

influencing the nature of stream incision, hydrologic regime, and vegetation pattern and structure. Stream reaches at or below fans are dominated by tree or shrub communities, while meadows occur almost exclusively upstream of fans. Progressive incision through fans or other base level controls results from episodic flood events. Incision can result in vegetation threshold crossings that can be defined largely in terms of stream gradient, substrate characteristics, and water tables. Meadow reaches are characterized by low gradients and fine particle sizes, and incision results in a progressive conversion from vegetation types with high and consistent water tables to types with lower and variable water tables. Reaches with deeply rooted woody vegetation have high gradients and coarser particle sizes and incision is reflected primarily in changes in understory vegetation. The streams and riparian ecosystems are functioning as non-equilibrium systems. Restoration to conditions that existed prior to the most recent incision is unrealistic, and management should focus on maintaining the integrity of stable stream reaches and increasing the stability of reaches at risk.

CHANDY, SHIBI^{1,*} and DAVID L. EULER. ¹ Department of Plant Biology, Southern Illinois University Carbondale; ² Faculty of Forestry, Lakehead University, Thunder Bay, Ontario, Canada. **Silviculture and its impact on four plants with medicinal value in Northwestern Ontario.**

Vegetation management to release conifers from competing angiosperms is practiced throughout Canada. Aerial herbicide application, mechanical cutting, are some of the techniques used to suppress competing vegetation. These techniques allow conifers to establish in the first few years after planting. One of the issues that arise, especially from the public, is concern that aerial herbicide applications have on other values. Hence, there is pressure on managers to find alternatives for the chemical control of vegetation that hinders early conifer growth. The abundance of (*Cornus stolonifera* Michx., synonym *serecia*), (*Epilobium angustifolium* L.), (*Pteridium aquilinum* (L.) Kuhn), and (*Rubus idaeus* L. var. *stringosus* (Michx.) Maxim) was determined, seven years after the silvicultural treatments were first applied in the area. All four species studied show potential medicinal ingredients both from ethnobotanical, and pharmaceutical perspectives. A single application of herbicides or mechanical treatments did not show any statistical difference from the control plots in the abundance of these species. By using mechanical methods for controlling these species, the medicinal values can be made available for development by the pharmaceutical companies, without contributing to any environmental degradation that may result from aerial herbicide application.

CHANG, GARY C.* University of Idaho. **Behavioral assessment of potential disruption of biological control by intraguild predation.**

The net impact of predators on a prey population may be disrupted if the predators also consume each other (an interaction called intraguild predation, IGP). Theory predicts disruption if the predators consumed in IGP are superior exploiters or if predators attack each other in preference to other prey. In an open field setting, I compared the exploitative abilities and consumption preferences of four insects that attack pea aphids by following freely-foraging individuals for 15-minute observation periods or until the focal insect was lost. I recorded what the insects encountered and the outcomes of those encounters. Parasitoid wasps and syrphid fly larvae were victims of IGP, while lady beetles and lacewings were perpetrators of IGP. The pea aphid attack rates of parasitoids, syrphid larvae, lady beetles, and lacewings were 0.87, 0.70, 0.68, and 0.74 pea aphids per individual per hour, respectively. These four rates were not significantly different. The ratio of IGP events to other predation events was less than 1:9, and did not differ significantly from the ratio of potential IG prey individuals to other potential prey individuals. Thus, the behavioral-level data predict that IGP should not disrupt biological control of the pea aphid under the study conditions.

CHAPMAN, KIM A.* and PETER B. REICH. University of Minnesota. **Conserving regional biodiversity across landscapes and habitats: role of reserves, rural lands, and suburbs.**

Conserving biodiversity in a human-dominated world requires understanding regional patterns in species distributions relative to environmental variables at landscape and habitat scales. We studied landscapes—reserves,

rural lands, suburbs—and their component habitats comprising the Anoka Sand Plain in the northern Twin Cities region (Minnesota, USA). Landscape features included land use and distances to natural and human features. Habitat features included vegetation and human-built structures and cover. Bird, tree and shrub species were used as indicators of biodiversity. Data were taken in 100m-radius bird census plots and 100m and 15m environmental plots at 302 random points in 1999 and 2000. Birds, trees and shrubs responded strongly to gradients controlled by people: land use at large geographic scales and land management at habitat scales. Two ordination techniques described similar patterns of species distributions. Correlation analysis confirmed strong relationships to landscape and habitat variables. Intensity of land use and management strongly affected composition of communities at specific locations. Birds were grouped by their response to land use and habitat management: 1) development-averse birds; 2) development-tolerant birds that needed high quality habitat; 3) development-tolerant birds that used degraded habitat; and 4) development-dependent birds that used environmental features provided by people. Rural lands were as important as reserves in maintaining current regional biodiversity. Features of suburbs had negative and positive effects.

CHAPMAN, SAMANTHA K.,* THOMAS G. WHITHAM, STEVEN C. HART, NEIL S. COBB and GEORGE W. KOCH. Northern Arizona University. **Herbivory alters pinyon pine litter biomass and chemical composition.**

Herbivores can affect ecosystem nutrient cycling by altering litter quantity and chemical quality. The impact of foliar insect herbivores on decomposition and nutrient cycling in coniferous systems is poorly understood. We are studying aboveground litter production and chemical composition in pinyon pines (*Pinus edulis*) infested with two herbivores: *Matsucoccus acalyptus*, a scale insect that infests juvenile trees, and *Dioryctria albovittella*, a stem-boring moth that infests mature trees, at Sunset Crater National Monument northeast of Flagstaff, AZ. Scale-infested trees display a significant 30% increase in yearly litter production compared to trees naturally resistant to scale and susceptible trees maintained scale-free for the past 16 years. Both herbivores at Sunset Crater significantly decrease lignin:nitrogen (N) ratio of pinyon litterfall (scale-30%, moth-20%). The lignin:N ratio has been shown to be a good predictor of decomposability and N mineralization rates in forest ecosystems. Additionally, mature trees have 30% greater lignin:N ratio than juvenile trees. The combination of increased quantity and quality of litter suggests that scale infestation may stimulate nutrient cycling rates. Moreover, herbivores amplify the range of litter quantity and quality in pinyon pine stands, which may lead to greater heterogeneity in decomposition rates, and nutrient availability in this arid ecosystem.

CHEN, HUA* and MARK E. HARMON. Department of Forest Science, Oregon State University, Corvallis, OR 97331. **Determination of ash and nitrogen concentration of decomposing woody roots by near infrared reflectance spectroscopy.**

Near infrared reflectance spectroscopy (NIRS) has been successfully used to measure ash, N, and carbon-fraction of leaf litter. However, it is not clear whether this technique will work for woody detritus litter such as woody roots. We evaluated the accuracy of NIRS predictions of ash and N concentrations of decomposing woody roots from a time series experiment and a chronosequence study and determined the effects of species, root size, degree of decomposition, tissues type, and site on NIRS predictions. The time series experiment included 11 coniferous and 7 deciduous tree species. After 4 years of decomposition the determination coefficients (R^2) of ash and N concentration of the woody root samples were 0.98 and 0.97, respectively. Analysis of calibration and validation using different data groups based on species, root sizes, and sites did not significantly improve the predictive accuracy of ash and N concentrations. The ages of root samples from the chronosequence study ranged from 1 to 45 years old. The values of R^2 of ash concentration for these samples ranged from 0.94 to 0.95, while the R^2 value of N calibration of root samples was 0.90. The predictive accuracy of ash concentration using all three-site samples for calibrations was much lower than for each site separately, although for N concentration predictions pooling sites had little effect. Our study indicate that NIRS can successfully determine ash and N concentration of woody

roots as long as the samples have been grouped appropriately to reduce their heterogeneity.

CHEN, JIQUAN,^{1,*} MATTHIAS FALK,² EUGENIE EUSKIRCHEN,¹ KYAW THA PAW U,³ TOM SUCHANEK,² SUSAN USTIN,² BARB BOND³ and KIM BROSOFSKE.⁴ ¹ Michigan Tech University, Houghton, MI 49931; ² University of California, Davis, CA 95616; ³ Oregon State University, Corvallis, OR 97331; ⁴ University of Rhode Island, Kingstown, RI 02881. **Biophysical controls of carbon flows in three successional Douglas-fir stands based upon eddy-covariance measurements.**

We used the eddy-covariance method to directly measure exchanges of CO₂ and H₂O at three successional *Pseudotsuga menziesii* forests in the Wind River valley of southern Washington between 6/15 and 10/15 of 1998 and 1999. The primary objective of this study was to explore and identify the key biophysical variables that drive carbon exchange between evergreen, coniferous forests and the atmosphere within a chronosequence of the dominant vegetation type in the Pacific Northwest. We used the Landsberg model, logarithmic power function, and regression to explore the potential influences of major biophysical variables on FCO₂ and potential thresholds controlling FCO₂. Overall, given the same light levels, FCO₂ was significantly higher ($P < 0.0001$) at the young stands than at the old-growth forest. The average summer and early autumn FCO₂ values were 2.2, 3.2, 6.1 and 4.2 ($\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}$) for OG98, OG99, 40Y98, and 20Y99, respectively. VPD was inversely and significantly correlated with FCO₂ at all three stands, but the slope of this relationship at the old-growth forest was steeper than at the young stands. Correlations between FCO₂ and all other environmental variables varied among ecosystems, with soil temperature showing a negative correlation and net radiation showing a positive correlation. WUE of the old-growth forest was significantly greater in the dry summer of 1998 than in 1999, when soil moisture was greater ($P < 0.0001$) with average WUE values of 2.67 and 1.02 mg.g⁻¹ for OG98 and OG99, respectively.

CHEN, YOLANDA H.* and STEPHEN C. WELTER. UC Berkeley. **The effect of domestication in sunflowers: Decoupling of parasitoid and herbivore responses to wild and agricultural plant genotypes.**

The domestication of crop plants has resulted in intended and unintended changes to physical and chemical plant characteristics. In the common sunflower, *Helianthus annuus*, domestication and subsequent breeding has led to larger floral structures, and an increased responsiveness to nutrients. Numerous studies in the area of tritrophic interactions have shown that plant characteristics may have different effects on the herbivore and natural enemy trophic level, or elicit different responses. We investigated the flight responses of the sunflower moth, *Homoeosoma electellum* and its parasitoid, *Dolichodegenidea homoeosomae*, to wild and domesticated plants. We found that *H. electellum* preferred to fly towards agricultural genotypes and preferred to oviposit on agricultural genotypes. In contrast, parasitoid flight orientation followed that of *H. electellum*, but parasitoid behavior differed between agricultural and wild flowers. Thus, parasitoid behavior did not track herbivores on the agricultural genotypes as effectively as on the wild genotype. This suggests that altering plant characteristics may decouple herbivore and parasitoid behavioral responses, thereby reducing the regulatory ability of the parasitoid on domesticated plants.

CHESSON, PETER* and ANNA L.W. SEARS. University of California, Davis. **Testing hypotheses in spatio-temporal plant competition using measures of interaction strength.**

Measures of interaction strength, such as the intensity of competition, are commonly used in the study of plant and animal communities to understand the dependence of interactions on such factors as stress, productivity, density and biomass. The potential connectedness of communities at different localities by dispersal, or connectedness through time by community persistence, are rarely considerations. Various measures of interaction intensity, closely related to those commonly used in empirical studies, have important roles in spatio-temporal competition theory and its extensions to consider apparent competition. Of major importance in this theory, however, is the nature of the variation in interaction strength between communities that are connected by dispersal or community persistence. This

variation is quantified by 1) standard statistical covariances between an interaction strength measure and environmental factors or densities, and 2) by variances of these quantities. Such covariances and variances help quantify spatio-temporal coexistence mechanisms such as the storage effect and relative nonlinearity of competition. Each of these mechanisms leads to predictions about patterns of variances and covariances that can be tested using the same methods in common use in the study of interaction strength. For example, coexistence by the storage effect predicts stronger intraspecific covariance between environment and competition than interspecific covariance between environment and competition, which distinguishes the storage effect from other mechanisms. In this way, these spatio-temporal mechanisms may be tested by modification of standard methodology currently used for different purposes.

CHICK, JOHN H.* Illinois Natural History Survey. **Effects of the 1993 flood on fish communities in the Upper Mississippi River: what can be learned from long-term monitoring?**

Exceptional rainfall in the Midwestern United States during 1993 resulted in a spatially extensive and prolonged flood in the Upper Mississippi River System. In the area just north of St. Louis, MO (Pool 26), the Mississippi River remained above flood stage from April through mid-October. Long term monitoring of fishes, aquatic invertebrates, water quality, and aquatic vegetation, which was initiated prior to 1993 and continues today, suggests this flood affected physical and biotic components of pool 26. Submersed aquatic vegetation in contiguous backwaters, side channels, and along the main channel shoreline was largely extirpated by the flood and has not recovered. Consistent with predictions of the flood pulse concept, the 1993 flood resulted in increases in nutrient inputs, algal production, and abundance of aquatic invertebrates. Several species of fish had elevated reproductive success during the flood of 1993. Recruitment and persistence of this year class varied among species. Populations of a few species, including common carp and small mouth buffalo, have persisted in great abundance since the 1993 flood. Other fishes, including white bass and largemouth bass, experienced peaks in abundance during 1993 or 1994, but abundance quickly declined to pre-flood levels. Insights into flood effects may be improved by comparing patterns in pool 26 to five other pools in the Upper Mississippi River System that have identical long-term monitoring data but experienced different severity of flooding.

CHOJNACKY, DAVID C.^{1,*} and LINDA S. HEATH.² ¹ USDA Forest Service, Washington, DC; ² USDA Forest Service, Durham, NH. **Down deadwood biomass of trees is correlated with standing mortality at a regional scale.**

Down deadwood (DDW)—also called coarse woody debris—is a carbon component important in the function and structure of forest ecosystems. However, DDW data are not widely available in forest inventory databases, which limits carbon, fire fuels, wildlife habitat, and other large-scale ecosystem assessments. Needed is a method to estimate DDW from existing forest inventory databases. This study examines DDW collected on over 3,000 plots in collaboration with recent U.S. Forest Service, Forest Inventory and Analysis (FIA) inventories in Maine, Vermont, and New Hampshire. Results show DDW is a function of annual tree mortality at a regional spatial scale for all conifer and hardwood forest types. This suggests DDW biomass may be in balance with disturbance factors in some manner. An explanation is suggested based on recent theoretical work for extending allometric relationships of individual trees to forest communities.

CHONG, GENEVA W.^{1,2,*} and THOMAS J. STOHLGREN.^{1,2} ¹ Midcontinent Ecological Science Center, US Geological Survey; ² The Natural Resource Ecology Laboratory. **Species-area curves indicate the importance of habitats' contributions to landscape-scale biodiversity.**

We examined species-area curves, species composition and similarity (Jaccard's Coefficients), species richness, and fine-scale heterogeneity (range in species richness and cover) in 17 vegetation types to develop a composite index of a vegetation type's contribution to landscape-scale species richness. We collected data from 1-m² to 1000-m² scales in 147 nested plots in Rocky Mountain National Park, Colorado, USA to compare three species-area curve models' abilities to estimate the number of species of



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