planning and as yet unsolved in a satisfactory manner. This paper contributes to development and operationalisation of a farm grouping and mapping methodology for land use planning and policy analysis. The paper comprises four sections. Section one gives a description of the problem. A methodology is developed and outlined in section two. Operationalisation of the methodology for the case of Amol sub-region in Mazandaran Province, Islamic Republic of Iran, is carried out and described in section three. Finally, strengths and limitations of the methodology are discussed in section four.

Iverson, Louis R., and Todd F. Hutchinson. USDA Forest Service, Northeastern Research Station, Delaware, OH 43015, USA. The effects of prescribed fire on soil temperature and moisture, litter consumption, and sapling topkill across a forested landscape in Ohio.

We have studied the potential of prescribed fires to restore mixed oak communities in Ohio since 1996. Here, we document landscape trends in soil temperature and moisture, and quantify variations in fire intensity and sapling topkill resulting from such fires. Soil temperatures at 1 cm depth increased only an average of 9.3 C for a 6-minute period during the fire, for minimal expected impacts. Following the fires, hourly sensing occurred on mesic and xeric sites for 7 months. Biologically significant effects may have occurred, as the soils on burned sites were warmer and drier, especially on xeric sites. Maximum daily soil temperatures averaged 3.5-5.7 C (maximum of 13 C) higher on the burned xeric sites during the first 30 days; elevated temperatures lasted 155 days. In a second study, fire intensity was monitored over four years of spring burns (some sites burned 4x and some 2x), under various weather conditions, and spatially modeled. The relationship of fire temperature to topkill of saplings was also used to map patterns of topkill across the landscape. The output maps show two very different prescribed fires, depending on weather: when recent rainfall has occurred, only the steep south-facing slopes experience higher temperatures and sapling topkill rates; under drier conditions, a greater portion of the landscape, including north-facing slopes, had greater temperatures and topkill. Fire intensity in 1999 also was higher on sites that had burned only once previously as compared to sites burned each year, because of higher fuels. These studies show importance of spatial and temporal conditions on fire outcomes.

Iverson, Louis R., and Todd F. Hutchinson. USDA Forest Service, Northeastern Research Station, Delaware, OH 43015, USA. The effects of prescribed fire on soil temperature and moisture, litter consumption, and sapling topkill across a forested landscape in Ohio.

The EPA Office of Research and Development (ORD) is addressing the question, “Where will projected land-use change most threaten ecological resources in the mid-Atlantic region?” Research is progressing within a multiple-scale framework to identify 1) county aggregations and 2) specific watersheds where projected growth and land-use conversion pose significant threats to sensitive ecological resources. Five region-wide modeling techniques were developed in-house and with the Departments of Agriculture and Interior. Synthesis of these results identified multiple-county aggregations most likely to undergo significant land-use change. When overlaid with large-scale ecological resources of concern, these subregions illustrate community risk management priorities for EPA Regions II, III, and IV. They also provide the focus for more intensive research, serving as test areas for the application and integration of higher-resolution, spatially explicit models developed within ORD, EPA Program Offices, and the academic community. Collaborative application of these models under selected economic and policy scenarios will lead to local development profiles across a range of resolutions and certainty. ORD will use the detailed development profiles that emerge to drive exposure and effects models, arriving at ecological vulnerability profiles at the eight-digit watershed scale. Vulnerability profiles will include ecological resources directly displaced by land-use conversion, and those indirectly impacted by

Disturbance and Vegetation Pattern and Dynamics

Assessing Current and Future Regional Vulnerabilities
increased quantity and toxicity of runoff and air pollution. A significant component of this initiative is the analysis of multiple scales and variables at work in current models, and the potential for their integration. ORD has evaluated 22 existing models of land-use change and related environmental impacts in the publication, “Projecting Land-Use Change: A Summary of Models for Assessing the Effects of Community Growth and Change on Land-Use Patterns” (EPA publication number EPA/600/R-00/098). Final reports will be available for distribution in January, 2001.

| 124. hans.jacquemyn @agr.kuleuven.ac.be | Poster | Jacquemyn, Hans, Jan Butaye, and Martin Hermy. Department of Land and Water Management, University of Leuven, Vital Decosterstraat 102, B-3000 Leuven, Belgium. Spatio-temporal effects of forest fragmentation on plant species composition in mixed deciduous forest patches. | Jacquemyn, Hans, Jan Butaye, and Martin Hermy, Department of Land and Water Management, University of Leuven, Vital Decosterstraat 102, B-3000 Leuven, Belgium. Spatio-temporal effects of forest fragmentation on plant species composition in mixed deciduous forest patches. Islands and terrestrial habitat patches isolated by the development of the surrounding landscape traditionally have been studied in terms of species richness (alpha-diversity) whereas patterns of species composition (beta-diversity) have received far less attention. Predictable patterns of species composition may be produced by both local and regional processes, which restrict the community pool to some subset of the regional species pool. By linking information of the exact spatial relations among patches, differences in age and habitat using extensions of the classical Mantel test, we tested the hypothesis that for 241 small and isolated forest patches embedded in a hostile agricultural landscape among-patch variation in species composition can be attributed to 1) differences in inter-patch distance, 2) differences in age or habitat or 3) a complex interaction of spatial and temporal aspects of fragmentation. Disentangling the relative importance of both spatial and temporal factors of fragmentation is of utmost importance for the development of more comprehensive guidelines for afforestation and forest conservation. Our results clearly show that the regulation of community structure is not only internally generated, but external processes such as dispersal may be important features explaining community structure in small and isolated forest patches. Hence, consideration of explicit spatial relations among forest patches is necessary for management of local ensembles of plants within patches. The general conclusion is that the goal of forest conservation is not to stop landscape change, not to try to conserve the status quo, but rather to ensure that populations continue to respond to landscape changes. | Landscape Pattern and Population Dynamics and Species Distribution |

| 125. jagerhi @ornl.gov | Oral/Regional | Jager1, Henriette Jim, Chandler2, Ken Lepla1, Annett Sullivan1, Webb Van Winkle3 1Oak Ridge National Laboratory, Oak Ridge, TN, USA, 2Idaho Power Co., Boise, ID, USA; 3Environmental consultant, Boise, ID, USA. A simulation study of how dams influence white sturgeon populations at three spatial scales. | Jager1, Henriette, Jim, Chandler2, Ken Lepla1, Annett Sullivan1, Webb Van Winkle3 1Oak Ridge National Laboratory, Oak Ridge, TN, USA, 2Idaho Power Co., Boise, ID, USA; 3Environmental consultant, Boise, ID, USA. A simulation study of how dams influence white sturgeon populations at three spatial scales. Most of the world's large rivers are fragmented by dams that provide benefits to society but have adverse effects on some fish populations. In order to study the spatial influences of dams on white sturgeon populations, we developed a hierarchy of models. These models revealed effects that operated at three different spatial scales: (1) the metapopulation scale that encompasses the whole river, (2) the population scale for populations that occupy river segments between dams, and (3) the individual scale that considers spatial heterogeneity within segments. At the metapopulation scale, dams alter metapopulation dynamics by blocking upstream movements between adjacent river segments. Simulations indicated that unbalanced migration had a negative effect on upstream populations. At the population scale, fragmentation has both quantitative and qualitative effects on fish habitat: (1) the overall amount of river habitat decreases and (2) the quality of habitat is altered because free-flowing habitat is converted to reservoir. For white sturgeon, we assumed that high flows were required for spawning and that episodic high mortality occurred in reservoirs with water quality problems. Simulated populations distributed among many, short river segments were more likely to reach local extinction, particularly when free-flowing habitat was eliminated, than those in fewer, long river segments. At the individual scale, our estimates of mortality associated with poor water quality in reservoirs depended strongly on model assumptions about the ability of white sturgeon to move to avoid local areas with anoxic water. We will now use the metapopulation model to compare management alternatives designed to reconnect subpopulations by translocation, upstream passage, or stocking. | Landscape Pattern and Population Processes |

| 126. mjaithe @ciesin.columbia.edu | Poster | Jaiteh1, Malanding S., Paul V. Desanker2 and Jiquan Chen3. 1Center for International Earth Science Information Network (CIESIN), Columbia University, 2Department of Environmental Science, University of Virginia, Clark Hall, Charlottesville, VA 22903; 3School of Forestry and Wood Products, Michigan Technological University, Houghton MI 49931. Land Use Change and Urban Ecology. | Jaiteh1, Malanding S., Paul V. Desanker2 and Jiquan Chen3. 1Center for International Earth Science Information Network (CIESIN), Columbia University, 2Department of Environmental Science, University of Virginia, Clark Hall, Charlottesville, VA 22903; 3School of Forestry and Wood Products, Michigan Technological University, 1400 Townsend Drive, Houghton MI 49931. Land Use Change and Urban Ecology. | Land Use Change and Urban Ecology |

---

| Atlantic Region. | increased quantity and toxicity of runoff and air pollution. A significant component of this initiative is the analysis of multiple scales and variables at work in current models, and the potential for their integration. ORD has evaluated 22 existing models of land-use change and related environmental impacts in the publication, “Projecting Land-Use Change: A Summary of Models for Assessing the Effects of Community Growth and Change on Land-Use Patterns” (EPA publication number EPA/600/R-00/098). Final reports will be available for distribution in January, 2001. | | | |
The Miombo, extending over 2.7 million km² is the most extensive dry woodland ecosystem in Africa. An estimated 55 million people are directly dependent on the ecosystems for settlement, cropland, grazing and woodfuels. A combination of anthropogenic activities (land use) and natural disturbances (drought and wildfires) has resulted in a significant modification of extensive areas of the Miombo with direct influence on regional biological diversity, climate and biogeochemical processes. The objective of this study was to analyze how spatial characteristics had changed within agricultural and forested landscapes between 1984 and 1995. Land cover maps derived from Landsat Thematic Mapper scenes of central Malawi acquired in 1984 and 1995 were used to characterize landscape change within shifting cultivation (extensive agriculture in forest areas), permanent settlement (intensive agricultural matrix areas) and Protected National Park (Brachystegia woodland) areas. Fragmentation of woodland covers particularly closed woodland was greatest in shifting cultivation areas with mean patch size decreasing from 27 to 17ha. In permanent settlement areas, cropland area increased 52% compared to 14% and 7% in shifting cultivation and National Park areas, respectively. New cropland areas in the permanent settlement areas came from natural woodland. This study provided evidence that landscape patterning within the Miombo is directly influenced by the intensity of human use.

Self-organizing complex systems generate a variety of behavioral patterns. Two contrasting types of organization, hierarchical and SOC, are commonly identified in ecological systems. Hierarchical organization is characterized by the creation of scale dependence; processes and patterns occur in specific scale domains. In contrast self-organized criticality (SOC) is characterized by scale invariance; system dynamics and patterns span all scales, there is no characteristic event or patch size. Here, we explicitly compare these two organizational structures, examining the conditions which promote their development and their effect on system functioning. A conceptual model is proposed that system organization, hierarchical or SOC, is mediated by environmental variability. In environments of high variability, hierarchical structure could be favored because it constrains system dynamics - it promotes metastability. In environments of low variability, fractal structure could provide a mechanism for generating novelty and promoting long rang coherence of the system. We explore the interactions of these differing system organizations by coupling a new ecosystem model that generates hierarchical structure with a simple fire model which generates self-organized critical behavior. The ecosystem model simulates the interactions of two vegetation functional groups, nitrogen fixers and non-fixers, as well as nitrogen dynamics. When initialized randomly, the model generates a dynamic spatial heterogeneity where vegetation types and nitrogen patterns form discrete clumps, hierarchical units. By coupling this model with a fire model that exhibits SOC, the interactions between these two organizational characteristics can be examined. Explicitly examining how model systems become organized will help us understand the functioning of real systems.

Soil organic matter (SOM) measurements were obtained from 200 sampling sites in central Arizona. The samples were distributed in a spatially stratified random design that encompassed an area of 6387 km². The study area includes the urbanized, suburbanized, and agricultural areas of metropolitan Phoenix and the surrounding native desert ecosystem. The objective of this study was to determine the spatial pattern of SOM content and then to scale-up the point measurements to generate a regional SOM estimate. We hypothesized that land cover would be an important factor explaining the variability of SOM content. In addition, we also hypothesized that the multiple stressors associated with urbanization would be
<table>
<thead>
<tr>
<th>129. <a href="mailto:alan@clemson.edu">alan@clemson.edu</a></th>
<th>Poster</th>
<th>Johnson, Alan R. and Karen M. Eisenreich. Department of Environmental Toxicology, Clemson University, Pendleton, SC, 29670, USA. Integrating Landscape Ecology into Ecological Risk Assessment.</th>
<th>Landscape Conservation, Management and Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>130. <a href="mailto:ljohnson@d.umn.edu">ljohnson@d.umn.edu</a></td>
<td>Special: Dent’s</td>
<td>Johnson, Lucinda B., Natural Resources Research Institute, University of Minnesota, Duluth, MN 55811, USA. Influence of landscape versus local scale factors on wood in low gradient streams.</td>
<td>Pattern and process in aquatic ecosystems: how patches and networks affect ecosystem function</td>
</tr>
<tr>
<td>131. <a href="mailto:dmkashian@students.wisc.edu">dmkashian@students.wisc.edu</a></td>
<td>Poster</td>
<td>Kashian¹, Daniel M. and Monica G. Turner². Departments of Zoology and Forest Ecology and Management, University of Wisconsin-Madison, Madison, WI 53706, USA; Departments of Zoology and Forest Ecology and Management, University of Wisconsin-Madison, Madison, WI 53706, USA; Department of Zoology, University of Wisconsin-Madison, Madison, WI 53706, USA. The persistence of landscape legacies following catastrophic fire in Yellowstone National Park.</td>
<td>Disturbance and Landscape Pattern Interactions</td>
</tr>
</tbody>
</table>

Ecosystem processes in streams are influenced by factors that operate over a large range of spatial and temporal scales. In streams, wood influences a variety of ecosystem processes by controlling some fundamental physical properties important to stream benthic and pelagic communities, including the flow regime, organic matter budgets, habitat structure. In low gradient, Midwestern streams, wood is scarcer relative to forested streams studied intensively in the southeastern US and the Pacific Northwest. Although scarce and highly mobile, wood plays an important role in structuring the aquatic invertebrate community. Wood abundance is best predicted by landscape features, while the number and size of debris dams is best predicted by a combination of local and landscape features, reflecting channel scale control over wood retention. Underlying hydrologic factors controlled by landform strongly influence the stability of woody structures. Landscape features that positively associated with wood abundance include link number (related to catchment size), low-density residential landuse, and topographically heterogeneous catchments. These areas are associated with landscape characteristics that are not amenable to agricultural production. Debris accumulations also are associated with residential landuse, but also are controlled by channel dimensions and the amount of open tree canopy. While wood abundance in small, forested streams is predominantly controlled by channel dimensions, wood in these Midwestern streams is largely source-controlled, with lesser control exhibited by the stream channel, since log dimensions are generally much smaller than channel widths. To fully understand factors controlling wood abundance, both local and landscape factors must be considered.

It is well known that landscape pattern is important for ecological processes, and thus understanding the biogeochemical controls in this region.
factors controlling landscape pattern is crucial for predicting ecosystem dynamics and vegetation development in disturbance-prone landscapes. The 1988 fires in Yellowstone National Park created a complex spatial pattern of lodgepole pine (Pinus contorta var. latifolia) seedling stands of differing structures across the landscape, but the spatio-temporal dynamics of post-disturbance heterogeneity such as this are poorly understood. We examined the long-term development of patches (mature forest stands of varying age) that constitute the Yellowstone mosaic to understand the degree to which major disturbances determine landscape pattern. We combined empirical measurements of tree density and age structure for stands in four age classes (50-100, 125-175 years, 200-250 years, and 300-350 years) with a simulation model to predict changes in the post-1988 landscape pattern over the scale of centuries. Preliminary results indicate that dynamics of the landscape mosaic depend on (i) magnitudes and rates of change in stand structure, (ii) the relative proportion of stand density classes across the landscape, and (iii) the initial spatial arrangement of patches produced by the disturbance. Initially dissimilar patches within the mosaic tend to coalesce with time since disturbance due to stand-level processes such as self-thinning or colonization, but coalescence depends on the initial spatial arrangement and level of dissimilarity between these patches. Thus, spatial heterogeneity of the landscape declines with time since disturbance despite the strong initial patterning imposed by the disturbance.

Keane, R.E. and R. Parsons.  USDA Forest Service Fire Sciences Laboratory, Missoula, MT 59807, USA.  Limitations of the Simulation Approach to Estimate Historical Range and Variation of Landscape Patch Dynamics.  Landscape patterns in the western United States are shaped by the interaction of fire and succession, and conversely, these vegetation patterns influence fire dynamics and plant colonization processes. Historical landscape pattern dynamics can be used to assess current landscape conditions and to design spatial characteristics for management activities. Historical range and variability (HRV) of landscape composition and structure can be quantified from simulated chronosequences of landscape vegetation and used (1) to describe temporal landscape characteristics, (2) to develop baseline threshold values, and (3) to design treatment guidelines for ecosystem management. But, this simulation approach has many limitations. To demonstrate the advantages and disadvantages of this approach, we performed several experiments using the spatially explicit, multiple pathway model LANDSUM (a LANDscape SUccession Model) to simulate a suite of landscapes in the Pacific Northwest of the United States. The experiments evaluated 1) the effect of effect of landscape size on pattern metrics, 2) simulation time spans of 100, 500, and 1,000 years and intervals 5, 10, 25 and 50 years to determine optimal output generation parameters, 3) the effect of topography on landscape...


Local species diversity in urban environments is influenced by the regional species pool, habitat diversity and productivity within the city, and landscape configuration. Studies on urban bird communities have focused more on habitat factors, but less on landscape structures, such as corridors, that influence species distribution. We studied the influence of riparian corridors on the distribution of Abert's Towhee (Pipilo aberti), a common resident of Arizona, in urban areas. Previous studies describe this species as common in residential habitats in Phoenix, but scarce in Tucson, though it is common in natural habitats surrounding both cities. An important difference between these cities is that several major riparian corridors cross-residential habitats in Phoenix, but not in Tucson. We tested the hypothesis that these riparian corridors influence the distribution and abundance of Abert's Towhee in Phoenix. We estimated Towhee abundance from 51 locations throughout the Phoenix area. We found that Towhees did not occupy all neighborhoods, and that their abundance decreased with distance from riparian corridor. This suggests that riparian corridors may facilitate towhee dispersal into residential habitats, and that the lack of such corridors in Tucson may explain their absence. The lack of towhees from neighborhoods far from riparian corridors may suggest landscape mediated source-sink population dynamics along a riparian-residential habitat gradient. We suggest that studies on residential habitat used by bird species need to incorporate appropriately large spatial scales and landscape elements, since data from only one city, regardless of size, may represent pseudoreplication.

133.  Poster  Keane, R.E. and R. Parsons. USDA Forest Service Fire Sciences Laboratory, Missoula, MT 59807, USA. Limitations of the Simulation Approach to Estimate Historical Range and Variation of Landscape Patch Dynamics.  Keane, R.E. and R. Parsons. USDA Forest Service Fire Sciences Laboratory, Missoula, MT 59807, USA. Limitations of the Simulation Approach to Estimate Historical Range and Variation of Landscape Patch Dynamics.  Landscape Pattern and Population Dynamics and Species Distribution.
metrics, 4) the effect of landscape shape on pattern metrics, 5) the influence of initial conditions on landscape metrics output, and last, 6) the sensitivity of input fire probabilities and transition times on landscape pattern. Results of these simulation tests are presented along with recommendations for employing simulation techniques to quantify landscape pattern HRV for fire management considerations.

| 134. rkeane@fs.fed.us | Special: Keane's | Keane¹, R.E., and S. Lavoreli². USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, P.O. Box 8089, Missoula, MT 59807, USA; ²CEFE - CNRS UPR 9056, 1919 Route de Mende, 34293 Montpellier Cedex 05, France. **A classification of landscape fire succession models: Presentation and Discussion.**
| Timothy Keitt@SUNYSB.Edu | Keitt, Timothy H. Department of Ecology and Evolution, State University of New York at Stony Brook, Stony Brook, NY 11794 USA. **Statistical Mechanics of a Continent-Wide Biological Survey.**
| kepner.william@epa.gov | Oral/Re | Kepner¹, W.G., S.N. Miller², M. Hernandez³, R.C. Miller², D.C. Goodrich⁴, C.M. Edmonds⁵, F. K. Devonald², L. Li⁶, and P. Miller⁷. ¹U.S. Environmental Protection Agency, National Exposure Research Laboratory, Las Vegas, Nevada, USA; ²USDA–Agricultural Research Service, Southwest Watershed Research Center, Tucson, Arizona, USA; ³U.S. Environmental Protection Agency, National Center for Environmental Assessment, Albuquerque, New Mexico, USA; ⁴USDA–Agricultural Research Service, Southwest Watershed Research Center, Tucson, Arizona, USA; ⁵U.S. Environmental Protection Agency, National Center for Environmental Research, Washington, D.C., USA; ⁶University of New Mexico, Department of Biology, Albuquerque, New Mexico, USA. **An Evaluation of Hydrologic Response to 25 Years of Landscape Change in a Semi-arid Watershed.**

This presentation will summarize the talks during the special session, and then present a classification and corresponding key for landscape fire succession models. Landscape fire succession models (LFSM) are those computer programs that simulate the processes of fire and succession in a spatial domain. The purpose of this classification is to support an ongoing model evaluation project sponsored by the Landscape Fire working Group (Group 2.2.2) of the Global Change and Terrestrial Ecosystems (GCTE) organization, an integral part of IGBP. This group is charged with exploring the interaction of fire and ecosystems at the landscape level to further understand this complex dynamic, and also to develop a strategy for incorporating fire into coarse scale DGVMs (Dynamic Global Vegetation Models coarsely simulate the migration of vegetation types across the globe as climate changes). We would like to solicit comments on the classification and promote a spirited discussion on the application of LFSM to coarse scale fire modeling.

| keane@fs.fed.us | Oral/Re | Kepner³, W.G., S.N. Miller⁴, M. Hernandez⁵, R.C. Miller⁴, D.C. Goodrich⁶, C.M. Edmonds⁷, F. K. Devonald⁸, L. Li⁹, and P. Miller¹⁰. ³U.S. Environmental Protection Agency, National Exposure Research Laboratory, Las Vegas, Nevada, USA; ⁴USDA–Agricultural Research Service, Southwest Watershed Research Center, Tucson, Arizona, USA; ⁵U.S. Environmental Protection Agency, National Center for Environmental Research, Washington, D.C., USA; ⁶University of New Mexico, Department of Biology, Albuquerque, New Mexico, USA. **An Evaluation of Hydrologic Response to 25 Years of Landscape Change in a Semi-arid Watershed.**

The assessment of land use and land cover is an extremely important activity for contemporary land management. A large body of current literature suggests that human land-use practices are the most important factor influencing natural resource management at multiple scales. During the past two decades important advances in the integration of remote imagery, computer processing, and spatial analysis technologies have allowed the examination of environmental change. Recently, changes have been documented over a period of approximately 25 years in a semi-arid watershed using a series of remotely sensed images. Landscape change analysis has been linked with distributed hydrologic models...
Environmental Research, Washington, D.C., USA; University of New Mexico, Department of Biology, Albuquerque, New Mexico, USA. An Evaluation of Hydrologic Response to 25 Years of Landscape Change in a Semi-arid Watershed. To evaluate consequences of land cover change to hydrologic response. A landscape assessment tool using a geographic information system (GIS) has been developed that automates the parameterization of the Soil Water Assessment Tool (SWAT) hydrologic model. This tool was used to prepare parameter input files for the San Pedro Basin, a watershed originating in Sonora, Mexico and flowing into southeast Arizona which has undergone significant land cover change. Runoff and sediment yield were simulated using this model. Simulation results for the San Pedro indicate that increasing urban and agricultural areas and the correlative decline of grasslands resulted in increased annual runoff volumes, flashier flood response, and decreased water quality due to sediment loading. These results demonstrate the usefulness of integrating landscape change analysis and distributed hydrologic models through the use of GIS for assessing watershed condition and the relative impacts of land cover transitions on hydrologic response.

Kerkhoff, Andrew J., Scott N. Martens, and Bruce T. Milne. Department of Biology, University of New Mexico, Albuquerque, NM 87131, USA. Landscape ecohydrology and patterns of tree cover in semi-arid woodlands. Ecologists have long assumed that water-limited vegetation systems exist in some sort of equilibrium with their climatic and soil environments. Extending this assumption to a landscape context leads to the hypothesis that vegetation patterns result from adjustments in canopy density to maintain this equilibrium along climate and soil gradients. Recent "ecohydrological" approaches provide optimality criteria for quantitatively describing the climate-soil-vegetation equilibrium. These theories are generally based on point models of water-balance, and have not been examined in the context of climate and soil gradients. We explore this approach to landscape ecohydrology using spatially explicit data on the climate, soils, and vegetation of pinyon-juniper woodlands of the Sevilleta LTER site. Specifically, we ask whether gradients in energy and water input, along with soil variation, can be used to predict patterns of tree density over a complex topographic landscape. While woodland trees are broadly constrained by drought stress (as measured by annual water deficit), local tree density bears a complex relationship to both intraseasonal and interannual variation in energy and water input, as well as to alternative optimality criteria.

Kerkhoff, Andrew J., Scott N. Martens, and Bruce T. Milne. Department of Biology, University of New Mexico, Albuquerque, NM 87131, USA. Landscape ecohydrology and patterns of tree cover in semi-arid woodlands. Ecologists have long assumed that water-limited vegetation systems exist in some sort of equilibrium with their climatic and soil environments. Extending this assumption to a landscape context leads to the hypothesis that vegetation patterns result from adjustments in canopy density to maintain this equilibrium along climate and soil gradients. Recent "ecohydrological" approaches provide optimality criteria for quantitatively describing the climate-soil-vegetation equilibrium. These theories are generally based on point models of water-balance, and have not been examined in the context of climate and soil gradients. We explore this approach to landscape ecohydrology using spatially explicit data on the climate, soils, and vegetation of pinyon-juniper woodlands of the Sevilleta LTER site. Specifically, we ask whether gradients in energy and water input, along with soil variation, can be used to predict patterns of tree density over a complex topographic landscape. While woodland trees are broadly constrained by drought stress (as measured by annual water deficit), local tree density bears a complex relationship to both intraseasonal and interannual variation in energy and water input, as well as to alternative optimality criteria.

Ki-Hwan Cho, Do-Soon Cho1 and Sun-Kee Hong2. Department of Environmental Sciences, The Catholic University of Korea, Puchon, Korea; 2Department of Environmental Planning Institute, Seoul National University, Seoul, Korea. Landscape ecological functions of mountain ridges between a bioreserve and its neighboring forest in the Kwangnung area, Korea. This study was carried out to assess the ecological structure and function of mountain ridges that are connected to the Kwangnung Natural Reserve Forest (KNRF). Three ridges were surveyed and divided into two categories: one includes A and B ridges that were regenerated forests in the neighborhood of KNRF, the other is C ridge that was within the KNRF (from core zone to managed zone). The forest to which these ridges belonged had a lobe shape. The decline of species richness with distance from KNRF (peninsular effect) for all tree layer species or herbaceous layer species on A and B ridges were not found. However, if the species that were appeared in C1-C11 (core zone quadrats) were considered only, there was a significant decrease in tree and herbaceous species richness on these ridges. This means that the neighborhood forest of KNRF plays a role of buffer zone. It also implies that the peninsular effect at landscape scale is related to the loss of interior habitats. Vegetation survey indicates that successional stages and community structures were different between inner and outer ridges. The results of a DCA ordination of quadrats in A and B ridges, axis 1 was significantly correlated with distance from KNRF, indicating that KNRF affects the regeneration of the neighboring forest. The regenerating species were different at different distances from KNRF. The bioreserve is important to biodiversity conservation as well as ecological management of the neighboring forest.

King, Anthony W. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6335, USA. Top Ten Challenges for Landscape Ecology: A Middle-Number Systems Perspective. My top ten challenges for the future of landscape ecology are a mix of the old and new. Ranging from the old and persistent challenge of defining the scientific scope of landscape ecology to newer challenges of considering landscapes as complex adaptive systems, I will touch on some familiar themes of scaling and
| 140. | kirkpat @mail.ucf.edu | Poster | Kirkpatrick \(^1\), Lee Anne, and John F. Weishampel \(^2\). \(^1\)Liberal Studies Program and \(^2\)Department of Biology, University of Central Florida, Orlando, FL 32816-2368, USA. Quantifying structure in volumetric neutral landscapes. Though usually characterized as fractal planes, i.e., between one- and two-dimensions, certain natural land- or sea-scapes are better represented as fractal volumes, i.e., between two- and three-dimensions. For example, the architecture of a forest canopy, the distribution of plankton in an ocean column, or the below ground organization of ant burrows can be depicted as a fractal sponge with occupied areas and empty spaces. Recognizing that the quantification of spatial heterogeneity is essential to understanding the relationships between patterns and processes, ecologists have developed and evaluated a host of landscape indices (e.g., connectivity, patchiness, porosity, contagion, etc.) and analysis techniques (e.g., geostatistics, lacunarity, wavelet, fractal, etc.) for planar spatial patterns. For this study, we developed binary cubic counterparts (voxel) to the more familiar flat, crossword puzzle-like (pixel) neutral models to assist in characterizing the relationships between measured patterns and volumetric formations in natural systems. Model types included simple random, percolation gradient, patchy, and hierarchically organized structures. We generated numerous variations of these and assessed the ability of certain pattern metrics derived from the planar landscape analyses to discriminate among the structural models. These experiments provide a statistical benchmark for measuring pattern in complex volumetric formations. | Ecology: A Middle-Number Systems Perspective. | Landscape Characterization and Pattern Analysis |
| 141. | klopatek @asu.edu | Poster | Koerner, Brenda A., and Jeffrey M. Klopatek. Department of Plant Biology, Arizona State University, Tempe, AZ, USA. Anthropogenic and Natural CO\(_2\) Efflux in an Arid Urban Environment: Pattern and Processes. The effects of land use change on deserts may have significant impacts on ranging from regional climate modification to being significant carbon exchange sites. Changing the biological structure of these ecosystems through agriculture and urbanization by subsidization with water and energy, significantly changes the carbon stocks and fluxes. We document sources of CO\(_2\) emissions across the Phoenix, Arizona metropolitan region. The Phoenix region, composed of a diverse mosaic of patch types, is characterized by a CO\(_2\) dome that peaks near the urban center. The concentrations are high, not just because of anthropogenic sources, but also due to the physical geography of the area. Humans and their automobiles provide a substantial amount of emissions, that we show using a GIS based approach. We have measured significant diurnal cycles related to emissions, meteorology, and vegetation interactions. Soil CO\(_2\) efflux is controlled by vegetation type and watering regime. Ecosystems dominated by natural vegetation, during hot dry periods, experience minimal emissions. Conversely, human maintained vegetation (i.e. golf courses, irrigated agriculture, lawns) shows significant soil CO\(_2\) efflux that is temperature and soil moisture dependent. We present a graphical portrayal of soil CO\(_2\) emissions for the dominant land use types in the metropolitan region and discuss how this relates to the portrayal of global carbon cycling. | Koerner, Brenda A., and Jeffrey M. Klopatek. Department of Plant Biology, Arizona State University, Tempe, AZ, USA. Quantifying structure in volumetric neutral landscapes. | Landscape Pattern and Ecosystem Processes |
| 142. | nassaue r@umich.edu | Oral/Reg | Kosek, Sandra E. and Joan Iverson Nassauer. Department of Landscape Architecture, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109, USA. Scale Influences on the Perception of Landscapes Designed for Ecological Function. Large-scale land cover patterns are aggregations of smaller scale design decisions resulting from parcelization that rarely take note of the ecologically functional characteristics of the larger landscape upon which they are imposed. This results in a dichotomy, and typically a conflict, between the scale of land ownership and the scale of landscape ecological function. At the scale of land ownership, what each land owner perceives about the landscape affects their decisions about the management of their parcel. The different management practices implemented by many land owners at the scale of residential parcels can result in habitat fragmentation and other negative effects on the ecology of the landscape. We surveyed 325 environmental group members and other residents of Southeast Michigan to determine their responses to two scales of landscape designs: front yards (0.1 ha) and subdivisions up to 150 ha. | Kosek, Sandra E. and Joan Iverson Nassauer. Department of Landscape Architecture, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109, USA. Scale Influences on the Perception of Landscapes Designed for Ecological Function. | Land Use Planning and Landscape Architecture |
| 143. | tkkratz @facsta ff.wisc.e du | Oral/Re g | Kratz1, Tim K., Thomas R. Harbik1, John J. Magnuson1, and Katherine E. Webster1,2. 1Center for Limnology, University of Wisconsin-Madison, Madison, WI 53706, USA; 2Wisconsin Department of Natural Resources, 1350 Femrite Dr., Monona, WI 53716, USA. The Role of Landscape Position in Lake Structure and Dynamics. | Each scale included a range of design treatments that varied in ecological function. At the subdivision scale, design treatments characterized by the most beneficial ecological function, with less lawn area and more forest or prairie, were more attractive to both groups. In contrast, at the front yard scale, the most ecologically beneficial designs were not found to be as attractive as designs that were moderate or low in ecological benefits, both of which included larger mown lawn areas. This scale difference in perception of the most ecologically beneficial residential landscapes suggests that designs that include larger ecologically beneficial patches within the design of an entire subdivision have more widely recognized cultural value than small patches on individual homeowners' parcels. | Pattern and process in aquatic ecosystems: how patches and networks affect ecosystem function |
| 144. | meg.kr awchuk @acadi au.ca | Oral/Re g | Krawchuk, Meg and Phil Taylor. Biology Department, ACWERN, Acadia University, Wolfville, NS B0P 1X0, Canada. The relative importance of habitat structure changes within a nested hierarchy of spatial scales for three species of insects. | The larvae of three dipterans develop within the leaves of the pitcher plant, providing naturally nested levels of scale including leaves within plants within clusters within bogs. A census of the three species was used to assess the influence of amount and configuration of habitat on distribution within this discrete hierarchy of spatial scales. In general, species responded to amount of habitat at relative fine (individual) spatial scales, and configuration of habitat at broader scales, though each responded at slightly different absolute scales. The study emphasizes that both amount and configuration of habitat are important determinants of organism distribution. | Landscape Pattern and Species Distribution |
| 145. | valen@ pik-potsdama m.de | Oral/Re g | Krysanova, Valentina and Frank Wechsung. Potsdam Institute for Climate Impact Research, P.O.Box 601203, Telegrafenberg, 14412 Potsdam, Germany. West-European trends in agriculture and their impact on ecohydrological processes: A modelling study in the state of Brandenburg. | During the last decade a tendency towards deintensification of agricultural land occurred in the state of Brandenburg, Germany, as in whole Western Europe, caused by a saturated market for agricultural commodities, less public acceptance for a subsidised agricultural production, and environmental pollution. The expansion of the EU and policy changes described in the Agenda 2000 indicate that this tendency will remain. Two possible ways of deintensification are: 1) an increase in temporary set-aside within crop rotations (the main measure applied during the last decade in Brandenburg), and 2) creation of buffer zones along river courses (river corridors) by converting arable land inside them into grassland (permanent set-aside). In our simulation study we explored the impact of temporary and permanent set-aside on regional water balance and nitrogen leaching to groundwater in Brandenburg. Simulations were made. | Landscape Pattern and Ecosystem Processes |
performed using the regional ecohydrological model SWIM, which integrates hydrological processes, crop/vegetation growth, erosion, and nutrient dynamics in soil and water. The model was used to simulate the consequences of land use change scenarios on main components of the regional water balance and nitrogen leaching. While positive trends were found for water quality, two opposite tendencies were established by introducing temporary and permanent set-aside on water resources. The temporary set-aside increased runoff from the whole area up to 6.7% due to lower evapotranspiration and higher soil moisture in arable land, while the conversion of agricultural land within river corridors to meadows had an opposite effect on regional runoff (-6.9%) due to higher water retention and higher evapotranspiration.

| 146. | kuperf@email.arizona.edu | Oral/Poster | Kuperf, John, and Scott Franklin. 1Department of Geography and Regional Development, University of Arizona, Tucson, AZ 85721, USA; 2Department of Biology, University of Memphis, Memphis, TN 38152, USA. Evaluation of an Ecological Land Type Classification System, Natchez Trace State Forest, Western Tennessee, USA. | Landscape Mapping and Characterization: Methods and Applications |
| 147. | laurente@msu.edu | Poster | Laurent, E.J., and Bruce Kingsbury. Center for Reptile and Amphibian Conservation and Management and the Department of Biology, Indiana-Purdue University, Fort Wayne, IN 46805-1499, USA; 2Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI 48824-1222, USA. Validation and Nullification of a Predictive Model for Habitat Context: the Effects of Location and Landcover Classification. | Landscape Pattern and Population Dynamics and Species Distribution |
| 148. | lawler, John, J., Denis White, and Jean C. Sifneos. 1NRC fellow, US EPA, National Health and Environment Laboratory, Cincinnati, OH 45268, USA; 2University of Memphis, Memphis, TN 38152, USA. 3Institute for Forestry and Natural Areas, University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA. 4Department of Zoology, University of Florida, Gainesville, FL 32611, USA. The Effects of Land Use Change on Species Distribution, Dynamics and Population Landscape Pattern and Characterization: Methods and Applications | Assessing Current |
Environmental Effects Laboratory, Corvallis, OR. 2 US EPA, National Health and Environmental Effects Laboratory, Corvallis, OR. 3 Department of Geosciences, Oregon State University, Corvallis, OR. Ecoregions and vertebrate assemblages: investigating indicators for prioritizing areas of conservation concern.

Surrogates and indicator groups have been proposed as useful tools for selecting areas for conservation when the knowledge of species distributions is limited. Tests of these concepts often produce a wide range of results which depend on the surrogates chosen as well as the spatial scale of the study. We investigated the use of both individual taxa and ecoregions as possible surrogates for all vertebrates for prioritizing areas for conservation in the Mid-Atlantic region of the U.S. First we investigated the degree to which species richness of birds, mammals, amphibians, reptiles, and fish were correlated. Then we defined species assemblages for each taxon using cluster analysis and measured the level of correspondence between the assemblages and ecoregions in the study area. Finally, we employed the concept of complementarity to determine the proportion of all vertebrates included in areas selected to cover all species of a particular taxon, or a minimum area of all ecoregions. Species richness was only weakly correlated across the four taxa (ranging from uncorrelated to r=0.55 for birds and mammals). In addition, species assemblages derived from cluster analyses showed a moderate level of correspondence with ecoregions (50-76% agreement as measured with classification tree models). Despite these relatively weak associations, we found that both individual taxa and ecoregions showed potential for being good surrogates with respect to complementarity. Ecoregions, fish and reptiles were the best surrogates covering 86%, 83%, and 79% of all other species respectively. Our results stress that although patterns of species richness may be only weakly correlated, individual taxa or ecoregions which capture a range of environmental conditions may be useful surrogates or indicators when areas are selected on the basis of complementarity.

We analyzed the spatial dispersion of Loggerhead Shrikes at three different scales (local population, regional metapopulation, and continental geography population) to find out the hierarchical pattern of spatial structure. At local scale, the survey data of breeding shrike territories at San Clemente Island showed that nearest neighbor distances were closer than habitat model predicted. The shrikes breeding territories dispersed in clustered pattern. It suggests some degree of conspecific attraction for territory establishing in male loggerhead shrikes. Above local population level, the local population, instead of individual, dispersion was analyzed. For regional metapopulation level, we examined a data set combined field notes and biological survey in western Riverside. For continental level, we used the national wide breeding bird survey data for the studies. The study will show a hierarchical pattern of spatial structure in different scales.

---

**Top 10 List (Mail in)**

1. Optimization of regional land-use patterns
   * problems of reserve design in terrestrial and aquatic systems
   * optimization under uncertainty
   * accommodating mobile species across multiple scales
   * scenario development
   * resolving multiple uses
2. Valuation of ecosystem services
   * utilitarian and other ethical perspectives
   * bases for comparison among alternative choices
3. Integration of human and natural systems
   * ecosystems and socioeconomic systems
   * property rights and local control
4. Spread of invading species
**multiple modes of dispersal**  
**species interactions**

**II. CONCEPTUAL and METHODOLOGICAL ISSUES**

1. Separating and integrating exogenous and endogenous influences  
   - pattern formation in heterogeneous landscapes  
   - integrated modeling

2. Ecosystems and the biosphere as complex adaptive systems  
   - macroscopic patterns in relation to the level of selection  
   - ecological and evolutionary trends in resiliency  
   - determinants of levels of biodiversity

3. Interfaces between population biology and ecosystems science  
   - evolution and the constancy of element ratios  
   - evolution and the development of modularity  
   - evolution and consequences of dispersal and other traits  
   - stability of element cycles  
   - structure-functioning relationships - a functional taxonomy  
   - biodiversity and ecosystem functioning  
   - food webs and resiliency

4. Problems of scaling  
   - from the individual to the aggregation  
   - from the small-scale to the large-scale  
   - from the species to the functional group  
   - renormalization methods  
   - dealing with multiple temporal scales and phase transitions

5. Dimensional reduction  
   - Simplifying complex models  
   - Lumping into functional groups

6. Terrestrial/marine comparisons  
   - Role of mixing

---

**Li, Bai-Lian. Department of Biology, University of New Mexico, Albuquerque, New Mexico 87131, USA. Spatiotemporal Complexity of Nonlinear Ecological Interactions.**

The exploration of complex spatiotemporal pattern formation mechanisms in a nonlinear complex system is increasingly becoming an important issue in natural, social, and technological sciences. The occurrence of multiple steady states and transitions from one to another after critical fluctuations, the phenomena of excitability, oscillations, waves and, in general, the emergence of macroscopic order from microscopic interactions in various nonlinear nonequilibrium systems in nature and society has required and stimulated many theoretical and, where possible, experimental studies. The classical approach to the solution of the problem of the origin of spatial structures was first developed by Turing (1952) and then elaborated by some followers. The results obtained in the course of these investigations indicate that the initially uniform distribution of reacting components can become unstable. As the instability develops further, a spatially nonuniform distribution of activators and inhibitors of the reaction occurs. The Turing pattern formation is based on the coupling of linear diffusivity of the activator is less than the diffusivity of the inhibitor. A major unsolved problem with the Turing approach is that the clear identification of activators and inhibitors which could be involved in the formation of patterns in chemical, biological or social systems is still missing and even seems hardly to be achieved. Nowadays, more realistic theoretical approaches are in progress. They are accounting for complex spatiotemporal dynamics of open spatially confined systems with the interaction between intrinsic dynamics and external forcing due to the impact of the system environment. This talk will introduce our recent work on this problem, especially on the processes underlying the dynamics of ecological interactions in spatially inhomogeneous aquatic systems to explain why the heterogeneity of the species spatial distribution can not always be reduced to the heterogeneity of the marine environment.

**Li, Chao. Northern Forestry Centre, Canadian Forest Service, Edmonton, Alberta, Canada T6H 3S5. Landscape Structure Based Simulation of Natural Fire Regimes.**

**Complexity Theory and Ecological Applications**

**Landscape Fire Succession**
The idea of emulating natural fire regimes in harvest planning to achieve the goals of sustainable forest resource development and biodiversity maintenance has been widely discussed and accepted in central and western Canada. This idea was based on the belief that “Mother Nature knows the best”. To implement this idea in practical forest resource management, managers need to know the natural fire size distributions and their spatial and temporal patterns, in order to decide the sizes of cutting patches over space and time. However, this information is not always available in most managed areas. The empirical methods of reconstructing natural fire regimes were well documented, but the associated errors demand often made them difficult or even impossible to be carried out. Therefore, the ecological modeling approach becomes an alternative for providing forest managers with such information. In this presentation, a methodology of reconstructing natural fire regimes based on current forest landscape structure shall be described. This methodology was based on the premise that a fire regime was the result of interactions among fire events, landscape structures, topography, weather, and fuels. A spatially explicit model for landscape dynamics (SEM-LAND) was developed for this purpose, and was validated in a study area in west-central Alberta. With the information of current landscape structure, a natural fire regime map can be generated from the application of this model.

The premises and problems with spatial analysis in landscape ecology

The growing concerns about global climate change have led to the international agreement of the Kyoto Protocol that calls for reduction of greenhouse gas emissions. However, the implementation of the Kyoto Protocol would require better estimates of carbon fluxes and pools at large scales. To get such estimates, one must scale up finer-scale information under great uncertainty because errors from many sources may propagate through the estimation processes. In this study, we examine and compare three methods to quantify uncertainty: the probability theory, the Taylor series approximation, and the Monte Carlo simulation. Errors propagate in the modeling process when the variances of the predictive variables get combined and when the output of one process (or operation) becomes the input of another. Using carbon estimates in peat soils of Finland as an example, we identify error sources, calculate the relative contribution of each source to the total uncertainty, and determine critical factors that are the most important sources of errors. For the analysis of carbon storage in peat soils, the four error sources (bulk density, carbon content, peat depth, total area of a forest type) contribute equally to the uncertainty because of the simple model structure used. All three methods work well. For analysis of carbon fluxes, more processes (e.g., plant growth, soil and root respiration, OM decomposition) must be included. Model
complexity and error sources increase. Only the Monte Carlo method handles this increased complexity. Uncertainties in both cases are high and must be reduced to arrive at useful estimates.

<table>
<thead>
<tr>
<th>155.</th>
<th>Top 10</th>
<th>Lieberman, Arthur S. (Professor Emeritus of Physical Environmental Quality at Cornell University), Rehov Shimkin 21, Ahuza 34750, Haifa, Israel. <strong>Top 10 list for landscape ecology.</strong> (Conveyed by J. Wu)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1. It is imperative that the visibility of holistic landscape ecology be heightened at universities in the U.S.A. and Canada, through full-time semester courses, workshops and problem-solving conferences. Emphasis on holistic thinking and research needs to be built into departments of urban and regional planning, landscape architecture, natural resources, and human ecology.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Training in holistic landscape ecology should be developed and conducted across North America in localities and regions for specialized audiences of decision-makers, planners and other professionals, as well as extension specialists and agents in land grant colleges in each of the states.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Long-term ecological research should increasingly include holistic landscape ecology focuses dealing with total human ecosystems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Because the findings of holistic landscape ecology research are often too difficult for the public and officials to comprehend, they must be “distilled” into semi-popular language.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. A bridging network of H.L.E. researchers, educators, practitioners and professional planners should be developed within the U.S. Section of IALE.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. The U.S. section of IALE should have an annual session that deals with holistic landscape ecology. This should also be the case in conferences of “General Ecology” groups as well.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Holistic landscape ecology educators and practitioners need to produce a guide to pressing land and resource issues in the U.S.A. and Canada, and for international/regional/local goals for ecodiversity/open space and landscape protection, showing how H.L.E. can be put to work.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. A brief, defining and clearly understood publication on holistic landscape ecology should be prepared, to sharpen the understanding of focuses, content and achievements for a variety of North American audiences.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9. In response to print and electronic mass medias attention to urban sprawl and misguided land-use determinations, H.L.E. committed ecologists need to make the relevance of their science’s perspectives known in these same media, for societal benefit in North America and internationally.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10. Holistic landscape ecology is noteworthy for its inclusion of the human societal dimension, which is too often excluded in other landscape ecology circles. Even in issues that seem to be strictly bio-ecological, human factors need to be in the picture. Today’s realities dictate such an approach, as well as scientific rigor!</td>
</tr>
</tbody>
</table>

| 156. | Oral/Reg | Lin¹,², Yu-Pin, Tung-po Teng² and Chen-Fa Wu¹.¹Department of Landscape Architecture, Chinese Culture University, Taipei, Taiwan 11114; ²Department of Geography, Chinese Culture University. **Spatial continuity and fragmentation analysis of vegetation landscape at Lugiaakan conservation area in Taiwan.** |
|      |          | The spatial patterns of vegetation may influence the ecological process and management in its environment, especially in conservation areas. Therefore, the systematic monitoring and spatial structural analysis of vegetation spatial variability are the most important issues for conservation management. This study conducted variography, indicator variography, Hausdorff-Besicovitch fractal dimension and geographic information system (GIS) to analyze the spatial continuity and fragmentation of the Normalized Different Vegetation Index (NDVI) of Lugiaakan conservation area in 1994 summer in the Yangmingshan National Park in Taiwan. The results revealed that the NDVI spatial structure of Lugiaakan Conservation Area. |

---

*Top 10 List (Mail in)*

| 156. | Oral/Reg | Lin¹,², Yu-Pin, Tung-po Teng² and Chen-Fa Wu¹.¹Department of Landscape Architecture, Chinese Culture University, Taipei, Taiwan 11114; ²Department of Geography, Chinese Culture University. **Spatial continuity and fragmentation analysis of vegetation landscape at Lugiaakan conservation area in Taiwan.** |

---

*Top 10 List (Mail in)*
area was a no nugget effect and geometric anisotropic exponential model with 780 m maximum range and 590 m minimum range. Moreover, the indicator variogram model of the 25th percentile NDVI was a 28.1% nugget effect and geometric anisotropic exponential model with 813 m maximum range and 1016 m minimum range. The indicator variogram model of the 75th percentile NDVI was a 27.0% nugget effect and geometric anisotropic exponential model with 947.1 m maximum range and 1227.3 m minimum range. Moreover, the highest Hausdorff-Besicovitch fractal dimensions of 25th and 75th NDVI were 1.901 and 1.851 in northeastern direction paralleled to topographical contour of this study area.

**157. yplin@staff.pccu.edu.tw**  
**Poster**  
Lin¹,², Yu-Pin, Tsun-Kuo Chang³, Tung-po Teng³ and Chen-Fa Wu¹. ¹Department of Landscape Architecture, Chinese Culture University, Taipei, Taiwan 11114; ²Graduate Institute of Agricultural Engineering, National Taiwan University, Taipei, Taiwan 10617; ³Department of Geography, Chinese Culture University, Taipei, Taiwan 11114. A study of Landscape diversity and soil heavy metal pollution in an agricultural landscape.

The soil of agricultural fields might be polluted by the wastewater, discharged into irrigation ditches, from human activities in Taiwan. This study used factor analysis and landscape diversity index of 55 16km² sampling sites in Changhua County in Taiwan to characterize the factor patterns among eight soil heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn), and to analyze the correlation between these factor patterns and landscape diversity to understand the characteristics soil heavy metals pollution and human activities. The results displayed that the agriculture-field was the matrix in this study area. Meanwhile, a four-factor model accounted for 92.03% of total variance in the measured soil heavy metal data of these 55 sampling sites. The first factor had high positive factor loading on Cd, Cr and Ni. The second factor had high positive factor loading on Cu, Pb and Zn. The third and forth factors had high positive loading on Hg and As, respectively. Moreover, only factor1 had significant relation with the landscape diversity index of these 55 sampling sites at the 0.05 level, according to the 2-tailed test. These results also implied that human activities dominated the local soil heavy metal pollution in this study area. Factors 3 and 4 had strongly no relation with landscape diversity. This might due to that soil parent material mineralogy may be a predominant factor in the total As content and Hg of soil. The results also displayed in geographic information system.

**158. lindemann@uwyo.edu**  
**Oral/Re g**  

Large, infrequent disturbances create long-lasting physical and biological impacts influencing ecosystem processes. On October 25th, 1997, an unusual windstorm occurred northeast of Steamboat Springs, Colorado, in the Routt National Forest. Over 10,000 ha of forested land were affected by this storm in an area over 15 km by 45 km. A number of predictors have been studied in the past to determine what causes windthrow to occur where it does. These factors range from the natural physical setting, past disturbances, human-caused or influenced features to the variation in wind patterns that occurred during the blowdown. All these factors, and the patches of the blown-down forest were mapped into a GIS for analyzing the 1997 Routt National forest blowdown, using ArcView, ArcInfo and GRASS. Two methods were used to determine which predictors were most influential in this particular blowdown. First, Classification and Regression Trees (CART) were used with S-Plus to create a map predicting the blowdown pattern. Second, Logistic Regression was used to create a probability map of areas that were susceptible to the blowdown. These models show that the blowdown was primarily influenced by topographical factors, such as the Continental Divide, elevation and wind exposure, with less dependency on biological or land-use factors. The complexity of the topography led to a highly variable mosaic of disturbance patches. The results of this study help us understand how natural disturbances, such as windthrow, interact with, and shape the structure of the surrounding landscape.

**159. lioubimtseva@gvsu.edu**  
**Oral/Re g**  
Lioubimtseva, Elena. Department of Geography and Planning, Grand Valley State University, Allendale, MI 49401, USA. Monitoring Changes in Arid Landscapes in Taiwan.

In Taiwan, there are several types of natural arid landscapes in this region, varying according to the mesoclimatic conditions. There are two main types: 1) the desert region of about 3.5 million sq. km comprises the entire Turan Lowland and the Kazakh hills. These desert landscapes are characterized by their sparse vegetation and minimal rainfall. The second type of arid landscape is found on cliffs and slopes, where wind throw, interact with, and shape the structure of the surrounding landscape. Over 10,000 ha of forested land were affected by this storm in an area over 15 km by 45 km. A number of predictors have been studied in the past to determine what causes windthrow to occur where it does. These factors range from the natural physical setting, past disturbances, human-caused or influenced features to the variation in wind patterns that occurred during the blowdown. All these factors, and the patches of the blown-down forest were mapped into a GIS for analyzing the 1997 Routt National forest blowdown, using ArcView, ArcInfo and GRASS. Two methods were used to determine which predictors were most influential in this particular blowdown. First, Classification and Regression Trees (CART) were used with S-Plus to create a map predicting the blowdown pattern. Second, Logistic Regression was used to create a probability map of areas that were susceptible to the blowdown. These models show that the blowdown was primarily influenced by topographical factors, such as the Continental Divide, elevation and wind exposure, with less dependency on biological or land-use factors. The complexity of the topography led to a highly variable mosaic of disturbance patches. The results of this study help us understand how natural disturbances, such as windthrow, interact with, and shape the structure of the surrounding landscape.
conditions, lithology of parent rocks and soil-vegetation relationships. As in many other arid regions of the world the influence of humans on the environment of Central Asia goes back a very long way. Except for the large oases alongside the major river valleys, where intensive irrigated agriculture was dominant for millennia, the most important human influences on the desert and semi-deserts biomes have been those connected with grazing. During the Soviet period, major efforts were focused on irrigation and monoculture development with extensive cotton plantations, especially in the southern desert biome, and cereal cultivation in the semi-desert. Analysis of temporal series of satellite data available since 1984 (NOAA-AVHRR and RESURS-MSU-SK imagery) and field research conducted in this region revealed dramatic transformation of landscape cover. Data interpretation resulted in the series of thematic maps including land cover change, landscape systems, and desertification. Several processes of human-induced landscape changes in this region comprise dramatic transformation of vegetation cover due to overgrazing and irrigation, salinization and petrification of soils, water and wind erosion as well as climatic changes caused the decrease of the Aral Sea level.

Changes in land use patterns and forest fragmentation over fifty years in the Baltimore area and their effects on forest composition and structure. The proximity of forestland to human development and land uses has increased rapidly in the Baltimore, Maryland area. Urban expansion and forest fragmentation reduce forest interior habitat, increase site disturbances, and often favor the invasion of exotic species. This study characterizes changes in land use patterns over the past 50 years and sets the stage for determining how these changes affect forest composition and structure. Historic data from periodic forest surveys conducted by the USDA Forest Service's Forest Inventory and Analysis (FIA) unit were analyzed in Anne Arundel and Baltimore counties. Contextual information surrounding each inventory plot was compiled by photointerpreting and digitally mapping land uses within one kilometer of plot centers using aerial photos from 1949, 1963, 1979, 1988, and 1998. Patch metrics and forest fragmentation indicators were calculated, and their temporal dynamics analyzed. The relationship between changes in landscape pattern and forest characteristics on FIA plots also was examined where remeasurement occurred. Results indicate that forest fragmentation in this area is a stochastic process, with gains in forest being made where agricultural fields have reverted to forest, and losses occurring where urban sprawl has occurred. The analysis of species composition, and structure on FIA plots affected by urbanization indicates that changes have occurred through time, however no clear pattern has emerged. These findings are part of an ongoing study that will be expanded to include additional counties, as well as the incorporation of satellite data, where possible, in the fragmentation analysis.

Global human population has exceeded six billion. It is now difficult to find a place on Earth that is not directly or indirectly affected by human activities. Obvious examples are urban systems, which are human-dominated. A less known and most surprising phenomenon is that even in many protected areas, human population size is also increasing rapidly and human activities are becoming more extensive and intensive. Because protected areas such as Wolong Nature Reserve in southwestern China are the last hope and stronghold for biodiversity, it is urgently needed to evaluate the effectiveness of protected areas and to understand the mechanisms of human impacts. Established in 1975, Wolong Nature Reserve is a high-profile reserve for conserving the world-famous giant pandas. Taking a systems approach that integrates landscape ecology with human demography, behavior, and socioeconomics at multiple scales, we found that panda habitat across the landscape had been declining and fragmented at a higher rate even after the reserve was established. These ironic results were due to the complex interactions among human population size, human population structure, needs of local residents, social attitude and...
<table>
<thead>
<tr>
<th>Scales.</th>
<th>perception, and economic development.</th>
</tr>
</thead>
</table>
Variability in temperature is a major determinant of vegetation pattern. Capturing fine-grain temperature variability at landscape scales cannot be accomplished easily using conventional sampling techniques. Yet, this is the scale at which ecosystems typically are managed. Various combinations of elevation, slope, and aspect often are used as proxies for temperature in montane ecosystems. We propose a low-cost and logistically feasible technique for collecting spatially explicit temperature data using a network of portable temperature micro-loggers. These data are used to generate simple equations for spatially extrapolating base station temperature measurements across complex terrain in the Sierra Nevadas and central Western Cascades. Results suggest that: (1) simple lapse rates do not adequately describe temperature in these ecosystems, and (2) temperature estimates would be improved significantly by using locally adapted lapse rates. DEM-derived proxies are compared in terms of their ability to describe temperature field data. The ability to estimate temperature variability across complex landscapes has important implications for ecological modeling, which frequently relies upon the simplifying assumptions associated with lapse rates in describing the environmental template. |
| 163. **Keynote Speech** | Loucks, Orie L. Department of Zoology, Miami University, Oxford, OH 45056, USA. Influencing the Social and Political Metabolism of Landscapes. 
This paper assumes we know about the natural processes of landscapes, including hydrologic interactions, carbon capture, secondary production, population and metapopulation dynamics, perturbation processes and ecological succession. Beyond that, we've learned much in recent years about human-generated processes that overlay natural landscapes, including land clearing, abandonment, fragmentation and recovery, conversion to commercial uses, reservoir development, irrigation, chemical enrichment of land and water, deposition of stressors, and introduction of exotic species. A further level of understanding is taking shape now. Here we need to consider how local to regional organizations, public and private, use policies or decision-making to influence the above processes. The result is a social and political integration of processes, a kind of metabolism, that is different for each landscape. Our economic and policy surveys on landscapes in the greater Columbus area of central Ohio have sought to estimate the willingness of people to pay for good stream water quality and biodiversity in the face of impending urban sprawl from Columbus into the Big Darby Creek watershed. We found the institutional influence is net-like, as well as hierarchical, capable of influencing pattern and process in both the natural and human-dominated system. Although essentially homeorhetic, however, the dynamics of this landscape system are capable of being redirected by human institutions. A second case study will illustrate why we believe financial institutions, such as the national capital markets, also can be enlisted to change human influence on the metabolism of landscapes. |
A healthy savanna landscape can be broadly defined as one that functions to (1) conserve resources by retaining water, soil and nutrients, (2) provide food and shelter (habitat) for fauna, and (3) meets the material, aesthetic and spiritual needs of people. How well landscapes specifically function to retain, not leak, vital resources such as water and nutrients can be indicated by the cover, number, size, shape and spatial pattern of vegetation patches. We have derived a landscape leakiness index for this resource retention function that is related to all these vegetation patch attributes, and that uses remotely sensed images. Using simulated landscape maps, and assuming that resources flow over these maps in a known direction, a directional leakiness index (DLI) was derived and tested for how well it logically related to patch cover, number and size, and to patch shape, arrangement and orientation (e.g., banded vegetation). Then, the utility of DLI was demonstrated to Australian savanna landscapes that obviously differ in their patch attributes. Results for this leakiness index were also compared to those for the lacunarity index. Both DLI and Lacunarity logically positioned savanna landscapes along a function-dysfunction continuum, where dysfunctional landscapes are leaky (poorly)
<table>
<thead>
<tr>
<th>ID</th>
<th>Author(s)</th>
<th>Poster</th>
<th>Title</th>
<th>Author(s)</th>
<th>Poster</th>
<th>Title</th>
<th>Department</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>165.</td>
<td>Marshall, Treneice and Jiquan Chen</td>
<td>Marshall, Treneice and Jiquan Chen. School of Forestry and Wood Products, Michigan Technological University, Houghton, MI 49931, USA. Contribution of wetland ecotones on vascular plant diversity within a northern hardwood landscape.</td>
<td>Marshall, Treneice and Jiquan Chen. School of Forestry and Wood Products, Michigan Technological University, Houghton, MI 49931, USA. Contribution of wetland ecotones on vascular plant diversity within a northern hardwood landscape.</td>
<td>Interior wetland ecotones exist as rare patch types in much of the Northern Wisconsin Landscape. The purpose of this project was to investigate the contribution of wetland ecotones to overall diversity in a northern hardwood landscape within the Chequamegon National Forest, WI. This study examines vascular plant diversity along a gradient from a wetland into a northern hardwood landscape. Data were collected along ninety 120 m transects that were established from bog, small lake, and ephemeral stream edges (30 transects per wetland type). Plots were sampled for percent understory, overstory, moss, litter, and coarse woody debris cover in 1 x 1 m plots placed at 11 distances (0, 5, 10, 15, 20, 25, 30, 40, 60, 80, and 120 m) along each plot for a total of 990 plots. Lake transects exhibited high diversity between 0 and 5 m with the Shannon-Wiener Diversity Index (H') = 2.52. Diversity drastically drops beyond 5 m from the edge to H' = 1.72. For bog transects, diversity was low at the edge with H' = 1.11 but increased to H' = 1.94 at 5 m. For ephemeral streams, diversity remained high between 0 and 30 m with H' = 2.43, indicating that this feature has the greatest edge influence of the three ecotones examined in this study. Diversity drops to H' = 1.80 after 30 m. Small lakes and ephemeral increase diversity in northern hardwood landscapes while bogs show little effect.</td>
<td>Vegetation Pattern and Plant-Environment Relationships</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>166.</td>
<td>Joy.Mas <a href="mailto:t@nau.edu">t@nau.edu</a></td>
<td>Mast&quot;, Joy N. and Lawrence E. Stevens&quot;, &quot;Department of Geography and Public Planning and &quot;Department of Biological Sciences, Northern Arizona University, Flagstaff AZ 86011, USA. Dendroecological study of black cottonwood dynamics along regulated and unregulated rivers in British Columbia.</td>
<td>Mast&quot;, Joy N. and Lawrence E. Stevens&quot;, &quot;Department of Geography and Public Planning and &quot;Department of Biological Sciences, Northern Arizona University, Flagstaff AZ 86011, USA. Dendroecological study of black cottonwood dynamics along regulated and unregulated rivers in British Columbia.</td>
<td>Dendrochronological data can be modeled to develop a longer-term understanding of riparian tree responses over pre-impoundment and post-impoundment time. Flow regulation can strongly affect riparian tree growth and seedling establishment, as has been detected on the regulated Missouri, in the Grand Canyon, in southern Alberta, and in the Pacific Northwest. In this study, we used tree ring data to model black cottonwood (Populus trichocarpa) growth in relation to flow regimes on eight regulated and unregulated rivers in southern British Columbia. Black cottonwood cores were analyzed to determine both the magnitude and timing of tree growth responses to past flow regimes in both types of river systems. Overall, the trees sampled along the regulated rivers established as a cohort following a high flow event, with moderately fast growth and strong releases after subsequent high flow events. In contrast, the black cottonwoods along the unregulated rivers were slower growing, older, and more sensitive to suppression events. Such analysis enhances the understanding of the role of the timing and frequency of past flows and floods across a landscape, which are important determinants of riparian vegetation. Understanding patterns of change and the potential to alter future riparian tree growth requires a sound understanding of existing conditions and past growth patterns. Development of a descriptive model of tree growth under various flow regimes will provide managers with a means of evaluating the options for riparian management.</td>
<td>Vegetation Pattern and Plant-Environment Relationships</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>167.</td>
<td>kmauz @u.ariz ona.edu</td>
<td>Mauz, Kathryn. Arid Lands Resource Sciences, Office of Arid Lands Studies, 1955 E 6th St The University of Arizona, Tucson, Arizona, 1984-1998: Application of remote sensing and GIS analysis techniques.</td>
<td>Mauz, Kathryn. Arid Lands Resource Sciences, Office of Arid Lands Studies, 1955 E 6th St The University of Arizona, Tucson, Arizona, 1984-1998: Application of remote sensing and GIS analysis techniques.</td>
<td>Rapidly expanding urban areas are ranked among the most serious threats to regional biodiversity in the Sonoran Desert. One of the several consequences cited of urbanization is habitat fragmentation - the reduction in size and segregation of areas of suitable habitat as a result of residential and other forms of development. Development in the Tucson, Arizona, urban area has for decades occurred along the floor of the Santa Cruz River valley, with well-known consequences for riparian habitats that once thrived there. More recently, residential and resort development has occurred on the bajadas and in the foothills of surrounding mountain ranges, representing encroachment into Arizona Upland as well as xeroriparian (dry wash) habitats unique to these physiographic settings. This study is an investigation of landscape fragmentation in the context of urban expansion through analysis of satellite remote sensing imagery of</td>
<td>Land Use Change and Urban Ecology</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
the northeast Tucson urban area. Analysis of landscape metrics for these images provides an indication of the effects of development on the size and distributions of upland habitat remnants between 1984 and 1998. These patterns are discussed in relation to county planning and zoning policies and to the urban ecological literature for the Tucson Basin.

McConnell, William J. Student Building, 331 Indiana University Bloomington, IN 47405-7100, USA. Human-Environment Relations in Madagascar: The importance of spatial and temporal perspective.

Madagascar has attracted widespread attention as a global biodiversity hotspot and, despite recent challenges, international biodiversity conservation policy continues to adhere to the population pressure-on-resources thesis, which holds that rapid demographic growth has caused widespread environmental degradation. This paper examines challenges to this thesis and evaluates its utility in explaining environmental change on the island. The paper examines the evolution of human settlement and forest cover in a region in the south-central highlands, and explores in detail one landscape -- the Pays Zafimaniry -- whose settlement in the past two centuries has been posited as an exemplar for the prior transformation of the rest of the highlands. The paper presents the results of a quantitative case study of population pressure and forest cover change in the region, considering these two variables at several spatial scales: the eastern forest, the Ambositra Region, and a portion of the Zafimaniry landscape. The case study sets out to explicate the scalar dynamics of land use and land cover change, specifically, to discover how and why the relationship between population and forest cover changes with the grain and extent of observation. The results of the case study and the historical narrative are analyzed with respect to the reliability of estimates of forest cover and population. The analysis identifies limitations and inconsistencies in our understanding of these phenomena and therefore in our ability to theorize the relationship between them.

McDonald, Robert I., Robert K. Peet, and Dean L. Urban. 1 Nicholas School of the Environment, Box 90328, Duke University, Durham, NC 27708, USA; 2 Department of Biology, Box 3280, University of North Carolina, Chapel Hill, NC 27599, USA; and 3 Nicholas School of the Environment, Box 90328, Duke University, Durham, NC 27708, USA. Landscape Impacts on Oak Decline and Red Maple Increase.

Throughout eastern deciduous forests, Quercus species are in decline, while more shade-tolerant species, especially Acer rubrum, are increasing in abundance. This study uses a unique time-series of data collected over 75 years in the Duke Forest (Durham, NC) to shed light on these trends. Results confirm that the transition from Quercus to A. rubrum dominance is occurring in the NC piedmont, with Quercus spp. declining in abundance over time on all mature hardwood sites studied. Early-successional stands dominated by Pinus taeda have shown a slight increase in Quercus spp. abundance, although Quercus spp. remain low in relative density. A. rubrum has increased in abundance 6-fold over the last 75 years, in both mature and early-successional stands. Spatial data from large stem maps confirms that Quercus spp. have elevated levels of mortality, primarily due to crowding with A. rubrum stems. An analysis of environmental characteristics that influence the rate of transition from Quercus to A. rubrum dominance shows that the transition rate is slowest on wet, clay-dominated soils. Factors increasing the transition rate include steep slopes, high solar radiation, and high levels of K in the soil. Interestingly, sites closer to urban developed lands have a faster transition rate as well, for unknown reasons. Overall, the rate at which the transition from Quercus to A. rubrum dominates is occurring is influenced by a complex set of local site and landscape characteristics, making prediction of the ultimate fate of these forests difficult.

McDonald, Mark J. and Kirsten Parris, Australian Research Centre for Urban Ecology, Royal Botanic Gardens Melbourne, c/o Botany School, University of Melbourne, Victoria, 3010, Australia. Creation of a Human Dominated Landscape (Melbourne) has

McDonnell, Mark J. and Kirsten Parris, Australian Research Centre for Urban Ecology, Royal Botanic Gardens Melbourne, c/o Botany School, University of Melbourne, Victoria, 3010, Australia. Creation of a Human Dominated Landscape (Melbourne) has Increased the Breeding Range of Grey-headed Flying Foxes (Pteropus poliocephalus) in Australia.

Grey-headed flying-foxes occur along the Eastern seaboard of Australia from southern Queensland to Victoria. They often roost in large diurnal aggregations, known as camps, in tree canopies located close to a food source. Camps can contain thousands of individuals and can occur in rural, suburban and urban environments. Due to the fact they form large breeding colonies and their native habitat has been reduced by land clearing, there is some concern about their conservation status. Historically, there have
Increased the Breeding Range of Grey-headed Flying Foxes (*Pteropus poliocephalus*) in Australia.

been several camps located within the Brisbane and Sydney metropolitan areas, but the Melbourne camp at the Royal Botanic Gardens has only recently developed. Although there were sightings of summer migrants in and around Melbourne for decades, the first seasonal camp was established in 1981 which has now grown to a year-round camp of up to 8,000 individuals. Climatic data from the last 100+ years indicate that the temperature in Melbourne has been increasing, thus reducing the frequency and magnitude of frosts. The availability of food resources in the Melbourne area has also increased over the last 30 years with the planting and maturation of Queensland and New South Wales trees such as *Corymbia maculata* and *Ficus macrophylla*. This represents an unusual case where the development of a human dominated landscape (Melbourne) is providing new habitat for the future conservation of a potentially vulnerable species. The extension of the flying-fox breeding range is causing tensions with the human inhabitants of Melbourne. Issues such as tree and fruit damage, noise, smell and the recent discovery of the Australian Bat Lyssavirus (ABL) and Hendra virus in the population have been identified as causes of concern.

**Characterizing the expected range of variation in landscape structure and function.**

Characterizing the expected range of variation (ERV) in landscape structure and function is a requirement of landscape planning in some federal land management agencies. A quantitative framework for characterizing ERV is especially useful for evaluating alternative land management scenarios. Spatially explicit computer models that simulate disturbance and successional processes and their affects on landscape patterns provide a means to establish this framework. We developed the Rocky Mountain Landscape Simulator (RMLANDS), a spatially-explicit, raster-based, stochastic simulation model of disturbance and succession in application in Rocky Mountain landscapes. The model is a visual C++ program that interfaces with ArcInfo and ArcView GIS software. It requires several input grids derived from the Integrated Resources Inventory (IRI) database used by the US Forest Service. Fire and various forms of logging disturbances are modeled as stochastic, multi-step, multi-scale processes that interplay with a stochastic, multiple pathway succession model at a 10-year time step. We applied this model to an area in the south-central highlands section of the southern Rocky Mountains province. To establish the ERV for current climatic conditions, we simulated several different fire regimes and quantified the range of variation in several landscape metrics computed using the program FRAGSTATS. The results illustrate the dynamic nature of landscape structure and highlight the effect of spatial extent on measured dynamics. They also demonstrate the relative sensitivity of measured dynamics to variations in fire size and frequency. More importantly, the quantified ERV provides a framework for evaluating alternative land management scenarios involving anthropogenic disturbances.

**Biodiversity assessment: A coarse-filtered landscape ecological approach.**

Given increasing threats of development in remaining natural areas, habitat protection is becoming increasingly important for the conservation of biodiversity. Yet, it is often difficult to identify the habitats and habitat patches in greatest need of protection, or those that will provide the greatest ecological value for the cost of protection. In response, we have developed a method for quantitatively evaluating biodiversity using a coarse-filter, natural community-based approach and applied this method in a western Massachusetts watershed. Our approach involves applying one or more biodiversity filters to each point and patch in the landscape. Our landscape is a map of predicted natural communities modeled from satellite imagery and terrain data. Each filter acts as a lens that allows you to see different aspects of the underlying natural community map, and consists of a model that applies community-specific criteria to the content, context, spatial character, or condition of a point or patch in the landscape to arrive at an index of biodiversity value. Each filter takes input parameters that are supplied separately for each community, and returns a value ranging from 0 (low biodiversity value) to 1 (high value). Typically, several filters are applied to the landscape and then integrated in a weighted linear combination. Weights are supplied by the user to reflect the relative importance of each filter for each community. This process results in a final biodiversity value for each point in the landscape. Our coarse
filter is a first step in the process of targeting land for conservation.

### 173. nancy.mcintyre@ttu.edu

**Special: McIntyre’s**

McIntyre, Nancy, and Mark Hostetler. 1 Department of Biological Sciences, Texas Tech University, Box 43131, Lubbock, TX 79409-3131, USA; and 2 Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611-0430, USA. **Effects of Urban Land Use on Pollinator Communities in a Desert Metropolis.**

We compared the richness and abundance of bee (Hymenoptera: Apoidea) communities in two seasons (September 1998 and September 1999) of urban land use in the Phoenix, Arizona, USA, metropolitan area (xeriscaped residential yards, mesiscaped residential yards, urban desert-remnant parks, and desert parks at the interface between the metropolitan area and the outlying desert matrix). Richness and abundance of bees were generally lower in residential areas than in desert areas, with desert areas on the fringe of the metro area possessing the highest diversity of all sites. Residential yards that utilized xeric landscaping had a more diverse bee community (with proportionally more rare species) than did mesic (turf grass) yards, particularly in late summer. Although bee community structure was apparently unaffected by the number of local habitat features (native and exotic trees, shrubs, cacti, and herbaceous plants in addition to human-built structures), the types of habitat features do appear to influence the number and types of bees present in an area. These results suggest that urban development can be designed to promote the conservation of pollinator bees. Specifically, preservation of desert and greater use of xeric landscaping rather than mesic-scaping may help preserve this ecologically and economically vital group of organisms.

### 174. dmck@u.washington.edu

**Special: Keane’s**

McKenzie, Donald, Amy E. Hessl, Susan Prichard, and David L. Peterson. Cascadia Field Station, Box 352100, University of Washington, Seattle, WA 98195, USA. **Linking multi-scale empirical approaches to process-based models of fire and succession.**

Spatially explicit models that are applied at broad scales require large amounts of empirical data as inputs, but existing data are rarely adequate for process-based modeling of fire and succession at these scales. Varying resolution, extent, and spatial pattern often limit the ability to aggregate raw data effectively. Empirical-statistical and semi-qualitative approaches can produce data layers or time series that capture the spatial and temporal variation in parameters essential for landscape fire succession models. We present five examples: three that demonstrate spatio-temporal layers. (1) A continental-scale qualitative model of vegetation transitions in response to altered fire regimes produces data layers that are keyed to modeling fire effects. (2) A regional-scale statistical model produces a spatial coverage of fire return intervals. (3) A sub-regional statistical model links vegetation to climate and implicitly incorporates fire when carefully validated at fine scales by a process-based fire succession model. (4) Landscape-scale models of fire-climate interactions over time refine spatial coverages of fire regimes and provide inputs for stochastic elements of fire succession models. (5) A sub-watershed-scale (1-3 ha) reconstruction of Holocene fire frequency using charcoal, linked to climate and macrofossils, provides a template for long-term simulations of fire and succession.

### 175. michelle.mcpherson@acadiau.ca

**Oral/Revised**

McPherson, A. Michelle, and Philip D. Taylor. ACWERN, Department of Biology, Acadia University, Wolfville, NS B0P 1X0, Canada. **Effects of Landscape Change and Forest Regeneration on Peatland Dragonflies (Odonata) in Western Newfoundland.**

Movements and distributions of many organisms are changed when landscapes are altered by human use. The boreal ecosystem near the Main River, Newfoundland has been extensively logged; we question how this activity has affected populations of dragonflies inhabiting peatlands in this naturally heterogeneous area. In particular, we are interested in 1) whether spatial structure of populations is altered and 2) whether these changes are caused by finer-scale characteristics of bogs or 3) changes in landscape connectivity. To determine how species abundance relates to the type of habitat in which bogs are imbedded and how this changes as forest regenerates, we sampled bogs in 7 different contexts. Exuviae (shed exoskeletons) of 11 odonate species were collected at water pools in bogs surrounded by: mature forest, scrub, and clear-cuts from 1991-1998. The structure of pools - water depth, pH, bank slope, bottom type, and emergent, submergent and surrounding vegetation - was also measured. We are using this information to model the effects of landscape change on species abundance and distribution at
Substantial research has been conducted addressing global environmental change and regional-scale biophysical factors. 47405, USA. Characterizing landscape composition and pattern: Cross-site comparison of social and institutional drivers to landscape-change outcomes across different social or physical monitoring through land-cover-change analysis. To date, however, little research has dealt with linking pollution would have the greatest impact by directing best management practices and land acquisition decreases in nitrogen (0.039 to 0.009 mg/L/month) and phosphorous (0.053 to 2.81 μg/L/month). With the release of agricultural fields from farming has returned a small percentage of land (2%) to secondary agriculture on steep slopes and agriculture on erodible soils were also contributed significantly to water and fecal coliform. Percentages of agriculture and urban development were the dominant landscape to determine the contribution of the landscape metrics to surface water total nitrogen, total phosphorous, and fecal coliform. Percentages of agriculture and urban development were the dominant landscape variables over the years and explained 25-65% of the variability in water quality measurements. Barren, agriculture on steep slopes and agriculture on erodible soils were also contributed significantly to water but explaining only a small portion (4-8%) of the overall variability. During the past two decades the release of agricultural fields from farming has returned a small percentage of land (2%) to secondary growth forest. Most of the change in landscape took place from 1985 to 1998 and corresponds to decreases in nitrogen (0.039 to 0.009 mg/L/month) and phosphorous (0.053 to 2.81 μg/L/month). With over half of the remaining agriculture located within 240 meters of streams, efforts to further decrease pollution would have the greatest impact by directing best management practices and land acquisition within these riparian zones. Notice: The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), funded this research and approved this abstract as a basis for an oral presentation. The actual presentation has not been peer reviewed by EPA.
Characterizing landscape composition and pattern: Cross-site comparison of social and biophysical factors.

Land-cover change modeling is a powerful tool to help researchers understand relationships between human processes and land-cover change. Agent-based modeling is one approach whereby agents of land-cover change are modeled as individuals and, critically, interactions between those agents are incorporated. In this presentation, we outline a methodology to calibrate and validate agent-based models of landscape change. We propose a conceptual framework of landscape characterization to address the need for cross-site and cross-time comparison, and the interactive relationships between social, institutional, and biophysical factors. We use this framework to compare a once deforested and now reforesting Midwestern landscape and a landscape in the Brazilian Amazon that is currently being deforested. Issues addressed in this cross-site analysis include (i) comparison of landcover classifications from different ecosystems, (ii) linking social factors to landscape outcomes under different land-use systems and (iii) comparison of landscapes at different stages of settlement/development. Our analytic techniques involve describing the spatial patterns of landscapes and relating these to anthropogenic drivers of landscape change. In particular, we examine the fragmentation and connectivity of landscapes in the context of various systems of agricultural production and institutional factors affecting landscape change.

Deforestation rate in the Brazilian Amazon has been increasing in recent years. According to the deforestation pattern, the spatial distribution of the forest remnants can considerably change, affecting differently the capacity of the landscape to conserve native species. In the present work, we simulated the effects of fallow period (long and short), deforestation pattern (EDGE, HALF-EDGE, RANDOM, ROW) and private nature-reserves extent (80, 50 and 20%) on forest conservation using simple land use and land cover sequences. Several issues emerge from increased collaboration and increased choice of level of observation, among individuals within a restricted area can now encompass interactions over large spatial areas. The premises and problems with spatial analysis in landscape ecology
I will review major issues identified in the past, and assess their current status, particularly in the context of how landscape ecology has developed historically from its roots. I will try to examine if the conceptual and applied issues have changed in emphases in the past decade or so, and why. Finally, I will look at current and future challenges in the application of the science.

Current methodologies for incorporating spatial heterogeneity in land use planning are based on the concept of land unit (LU). The LU is defined as a relatively homogenous area of land demarcated on a map and possessing specified land characteristics and/or qualities. These land characteristics and qualities are described only in biophysical terms. Purely socio-economic characteristics are not included in the concept. A feature common across rainfed production environments is the high micro spatial heterogeneity. The sources of this heterogeneity are the significant differences over space in biophysical and socio-economic conditions. Obviously, this creates the difficulty of using the land unit as a unit for land use modeling in spatially heterogeneous rainfed environments. In this paper a methodology for modeling spatial heterogeneity in land use planning is developed and operationalised. The paper comprises four sections. Section one gives a description of the problem. Section two lays the main conceptual foundation. A methodology is developed and outlined in section three. Operationalisation of the methodology for the case of Ubon Ratchathani District in North East Thailand is carried out and described in section four. Finally, strengths and limitations of the methodology are discussed in section five.

This investigation explores how urban growth and landscape change in the Upper San Pedro River Watershed (from its headwaters near Cananea, Sonora, to Redington, Arizona) might influence the hydrology and biodiversity of the area over the next 20 years. The assessment considers the Sonora and Arizona portions of the watershed as a single area; it investigates the widest range of policy issues which have been raised by stakeholders; and it adds spatial and temporal dimensions to anticipated changes and their impacts. The purpose of the investigation is to provide information to the many stakeholders and jurisdictions of the region regarding issues, strategic planning choices, and their possible consequences related to the built and natural environment. We have modeled and designed three groups of scenarios projected to the year 2020. These include one which considers interpretations of the region's existing planning documents and land use practices, one which investigates lower than forecast population growth and tightly controlled development zones, and one which anticipates greater than forecast population growth and low density development across the region. Each of these is expanded by variations that alter key policy positions. Evaluations of the scenarios reveal the impact which each of the scenarios and the scenario variants are likely to have on water, especially ground water, and consequently the ability of the San Pedro River to maintain its flow as well as on species habitats both within the riparian zone and elsewhere. These evaluations provide guidance for the region's stakeholders to better determine how they wish their future to be.
<table>
<thead>
<tr>
<th>No.</th>
<th>Email</th>
<th>Author(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>184.</td>
<td><a href="mailto:felix@e-cology.uni-kiel.de">felix@e-cology.uni-kiel.de</a></td>
<td>Special: Jones' Müller, Felix and Ernst-Walter Reiche. Ecology Center, University of Kiel, Schauenburgerstrasse 112, D 24118 Kiel, Germany.</td>
<td>Ecological gradients as hierarchical indicators of ecosystem and landscape integrity. The paper will give a report on a landscape oriented analysis of different Northern German ecosystems (forest and arable land) and watersheds which was carried out to analyze the interactions of spatial patterns and ecological processes on different scales. Soil analyses, modelling approaches and community ecological methods to characterize ecological heterogeneity have been combined as parts of a long-term ecosystem research project to investigate the role of scale in heterogeneous landscapes. The results of the presented study lead to the understanding of ecosystems and landscapes as systems of interacting ecological gradients which are assigned to a hierarchy of structural scales. They are specifically interrelated with different ecological processes and also the consequences of human landuse can be distinguished to corresponding scales. The resulting significance of gradient hierarchies will be used to apply the principles of ecosystem thermodynamics, self-organization and emergence. Finally an outlook will be given to potential pathways of applying the derived theory in environmental management.</td>
</tr>
<tr>
<td>185.</td>
<td><a href="mailto:felix@ecology.uni-kiel.de">felix@ecology.uni-kiel.de</a></td>
<td>Special: Jenerett-e-Wu Müller, Felix. Ecology Center, University of Kiel, Schauenburgerstrasse 112, D 24118 Kiel, Germany.</td>
<td>Ecosystem Synergetics - Applying Systems Theoretical Concepts to Ecosystem and Landscape Development. In this paper the general contributions of different ecosystem theories for the understanding of ecosystem and landscape development are discussed. The fundamental principles of network theory, information theory, thermodynamics, self-organization and emergence are discussed in a set of integrating hypotheses to describe the general tendencies in ecosystem and landscape development. One central concept which arises from a combination of the various theories is based on the comprehension of gradients as holistic linkages between structural and functional views of ecosystems. The dynamics of these gradients are coupled with the thermodynamically based theory of ecological orientors which describe the &quot;complexification&quot; phase of ecosystem successions. The orientor principles will be illustrated by empirical and model based case studies to characterize and to compare different ecological systems.</td>
</tr>
<tr>
<td>186.</td>
<td><a href="mailto:nassauern@umich.edu">nassauern@umich.edu</a></td>
<td>Oral/Reflections Nagendra, Harini, Southworth, Jane, and Tucker, Catherine M. Center for Study of Institutions, Population, and Environmental Change, Indiana University, Bloomington, IN 47408, USA.</td>
<td>Using landscape metrics to interpret trajectories of land cover change: A case study in Western Honduras. Understanding the relationship between human behavior and forest change poses a major challenge for environmental research. This study addresses the issues of trajectories of land cover change and their relationship to the social and biophysical characteristics of the landscape. The study area is located within a mountainous region of pine oak forest in Western Honduras. Remote sensing imagery of three time points: 1987, 1991 and 1996: were used to create single date classifications. In addition, a number of change grids were created for forest and non-forest classes between the different time periods. Metrics of land cover change were used to infer patterns of land use change. For instance, areas of deforestation were significantly larger when compared to areas of deforestation, across all dates. In addition, land cover trajectories were related to accessibility characteristics of the landscape, including distance to roads, elevation and slope. In the study landscape, patch size was a good indicator of economic activity: with small patches representing subsistence agriculture, and large patches relating to logging. Spatially, the small patches of swidden agriculture were found close to roads, at lower elevations and on more gradual slopes between 1987 and 1991. However, since 1991, coffee production has started to spread throughout the community and this resulted in clearings of forest on steep slopes and higher elevations. Results highlight the importance of landscape metrics in monitoring multi-date land cover change as compared to single date analyses.</td>
</tr>
<tr>
<td>187.</td>
<td>nassauer, Joan Iverson, Corry*, Robert C. School of Natural Resources and</td>
<td>Oral/Reflections Nassauer, Joan Iverson, Corry*, Robert C. School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115, USA.</td>
<td>A GIS-Based Spatial Model of Cultural Landscape Preferences for Alternative Agricultural Landscape Scenarios. Land Use and Land Cover Change: Pattern and Process</td>
</tr>
</tbody>
</table>
To model cultural preference for alternative landscapes, we developed a method that uses empirical surveys to derive landcover-specific preference values. Investigators using surveys to measure cultural landscape preferences depict landscapes in a mode that closely approximates the perspective from which people are likely to see the landscape in ordinary experience: on the ground or in a low-level aerial perspective view. These landscape images are the experimental stimuli for which respondents rate their preferences. Results reflect respondents, preferences for whole landscape views not particular landcovers or maps of landcover combinations. At the same time, to include cultural preference in an integrated assessment of multiple landscape variables across a large area, investigators want to display preference values as spatial landscape characteristics (i.e., in a GIS). Determining spatial characteristics from empirical responses to landscape images typically has required investigators to make dramatic inferences from the survey data or to rely solely on expert-based systems of aesthetic valuation to link attributes to GIS landcover data. The method we have developed directly employs empirical data from preference surveys to ascribe an objective preference value to each GIS landcover class in the context of a specific alternative agricultural landscape scenario. The method allows the relative overall cultural preference for each alternative scenario to be objectively described and compared, and it allows preferences to be combined with other landscape ecological variables in an integrated assessment across a larger landscape. We will demonstrate the method as we applied it to compare alternative scenarios for two Iowa watersheds.

My first topic is the suggestion to deal further with the topics presented in this session by using the IALE bulletin internet website as a forum for further dialogue and enhancing better interaction between landscape ecologists all over the world. In my opinion, these topics cannot be formulated in isolation from the severe global ecological crisis. They should be therefore problem-solving oriented and present a clear vision of the practical goal(s) that landscape ecology has to achieve. These have to take into consideration that at the present transition stage towards the global information age, human society has reached a crucial turning point in its relation to nature. It is confronted with the choice between further sustainable evolution of organic life on earth or its further degradation and extinction. In these topics I will make a strong point that if landscape ecology wishes to play a meaningful role in this choice, it has to become a transdisciplinary, future-oriented and mission driven science. For this purpose it has to broaden its conceptual and methodological basis and shift its main focus to the prevention of further landscape degradation, and to the safeguarding, restoring and creating of sustainable, healthy, productive and attractive multifunctional landscapes for the emerging information society. These topics will indicate how to implement these transdisciplinary challenges in landscape ecological education, research, and action.

This study examines the feasibility of using solar energy in small, environment-dependent business systems and recommends government policies to promote the usage of alternative energy. The study is meant to be applicable to businesses such as ranches or small nature-based resorts that are willing to be environmentally friendly and reduce their overall operating costs. The study focuses on the energy needs of such operations and an assessment of their option to utilize solar energy technology. The viability of this option is measured by evaluating environmental factors, capacity of technology and qualification for government incentives. Three Wyoming guest ranches are used as case studies to compare the practicability of harnessing solar energy for different sized operations. The ranches were selected based on their number of guests, varying from small to large. An analysis of energy use based on diurnal and seasonal demands and need location reveals that solar energy is a viable option for small businesses. Federal and local government policies concerning solar energy usage are investigated, particularly those pertaining to small businesses. Their applicability to the case studies is examined and recommendations for solar energy use in a closed micro-business system presented.

This study examines the feasibility of using solar energy in small, environment-dependent business systems and recommends government policies to promote the usage of alternative energy. The study is meant to be applicable to businesses such as ranches or small nature-based resorts that are willing to be environmentally friendly and reduce their overall operating costs. The study focuses on the energy needs of such operations and an assessment of their option to utilize solar energy technology. The viability of this option is measured by evaluating environmental factors, capacity of technology and qualification for government incentives. Three Wyoming guest ranches are used as case studies to compare the practicability of harnessing solar energy for different sized operations. The ranches were selected based on their number of guests, varying from small to large. An analysis of energy use based on diurnal and seasonal demands and need location reveals that solar energy is a viable option for small businesses. Federal and local government policies concerning solar energy usage are investigated, particularly those pertaining to small businesses. Their applicability to the case studies is examined and recommendations for solar energy use in a closed micro-business system presented.
Lyme disease is a tick-transmitted borreliosis of humans and domestic animals emerging as a significant threat to public health in north temperate regions of the world. The disease is caused by infection with the spirochete *Borrelia burgdorferi* and is transmitted by the bite of ticks in the genus *Ixodes*. Clearly, disease vector-host-pathogen interactions exist at multiple scales, both temporally and spatially, however, few researchers have addressed the scale of disease risk. We have been investigating the spatial and temporal aspects of human Lyme disease risk for 7 years in an endemic area, Rhode Island, USA. Although suitable habitats are available across the state clear spatial trends exist in disease risk and tick abundance. Indeed, tick populations are highly spatially autocorrelated with hyperabundant tick populations and areas where ticks are absent from suitable habitats occurring within 60 km. In addition, a two-year cycle appears to exist in both tick abundance and Lyme disease prevalence. We report on those landscape features that affect tick distribution and abundance. Further, we examine environmental factors that could be used as predictors of human Lyme disease risk.

Analyses of habitat use-availability are central to landscape-scale ecological studies of many wildlife species. Choice of appropriate variables to represent landscape structure is an important consideration for use-availability analyses. Landscape structure is comprised of 2 primary elements: composition (i.e., proportion of each cover type, regardless of placement) and physiognomy (i.e., shapes and arrangements of cover-type patches). However, few researchers have incorporated physiognomic variables in studies of habitat use-availability. We quantified compositional and physiognomic habitat variables within 4 categories of fixed kernel use-area (home ranges and core areas of M and F, respectively) for 52 adult bobcats (*Lynx rufus*) in southern Illinois. We tested for differences in habitat use among these 4 use-area categories to illustrate the importance of physiognomic variables in studies of habitat use-availability.

Five of 69 habitat variables differed among categories of use-area (P < 0.0295); of these, 4 were physiognomic variables. We also tested whether habitat variables predicted size of bobcat use-areas.

Pattern and Process in Urban Landscapes

As we are all aware, human influences on landscapes are numerous and subject to various levels of activities. The rapid growth and development of towns and cities in Malaysia have posed a significant influence and increase in the landscape heterogeneity and organisation of the urban areas. As the country progresses towards a developed nation, a more promising approach is being undertaken and planned in order to ensure a balance between natural and built environment, while at the same time developing a harmonious relationship between man and nature. This paper intends to present some aspects of the development focussing on the strategies, approaches and management of the urban landscapes in gearing towards a sustainable future.

Pattern and Process in Urban Landscapes

Pattern and Process in Urban Landscapes
Biophysical and Socio-economic Correlates of Land Cover in the Mae Taeng Watershed of Northern Thailand.

Environmental factors and socio-economic driving forces contribute to the complexity and patterns of land cover. The objective of this study is to understand the biophysical, social, and economic forces that affect land use and land cover in the Mae Taeng watershed in northern Thailand. We used 1997 Landsat Thematic Mapper imagery to assess land cover. Historical aerial photography and 1:50,000-scale land-use maps were used as reference data. The overall classification accuracy was 96 percent with a Khat value of 0.95. Census statistics from the Thai government provided social and economic characteristics of the region. We obtained landform and infrastructure information from regional maps. Villages were the spatial unit of analysis for this study and we had biophysical data for 147 villages and socioeconomic data for 51 villages. These data were integrated with a Geographic Information System (GIS) and used to develop a predictive model of land cover based on biophysical, social, and economic characteristics of the region. Models created from the biophysical or socio-economic variables explained 70%-90% of the variation in land-cover composition of villages. Developed lands occurred near rivers in low, flat regions and had a population of older, more educated individuals. Agricultural land occurred near rivers in low slope regions. Forests occurred at high elevation on steep slopes away from rivers.

Land Use and Land Cover Change: Modeling

In the last two decades, tropical rainforests have been modified most profoundly by humans. Monitoring the rapid decline of rainforests is of utmost importance. Traditionally, remote sensing image-processing techniques are focussed on land cover classifications per-pixel. However, to facilitate policy decisions and support planning and development strategies, information is needed on change processes. Human-induced change processes occur on higher spatial aggregation levels and are visual on high-resolution remote sensing imagery due to the mosaic patterns at supra-pixel level. The land cover mosaics are complex spatial patterns characterised as non-nested aggregated heterogeneous objects with fuzzy spatial extents. A promising approach to observe and model these kinds of spatial objects is aggregate sets. Aggregate sets are hierarchical linked spatial n x n pixel blocks or windows at supra-pixel level. It is a true multi-scale approach. Aggregate sets stratify systematically remote sensing imagery into observable or measurable units. For each spatial object in particular, an aggregate set is defined. A set consists of at least three elements: the focal, upper and lower aggregate. The selection of the elements is semantically driven. Each aggregate is described by its pattern primitives. This multi-dimensionality can be regarded as a fuzzy partition of the aggregate universe. The combination of multi-scale and multi-dimensionality is a new alternative concept to model complex heterogeneous objects with fuzzy spatial extents. Described hierarchical approach is currently tested using optical and radar satellite data for a study site in Indonesia (Kalimantan).

Case Studies

Landscape ecologists now have tools that allow them to predictively map forest vegetation across large regions at very fine spatial resolution, and with a high degree of floristic and physiognomic detail. However, this overload of information must be aggregated and summarized before it is interpretable and useful for regional analysis. We examined alternative approaches for rescaling mapped vegetation for three million hectares in the coastal province of Oregon, USA. The map was produced with the Gradient Nearest Neighbor method for predictive vegetation mapping. It had a spatial resolution of 25 m and each pixel was attributed with a list of tree species, sizes, and densities present. We compared three rescaling methods, each at four spatial resolutions (0.06 ha, 1 ha, 4 ha, and 8 ha): resampling the mapped independent variables to a coarser resolution prior to spatial prediction; resampling the predicted vegetation to a coarser resolution; and aggregating pixels in the mapped predictions to larger, irregularly shaped patches using a rule set based on a vegetation similarity matrix. We compared the rescaling methods and resolutions for how well they maintained relative proportions of vegetation conditions within the regional landscape, and for their effect on metrics of landscape pattern. We also evaluated effects on prediction accuracy at the local scale using an independent dataset of field plots. None of the rescaling methods and resolutions appeared to reliably capture the spatial pattern of observed vegetation conditions.
methods was superior for all of the evaluation criteria. Choice of an appropriate approach will depend on study objectives and costs.

| 196. | oneill | Top 10 | O’Neill, Robert V. Oak Ridge, TN 37830, USA. Top issues in landscape ecology. (Conveyed by J. Wu) | O’Neill, Robert V. Oak Ridge, TN 37830, USA. Top issues in landscape ecology. (Conveyed by J. Wu) | 1. Landcover dynamics are driven by Economics. Landscape Ecology needs to incorporate the insights of Economic Geography which studies how economic activity is distributed in space and Resource Economics which determines how land will be used.

2. Metapopulation Theory. Landscape Ecology needs to increasingly emphasize modeling of aquatic and terrestrial organisms operating on a landscape fragmented and structured by Economics. Insights should be incorporated from Metapopulation Theory, Population Genetics and Cellular Automaton to be able to translate changes in the landcover to impacts on populations.

3. Nonlinear Dynamics. Ecological systems are adapted to the spatial distribution of habitats, resources, and disturbance regimes that they have experienced over their evolutionary history. Currently, human society is driving ecological systems outside their evolutionary envelope and the assumption that the ecological systems will remain stable is unjustified. Landscape Ecology needs to develop a theory of metastable, nonlinear systems distributed in space.

4. Monitoring. Approaches to instability on large scales may be most detectable at the landscape scale = increases in spatial variability. |


Over the course of the 20th century, the trend towards urbanization has multiplied all over the world. Natural landscapes are being compromised with little or no concern towards preserving their natural quality. In the past three decades, research has empirically shown that the visual quality of the natural landscape is a very valuable resource. Efforts have been pioneered to assess and mitigate the visual quality of natural landscapes in face of growth and development. The negative externalities imposed by urbanization activities have compelled all federal agencies to assess and mitigate visual impacts on federal lands. The Forest Service and the Bureau of Land Management (BLM) have developed a framework of guidelines for assessing the visual quality of landscapes, enabling effective visual impact mitigation. The Visual Resource Management (VRM) Systems are now employed by these federal agencies to manage visual quality on federal lands. At the same time, research has extended to the visual quality analysis of the complex urban environment. Urban imageability and likability concepts have been put forth to better understand the human preference for landscape visual quality in the urban landscapes. Through this thesis research, a broad outline or a framework is presented to assess the visual quality of urban-natural landscapes. An attempt is made to tie together the two theories, namely the VRM systems and the urban likability, to develop a methodology for visual quality and impact assessment. This work seeks to extend the VRM systems into the visual quality analysis of landscapes within an urban setting. |


In a previously published study, quantitative relationships were developed between landscape metrics and sediment contamination for 25 small estuarine systems within Chesapeake Bay. Nonparametric statistical analysis (rank transformation) was used to develop an empirical relationship between sediment contamination and developed land (positive), herbaceous land (negative), and point source loading (positive). These analyses have been extended to include 75 small estuarine systems across the mid-Atlantic and southern New England region of the U.S. for which USEPA Environmental Monitoring and Assessment (EMAP) data were available. Because of the dramatic differences in characteristics and dynamics of the estuaries across the region, adjustment for differing hydrology, sediment characteristics,
and sediment origins were included in the analysis. Multiple linear regression with stepwise selection was used to develop statistical models for sediment metals, organics, and total PAHs with three functional forms (linear, rank, and exponential). The landscape metrics most strongly related with sediment metals levels were the percent area of non-forested wetlands (negative contribution), and percent area of urban land and effluent volume (positive correlations). The metric most strongly related with sediment organics was percent area of urban land, while with total PAHs the metrics were percent area of urban land and percent area of nonforested wetlands. The models included silt-clay content or total organic carbon of sediments and categorization by sediment origin or estuarine hydrology, suggesting the importance of sediment characteristics and hydrology in mitigating the influence of the landscape metrics on sediment contamination levels. The results suggest the possibility of developing predictive models of estuarine sediment contamination for various distributions of land cover and point source discharges.

<table>
<thead>
<tr>
<th>198. <a href="mailto:pennington@geo.orst.edu">pennington@geo.orst.edu</a></th>
<th>Oral/Poster</th>
<th>Pennington, Deana D.  Department of Geosciences, Oregon State University, Corvallis, OR 97331, USA. Spatiotemporal Analysis of Landscape Structure, Function and Change in the Western Cascades of Oregon.</th>
<th>Pennington, Deana D.  Department of Geosciences, Oregon State University, Corvallis, OR 97331, USA. Spatiotemporal Analysis of Landscape Structure, Function and Change in the Western Cascades of Oregon.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The purpose of this study was to compare the effects of naturally and anthropogenically disturbed forests in the Western Cascades of Oregon on selected biotic, hydrologic, and nutrient processes. Objectives were to: 1) develop methods for creating representative landscapes, 2) quantify landscape structure and function, and 3) compare the effects of natural and human landscape patterns on specific elements of biodiversity, evapotranspiration, stream flow, and carbon processes. Wildfire landscapes were simulated using the LADS model and parameters from dendrochronological studies. Archival research on spatial patterns and rates of early harvest disturbance were integrated with TM imagery to create historical harvest landscapes. Results from smaller scale harvest modeling were used to create hypothetical future landscapes. Vegetation structure was characterized in terms of the types and amounts of vegetation present through distributed, stratified, and spatially explicit metrics. Vegetation was placed in the context of ridges, streams, and hillslope components and broad scale environmental trends to delineate critical landscape features. Expected results include a decrease in the heterogeneity of vegetation structure. Connectivity between habitats via riparian corridors may be marginal, mitigated by landscape context. Evapotranspiration is expected to vary significantly in low elevation lands, where the conversion to predominantly young conifer plantations should result in much higher rates. At high elevations, variability of peak and low flows is expected to be influenced by increased connectivity between open patches and stream networks. Carbon cycling is increased in harvested landscapes, with interesting resultant fuel connectivity.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The objective of this study was to evaluate the role of small-scale disturbances within different patch types to landscape-scale patterns in species composition and dominance at a shortgrass steppe-Chihuahuan desert ecotone. Species removals were conducted at the Sevilleta LTER in central New Mexico within five different patch types where communities are dominated or codominated by one of two perennial grasses (blue grama, black grama) and one shrub (creosotebush). Within each patch type, all plants of the dominant species were removed from 5 m x 4 m plots starting in 1995; five control plots were also located within each patch type. Cover and density by species have been estimated annually. Similarity indices were used to compare patch-scale patterns in species composition with the landscape mosaic. Annuals dominated all removal plots one year after removals were initiated. Subsequent recovery patterns depended upon the dominant species removed. Blue grama removal resulted in establishment and growth of perennial grasses whereas removal of black grama promoted recovery by perennial forbs. Removal of creosotebush in mixed communities with black grama resulted in recovery by perennial forbs, grasses, and shrubs whereas removal of this species in shrub-dominated communities resulted in little change in the vegetation. These results indicate that mortality of dominant species by small-scale disturbances has dramatic effects on vegetation patterns that may alter the landscape mosaic at this arid-semiarid ecotone.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>201. picketts@ecost</th>
<th>Keynote Speech</th>
<th>Pickett, S.T.A.  Institute of Ecosystem Studies, Millbrook, NY 12545. The Landscape Paradigm in Ecology: Heterogeneity, Hierarchy, and Humans.</th>
<th>Keynote Speech</th>
</tr>
</thead>
<tbody>
<tr>
<td>The purpose of this study was to compare the effects of naturally and anthropogenically disturbed forests in the Western Cascades of Oregon on selected biotic, hydrologic, and nutrient processes. Objectives were to: 1) develop methods for creating representative landscapes, 2) quantify landscape structure and function, and 3) compare the effects of natural and human landscape patterns on specific elements of biodiversity, evapotranspiration, stream flow, and carbon processes. Wildfire landscapes were simulated using the LADS model and parameters from dendrochronological studies. Archival research on spatial patterns and rates of early harvest disturbance were integrated with TM imagery to create historical harvest landscapes. Results from smaller scale harvest modeling were used to create hypothetical future landscapes. Vegetation structure was characterized in terms of the types and amounts of vegetation present through distributed, stratified, and spatially explicit metrics. Vegetation was placed in the context of ridges, streams, and hillslope components and broad scale environmental trends to delineate critical landscape features. Expected results include a decrease in the heterogeneity of vegetation structure. Connectivity between habitats via riparian corridors may be marginal, mitigated by landscape context. Evapotranspiration is expected to vary significantly in low elevation lands, where the conversion to predominantly young conifer plantations should result in much higher rates. At high elevations, variability of peak and low flows is expected to be influenced by increased connectivity between open patches and stream networks. Carbon cycling is increased in harvested landscapes, with interesting resultant fuel connectivity.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Landscape Pattern and Ecosystem Processes

Disturbance and Landscape Pattern Interactions
<table>
<thead>
<tr>
<th>Email</th>
<th>Title</th>
<th>Authors</th>
<th>Institutions</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="mailto:todd.lookingbill@duke.edu">todd.lookingbill@duke.edu</a></td>
<td>Poster</td>
<td>Pierce, Kenneth B., Todd Lookingbill, and Dean Urban.</td>
<td>Nicholas School of the Environment, Duke University, Durham, NC 27708, USA.</td>
<td>An Assessment of Proximate Climate Variables and their Relative Impact of Vegetation Patterns in Montane Systems.</td>
</tr>
<tr>
<td><a href="mailto:pierce.kenneth@tamu.edu">pierce.kenneth@tamu.edu</a></td>
<td>Oral/Poster</td>
<td>Pierce, Kenneth B., Todd Lookingbill, and Dean Urban.</td>
<td>Nicholas School of the Environment, Duke University, Durham, NC 27708, USA.</td>
<td>An Assessment of Proximate Climate Variables and their Relative Impact of Vegetation Patterns in Montane Systems.</td>
</tr>
<tr>
<td><a href="mailto:r-coulson@tamu.edu">r-coulson@tamu.edu</a></td>
<td>Poster</td>
<td>Pinto, M. A., K. Baum, W. Rubink, S. Johnston, R. N. Coulson.</td>
<td>Knowledge Engineering Laboratory, Department of Entomology, Texas A&amp;M University, College Station, TX, USA; USDA/ARS, Weslaco, TX, USA.</td>
<td>Spatial and Temporal Patterns of Mitochondrial DNA in Feral Honey Bees: Impact of Africanization.</td>
</tr>
</tbody>
</table>

Using disparate examples of research projects that I have been involved in highlights key aspects of a framework for landscape ecology. The attempt to extract the similarities from these examples shows the ubiquity of heterogeneity, exposes some of its functional features, and helps to show the role of humans in creating and responding to heterogeneous urban and wild systems. A framework that can accommodate such a wide variety of kinds of studies recognizes 1) the kinds, frequency and configuration of elements of heterogeneity, 2) that heterogeneity is nested and scalable, 3) that determining the nature and control of flux is key to understanding heterogeneity, and 4) that a human ecosystem model can accommodate the range of individual and institutional processes in understanding ecosystems. Such a framework may serve landscape ecology well, and help inform other disciplines about the important insights of landscape ecology.

- Landscape analyses of vegetation patterns often rely on slope, aspect and elevation as determinants of local climate. Although there are obvious relations to these factors at large scales, at smaller scales the correlations are often less strong. This may in part be due to the fact that multiple sites with identical elevation, slope and aspect may occupy many different topographic positions. We took the position in the landscape matrix into account by using a GIS and a digital elevation model to assess the annual potential solar radiation (PSR) at a site using solar/land surface geometry and local topographic shading. We also used a temperature model based on HOBO data loggers to calculate a measure of growing degree days at our field sites in the Sierra Nevada and the Western Cascades. We then compared vegetation patterns to several indices derived from local topographic field measurements, our PSR landscape index, estimated growing degree days and a similar measure of mid-afternoon solar exposure using the ARC/INFO function Hillshade. Results suggest a more explicit representation of the landscape context of a site is important in assessing vegetation responses to local environment.

- I parameterized the GIS and neural net-based Land Transformation Model for the Detroit (DMA) and Twin Cities Metropolitan Areas (TCMA) using historical land use data derived from aerial photography. I built several neural net models and attempted to test whether these models were transferable across the two metropolitan regions and whether a regional model provided as good a fit as a locally parameterized model. The overall accuracy of the model to predict urban transitions was 37% and 33% for the TCMA and DMA, respectively. An "internal" versus "external" learning exercise resulted in models that appeared to be fairly transferable in one case (DMA applied to TCMA) and not well transferable in the other case (TCMA applied to DMA). A "local" versus "regional" exercise produced results suggesting that learning from larger scale spatial patterns does not reduce the affect of the model to predict smaller, local trends. I discuss the implications of these two learning exercises and suggest ways in which the models could be improved. Overall accuracy of the presented models is judged against previous LTM applications in Michigan's Grand Traverse Bay Watershed and Kuala Lumpur, Malaysia.

- There are two controversial views about the genetic nature of the Africanized honeybee in the Americas. One view reports that Africanized honeybees have spread by maternal migration of African swarms and the population has retained an African genetic integrity. The other one states that the population of Africanized honeybees consists of African/European hybrids. In the present study the genetic interaction between Africanized and European honeybees is investigated. From 1990 to 2000, honeybee workers have been collected from feral colonies on the Welder Wildlife Refuge (San Patricio County, Texas).
A major challenge is to understand how the location and extent of human disturbance, within a drainage basin, interact with stream network configuration to affect ecosystem processes. Cumulative hydrological modifications (dams, water withdrawals, etc.) along drainage networks are increasingly affecting the biological integrity of the greater landscape, to the extent that even protected areas (e.g., parks) are threatened. Given the magnitude and extent of hydrological modifications, can we develop some predictive capability regarding how different spatial patterns or configurations of hydrological alterations within a stream network affect ecosystem function? Two case studies illustrate how development of this predictive capability would allow us to make more environmentally sound decisions regarding the
placement of future dams, water diversions, and other hydrological modifications within drainage networks. A case study from Puerto Rico shows how the location of dams and water withdrawals along island streams can affect the longitudinal distribution of fishes and shrimps (by blocking migration and/or causing direct mortality), with cascading ecosystem-wide effects. Our studies of migratory shrimps indicate that there is a positive exponential relationship between total stream length (above a given location within a stream network) and the magnitude of migration of larval shrimps, indicating that managers might consider establishing water intakes on low-order, low altitude streams to avoid massive larval shrimp mortality which often occurs at water intakes. A second case study examines recent hydropower development on Costa Rica’s Atlantic Slope which has resulted in stream de-watering and isolation of stream headwaters. Studies are currently underway to examine cumulative impacts of established hydropower projects within the drainage network.

Qi, Ye. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720-3310, USA; Estimating Species Richness by Family: Does Scale Matter?

We derived an equation for the relationship between species and family numbers of plants within a region, based on species-area and family-area relationships. Using an analytical procedure, we showed that the size of census plot does not affect the species-family relationship. The equation of the species-family relationship was used to explain the similarity in the species-families relationships obtained statistically for samples of Neo-tropical forests and of Southern Africa woody plants, with striking contrast in their size of sampling grids. The equation is also used to explain the difference between these two regions and the State of California. The derived species-family relationship serves as a basis for an effective approach in mapping the geographical distribution of plant species diversity based family numbers. The latter tends to be estimated much more easily and accurately.

Redman\textsuperscript{1}, C. L. and N.B. Grimm\textsuperscript{2}. Center for Environmental Studies and \textsuperscript{1}Department of Biology, Arizona State University, Tempe, AZ 85287, USA. Pattern and process in the human-dominated landscape of central Arizona

The Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER) project is a multifaceted study aimed at answering the question, “How does the pattern of development of the city alter ecological conditions of the city and its surrounding environment, and vice versa?” Central to answering this question is understanding how land-use change is driven by societal decisions, how these decisions alter ecological pattern and process, and how changes in ecological conditions further influence human decision-making. Of the 24 sites funded under the nationwide LTER program, Phoenix and Baltimore are the only 2 established specifically to study urban ecosystems. The rationale for the study of human-dominated systems is three-pronged. First, humans dominate Earth’s ecosystems; therefore, humans must be integrated into models for a complete understanding of ecological systems. Second, development of these more realistic models for ecological systems will lead to greater success in finding solutions to environmental problems. Third, although the study of ecological phenomena in urban environments is not a new area of science, the concept of city as ecosystem is relatively new for the field of ecology. Studying cities as ecosystems within new paradigms of ecosystem science will both raise the collective consciousness of ecologists about urban ecosystems and contribute to the further development of concepts that apply to all ecosystems. We will present background information on the central Arizona-Phoenix landscape, results from the first three years of CAP LTER research, and a conceptual basis for integration of social and ecological systems.

Reed, Catherine C. Entomology Department, University of Minnesota, St. Paul, MN 55108, USA. Native Bee Species Persistence and Recolonization on Midwestern Prairie Fragments.

A three-year field study of insects on flowers in 8 Minnesota prairies showed a high diversity of bee species persisting on prairie remnants, and recolonizing prairie reconstructions, even where plant populations were small. Both remnants and reconstructions usually display high plant species richness and long blooming season, so that both generalist and specialist bee species are able to survive. Bees are well adapted to foraging for scattered resources. Prairie and most other habitats are patchy at the scale of bee foraging distances. The prairie on small and large scales has been continually disturbed by fire, and most prairie animals are able to disperse rapidly into areas where vegetation is regrowing.
following fire, so the ability of bees to recolonize new areas is not surprising. However, the major differences in bee species composition among nearby sites suggests that there is some randomness in location of and establishment on prairie sites by bees. The distance bees can fly to colonize new sites remains unknown. Despite the apparent high mobility of bees, many studies of prairie plant demography indicate that lack of pollinator visits is reducing seed production by plants, especially in small fragmented populations. Reduced pollinator visitation to plants in small populations relative to nearby large populations may be based in bee patch choice on the scale of daily foraging bouts. We do not know whether bees are unable to find isolated small clusters, unwilling to return to them, and the distance they will fly from nest to foraging site remains unknown also.

| 211. | carlae@sevilleta.unm.edu | Special: Jenerett e-Wu | Restrepo, Carla, Bruce T. Milne*, D. Bader, W. Pockman, and A. Kerkhoff. Department of Biology, The University of New Mexico, Albuquerque, NM 871131, USA. Variation in vegetation growth rates: Implications for the evolution of semi-arid landscapes. | Restrepo, Carla, Bruce T. Milne*, D. Bader, W. Pockman, and A. Kerkhoff. Department of Biology, The University of New Mexico, Albuquerque, NM 871131, USA. Variation in vegetation growth rates: Implications for the evolution of semi-arid landscapes. | Complexity Theory and Ecological Applications |

| 212. | drichey@satrep c.com | Oral/Re g | Richey, David J. Department of Landscape Architecture, University of Oregon, Eugene, OR 97403-5247, USA. Design and Prioritized Implementation of Woody Riparian Buffers for Increasing Effective Shade in Agricultural Landscapes of the Willamette River Valley, Oregon. | Richey, David J. Department of Landscape Architecture, University of Oregon, Eugene, OR 97403-5247, USA. Design and Prioritized Implementation of Woody Riparian Buffers for Increasing Effective Shade in Agricultural Landscapes of the Willamette River Valley, Oregon. | Landscape-Scale Ecological Assessment |

<p>| 213. | kрит<a href="mailto:ters@frs.fed.us">ters@frs.fed.us</a> | Special: Smith's | Riitters*, Kurt, Jim Wickham*, Bob O’Neill*, and Bruce Jones*. 1 US Forest Service, Research Triangle Park, NC 27709, USA; 2 US EPA, Research Triangle Park, NC, 27709, USA; 3 Oak Ridge, TN 37830, USA; 4 US EPA, Las Vegas, NV, 89173, USA. The risk that a landscape will experience forest fragmentation is modeled as a function of sensitivity, vulnerability, and future stress for landscapes in the mid-Atlantic region. In a model appropriate for the risk of forest fragmentation, the return on investment for incremental stream buffering. Geographic configuration and estimated cost-to-benefit ratios of different valuation assumptions are compared and evaluated with regard to informing the design of riparian conservation buffer strategies. | Riitters*, Kurt, Jim Wickham*, Bob O’Neill*, and Bruce Jones*. 1 US Forest Service, Research Triangle Park, NC 27709, USA; 2 US EPA, Research Triangle Park, NC, 27709, USA; 3 Oak Ridge, TN 37830, USA; 4 US EPA, Las Vegas, NV, 89173, USA. The risk that a landscape will experience forest fragmentation is modeled as a function of sensitivity, vulnerability, and future stress for landscapes in the mid-Atlantic region. In a model appropriate for the risk of forest fragmentation, the return on investment for incremental stream buffering. Geographic configuration and estimated cost-to-benefit ratios of different valuation assumptions are compared and evaluated with regard to informing the design of riparian conservation buffer strategies. | Assessing Current and Future Regional Vulnerabilities |</p>
<table>
<thead>
<tr>
<th>214.</th>
<th><a href="mailto:mrollins@fs.fed.us">mrollins@fs.fed.us</a></th>
<th>Oral/Poster</th>
<th>Rollins, Matthew, and Robert Keane, Fire Sciences Laboratory, Rocky Mountain Research Station, United States Forest Service, Missoula, Montana 59807, USA. Remote sensing and gradient modeling for ecosystem management.</th>
<th>Landscape Mapping and Characterization: Methods and Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>216.</td>
<td><a href="mailto:arturo.sanchez@ualberta.ca">arturo.sanchez@ualberta.ca</a></td>
<td>Oral/Poster</td>
<td>Sanchez-Azofeifa1, G. Arturo, Gretchen Daily2, and Paul Ehrlich3. 1 Earth and Atmospheric Sciences Department, University of Alberta, Edmonton, AB, Canada T6G 2E3; 2 Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA 94305-5020, USA; and 3 Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA 94305-5020, USA. Isolation of National Parks in the Tropics.</td>
<td>Landscape Pattern and Biodiversity Conservation</td>
</tr>
</tbody>
</table>
Tropical deforestation and habitat fragmentation are important forces driving environmental deterioration and biodiversity losses in tropical environments. Efforts to control the spread and impacts of these forces are often promoted by the implementation of national parks and biological reserves. These policies contribute to having two main land use/cover change (LUCC) gradients in the landscape: one in which conservation policies are effective and another in which we have uncontrolled deforestation and habitat fragmentation which-in fact- contributes to the isolation of the former. In this paper, we present results from a nationwide landscape fragmentation study conducted in Costa Rica, Central America. Costa Rica has been selected not only because 25% of its territory is under conservation initiatives, but also because the country holds approximately 4 to 5% of all tropical biodiversity worldwide. In this paper, we present the first estimates ever of habitat fragmentation, deforestation rates and secondary growth inside of Costa Rica's National Parks and Biological reserves. In addition, we provide the results of a comprehensive analysis of the level and impact of habitat fragmentation of each of the twelve ecological life zones presented in the country. We also evaluate the use of non-traditional landscape fragmentation measures to quantify the level of national parks and biological reserves. We concluded that national parks in Costa Rica are currently stable in terms of the LUCC dynamics, but that current deforestation and habitat fragmentation processes outside of these conservation areas are contributing to their isolation in the Central American landscape.

**Poster Special: Den't's**

**Schade, John D., Stuart G. Fisher, Julia C. Henry, and Jill, R. Welter.** Department of Biology, Arizona State University, Tempe, AZ 85287, USA. Hydrologic and nutrient exchange between stream and riparian zone in an arid-land watershed.

Our objectives were to determine the hydrologic linkage between surface stream and riparian zone, and the role of riparian vegetation in retention of stream-water nitrogen at multiple spatial scales in Sycamore Creek, a Sonoran Desert stream. At the reach scale (~1 km), several studies have shown that the dominant flowpath of water is from stream to riparian zone. These studies also show the riparian zone to be a strong sink for stream water nitrogen. Mass balance calculations suggest most nitrogen retention is due to denitrification, with a smaller contribution by plant uptake. Stable isotope experiments suggest that most nitrogen is removed at a narrow interface between stream and riparian zone. At a smaller scale (1-10 m), patches of gravel bar colonized by a riparian shrub within a single reach showed similar patterns, with colonized patch sinks and denitrification, and most nitrogen retention occurring over a small spatial scale (~10 cm) at the interface between colonized and uncolonized gravel bar locations. These smaller scale riparian patches allowed us to more rigorously determine the mechanism for nitrogen retention. Results of experimental manipulations showed that the presence of the plant stimulated microbial process rates leading to loss of nitrogen via denitrification. These results show a strong hydrologic connection between surface stream and riparian zone. They also suggest that a strong interaction between plants and microbes is responsible for the effectiveness of the riparian zone as a sink for nitrogen at multiple spatial scales.

**Poster**

**Schoennagel*, Tania, Monica G. Turner*, and William H. Romme*.** Dept.of Botany and Zoology, University of Wisconsin, Madison, WI, USA; Dept. of Zoology, University of Wisconsin, Madison, WI, USA; Dept. of Biology, Fort Lewis College, Durango, CO, USA. Spatial and temporal influences of fire regimes on initial pathways of succession across the Yellowstone landscape.

Climate change is expected to alter disturbances regimes such as fire, resulting in significant changes in vegetation patterns and carbon sequestration across forested landscapes. The objective of this research is to test for and predict shifts in initial successional pathways in response to a range of different intervals between stand replacing fires across the subalpine plateaus of Yellowstone National Park. Previous work has considered the effects of fire severity, fire size and level of serotiny in explaining initial pathways of postfire succession across the Yellowstone landscape. The effects of the third component of the disturbance regime, fire interval, remains largely unexplored, and is a fundamental link in predicting effects of climate change across the landscape. Plant community composition was sampled during summer 2000 in 50 stands exhibiting a range of fire intervals between stand replacing fires (12 yrs - 395 yrs). Our results highlight significant interactions between fire interval, fire size and percent serotiny in predicting initial postfire succession. For example, we detect threshold responses in lodgepole pine densities to different fire intervals in areas where the percentage of serotinous individuals is high. These
results suggest that the landscape mosaic of stand structure produced by fire regimes in Yellowstone National Park is contingent on variation in both the spatial and temporal patterns of fire.

| 219. schooley@lama r.colosta te.edu | Poster | Schooley1, Robert L., and John A. Wiens 1,2. 1Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; 2National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA. Predicting the Distribution and Abundance of a Habitat Specialist: Grain Size and Spatial Effects. | Schooley1, Robert L., and John A. Wiens 1,2. 1Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; 2National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA. Predicting the Distribution and Abundance of a Habitat Specialist: Grain Size and Spatial Effects. | | | Scale: Methods and Case Studies |


<p>| 221. SEAGL E@AL. UMCES .EDU | Poster | Seagle, Steven W., Brian R. Sturtevant, Robert A. Chastain, and Philip A. Townsend. Appalachian Laboratory, University of Maryland Center for Environmental Science, Frostburg, MD 21532, USA. Spatial variation of forest-floor litter invertebrates in topographically diverse landscapes. | Seagle, Steven W., Brian R. Sturtevant, Robert A. Chastain, and Philip A. Townsend. Appalachian Laboratory, University of Maryland Center for Environmental Science, Frostburg, MD 21532, USA. Spatial variation of forest-floor litter invertebrates in topographically diverse landscapes. | | | Landscape Pattern and Population Dynamics and Species Distribution |</p>
<table>
<thead>
<tr>
<th>Authors</th>
<th>Role/Region</th>
<th>Title and Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shapiro, Tamara*, Emily W.B. Russell*, and Jean Marie Hartman*.</td>
<td>Department of Landscape Architecture, Rutgers University, New Brunswick, NJ 08901, USA; Department of Geologic Sciences, Rutgers University, New Brunswick, NJ 07710, USA; and Department of Landscape Architecture, Rutgers University, New Brunswick, NJ 08901, USA.</td>
<td>Forces of Environmental Change in the Hackensack Meadowlands: A Historic Analysis.</td>
</tr>
<tr>
<td>Hartman, Janet, and T.F.H. Allen*.</td>
<td>Department of Landscape Architecture, University of Wisconsin, Madison, WI 53706, USA; Department of Botany, University of Wisconsin, Madison, WI 53706, USA.</td>
<td>Negotiating the Cultural Landscape as a Bumblebee: Complex Foraging Behavior and Levels of Organization.</td>
</tr>
<tr>
<td>We are interested in how native pollinators, namely bumblebees, move about a cultural landscape while foraging. More specifically, how does the heterogeneity of floral resource patches influence foraging paths? In our first test of this process we compared paired natural heath bogs and cultivated cranberry bogs in Northern Wisconsin. However, like any ecological process, there are multiple scales of foraging, with different activities operating at different scales. Moreover, some scales of foraging behavior are not coincident with human levels of observation or typical scales of cultural landscape form. For example, there is a wealth of controlled, experimental research on bumblebee foraging at the flower or flower cluster scale. But there has been little work that assesses spatially explicit foraging between plants or patches. On the other hand, there have been broader scale studies to address habitat preferences and foraging distance across fields and landscapes, but the results are inconclusive and provide little understanding of the flight sequence between habitats. In other words, beyond the small patch / plot scale, the world of bumblebee travel is nearly invisible to us. And it is at these scales that cultural processes most significantly alter landscape structure. This paper presents the issue of native pollinator landscape relationships where levels of observation and management inadequately match those of the process under study. We propose an approach that borrows from complex systems theory to model spatial processes for scales with little empirical data, based on current knowledge from scales above and below that in question.</td>
<td>Land Use and Land Cover Change: Pattern and Process</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The table entries include authors, their roles, and the title and abstract of their research papers.
The importance of initiating planning/design with a sufficient understanding of a site and its larger landscape connections -- including the interactions among pattern, process, scale, and hierarchy -- cannot be underestimated. Failure to understand and reveal site and landscape structure, function and dynamics to participants in citizen-driven planning processes leads to less effective, inefficient and often contentious master planning. This presentation critiques the development of the Brown Farm Park Master Plan in Blacksburg, Virginia, focusing on what we learn from mistakes made during the process -- and from the coordinating efforts of EPA's Regional Vulnerability Assessment (ReVA) Program. Purchased by the town in fall 1998, Brown Farm became a center of community attention when the master planning process was initiated in 1999. As a result of recent changes in its use and management, this human-dominated farm has been profoundly altered by natural forces, now providing cover, food and nesting habitats for over 160 species of birds, and for many mammals, amphibians, reptiles, butterflies and insects. It is posited that earlier analysis and community dialogue about site/landscape ecology would have narrowed the range of recreation facilities considered appropriate for Brown Farm Park, encouraging park planners/designers and community members to look beyond this ecologically important site for more intensive park facilities and recreation programs. Grounding community land planning and design with an understanding of site and landscape ecology is more likely to occur where ecologists, biologists and environmental planners/designers become actively involved in local planning efforts early in the process.

Changes in fire regimes in mixed conifer forests of the Sierra San Pedro Martir, Baja California, Mexico.

The conifer forests of the Sierra San Pedro Martir (SSPM) of northern Baja California, Mexico are unusual among forests of western North American because they have not been harvested and have not been influenced by systematic fire suppression. The species found there are common in forests of California. Some have suggested these forests may serve as reference conditions for forests of the Sierra Nevada. We are conducting a dendrochronology based fire history for two 1 km2 areas within the SSPM. Our data from these sites suggest that several fire regime parameters changed around 1800 AD. Fires became less frequent after 1800. For fires that scarred at least 3 trees in each sample area, the pre-1800 median fire return intervals were 9 and 8.5 (ranges 4-21 and 4-27) while post-1800 were 18 and 17 (ranges 7-43 and 5-43) respectively. Several factors may have contributed to this apparent change in the fire regime. The San Pedro Martir mission was established in 1794 bringing a) the introduction of cattle grazing to the adjacent mountains and b) diseases that contributed to decline in native populations. Additionally, climate variation as evidenced in a synchronous decline of fire scars from ~1780 to ~1840 throughout the American Southwest and northwestern Mexico may have been a factor.

Improving environmental decision-making requires an assessment of relative risk posed by multiple stressors, now and into the future. Landscape sciences provide an opportunity to put regional-scale problems into perspective, and allow trade-offs to be compared through future scenario analysis. EPA's Regional Vulnerability Assessment (ReVA) Program is a new research initiative designed to develop and demonstrate an approach for assessing current and future environmental vulnerabilities and applying this information at the regional- to local-scales. This is being done through a combination of landscape-based exposure/effects models, regional-scale stressor- and resource-distribution models, new integrative techniques, and incorporation of socio-economics to develop plausible future scenarios and to communicate results in terms of potential changes to life. ReVA's pilot study is being done in the mid-Atlantic region as a part of the Mid-Atlantic Integrated Assessment (MAIA). The first assessment, vulnerability of forests and streams, will be completed in FY 2002.
| 227. | magwitt @larna r.colosta te.edu | Oral/Re g | Smith¹, Eric L., and Drew McMahan².¹ Forest Health Technology Enterprise Team, USDA Forest Service, Fort Collins, CO 80526, USA; ²Intecs International, Fort Collins, CO 80526, USA. An Integrated System to Model and Display Bark Beetle and Management Impacts on a Forest Landscape. | Landscape Pattern and Population Processes |
| 228. | smith.jo nathanh @epa.g ov | Oral/Re g | Smith¹, Jonathan, James D. Wickham¹, Douglas Norton¹, Tim G. Wade¹, and K. Bruce Jones¹. Landscape Characterization Branch (MD-56), US EPA, Research Triangle Park, NC 27711, USA; Office of Water, US EPA, 1200 Pennsylvania Ave, NW, Washington DC, 20460; Landscape Ecology Branch, US EPA, PO Box 93478, Las Vegas, NV 89193. Utilization of Landscape Indicators to Model Water Quality. | Landscape-Scale Ecological Assessment |
populations in the port of Rotterdam. Second question is how the ongoing process of urban development can be steered in such a way, that ecological conditions are optimized. A planning strategy has been developed, the so-called 'strategy of the two networks'. This strategy leads to a planning based on flows of water and traffic. Goals are to establish clean urban water systems and urban areas without the noise of traffic; these are the spatial basis for continuous networks of green and water areas, with (among others) high value for urban nature and recreation. Third question is how urban nature can get the active support from local people. Urban ecologists tend to think in terms of functional biodiversity. However for a successful implementation more attention has to be paid for other aspects of the multipurpose use of urban nature, as for example recreational and sport interaction. Also the visible quality of urban nature, as experienced by architects and urban planners, is very important. The challenge is how to combine all these different aims in urban nature with a high rate of biodiversity. The question how to develop sustainable populations of urban species turns out to be a delta research. This means that alpha (sociological and psychological), beta (ecological) and gamma (planning) researchers have to cooperate in this research program.

<table>
<thead>
<tr>
<th>230.</th>
<th><a href="mailto:bosong@facstaff.wisc.edu">bosong@facstaff.wisc.edu</a></th>
<th>Oral/Reg</th>
<th>Song, B.¹, P. Zöllner², D. J. Mladenoff¹, Eric Gustafson², H. S. He³, and V. C. Radeloff¹. ¹Department of Forest Ecology and Management, University of Wisconsin, Madison, Madison, WI 53706, USA. ²North Central Research Station, 5985 Highway K, Rhinelander, WI, USA. ³School of Natural Resources, University of Missouri, Columbia, MO, USA. 3-D Visualization of Management Alternatives on the Chequamegon National Forest.</th>
<th>Song, B.¹, P. Zöllner², D. J. Mladenoff¹, Eric Gustafson², H. S. He³, and V. C. Radeloff¹. ¹Department of Forest Ecology and Management, University of Wisconsin, Madison, Madison, WI 53706, USA. ²North Central Research Station, 5985 Highway K, Rhinelander, WI, USA. ³School of Natural Resources, University of Missouri, Columbia, MO, USA. 3-D Visualization of Management Alternatives on the Chequamegon National Forest.</th>
<th>Landscape Mapping and Characterization: Methods and Applications</th>
</tr>
</thead>
</table>

231. | Anne Whiston Spiri <spirn@mit.edu> | Keynote Speech | Spiri, Anne W. School of Architecture and Planning, MIT, Cambridge, MA 02139, USA. Watersheds, History, Landscape Planning and Community Development: Reflections on Fifteen Years of the West Philadelphia Landscape Project. | Spiri, Anne W. School of Architecture and Planning, MIT, Cambridge, MA 02139, USA. Watersheds, History, Landscape Planning and Community Development: Reflections on Fifteen Years of the West Philadelphia Landscape Project. | Keynote Speech |

232. | espn2@pop.uky.edu | Oral/Reg | Springborn¹, Elizabeth G., and David S. Maehr². ¹Departments of Animal Science and Forestry, University of Kentucky, Lexington, KY 40503, U.S.A.; ²Department of Forestry, University of Kentucky, Lexington, KY 40503, U.S.A. Conduits, filters, and | Springborn¹, Elizabeth G., and David S. Maehr². ¹Departments of Animal Science and Forestry, University of Kentucky, Lexington, KY 40503, U.S.A.; ²Department of Forestry, University of Kentucky, Lexington, KY 40503, U.S.A. Conduits, filters, and barriers to elk movement in a heterogeneous landscape in eastern Kentucky. To evaluate the restoration of a native species, such as elk which was extirpated from Kentucky by 1850. It is important to understand the colonization patterns of translocated individuals. The object of this study was to identify landscape features that influence the dispersion and home range establishment of reintroduced elk (Cervus elaphus) in eastern Kentucky. GPS radio collars were fitted on 22 elk during 1998, 1999, and 2000 to study elk movement from 4 release sites. Locations were obtained every three | Landscape Pattern and Population Processes |
barriers to elk movement in a heterogeneous landscape in eastern Kentucky.

...six hours for up to 13 months per elk. A total of 250 - 2500 locations were obtained for each animal. This variation was caused by an equipment failure rate of over 50%. Topography, hydrology, land use, urban areas, mining sites, and highway land cover data were examined in ArcView GIS relative to elk movement data. To date, most elk (87-90%) appear to remain within 20 km of the release site, whereas others (<5%) have moved >150 km from it. Landscape features such as rugged topography, rivers, and highways do not present barriers to the movement of individuals that chose to leave the release site, but may influence colonization patterns. Elk prefer to follow topographic contours rather than moving perpendicular to ridgelines and valleys. As such, ridgelines may act as conduits to elk movements and may help managers predict the direction and extent of colonization.

233. dls@physics.arizona.edu Special: Jenerrt e-Wu Stein, D. L. Department of Physics, University of Arizona, Tucson, AZ 85721, USA. Spin glasses, disorder, and complexity.

Stein, D. L. Department of Physics, University of Arizona, Tucson, AZ 85721, USA. Spin glasses, disorder, and complexity.

Our deep physical and mathematical understanding of ordered systems in the solid and liquid state --- for example, crystals, ferromagnets, superconductors, liquid crystals, and many others --- has been of fundamental scientific and technological importance throughout the second half of this century. However, there exist many systems, both familiar and unfamiliar in everyday use, in which randomness or disorder plays a key role, and in which our mathematical and physical understanding remains comparatively primitive. One familiar example is ordinary window glass, where the atoms or molecules are "stuck" in random locations (as opposed to a regular crystalline array as would be found, for example, in ice). Spin glasses are disordered magnetic systems that are thought to be prototypes for this kind of macroscopic "frozen-in" disorder, and they may be more amenable to mathematical analysis than other materials in this class. Nevertheless, little fundamental progress has been made even here. In this talk I will introduce some basic features of spin glass experiment and theory, and discuss why some the methods and concepts developed to understand spin glasses may have wider applicability in the field of complexity.

234. steinitz@gsd.harvard.edu Oral/Reg Steinitz1, Carl, David Mouat2, Robert Anderson3, Hector Arias4, Scott Bassett5, Mary Cablik6, Micahel Flaxman7, Tomas Goode8, Rbert Lozar9, Thomas Maddock, Ill6, Winifred Rose5, Richard Peiser1, and Allan Sheaer3.  1Department of Landscape Architecture, Harvard University, Cambridge, MA 02138, USA; 2Division of Earth and Ecosystem Sciences, Desert Research Institute, Reno, NV 89512, USA; 3Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721, USA; 4Environmental Division, U.S. Army Training and Doctrine Command, Fort Monroe, VA 23651, USA; 5Gabinete de Estudios Ambientales, A.C., Hermosillo, Mexico; 6Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721, USA; 7U.S. Army Construction and Engineering Research Laboratory, P.O. Box 9005, Champaign, IL 61826, USA. Alternative Futures of the Upper San Pedro River Watershed, Arizona and complexity theory and ecological applications.
Changes in landscape pattern and their effects on ecosystem functions in the Seoul area: Guidelines for urban landscape conservation and ecological planning.

Landscape change has been largely influenced by human activities. Developed urban areas may often serve as an important source habitat for populations of introduced plant species. In recent years, this situation has become one of environmental problems in urban landscape management for controlling landscape changes and their effect on ecosystem functions in the Seoul area. Spatio-temporal variations in the structure of forest patches in the urban landscape were quantified from 1983 to 1999. Thirty-two landscape indices were analyzed using FRAGSTATS and found that these were selected by Pearson’s correlation analysis and factor analysis. In order to know the distribution pattern of two representative naturalized plants (Robinia pseudoacacia and Eupatorium rugosum) in the developed area of Seoul, Kangdong-Gu, one of administrative areas was selected for this study. The results showed that forest
<table>
<thead>
<tr>
<th>Page 90</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>urban landscape conservation and ecological planning.</strong> patches became smaller and more irregular in shape and that the diversity of patch types and the variation in forest patch size both increased. The analysis also suggested that the two species often occurred in the same habitat and were often found in forest edges disturbed by human activities. Their distribution patterns were related to landscape indices (patch size and shape) in the forest edge. Based on these findings, we propose guidelines for the urban landscape conservation and ecological planning in Seoul.</td>
</tr>
<tr>
<td>240.</td>
</tr>
</tbody>
</table>
Patterns of disturbance in aquatic and riparian systems in mountain landscapes can be strongly influenced by the structure of stream networks. Network structure determines, in part, the distribution of geomorphic processes and their effectiveness as disturbance agents within stream systems. A 50-year record of debris flows in a Cascade Mountain landscape reveals a concentration of events in a limited set of the first- through third-order channels and a shifting mosaic of linear disturbance patches within the stream and riparian network across that part of the landscape. Channel segments not subjected to recent debris flows may serve as refuges for debris-flow producing floods, and sources of organisms to recolonize severely disturbed patches. Study of a major flood in 1996 on fourth- and fifth-order channels suggests that the widespread, 30-year-old, riparian alder stands experienced highest severity disturbance (removal) where floated wood was moving in a congested manner. These batches of wood were commonly delivered to the larger channel by debris flows from tributaries. Uncongested wood movement (floating individual pieces) tended to topple trees without removing them. Analysis of stem-map data from before and after the flood in a wide valley floor area with extensive alder stands shows a fine-grained pattern of disturbance patches of toppled and removed stems. These patterns reflect changes in channel position, impacts of floated wood, and other processes influenced by channel position. Aquatic habitat was altered directly by channel change and bed turnover, as well as indirectly by alteration of the riparian zone and its influences on the aquatic system. These observations form a basis for defining both deterministic and more stochastic properties of the disturbance regime over this mountain stream network.

Forest thinning is one of the main forest management practices in Brazil. Natural disturbances and human activities lead to changes in the forest landscape, which can be evaluated using spatial models. In this study, we evaluated the effects of forest thinning on soil respiration in a 20m by 20m plot in a 3 by 3 matrix of sampling points. We found that soil temperature and moisture explain most of the temporal variations in soil CO2 efflux, but soil CO2 efflux does not vary significantly before and after the thinning. The impact of forest thinning on soil respiration is controlled by soil temperature, soil moisture, fine root biomass, microbial biomass, and soil physical and chemical properties. The thinning of forests will change soil temperature and moisture and thus change the soil CO2 efflux. Using an LI-6400 Soil CO2 Flux System we measured soil surface CO2 efflux in an 8-year-old ponderosa pine plantation, 58% of which is covered by trees, in the Sierra Nevada Mountains in California from June 1998 to April 2000 before a pre-commercial thinning, and from April to November 2000 after the thinning. We established two 20m by 20m sampling plots and measured soil CO2 efflux and soil temperature at 10 and 20 cm in depth and moisture on a 3 by 3 matrix of sampling points in each plot. We found that soil temperature and moisture increase in the temporal variations of soil CO2 efflux, they explain only a little part of the spatial variation of soil CO2 efflux. A thinning intensity of 60% of the trees significantly changed the microclimate in the forest, but the soil CO2 efflux does not vary significantly before and after the thinning.
Habitat Selection along the lower Hudson River.

This project examines Neotropical migratory birds in the Eastern United States, using habitat and movement models to highlight stopover hotspots. Integrating with other research in ReVA, we will examine how future scenarios affect existing migratory habitats. For example, new development may bisect a forested river corridor used by migrants. At certain locations, this type of disturbance may have a significant impact on the migrant bird population. Only through a landscape view can we identify environmental factors key to successful migration, and understand how future changes may alter the migration landscape.

Patterns and processes in urban landscapes: reducing the human footprint with landscape ecology.

An important challenge of landscape ecology is to integrate socio-economic and ecological data in a quantitative fashion in an effort to better understand human-dominated ecosystems. However, progress in such integration is impeded by a lack of standard definitions and a lack of an operational gradient. For example, although “urban” is defined by the US Census Bureau as a population density of 1,000 per square mile or more, suburban, exurban, and rural are defined simply as “not urban”. However, these terms are commonly used in social and ecological research, though only infrequently are they defined quantitatively. This handicaps not only attempts to integrate socio-economic and ecological data, but it obviates comparative analyses of research conducted in different locations and times. There are a number of conceptual frameworks to draw from, such as Forman and Godron’s urban-suburban-cultivated-managed-natural, McIntyre and Hobbs’ relictual-fragmented-variegated-intact, and McDonnell and Pickett’s urban-rural transect. In this paper I describe a number of quantitative attributes of human-dominated ecosystems, such as population density, housing density, land use type, and road density, to operationalize the urban-rural gradient.
| 246. | tinker@wcu.edu | Oral/Research | Tinker1, Daniel B., William H. Romme2, and Don G. Despain3. 1Department of Geosciences and Natural Resources Management, Western Carolina University, Cullowhee, NC 28723, USA; 2Biological Department, Fort Lewis College, Durango, CO 81301, USA; and 3USGS, Department of Biology, Montana State University, Bozeman, MT 59717, USA. Historic Range of Variability in Landscape Structure in Subalpine Forests of the Greater Yellowstone Area. | Landscape Pattern Analysis: Theory and Methods |

Increasing a window of analysis around used habitat. Discriminant analysis of landscape metrics was used to quantify selection between used and random locations at each extent. We believe that such a hierarchical approach can better define the effects of scale on both species habitat selection and the variation within resource selection, and could be useful in improving wildlife management techniques.


In the “old world” cities needed to adapt to their landscape. More recently, urban form and function seem to have almost lost contact with the local landscape. In this paper I argue there is a need to pick up the “old thread” and develop a new ecological approach to urban development in general: an ecological conditions strategy in urban planning and design. Following the ‘design with nature’ tradition, I will elaborate new practical answers to planning issues of the network society and network urbanization. A case study of the region around Schiphol Airport near Amsterdam, The Netherlands, will demonstrate the approach which aims to create supporting conditions for human health and safety, for the identity of urban places and for sustainable urban development, including basic environmental conditions for wildlife. The strategy of the two networks is central to this approach. Carrying both land use and flow management, the two spatial networks of traffic and water may act as a starting point in a planning process that may frame further decision making about new urban developments as well as for the restructuring of old urban districts.

| 248. | katharinaa@syst orms-sience.de | Oral/Research | Tluk v. Toschanowitz1, Katharina, Timothy J. Roper2, Karin Frank3. 1Institute of Environmental Systems Research, University of Osnabrueck, D-49076 Osnabrueck, Germany; 2School of Biological Sciences, University of Sussex, Brighton BN1 9QG, Great Britain; 3Department of Ecological Modelling, UFZ-Centre for Environmental Research Leipzig-Halle, D-04318 Leipzig, Germany. Assessing the effect of traffic on different hierarchical levels of population ecology: Lessons from an individual-based model. | Landscape Pattern and Population Processes |

In human-dominated areas, traffic represents one of the most important driving forces for population decline. Therefore, developing strategies for reducing the negative effect of traffic is an important contribution to harmonizing human beings and nature. We present an individual-based, spatially explicit simulation model that allows the effect of traffic (road network, traffic flow) on different hierarchical levels of population ecology (from individual mortality to population viability) to be assessed, the role of the species’ ecology (esp. spacing behaviour) to be analyzed and rather general conclusions for landscape...
evaluation as well as traffic planning and management to be drawn. To demonstrate the potential of this approach, the model is applied to a population of the Eurasian badger (Meles meles) in Great Britain. Moreover, the results of the simulation model will be compared with the results produced by a simple landscape index for “Traffic Mortality”. This index summarizes certain characteristics of both the spatial structure of the road network and the traffic flow as well as the species’ ecology. We will demonstrate to what extent the simple index allows the results of the model at least qualitatively to be correctly predicted so that it can be used as a tool for decision-support. Finally, some general conclusions are drawn concerning a model-based deduction of indices which allow both landscape structures and disturbance regimes to be assessed ‘through the eyes’ of a certain species.
A fuzzy decision analysis method for integrating ecological indicators is developed. This is a combination of a fuzzy ranking method and the Analytic Hierarchy Process (AHP). The method is capable ranking ecosystems in terms of environmental conditions and suggesting cumulative impacts across a large region. Using data on land-cover, population, roads, streams, air pollution, and topography of the Mid-Atlantic region, we are able to point out areas which are in relatively poor condition and/or vulnerable to future deterioration. The method offers an easy and comprehensive way to combine the strengths of fuzzy set theory and the AHP for ecological assessment. Furthermore, the suggested method can serve as a building block for the evaluation of environmental policies.

Range management has two basic components: (1) protection and enhancement of the soil/vegetation complex, and (2) maintaining or improving the output of consumable range products. Preexisting rangeland data can be applied to range management questions using landscape ecology techniques along with remote sensing/GIS. Vegetation of the eastern Carson Valley, Nevada was mapped using image processing techniques to decorellate and classify bands 4, 3, and 1 of two Landsat Thematic Mapper satellite images from 1984 and 1996. The maximum likelihood supervised classification algorithm with the addition of United States Geological Survey Digital Elevation Models resulted in 64% overall map accuracy. Landscape structure metrics were calculated using FRAGSTATS. Above ground biomass and plant canopy cover data were collected by analyzing NRCS soil surveys and ground survey data, respectively. Relationships between vegetation type, landscape structure metrics, and ecosystem attributes were detected using correspondence analysis. A relationship was found between plant cover variables and shape index, core area and core area index. A plot of factor 1 vs. factor 2 together represented 98.4% of the variation within the data set. Changes in vegetation from 1984 to 1996 were described using GIS techniques. Changes in landscape structure metrics were quantified by applying a multivector subsampling technique to the 1984 and 1996 vegetation maps. Results varied from quadrant to quadrant. In the northeast quadrant the only substantial change was in average patch fractal dimension, in the northwest a slight decrease in mean patch size suggested an increase in uniformity to quadrant. In the northeast quadrant the only substantial change was in average patch fractal dimension.
Thresholds, nonlinearities, and rules for scaling. Critical thresholds in landscape pattern provide an example of a nonlinearity with important implications for understanding the relationship between pattern and process. Identifying and understanding the nonlinearities associated with changes in spatial and temporal scale provide exciting opportunities for research and very practical applied challenges. The effects of scale are now well recognized, but the need for improved quantitative understanding remains critical. Ecologists still struggle with identifying the "right" scale(s) for studying and understanding particular patterns and processes, and extrapolating the knowledge gained at one scale to other scales. The "rules of thumb" that have been suggested for scaling need to be tested more widely, and the qualitative differences associated with changes in spatial pattern (e.g., critical thresholds) need to be considered in actual landscapes. Nonlinear dynamics and scaling are likely to continue to motivate a considerable volume of basic and applied research in landscape ecology.

Causes and consequences of land use change. Increases in the extent and intensity of human land uses are primary drivers of landscape change worldwide. Land-use patterns and changes are spatial phenomena, and landscape ecologists have an opportunity to contribute toward understanding and predicting these patterns and their ecological consequences. This area should receive increasing attention from landscape ecologists. In addition, greater emphasis is needed on understanding "land use legacies", i.e., the types, extents, and durations of persistent effects of prior land use on ecological patterns and processes.

Sampling. Landscape ecology is certainly not constrained to address questions over large areas, but one must recognize that many landscape ecological studies do so. The problems inherent in sampling across large regions in a way that permits inference of the effects of spatial heterogeneity remain challenging. We need to develop improved ways of sampling (and possibly new) statistical methods for data analysis, and using creative combinations of the assortment of available methods, including field sampling, experimentation, remote sensing, and modeling.

Relating landscape metrics to ecological processes. The development of landscape pattern analysis has been rapid, but there are major areas in which further understanding is sorely needed. Most importantly, the empirical relationships between landscape patterns and ecological processes of interest must be better documented and the underlying mechanisms understood. The relative sensitivity of different metrics to detecting changes in the landscape is not known; i.e., how much does the landscape need to change before a metric can detect the change? Progress in these areas will help ecologists determine what is worth measuring and why, and when a change in a metric is significant both statistically and ecologically. It remains a critical research task to determine what constitutes a "significant" change, both statistically and ecologically, in spatial metrics, and to relate such changes to ecologically relevant responses. Many applications of landscape ecology depend heavily on such understanding.

Relating landscape metrics to ecological processes. The development of landscape pattern analysis has been rapid, but there are major areas in which further understanding is sorely needed. Most importantly, the empirical relationships between landscape patterns and ecological processes of interest must be better documented and the underlying mechanisms understood. The relative sensitivity of different metrics to detecting changes in the landscape is not known; i.e., how much does the landscape need to change before a metric can detect the change? Progress in these areas will help ecologists determine what is worth measuring and why, and when a change in a metric is significant both statistically and ecologically. It remains a critical research task to determine what constitutes a "significant" change, both statistically and ecologically, in spatial metrics, and to relate such changes to ecologically relevant responses. Many applications of landscape ecology depend heavily on such understanding.
modeling study that investigates the sustainability of interacting populations of native plants and their pollinators in ecosystems within a landscape mosaic of different land uses.

Tyler', Marnie W., Don McKenzie', and David L. Peterson'. 1College of Forest Resources, University of Washington, Seattle, WA 98195, USA; and 2USGS Forest & Rangeland Ecosystem Science Center, Cascadia Field Station, University of Washington. Effects of Human Land Use on Landscape Structure on the Western Olympic Peninsula, Washington, U.S.A.

Tyler', Marnie W., Don McKenzie', and David L. Peterson'. 1College of Forest Resources, University of Washington, Seattle, WA 98195, USA; and 2USGS Forest & Rangeland Ecosystem Science Center, Cascadia Field Station, University of Washington. Effects of Human Land Use on Landscape Structure on the Western Olympic Peninsula, Washington, U.S.A.

The Pacific Northwest and Washington's Olympic Peninsula (OP) in particular have received a great deal of attention regarding loss and fragmentation of some of the largest tracts of old-growth forests in the U.S.A. Human activities, including timber harvest, urban development, and agricultural conversion, have dramatically changed landscape structure on the OP over the last 40 years. Timber harvest has been the single most significant agent of change. This study evaluates current landscape structure on the western OP and projects conditions 200 years into the future. We examine the current spatial distribution and associated diversity of forest herbaceous species diversity of forests in four age categories: regeneration (0-20 years), young (21-80), mature (81-200) and late seral (>200 years). We then project future spatial patterns of these age categories and quantify landscape structure under three land use scenarios: 1) zero timber harvest on public lands, 2) continued implementation of the 1994 Northwest Forest Plan, and 3) resumption of harvest levels that occurred on the OP during the 1970s and 1980s. The structures of these future landscapes are compared with respect to patch diversity, edge, evenness, and other landscape metrics. Future landscapes will be interpreted in terms of herbaceous species diversity and relative abundance of four forest bird species.
Spatial structure in plant communities occurs in the forms of (1) species-specific aggregation patterns (auto-correlation), (2) distance-dependent interaction between species (cross-correlations), and (3) the spatial structure of environmental conditions (trend). Different methods deal with these different components of spatial variation; geostatistical analysis reveals autocorrelation in a spatial sample; ordination techniques describe multi-species response to environmental factors; and the variance of quadrat species richness has been used as an indicator for interspecific interactions in the search for community assembly rules. Based on the mathematical properties of presence-absence data we show how variogram modeling, multi-scale ordination and the testing of interspecific associations can be integrated by using the same set of distance-dependent variance-covariance matrices. We thus provide a framework for partitioning spatial covariance and for factoring out specific components of spatial covariance. Furthermore, this mathematical approach greatly increases the interpretability of variograms of plant communities, extends multi-scale ordination to non-systematic spatial samples, and provides a spatial extension and an empirical null-model for the variance test of species richness.

We are designing a system where regional environmental resources are viewed as an asset portfolio to be managed for risk. Our analysis examines the trade-offs between land conversion and the maintenance of ecosystem services necessary to meet environmental and economic goals. By examining the services that are of particular importance to the economy or character of a region, we emphasize issues central to the management of natural capital. We are developing a terrain-based approach, which link changes in environmental resources with their consequences in terms of changes in risks or values to valued ecosystem services. We use two main approaches: (1) Develop a suite of spatial risk indicators that will show where projected changes in environmental resources are likely to produce costs or hardships due to dominant economic activities or other socio-economic conditions; (2) Employ regional economic models to evaluate the economic effects of investments in (e.g., preservation or restoration) and use of environmental resources under projected land use change. Our approach will consider variables reflecting quality of life, resource pressure and the levels of risk management by governments. Quality of life will be reflected in indicators of access to resources and of projected changes in household spending to accommodate resource change (e.g., increased costs of water filtration, commuting times). Resource pressure indicators will aim to gauge the efficiency of resource use. Risk management indicators will evaluate management activities that act to minimize disruption of ecosystem services (e.g., greenway preservation incentives).

Natural or anthropogenic fragmentation of habitats is expected to increase the isolation of plant populations from each other, reduce population sizes, and decrease local population densities. Separately or in concert these changes in population attributes may influence plant reproduction through changes in the quantity or quality of pollination services. Experiments with herbaceous montane plants suggest that bumblebee and hummingbird pollinators will fly relatively long distances among population isolates, effectively connecting them as a metapopulation in terms of pollen dispersal. However, overall pollination success is reduced in isolates, and might have been reduced even further if other flowers acceptable to these generalist pollinators had been abundant in intervening landscape elements. Additional experiments suggest that the rate of pollinator visitation to flowers sometimes declines as population density is reduced, and seed production sometimes declines as well, but these results are not universal and vary with pollinator species and ecological context. To reach predictive generalizations about fragmentation and pollination success, it will be most profitable to begin with a solid focus on pollinator foraging behavior and how this is adapted for a complex mosaic of landscape elements and of diverse flowers distributed within elements.

Assessing Current and Future Regional Vulnerabilities

Pollinators in heterogeneous and dynamic landscapes
Effects of riparian buffer configuration on nutrient inputs to streams. Nutrient losses from the land impact aquatic ecosystem processes, particularly where human activities elevate land discharges. Riparian buffers can moderate such impacts by intercepting nutrients lost from upland ecosystems. The spatial distribution of riparian buffer and its nutrient retention function interact to control on the linkage of terrestrial and aquatic systems through nutrient transfers. We have studied the effects of riparian buffers on nutrient discharges with several methods applied at different spatial scales. Sampling nutrient concentrations along transects through riparian forests has shown strong filtering effects, and riparian forests can retain 90% or more of the sediment, nitrogen, or phosphorus transported.
264. jill.welt @asu.ed u
Special: Dent's
Welter, Jill R., Stuart G. Fisher, Julia C. Henry and John D. Schade. Department of Biology, Arizona State University, Tempe, AZ 85287, USA. Nutrient transport and processing in the uplands and intermittent drainage network: linking terrestrial and aquatic ecosystems.

Welter, Jill R., Stuart G. Fisher, Julia C. Henry and John D. Schade. Department of Biology, Arizona State University, Tempe, AZ 85287, USA. Nutrient transport and processing in the uplands and intermittent drainage network: linking terrestrial and aquatic ecosystems.

In the Sycamore Creek watershed in Arizona, only 10% of annual atmospheric nitrogen inputs to the watershed are exported in streamflow. In this nitrogen-limited system, where is the missing nitrogen and which components of the landscape are responsible for its retention? We investigated the role of the terrestrial uplands, which are variable in topography and vegetative cover, as well as the network of intermittent rills and channels that hydrologically link the terrestrial landscape with perennial streams during storms. Storm size and intensity are extremely variable in the Southwestern U.S. and therefore, characteristics of individual storms may influence where and by what mechanism nutrient retention occurs. Results show that small storms (<0.5 cm) wet the desert uplands and generated some overland flow, but did not hydrologically connect the terrestrial landscape with the intermittent stream network. Soil nitrogen storage varied with topography, with highest storage occurring within vegetated patches, and sites with low relief. As storm size increased, the extent of surface flow in the channel network increased. Only the largest storms generated flow in high order channels and during the 2000 monsoon season, only one storm (2.9 cm) resulted in flooding in Sycamore Creek, the largest channel in the catchment. Results suggest that storms interact with the landscape, wetting and "activating" different parts of the landscape in relation to storm size and intensity. During most of the year retention of atmospheric nitrogen is confined to the terrestrial landscape, while only large storms result in transport of nitrogen to the aquatic components of the watershed.

265. wickham.j ames @epam al.epa.go v
Special: Smith's
Wickham, J., E. Smith\textsuperscript{1}, R. O'Neill\textsuperscript{2}, T.Wade\textsuperscript{1}, K. Riitters\textsuperscript{3}, K. Jones\textsuperscript{3}. National Exposure Research Laboratory, EPA, RTP, NC 27711, USA; \textsuperscript{2}Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA; \textsuperscript{3}Forest Health Monitoring Unit, Forest Service, RTP, NC, 27709, USA. Propagating nutrient export risk across watersheds.

Wickham, J., E. Smith\textsuperscript{1}, R. O'Neill\textsuperscript{2}, T.Wade\textsuperscript{1}, K. Riitters\textsuperscript{3}, K. Jones\textsuperscript{3}. National Exposure Research Laboratory, EPA, RTP, NC 27711, USA; \textsuperscript{2}Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA; \textsuperscript{3}Forest Health Monitoring Unit, Forest Service, RTP, NC, 27709, USA. Propagating nutrient export risk across watersheds.

The disciplines of landscape ecology and ecological risk assessment emerged at about the same time. A focus of landscape ecology is the movement of biota, water, and energy across the horizontal (x,y) plane. Ecological risk assessment focuses on methodologies for predicting the likelihood of an event (e.g., local extinction). The two disciplines can be linked by moving risk in the x,y plane. We present a model of nutrient export risk that is based on relationships between nutrient export and land cover that are well documented in the literature. We then accumulate the risk in downstream watersheds based on in-stream nutrient decay relationships developed for modeling the processes denitrification and sedimentation. Initial results suggest that nutrient export risk accumulates quickly in downstream watersheds, and reducing that risk is best optimized by afforestation of downstream not upstream watersheds.

266. wiens@ncea sucsb.edu
Top 10
Wiens, John A., National Center for Ecological Analysis and Synthesis, University of California Santa Barbara, 735 State Street, Suite 300, Santa Barbara, CA 93101 and Department of Biology, Colorado State University, Fort Collins, CO 80523. Looking

Wiens, John A., National Center for Ecological Analysis and Synthesis, University of California Santa Barbara, 735 State Street, Suite 300, Santa Barbara, CA 93101 and Department of Biology, Colorado State University, Fort Collins, CO 80523. Looking Ahead by Looking Back: What are the Central Issues of Landscape Ecology?

It isn't clear whether the number of central issues in a discipline increases or diminishes as the discipline grows and matures. One might think that some issues would be resolved, but as we accumulate new knowledge or develop new theories, new issues may emerge. From time to time over the past two decades, prominent landscape ecologists have identified what they considered to be the primary issues.
Ahead by Looking Back: What are the Central Issues of Landscape Ecology?

I'll draw on this historical perspective to develop a set of current issues that demand our attention. The degree of concordance between this list and those presented previously may be an indication of whether we're making real progress, or simply restating or refining the same old issues with new technologies and terminologies.

| 267. helene. wagner @colost ate.edu | Poster | Wiens¹, John A., Helene H. Wagner², Michelle M. Hawks², Jonathan M. Bossenbroek², and Beatrice Van Horne². ¹National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA; ²Department of Biology, Colorado State University, Fort Collins, CO 80523, USA. Changes in the structure of grassland dominated landscapes along a precipitation and productivity gradient in the central plains. Cross-site comparisons are often used to understand how ecological patterns and processes vary with environmental conditions. Sites are often contrasted in terms of differences in the mean values of environmental factors, assuming that their spatial structure remains constant. We examined changes in the nature and the scale of landscape patterns along a transect from the Shortgrass Steppe LTER in eastern Colorado to the tallgrass prairie at the Konza Prairie LTER in eastern Kansas. For each grassland in a random sample of grasslands along this transect, we performed moving window analysis of 30-m resolution spectral bands (Landsat 7). Multi-scale ordination revealed that both the relative importance of PCA factors and the scale of their pattern of variation changed systematically along the transect. We conclude that cross-site comparisons should consider not only changes in the mean of environmental factors, but also their spatial structure. | Scaling: Methods and Case Studies |

| 268. cynthia @enviro web.org | Oral/Reg | Wilkerson, Cynthia R. Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Fl 32611, USA. Isolated Temporary Wetlands as Prey Refugia for Anuran Communities. Classic island biogeography theory predicts that presence of near, connected patches in close spatial proximity are best for maintaining viable metapopulations. However, in some systems with spatially and temporally asynchronous dynamics in herbivore-plant and predator-prey relationships, isolated patches may play a key role in persistence of species assemblages at the landscape scale. This research investigates the importance of isolated, temporal wetlands of north-central Florida for viable anuran communities. My hypothesis is that isolated temporary wetlands function for these species as refugia from predation by aquatic insects. The field experimental design consists of eight mesocosms arrays. Each array includes three mesocosms at 10m, 100m, and 500m distances from a natural source pond. Response variables are identity and timing and species of adult and larval aquatic insects that are potential predators of anuran larvae. Preliminary results indicate that a longer predator-free period exists in more isolated mesocosms. Field results will be combined with anuran and aquatic insect natural history data to develop a spatial model that will relate relative wetland isolation to anuran productivity. This project is an attempt to incorporate predator-prey relationships into a spatial analysis of community-level habitat dynamics. | Landscape Pattern and Population Processes |
Between 1936 and 1996. Oregon Coast Range Landscape Change in the Spatial Patterns of Forest Landscape Change in the Oregon Coast Range

Wimberly, Michael C., and Janet L. Ohmann. USDA Forest Service Pacific Northwest Research Station, Corvallis, OR 97331, USA. Spatial Patterns of Forest Landscape Change in the Oregon Coast Range Between 1936 and 1996. USDA Forest Service Pacific Northwest Research Station, Corvallis, OR 97331, USA. Spatial Patterns of Forest Landscape Change in the Oregon Coast Range Between 1936 and 1996. Forest landscapes in the Douglas-fir region of western North America have changed considerably since the early 20th century. Fires and timber harvesting have reduced the amount of old growth in the landscape, leading to concern for the survival of native species associated with late-successional habitats. Quantitative assessments of these landscape transformations are needed to measure the amount of change, and to elucidate the processes that drive landscape dynamics. Our study examined changes in the proportion of forest seral stages in the Oregon Coast Range between 1936 and 1996. A map of forest composition and structure in 1996 was derived from Landsat TM imagery and environmental GIS data using the Gradient Nearest-Neighbor (GNN) technique. The 1996 map was

Landscapes are being used more intensively than ever before. This is especially true for those landscapes around cities. The result is the need for a proper and adequate planning of the rural-urban interactions that occur within such intensively used areas. In this paper we will focus on planning measures, based on both patterns of movement and underlying processes of time and space from the perspective of both fauna and recreationists. The rural surroundings of a city often provide a suitable setting for many different outdoor recreational activities. However many animals, in search of their daily food and a resting-place, use these same rural surroundings. Both movement patterns of man and animal can cross paths with each other. The results are often disturbances that can negatively affect the animal. With the geographical time-space analysis (Hägerstrand-approach) one can visualize time-space behavior of people. This human-based approach has already been applied for various subsets of people, like recreationists. Here we have extended the approach to movement patterns in time and space of animals. Next, confronting both patterns of man and animal, we will focus on the conflict-situations that occur either in time, in space or both. Based on the results, any related constraints become apparent and can be addressed by specific planning of mitigating measures. This procedure can be repeated for different scales (in time and space), landuses and species. Both GIS and 3D presentations herewith provide useful tools to customize and further develop this approach. Examples will be used to illustrate several aspects of this approach.

Ecologists have recognized disturbance as an important driver of spatial patterns in a landscape and the composition of its species. Wildfire in particular has received special attention as a recurrent, ubiquitous disturbance that has greatly influenced the structure of Rocky Mountain forest ecosystems. However, in recent decades, staggered-setting clearcut logging has altered the spatial and temporal characteristics of historic landscape patterns driven by fire. Increasingly, landscape ecologists are using patterns of natural disturbance as a guide for ecosystem management. My study area in the Greater Yellowstone Ecosystem (GYE) contained patterns of intensive logging in the Targhee National Forest (TNF) directly adjacent to patterns resulting from wildfire in 1988 in Yellowstone National Park (YNP). To compare these disturbance types, I tested hypotheses at two scales. At the landscape scale, spatial patterns of clearcuts and wildfires were subsampled at various extents and quantified using landscape metrics. A finer-scaled field study focused on post-disturbance biological legacy within stands. Results indicate that clearcutting fragmented forests more than wildfire. Furthermore, multi-scaled frequency distributions of 9 landscape metrics revealed thresholds in scaling effects for each disturbance type. The field study demonstrated that clearcutting represents a more severe disturbance type than wildfire. These differences between clearcutting and wildfire at both the landscape and stand scales have important ecological consequences for the natural fire regime. Spatially explicit fire simulations indicated that clearcutting disrupts the natural disturbance regime. Recognizing this important consequence, timber harvest strategies can be developed that better mimic natural landscape patterns and sustain levels of biodiversity.
272. kwith@ksu.edu Special: Jenerett e-Wu

| With1, Kimberly A., and Anthony W. King2. Division of Biology, Kansas State University, Manhattan, KS 66506, USA; and Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA. The effect of landscape structure on critical biodiversity. |
|-----------------|---------------------------------|
| Wolf, Joy J. Department of Geography, University of Wisconsin – Parkside, Kenosha, WI 53141, USA. Effects of Prescribed Burning as a Control for Exotic Invasion in Rocky Mountain National Park Grasslands. |
| Natural disturbance regimes are key elements of vegetation patterns and dynamics, and maintain heterogeneity in natural plant communities. Exotic invasion, often fostered by disturbance created by humans and altered natural disturbance regimes, has led to a change in resource availability and species composition in many grassland communities. In Rocky Mountain National Park, montane grasslands invaded by Melilotus officinalis and M.alba invasion had less native, grass and perennial species, more exotic, forb and annual species and less available nitrogen, net mineralization and soil moisture compared to non-invaded grasslands. In order to test the restoration of species composition and nitrogen availability in invaded grasslands and control Melilotus invasion, I employed a prescribed burn experiment. I burned field plots in invaded and control patches. Fire eliminated Melilotus species throughout the season, increased the number of native, grass and perennial species in invaded patches, facilitated the germination of new species, and temporarily increased available nitrogen. This experiment assessed the competitive niche of native species on Melilotus species and the role of disturbance regimes in exotic invasion. The application demonstrated that Melilotus species’ ability to invade grasslands may be influenced by fire as a natural disturbance. |

273. wolf@uw.edu Poster

| Wolf, Joy J. Department of Geography, University of Wisconsin – Parkside, Kenosha, WI 53141, USA. Effects of Prescribed Burning as a Control for Exotic Invasion in Rocky Mountain National Park Grasslands. |
|-----------------|---------------------------------|
| Cal Poly Pomona’s Graduate Program in Landscape Architecture has produced over 100 client-funded |

274. jhirschm an@csu pomona .edu Special: Ahern’s

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>With1, Kimberly A., and Anthony W. King2. Division of Biology, Kansas State University, Manhattan, KS 66506, USA; and Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA. The effect of landscape structure on critical biodiversity.</td>
<td></td>
</tr>
<tr>
<td>Wolf, Joy J. Department of Geography, University of Wisconsin – Parkside, Kenosha, WI 53141, USA. Effects of Prescribed Burning as a Control for Exotic Invasion in Rocky Mountain National Park Grasslands.</td>
<td></td>
</tr>
<tr>
<td>Natural disturbance regimes are key elements of vegetation patterns and dynamics, and maintain heterogeneity in natural plant communities. Exotic invasion, often fostered by disturbance created by humans and altered natural disturbance regimes, has led to a change in resource availability and species composition in many grassland communities. In Rocky Mountain National Park, montane grasslands invaded by Melilotus officinalis and M.alba invasion had less native, grass and perennial species, more exotic, forb and annual species and less available nitrogen, net mineralization and soil moisture compared to non-invaded grasslands. In order to test the restoration of species composition and nitrogen availability in invaded grasslands and control Melilotus invasion, I employed a prescribed burn experiment. I burned field plots in invaded and control patches. Fire eliminated Melilotus species throughout the season, increased the number of native, grass and perennial species in invaded patches, facilitated the germination of new species, and temporarily increased available nitrogen. This experiment assessed the competitive niche of native species on Melilotus species and the role of disturbance regimes in exotic invasion. The application demonstrated that Melilotus species’ ability to invade grasslands may be influenced by fire as a natural disturbance.</td>
<td>Complexity Theory and Ecological Applications</td>
</tr>
<tr>
<td>ID</td>
<td>Type</td>
</tr>
<tr>
<td>-----</td>
<td>------------</td>
</tr>
<tr>
<td>275</td>
<td>Poster</td>
</tr>
<tr>
<td>276</td>
<td>Top 10</td>
</tr>
<tr>
<td>277</td>
<td>Poster</td>
</tr>
<tr>
<td>Page</td>
<td>Title</td>
</tr>
<tr>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>278.</td>
<td>Detecting spatial patterns in a young ponderosa pine plantation using 0.5 m resolution digital imagery.</td>
</tr>
<tr>
<td>279.</td>
<td>Detecting spatial patterns in a young ponderosa pine plantation using 0.5 m resolution digital imagery.</td>
</tr>
<tr>
<td>280.</td>
<td>Detecting spatial patterns in a young ponderosa pine plantation using 0.5 m resolution digital imagery.</td>
</tr>
</tbody>
</table>
281. samp@iip.kyusa. u.ac.jp Poster Yamashita, Sampei. Department of Civil Engineering, Kyushu Sangyo University, Fukuoka, Japan. Attractiveness of a Wooded River Landscape and Changes in its Colors in the Daytime.

The woods and trees along a river play an important role in mitigating flood damage, restoring and purifying river water, and providing water birds and aquatic animals with food and habitats. In addition to these objective qualities, trees have the subjective, aesthetic quality of enhancing the attractiveness of a river landscape by casting their shadow across the water. This study takes landscape colors into consideration and evaluates the attractiveness of a wooded river landscape in a rural area of Japan by using the method of paired comparisons. Photographs of the landscape are taken and colors of its major elements are measured from different viewpoints at different times. After the most preferred viewpoint is determined, the relationship between preferred landscape images and apparent colors of the landscape elements is examined. Preference of a landscape image is primarily affected by the value and chroma of the landscape elements relatively close to the viewpoint - woods, its shadow on the water, and its reflection in the water. The value and chroma of both relatively distant mountains and the reflection of the sky on the water are also relevant to the preference of the image. The results can give us information about how to design and preserve valuable woods along rivers.

282. dennis.yemshan off@mn r.gov.on.ca Special: Keane’s Yemshanov, Dennis and Ajith H. Perera. Ontario Forest Research Institute, 1235 Queen St. E., Sault Ste. Marie, P6A 2E5, ON, Canada. Modelling boreal forest landcover dynamics after fire disturbance: a Markovian approach.

We describe a large-scale spatially explicit simulation model of postfire landcover changes in north-American boreal biome. This model is a time-dependent Markov chain with discrete states of succession corresponding to dominant tree species in forest canopy. The period of species persistence in canopy and their extinction rates constitute temporal variables used in the model parameterization. Probabilities of forest cover transition are stratified spatially by geoclimate, moisture and edaphic gradients and are organized in a decision-tree. The model is spatially explicit, using GIS data layers of forest cover composition, time since last forest cover transition, time since last catastrophic fire, geoclimate, soil moisture regime and soil nutrient status. The model output constitutes GIS layers of time since last fire disturbance, transition age, forest cover composition, and canopy age for every 10-year time step of simulation at 1 ha resolution. As a case study, we simulated post-fire forest cover transitions in a 3.7 million ha region in northern Ontario, Canada. The results showed that the dependency of transition processes on site conditions (moisture and geoclimate) is higher than on time since last forest transition or fire disturbance. Also, we estimated the trend of post-fire change of forest cover over 200 years: a decline of pioneer forest cover types and their replacement by late-successional tree species exceeded 10 times the average replacement rate of forest cover in the study region.

283. myoko @sk.tsu kuba.ac.jp Special: Ahern’s Yokohari, Makoto, Takashi Watanabe and Takashi Hirohara. University of Tsukuba, Tsukuba, Ibaraki, 305-8573, Japan. Restoring ecological relationships between urban and rural landscapes: A new ecological planning concept for Asian mega-cities.

The explosive post-war growth of Asian mega-cities has resulted in serious environmental problems including air and water pollution and insufficient urban infrastructure. The rapid growth has also produced a disordered mixture of urban and rural landscapes at the fringe of these mega-cities. Western urban planning concepts including greenbelts and zoning have been ineffective in managing urban growth. Through historical spatial analysis, a distinct “micro-juxtaposition” pattern of urban and rural landscapes was identified. This pattern informed a planning concept for landscape ecological-based urban planning for these mega-cities. In the concept, the ecological functions of farmland and woodland, including water retention capability, micro-climate control and the conservation of visual quality of the area, are regarded as the key functions for the restoration of contemporary urban landscapes. Case studies of this ecological planning concept are made to the urban fringe areas of Tokyo, Japan. The concept is proposed as a model for 21st century urban planning for Asian meg-cities.

284. zebisch @ile.tu- berlin.de Oral/Re g Zebisch¹, Marc, Hartmut Kenneweg¹, Valentina Krysanova², and Frank Wechsung². ¹Institute for Landscape Design Development, Technical University Berlin, Germany; ²Potsdam Institute for Climate Impact Research, Germany. Landscape responses to external driving forces in Brandenburg, Germany.

Land Use and Land Cover Change: Pattern and Process
Global change, reflected in a modified EU agrarian policy, may influence the future land use pattern across Europe. Three districts in the state of Brandenburg (East Germany) were selected to investigate the impact of land-use changes on landscape quality represented by biodiversity and landscape aesthetics. Initially two sets of future land use patterns were created: the first one realized a pattern according to predicted trends in agriculture and forestry, which were obtained by agro-economical simulations. The second set contained conversion patterns along these trends in a range from zero to hundred percent. The pattern generation was performed by rule-based decision approaches as well as by statistical classification methods. The resulting sets of land use patterns were evaluated in respect of the landscape qualities biodiversity and landscape aesthetics. It was assumed, that both landscape qualities are related to internal as well as to spatial attributes of the patches and of the patch composition. While internal attributes were assessed by rule-based systems, spatial attributes were investigated using landscape metrics, calculated with FRAGSTATS and other spatial evaluation methods. The sum of single indices was merged to a set of attributes related to biodiversity and landscape aesthetics. Finally the sensitivity of landscape qualities towards land-use change was summarized in partial response function towards land-use change. This supplements the statements about the impact of the predicted changes according to the agro-economic scenarios.

The relationship between vegetation pattern and environmental factors has long been a central issue in ecology, and is particularly important to the study of structure and functioning of landscapes. Early seminal works in the formation and distribution of plant communities by ecologists, notably Frederic E. Clements, Henry A. Gleason, John Curtis, and several European geobotanists, laid an extremely important empirical foundation necessary for understanding the relationship between vegetation and climate. However, to a large extent it was Robert H. Whittaker's gradient-based approach and community-ecosystem integrative framework that most effectively synthesized diverse views, leading to a general and comprehensive theory of large-scale vegetation pattern which has influenced the thinking of generations of ecologists worldwide after him. However, this general theory is basically an empirical and inductive one that was gradually formed by accumulating and distilling numerous factual studies. In recent decades, with considerable success attempts have been made to identify environmental factors and mechanisms that are responsible for vegetation formation and distribution. Yet, a general deductive theory that can quantitatively predict large-scale vegetation pattern is still lacking. If the goals of science are understanding and prediction, developing such theories has to be satisfactory and rewarding. In this paper, we develop such a theory based on statistical thermodynamics and ecological principles. Based on the general understanding that evapotranspiration is closely correlated to vegetation pattern over large spatial scales, we assume that the amount of entropy "pumped" into the environment by a landscape through evapotranspiration approximates the total loss of entropy of the landscape system. According to the Boltzmann equation, we have derived a statistical thermodynamic model to describe the formation and distribution of vegetation pattern at regional or global scales. The index, 1/w, which is a function of the area of the ecological system and the efficiency of exporting entropy from the ecological system by evapotranspiration, can be used to indicate the degree of "order" in the vegetation pattern. By analyzing the mathematical properties and ecological meanings of this statistical thermodynamic model, some interesting general properties of vegetation patterns become apparent. The model predicts that for a landscape to maintain a persistent vegetation pattern, it must be larger than a minimum area which can be estimated using the model. The model also predicts how climatic conditions (temperature and evapotranspiration, can be used to indicate the degree of "order" in the vegetation pattern. By analyzing the mathematical properties and ecological meanings of this statistical thermodynamic model, some interesting general properties of vegetation patterns become apparent. The model predicts that for a landscape to maintain a persistent vegetation pattern, it must be larger than a minimum area which can be estimated using the model. The model also predicts how climatic conditions (temperature and moisture) determine the complexity and degree of order of landscape pattern. For a given landscape, the model can be used to predict how its vegetation pattern, as a system property, when climatic conditions change. Our model can serve as a uniform theoretical framework that describes the order and complexity in large-scale ecological patterns and the critical conditions of phase transitions in the formation and evolution of these patterns. To test this validity of the model, we have generated a map of world biome types in relation to mean annual temperature and mean annual precipitation, and compared it with the empirical global biome map by R. H. Whittaker (1975). The model predicted map agreed with the empirical map remarkably well at the global scale.
| 286. | Zhang, Jiahua and Hiroshi Kanzawa. Atmospheric Environment Division, National Institute for Environmental Studies, Tsukuba, Ibaraki, 305-0053, Japan. Landscape dynamic in typical ecological regions of China based on remote sensing and GIS. | Zhang, Jiahua and Hiroshi Kanzawa. Atmospheric Environment Division, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki, 305-0053, Japan. Landscape dynamic in typical ecological regions of China based on remote sensing and GIS. | Land Use Change and Urban Ecology |
| 287. | Zheng, Daolan, and Stephen D. Prince. Department of Geography, University of Maryland, College Park, MD 20742, USA. Grid net primary production estimates in Finland and Sweden at 1-km and 0.5 degree cell sizes. | Zheng, Daolan, and Stephen D. Prince. Department of Geography, University of Maryland, College Park, MD 20742, USA. Grid net primary production estimates in Finland and Sweden at 1-km and 0.5 degree cell sizes. | Landscape Pattern and Ecosystem Processes |
| Lake States. | alternative timber production zones that were more contiguous, changing the size of the timber production zones, and changing the length of the period between harvests within a timber production zone. All simulations were run for 100 years with the same background level of natural disturbance from forest fires and windthrows. Scenarios with more intense dynamic activity (e.g. fewer timber production zones that were larger but where harvests occurred for longer periods) produced more forest interior, but a higher proportion of early successional tree species on the ranger district. Our results demonstrate LANDIS’s capability to examine the influence of dynamic zoning scenarios on multiple characteristics that are important to forest management. |