areal unit problem (MAUP) as well as multiple-scale structures in landscape pattern. The direction of analysis also may have significant effects on the result of pattern analysis as the extent is changed. Some aspects of landscape pattern exhibit consistent, predictable patterns over a wide range of grain size or extent, suggesting general scaling functions, whereas others have nonlinear, apparently unpredictable response curves. We also discuss the implications of these results for landscape analysis and present recommendations for the proper use of pattern indices.

WU, MEI-YIN,[1]* ELDON H. FRANZ[2] and SHULIN CHEN.[2] [1] Plattsburgh State University of New York, Plattsburgh, NY, USA; [2] Washington State University, Pullman, WA, USA. **Oxygen fluxes in constructed wetlands.**

Two dominant routes have been documented for transfer oxygen from air to constructed wetland systems: 1) atmospheric oxygen diffusion and 2) oxygen release from plant roots. This study quantified the atmospheric oxygen diffusion and plant oxygen release rates in constructed wetland systems. We found that oxygen transfer to the constructed wetland was dominated by atmospheric oxygen diffusion. Nitrogen removal efficiency in a constructed wetland is often limited by the amount of oxygen available in the system. The atmospheric oxygen diffusion rates to laboratory-scale subsurface flow constructed wetlands and free water surface constructed wetlands were quantified in this study under two rates of NH_4^+ loading, 50 mg-N/l and 10 mg-N/l. Appreciable amounts of oxygen were found to diffuse into the subsurface flow constructed wetlands, and the diffusion rates were strongly correlated with the NH_4^+ concentration in the water. In contrast, little oxygen actually diffused into the free water surface systems. Statistically, the existence of plants on the wetland had no significant impacts on either atmospheric oxygen diffusion rates or NH^{4+} removal efficiencies in both subsurface flow systems and free water surface systems. This observation was further verified with the tests on oxygen leakage from plant roots. Only approximately 0.023 g/m^2/day of oxygen was released from roots of *T. latifolia* measured using the titanium (III) citrate buffer method. The results of the NH_4^+ removal rates of the lab scale constructed wetland were further verified with pilot scale constructed treatment wetlands under greenhouse conditions. There was no statistically significant difference between NH_4^+ removal efficiencies in either lab or greenhouse scale constructed treatment wetland system.

XU, YI-JUN[1]* and WERNER BORKEN.[2] [1] Virgina Polytechnic Institute and State University, Blacksburg, VA 24061, USA; [2] The Woods Hole Research Center, Woods Hole, MA 02543, USA. **Simulation of soil carbon dioxide efflux in a mature temperate spruce forest from 1975 to 1999.**

Long-term trends of soil carbon dioxide (CO_2) efflux must be identified to accurately establish carbon budgets and better understand soil respiration response to future climate. In this study, we simulated soil CO_2 efflux for 25 years in an mature temperate spruce forest at Solling in Germany, using a soil water balance model and a soil respiration model developed from the same site. The hydrological model was calibrated using 9-year-measurements of soil matric potential, whereas the soil respiration model was calibrated using 2-year-measurements of soil respiration. Daily means of air temperature, humidity, wind speed, and solar radiation were used to simulate temporal patterns in soil matric potentials from 1975 to 1999, and soil CO_2 effluxes were simulated using the modeled soil matric potentials and measured air temperature during this period. Our results show no increasing trend of soil CO_2 efflux over the 25 years. The annual CO_2 efflux varied from about 3.9 to 4.6 Mg C ha^{-1}, whereas annual means of temperature and rainfall fluctuated from 5.9 to 8.4 °C and from 706 to 1545 mm, respectively. The relationship between annual soil CO_2 efflux and mean annual temperature was not close (r^2=0.39). Monthly soil CO_2 efflux was strongly related to monthly mean temperature, and was well described by an exponential function, CO_2 =a exp(ln(b)T) (r^2=0.99), where a and b are functional parameters and T monthly mean temperature. These results suggest that interannual variability in soil CO_2 efflux may be relatively low at sites with sufficient rainfall, and that long-term prediction of soil respiration using monthly mean temperature may be a good approach.

YAN, NORMAN D.,[1,2]* CHARLES W. RAMCHARAN,[3] DONALD J. MCQUEEN[1] and GARY SPRULES.[4] [1] York University; [2] Dorset Environmental Science Centre; [3] Louisiana State University; [4] University of Toronto. **Comparing the impacts of bass and Bythotrephes introductions on the zooplankton of Canadian Shield lakes.**

It is commonly assumed that zooplankton communities are more sensitive to introductions of fish than invertebrate predators; however this assumption has not been tested at a whole-lake scale. An opportunity for such a test developed when the invading spiny water flea (Bythotrephes) appeared in Harp Lake, Ontario, in 1993, the same year we experimentally introduced large- and small-mouth bass to the nearby Mouse Lake. Using Levene's tests, we compared the inter-annual variability of four univariate (richness, biomass, abundance, mean Cladoceran size) and two multivariate (two axes of a correspondence analysis, CA) zooplankton metrics in Mouse and Harp Lakes and two reference lakes. Most community metrics did change after introduction of either predator. However, inter-annual variability in richness, cladoceran size, and the first CA axis could not be distinguished in Mouse and Harp lakes, and the compositional information represented by the second ordination axis was actually more variable in Harp Lake. Total biomass and abundance were more variable in Mouse Lake than in Harp Lake; however, these two metrics were just as variable in the two reference lakes as in Mouse and Harp lakes. This implies that some factor other than predator additions was regulating total zooplankton standing stock in the lakes. Our comparison does not support the assumption that the addition of bass exerts larger impacts on freshwater zooplankton than the addition of at least one invertebrate predator, Bythotrephes.

YANAI, RUTH D.,[1]* WILLIAM S. CURRIE,[2] CHRISTINE L. GOODALE[3] and W. WALLACE COVINGTON.[4] [1] SUNY-ESF, Syracuse NY 13210; [2] University of Maryland, Frostburg MD 21532; [3] Carnegie Institution, Stanford CA 94305; [4] Northern Arizona University, Flagstaff AZ 86011. **Soil carbon dynamics following forest harvest: an ecosystem paradigm reviewed.**

One of the most influential studies in the history of forest ecology is that of Covington (1981), which described a pattern in organic matter storage in the forest floors of northern hardwood stands as a function of date of harvest. We review the history of use and misuse of Covington's curve, describe the studies that tested and failed to support early interpretations of the curve, and provide an alternate interpretation. The curve suggested that forest floor organic matter declines by 50% within 20 years after harvest; this rate has been applied to mineral soil carbon, with dramatic consequences for global carbon budgets. However, recent studies show that soil carbon is not much affected by forest harvest, and even the forest floor may not decline as dramatically as suggested by Covington's chronosequence. Litterbag experiments have not found decomposition rates to be increased by forest harvest, which was the original interpretation of the curve. The leading alternative explanation, supported by model simulations, is that the degree of mixing of forest floor into mineral soil during harvesting operations has changed over time, due to changes in logging technology and the intensity of biomass removal. It is true that recently logged stands have less organic matter in the forest floor than older stands, but this may be due to changes in logging treatment, rather than time since treatment, and it may be incorrect to infer that the difference in carbon stored was released to the atmosphere.

YANO, YURIKO,[1]* KATE LAJTHA,[2] PHIL SOLLINS,[1] BRUCE A. CALDWELL[1] and JULIE D.H. SPEARS.[2] [1] Department of Forest Science; [2] Department of Botany & Plant Pathology. **Characteristics of dissolved organic matter and its stabilization in forest soil.**

Stabilization of dissolved organic matter (DOM) via abiotic adsorption is an important process for soil organic matter (SOM) formation. We investigated the effects of detritus type on DOM chemistry and DOM adsorption to mineral soil in an old-growth Douglas-fir forest in the Pacific Northwest, OR. Chemical fractionation of DOM extracted from different types of Douglas-fir litter (new or decomposed leaf and wood, and new fine root) showed considerable differences in DOM chemistry across tissue types within new type litter. Leaf litter extracts generally had a greater hydrophilic acid content than wood litter extracts. The degree of decomposition

had a stronger effect on DOM chemistry than differences in tissue type. As litter decomposes the proportions of hydrophobic acid and base fractions increased, and the hydrophilic neutral fraction decreased. These differences across tissue types were not found for the chemical compositions of O horizon leachate collected in a long-term litter input plots (2x leaf, 2x wood and natural inputs). This may indicate that the decomposition of litter in forest floor contributes to the production of relatively homogenous DOM that leaches into the mineral soil. Field observation suggests preferential removal of hydrophobic acids in the B-horizon, regardless of the season. The lab incubation of the various litter extracts and B-horizon soil also showed preferential removal of the hydrophobic acid fraction. The implication of the results on SOM formation will be discussed.

YANOSKY, THOMAS M.[1] * and MICHAEL R. SCHENING.[1] [1] U.S. Geological Survey; . **Effects of chlorinated hydrocarbons on the growth of oak trees in south-central Massachusetts.**

Black oaks (*Quercus velutina* Lam.) growing over a shallow aquifer in Millville, Massachusetts, were studied to determine the effects of trichloroethylene (TCE) and other chlorinated solvents upon radial growth. Contamination resulted from an undetermined number of releases to the ground surface over an unknown period of time. The annual rings of oaks along the axis of contaminant flow contained elevated concentrations of elemental chloride possibly derived from the dechlorination of TCE and other volatile organic compounds. Additionally, a persistent radial-growth decline began in these trees at approximately the same time that chloride became elevated. Growth did not decline in trees that contained smaller concentrations of chloride. The source of elevated chloride and the corresponding reductions in tree growth could not be explained by factors other than contamination. We believe that chloride-enriched flow began to irrigate trees in the late 1960s or early 1970s, which also is probably the approximate time that contaminants first were released at the site. Contaminant release at a second location nearby apparently occurred in the mid- to late 1970s, suggesting that the area was used for disposal for at least five years and possibly longer.

YEAKLEY, J. A.* and M. P. O'NEILL. Portland State University, Portland, OR 97207-0751 USA. **Biogeographic factors influencing native plant species distribution in riparian areas in an urbanizing Oregon basin.**

Our objectives were to determine if native plant species composition differed between urban and rural riparian zones, and if native plant species diversity and cover decreased with decreasing width and with increasing fragmentation of the riparian corridor. For each of 17 rural and 18 urban riparian sites in northwestern Oregon, we measured vegetation along 4 transects established perpendicular to stream. Using digitized aerial photographs, we measured biogeographic variables for each site. For 138 total species, native plants had greater diversity and relative cover in rural sites than in urban sites ($p<0.05$). Multiple regression results showed that riparian width was the only significant biogeographic predictor of native plant species richness, explaining 81% of the variance in rural sites and 35% of the variance in urban sites. Native plant species diversity, however, was generally better explained in either rural or urban sites by perimeter-to-area ratio, a measure of edge. Isolation was the most significant biogeographic predictor for relative cover of native plants in urban riparian sites.

YEMSHANOV, DENNIS G.* and AJITH H. PERERA. Ontario Forest Research Institute. **Modeling spatially explicit transition of boreal forest cover in the absence of disturbances.**

We developed a spatially explicit model of large-scale, post-fire forest cover change for the North-American boreal biome. We used a semi-Markovian approach, with discrete states corresponding to dominant tree species. Species persistence in the canopy and their replacement rates formed the constraints of the time-dependent Markov chain. Probabilities of discrete state transition were stratified spatially by geoclimate, soil moisture, and edaphic gradients. Information collected from published literature was used to parameterize the model. Canopy composition, age, time since last disturbance, geoclimate, soil moisture and nutrient status were used as input data. Model output included forest cover, time since last disturbance, and canopy age at 10-year time steps, and 1-ha resolution. As a case study, we simulated post-fire forest cover transitions in a 3.7 million ha region in northern boreal Ontario, Canada. We initialized the model with a large-scale fire disturbance using a spatial fire regime model. The replacement of early successional forest cover by late successional forest cover produced by the model was compatible with existing theories of boreal forest succession. Geoclimate and soil moisture variability substantially influenced the rate of replacements. The model predicted transitions among late successional species, indicating that the distribution of late successional forest cover is not stable in space and time. We propose these results as a null hypothesis of forest cover change in the absence of disturbances or fire suppression in boreal landscapes.

YEN, CHIUNG-FEN.* Division of Humanity, General Education Center, Providence University. **Alternative conceptions in biodiversity: a cross-age study focus in animal classification.**

This study examined student's alternative conceptions of animals and animal classification. Probing student's ideas at each of four educational levels, I investigated the extent to which these ideas remained intact through the elementary, secondary, high school, and college students. Multiple-choice/free-response instruments were administered to a total of 410 students. The student's attitudes to classification and their uses of classification inside and outside school were also probed by means of questionnaires. Results showed that students subscribed to a highly restricted view of animals, especially to common mammals. When asked to distinguish between vertebrate and invertebrate animals and to classify several species into vertebrate groups, a wide range of alternative conceptions also emerged. Cross-age comparisons indicate that many of the alternative views remained intact throughout the school years. Results also showed that personalized uses for classification might improve classroom performance as well as a more general competence on observation. I conclude with some practical suggestions for teaching concepts of animal diversity.

YLIOJA, TIINA R.,[1]* MATTHEW P. AYRES,[1] RONALD F. BILLINGS[2] and JOHN M. PYE.[3] [1] Dartmouth College, Hanover, NH 03755, USA; [2] Texas Forest Service, Lufkin, TX 75902, USA; [3] USDA Forest Service, Research Triangle Park, NC 27709, USA. **Spatio-temporal patterns in population dynamics of the southern pine beetle.**

Population dynamics can have structure in space and time. Furthermore, temporal patterns could change in predictable ways across space. We analyzed 10-40 years of abundance data for the southern pine beetle, *Dendroctonus frontalis*, across 1,000,000 km^2. Time series analyses indicated that endogenous dynamics account for 40-50% of the variation in population growth rates throughout the southeastern US, but that delayed density-dependence and cyclical dynamics were stronger in the warmer, southern regions. High spatial synchrony of outbreaks (at a scale far beyond the dispersal of beetles or their natural enemies) implicated spatially autocorrelated exogenous effects throughout the range. Variability in annual population growth rates was lower in southern populations, where *D. frontalis* has $\approx$6 generations per year compared to northern populations with $\approx$4 generations per year. This suggests stronger density-dependence within years in the south and/or stronger exogenous effects in the north. Indeed, interannual growth rate in the north was negatively correlated with the occurrence of lethal winter temperatures, suggesting that minimum annual air temperature are a driver of northern population dynamics. Apparent population dynamics were generally similar whether abundance was measured as number of infestations, m^3 of trees colonized, or trap captures, but exceptions suggested that the relevant demographic processes can have different effects at different scales. Evidently, understanding and predicting beetle population dynamics requires models that include regional patterns in the strength and nature of exogenous and endogenous drivers.

YORKS, THAD E.,* DONALD J. LEOPOLD and DUDLEY J. RAYNAL. State University of New York - College of Environmental Science and Forestry, Syracuse, NY 13210. **Potential biogeochemical and vegetative consequences of an invasive insect herbivore in *Tsuga canadensis* stands.**

We monitored soil water chemistry and vegetation in two healthy *Tsuga canadensis* stands and two *T. canadensis* stands subjected to a girdling

Keeping All the Parts:
Preserving, Restoring
& Sustaining Complex
Ecosystems

THE ECOLOGICAL
SOCIETY OF AMERICA
86th ANNUAL MEETING
MONONA TERRACE, MADISON, WISCONSIN
AUGUST 5–10, 2001

The Ecological Society of America
1707 H Street, N.W., Suite 400
Washington, D.C. 20006
Web: http://esa.sdsc.edu