

**ORAL PRESENTATION ABSTRACTS  
ESA MID-ATLANTIC CHAPTER  
ECOLOGY CONFERENCE 2005**

**Urban Ecology: Human Impacts and Management**

**Land-use effects on amphibian use of stormwater retention ponds and larval metal concentrations**

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Stormwater retention ponds, designed to mitigate the effects of runoff from impervious surfaces in urban landscapes, may provide amphibian breeding habitat, especially given marked global declines in natural wetlands. However, because retention ponds sequester a wide range of pollutants such as heavy metals and are located in human-dominated areas, scientists have expressed concern over the use of these ponds by wildlife. We investigated the effects of adjacent land-use on amphibian species richness and metal (Cr, Ni, Cu, Zn, As, Cd and Pb) concentrations in anuran larvae and sediments from seventeen retention ponds in Anne Arundel, Howard and Prince George's Counties, Maryland. Each site was categorized based on surrounding land-use (residential, commercial, or highway). Three constructed wetlands, with less than one percent impervious surface cover in their watersheds, were classified as open space ponds and used as reference sites. We determined species richness using calling and larval surveys. Metal concentrations were determined using inductively coupled plasma mass spectrometry (ICPMS). Mean species richness was lowest at highway ponds and greatest at open space ponds, while residential and commercial ponds showed intermediate levels of species richness. Larval metal concentrations, but not sediment metal concentrations, varied significantly among land-uses. These results indicate that amphibian breeding habitat suitability and use of retention ponds are related to surrounding land-use, and that urban planners may enhance the wetland function of retention ponds by considering their placement in the landscape.

**Diversity of the Unionidae in the West Branch Rocky River, Ohio**

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A survey of the freshwater mussel (Mollusca: Bivalvia: Unionidae) populations and their distributions in the West Branch Rocky River was conducted in June-July, 2003. The West Branch Rocky River is concentrated in the western suburbs of the city of Cleveland. These data represent the first survey ever conducted in this Lake Erie watershed. This survey produced a total of 529 unionid specimens. Of these 176 were alive and 353 were freshly dead shells. Nine species were found to be living in the West Branch Rocky River. These are *Anodontoides ferussacianus*, *Elliptio dilatata*, *Lampsilis cardium*, *Lampsilis radiata luteola*, *Lasmigona compressa*, *Lasmigona costata*, *Pyganodon grandis grandis*, *Strophitus undulatus undulatus*, and *Toxolasma parvus*. Two additional species, *Utterbackia imbecillis* and *Villosa iris iris*, were also represented as freshly dead shells in this river. The area of greatest species richness exists in the lower (northern) portion of the river just north of the city of Brunswick. Sites in this area support at least seven live species. Species richness is also notable in the upper (southern)

portion of the river just north of the city of Medina where sites yielded at least seven live species. These healthy mussel populations found downstream of Brunswick and Medina suggest that these cities are not harmful effluent sources. Mussel diversity decreases and in some cases mussels are absent in the central survey localities and far upstream (northern) locations. The reason for these declines in species richness is presently unknown.

### **Incorporation of storm sewer networks in urban watershed delineation**

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Watersheds are a common unit for environmental research or management in part due to the fact that water quality is affected by upstream land use and land cover. In urban areas, storm sewer networks can change watershed boundaries when water is drained via pipes across ridges that separate watersheds. In Fredericton, New Brunswick, Canada nine sub-watersheds of the Saint John River were delineated using a digital terrain model both with and without the storm sewer network included. When comparing the two delineations, six of the nine sub-watersheds showed no change or a negligible change, while the other three showed 2, 5 and 68 percent changes in area. It was also found that storm sewer networks can create drainage areas which contribute to multiple watersheds. The knowledge of additional watershed area resulting from storm sewer networks can affect project planning and management decisions. This presentation will cover the delineation process and a discussion of the results.

### **Impact of 10 years of the MD Forest Conservation Act on Maryland's Forest Cover**

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The loss of forest during land use development is an increasing problem for developing towns, counties and states with the immediate impact of decreased forested stream buffers, loss of large blocks of forest and a loss of urban tree canopy. The Maryland Forest Conservation Act (FCA) was adopted to stem the loss of forest cover in the state by requiring, at both the local and state level, most permitted land use change to include forest mitigation. Overall, after 10 years of implementation, statewide 79,174 acres of forest has been retained, 13,611 acres of trees planted, and 42,906 acres of forest cleared. In other words, 65% of forest has been retained and 34% cleared. FCA has spurred innovative techniques that are applicable regionally/nationally to conserve functional forest during development. These include mitigation banks, clustering and long-term protection. Forest mitigation, both retention and planted, is required in sensitive priority areas like stream buffers, floodplains and wetlands helps retain functional forest.

### **Humans as sociocultural ecosystem engineers of urban landscapes: a metaphor for integrating the social sciences and ecology**

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Interactions among human sociocultural characteristics and biophysical variables generate the structure and function of urban ecosystems. However, integrating sociocultural variables into ecological theory and research remains a challenge because of disciplinary divides and the inherent complexity of social-ecological systems. A deeper understanding of urban ecology can be achieved by developing conceptual frameworks that build relationships among sociocultural

and biophysical variables and foster interdisciplinary research. The metaphor of humans as sociocultural ecosystem engineers provides such a linkage. Building from Jones et al's original ecosystem engineering concept, I define sociocultural ecosystem engineering as the modification of landscapes by humans as influenced by sociological, economic and other cultural factors. The objectives of this talk are to 1) discuss sociocultural ecosystem engineering as a useful metaphor for human activities that determine patterns and processes in urban landscapes and 2) develop a unifying conceptual framework centered on sociocultural ecosystem engineering that integrates sociocultural and biophysical variables. To exemplify how my framework can be used to generate and test hypotheses, I will discuss relationships among the sociocultural and ecological dynamics of lawn and garden management by homeowners using data from my field experiment on lawn and garden ecology and relevant published literature. Urban ecology research clearly shows that humans are dominant ecosystem engineers who determine the structure and function of urban ecosystems. A conceptual framework centered on sociocultural ecosystem engineering provides a useful guide for developing interdisciplinary urban ecology research that seeks to clearly elucidate the complex interactions among sociocultural and biophysical variables.

### **Establishing Credibility: Building partnerships for urban watershed management in Fredericton NB, Canada**

MERRILL, S. University of New Brunswick, Fredericton Area Watersheds Association, Fredericton, New Brunswick, Canada

Integrated watershed management requires a participation of a variety of actors: public, private, corporate, and non-private sectors. The Fredericton Area Watersheds Association was born out of conflict, mistrust and misunderstanding between many of these players. Despite its origins, our group has built successful partnerships with and among them. We have sought common ground, interests and concerns, learned to work with and not against, and provided resources such as expertise, data and maps that are beneficial to all our partners. This presentation describes the history of these relationships and evaluates the relative efficacy of collaboration, rather than opposition.

### **Urban Ecology: Assessment of Impacts**

#### **Where are the fauna and the forests of the Mid-Atlantic suburbs sustainable, and where are they not? Finding the answers involves solvable detection problems**

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Detection problems are common in ecology, and this presentation describes new experiments that measure detection differences among amphibians and reptiles. The experiments provide solutions and take-home lessons that could extend to other communities. The apparent losses of a variety of reptile and amphibian species are subtle, in part because most are quite seasonal. Apparent losses of a variety of spring and summer flowers are also subtle because of seasonality. I suggest that detection measurements and solutions that work with reptiles and amphibians in my search experiments, could work in finding plant regeneration, plant diseases, partial predation... There is little or no literature on sustainability of Mid-Atlantic suburbs, even obvious failures in some areas of dominant oaks to regenerate. Best documented is not

sustainability, but increases in vector-borne diseases. Particularly puzzling is that when diseases such as rabies and RMSF emerged following large increases in raccoon population density, even specialist articles do not connect the logical dots between populations so dense as to sustain diseases, and plausible increases in impacts of those predators upon their prey. At least for deer, logical connections are often made between emerging diseases and deer impacts upon flora. With deer impacts known elsewhere, there seem to be no published comparisons of regeneration, even of oaks in Mid-Atlantic suburbs. We can ask if sustainability occurs along gradients such as distance from stream corridors for mammals to disperse, distance from roads... We can discuss opportunities for specialized studies to contribute to clarifying the larger picture and evaluating solutions.

### **Methodology and Results of an Ecological Assessment of an Urban Natural Area in Northern Manhattan**

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Natural areas in urban settings are usually mosaics of many vegetation types and often reflect 100 years or more of human disturbance. Traditional sampling methods, such as line transects, rarely capture the full diversity of these sites. However, during the 1980's, a classification system, called, "entitiation," designed specifically for urban sites was developed and employed in New York City Parks to map a number of natural areas. Using entitiation, the site is mapped as a series of vegetation types called "entities." Entitiation produces a map of the entire site by using a set of generalized plant communities, based on covertype, dominant species, and understory composition. Transect methods, in contrast, produce a series of detailed, but isolated, samples that cannot capture all of the variation in one area. The entitiation method is based on an ecological classification developed by Ellenburg and Mueller-Dombois (1967). It has been updated by the authors, using GIS technology, and applied to a 128 acre, mostly natural, park in northern Manhattan. This inventory produced over 200 distinct ecological entities within the park, documenting patterns of disturbance, invasion, and restoration throughout the park, and providing a template for future management plans.

### **Measuring long-term ecological change in urban and suburban landscapes**

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This presentation will describe a standardized approach for high-resolution long-term ecological change measurements across densely populated anthropogenic landscapes. The approach is specifically designed for urban, suburban, and rural landscapes and is based on the direct interpretation of high resolution ( $\leq 1$  m) imagery combined with groundtruthing in the field. The anthropogenic ecotope classification and mapping system characterizes all stable land use systems employed by local land managers in rural, suburban, and urban landscapes, so that data obtained directly from land managers can be integrated with ecological measurements to make spatially-explicit high resolution ecological change estimates across landscapes. The system effectively identified significant ecological changes between the 1940s/50s and the current time across 1 km<sup>2</sup> sites in urban Baltimore (Watershed 263) and suburban Baltimore (Cub Hill). Standardized comparisons across sites demonstrated the role of environmental and economic constraints in modulating the ecological impacts of land use change. The relative strengths and weaknesses of ecotope mapping relative to traditional land use/land cover mapping such as the

NLCD system will be described, along with strategies for integrating high-resolution site-based measurements with regional data to make regional and global change estimates.

### **Ecological Risk Assessment of Contaminated Sites in Urban Areas**

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Performance of ecological risk assessment is a requirement when cleaning up contaminated sites under federal and state regulatory programs. Deciding and documenting the level of assessment necessary in urban settings can be challenging. Four case studies are presented (Newark NJ; Philadelphia PA; Southbridge MA; York PA). The problem formulation, analysis, and risk characterization are summarized and compared. Decision points and documentation are discussed. The level of analysis necessary to ensure the remedy will be protective of ecological receptors is presented.

### **Accessing Long Term Ecological Research Program climate and hydrology data**

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Standardized measurements and reporting of meteorological variables at Long Term Ecological Research (LTER) sites facilitate comparison of conditions at two or more sites. The LTER Climate Committee established guidelines for measurements in 1986. Meteorological stations may range from those that observe daily maximum and minimum temperatures or precipitation to stations that continuously record vapor pressure, wind speed and direction, solar radiation, and other site-specific variables along with the air temperature and precipitation. Each LTER site has one station designated as the "primary" station and most have other stations designated as secondary. Secondary stations may be those that measure only precipitation in proximity to a gauged watershed. The Baltimore Ecosystem Study (BES) established a primary station at the McDonogh School in April 2000. The array of variables measured at McDonogh puts the BES station at the highest level according to LTER Climate Committee standards, because, in addition to standard weather variables, the station measures down- and up-welling photosynthetically active radiation, net all-wave radiation, soil temperature at two levels, and soil moisture. LTER sites archive daily summaries of climate data in a system called ClimDB, and these data are freely available from a server at Oregon State University (<http://www.fsl.orst.edu/climhy/climdb/>). Data may be downloaded numerically in several formats as well as graphed online. Some LTER sites provide data from nearby stations other than their own. This presentation will illustrate the procedures for accessing ClimDB data and metadata as well as hydrologic data from HydroDB that is part of the same data archive system.

### **Resource land loss and forest vulnerability in the Chesapeake Bay watershed**

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The contemporary pattern of urban development in industrialized countries is increasingly taking the form of low density, decentralized residential and commercial development. In the Chesapeake Bay watershed, which is located within the mid-Atlantic region, dispersed

development patterns have been linked to habitat fragmentation and declining water quality. Our objectives were to document how this urbanization process has expanded throughout the watershed and to explore how lands comprising the natural resource base, particularly forests, have been replaced by a matrix of the built environment. We accomplished this by mapping impervious surface cover (houses, roads, etc) and forests across the ~200,000 km<sup>2</sup> area using a time series of satellite imagery. We calculated metrics of land use change and used these to estimate the loss of resource lands across the region. We also used the time series to calibrate a spatial model of urban land use change, and forecasted future development patterns in Maryland out to 2030 under different policy scenarios. Using Maryland Department of Natural Resources' (DNR) Strategic Forest Lands Assessment (SFLA), which evaluates forest resources in terms of their economic and ecologic value, and Maryland's Green Infrastructure, which identifies ecologically valuable patches of contiguous forests, we evaluated the vulnerability of forest resources in Maryland. Threats associated with loss and fragmentation were identified. Future work will focus on potential impacts to specific biota and to water quality, as well as a region-wide application of the urban land use change model.

## **Nutrients and Pollution**

### **The influence of hyporheic exchange on primary productivity and phosphorus uptake in urbanizing streams**

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Work was conducted in two streams as part of a comprehensive investigation of the effects of urbanization on the Valley Creek watershed, an urbanizing piedmont stream located in Chester County, Pennsylvania, approximately 30 km west of Philadelphia. Results from field experiments at one site showed that the silt-clay ( $d < 50 \mu\text{m}$ ) content of the fine ( $d < 2 \text{ mm}$ ) bed sediment controlled streambed hydraulic conductivity and hyporheic exchange rate, which in turn played an important role in phosphorus uptake, net primary productivity, and community respiration. At a less severely impacted site, the phosphorus uptake rate was controlled by a combination of the hyporheic exchange rate, silt-clay content of the fine bed sediments, and the aluminum content of the fine bed sediments. By comparing temporal changes within a given stream, this study found that the phosphorus uptake rate ( $\text{s}^{-1}$ ) was related to the transient storage exchange rate ( $a, \text{s}^{-1}$ ) when either biotic or abiotic processes were dominant. This contrasts with other researchers who have examined differences between multiple forested mountain streams. When biotic processes were dominant, phosphorus uptake (Mulholland et al., 1997) and community metabolism (Fellows et al., 2001) were shown to be related to the size of the storage zone. However, when abiotic processes were dominant (Hall et al., 2002), phosphorus uptake was shown to be unrelated to the size of the storage zone. We conclude that the relationship between hyporheic storage and biological activity is best studied by examining temporal changes within a given stream.

## **IMPACT OF LAND USE ON FECAL COLIFORM LEVELS IN SURFACE WATERS OF FAIRFAX COUNTY, VIRGINIA**

BUCHINO, J. Environmental Science and Policy, George Mason University

Elevated levels of fecal coliforms in the surface waters for Fairfax County have been of concern because of numerous violations of water quality standards and the inherent public health issues. This dissertation analyzed Fairfax County Health Department monitoring data from 1986 through 1999 and developed statistical models to explore the impact of land use on fecal coliform levels. The explanatory variables included the water chemistry data, impervious surface, NRCS curve number, drainage area, precipitation, stream flow and land use. Individual regression models for each watershed were developed to investigate geographic variability in the models. A regional model was developed using land use data from the Northern Virginia Regional Commission for 1997, and spanned a five-year period (1995 through 1999). The results of this regional model indicate that impervious surface is the major explanatory variable, explaining 40% of the variability in fecal coliform levels in the model ( $R^2 = 0.6585$ ). Impervious surface is highly correlated with land use, being positively correlated with High Density Residential ( $R^2 = 0.6108$ ) and negatively correlated with Open Spaces ( $R^2 = -0.3538$ ) and Low Density Residential ( $R^2 = -0.2851$ ). Results are consistent with the hypothesis that land uses associated with increasing urbanization are correlated with elevated fecal coliform levels in surface waters of Fairfax County, Virginia.

## **Landscape Level Airborne Mercury Deposition in the Shenandoah Valley, VA**

### **I: Detection of Non-random Patterns**

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There is significant inorganic Hg contamination at Waynesboro, VA in the South River and on its floodplain. This resulted from industrial contamination in the early 1900s. The purpose of this study was to establish an extensive airborne Hg deposition sample grid with 125 sites in Waynesboro, VA, and compare Hg concentration data with 25 sites in Harrisonburg, and Staunton, VA; cities that are removed geographically from the South River. Duplicate low cost plastic Petri plate passive samplers with a sticky “tangletrap<sup>®</sup>” gum surface exposed were attached to telephone poles. The dust, insects, and other debris was digested ( $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$ ) along with the gum and analyzed for Hg using cold vapor atomic absorption spectrophotometry with a Perkin Elmer FIMS. Hg deposition is expressed as  $\mu\text{g Hg}\cdot\text{m}^{-2}\cdot\text{mo}^{-1}$ . The deposition in northeastern Waynesboro (downstream from the point source) was significantly greater ( $p < 0.01$ ) than the southwestern sector (upstream from the point source), eliminating random regional atmospheric deposition as the only source of mercury. There was no significant difference between the two control locations, Harrisonburg and Staunton, and Hg deposition in Staunton was significantly lower than that in northeast Waynesboro ( $p < 0.01$ ). However, due to the high variability and small sample size in Harrisonburg, the difference between it and northeast Waynesboro was not significant ( $p < 0.5$ ). Therefore, non-random airborne deposition in Waynesboro, VA, has been demonstrated and illustrates the potential value of networks of low cost samplers to identify locations of interest at the landscape level.

## **Seasonal variation in non-point source nutrients and stormwater run-off in an urban wetland**

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Wetlands in urbanizing areas are particularly vulnerable to loss through residential and commercial land-development. These wetlands are generally perceived as having low ecological value. When lost, mitigation sites are often outside the local watershed and little is known about the impact this has on water quality. To examine the possible role urban wetlands play in processing nutrient and stormwater inputs, we conducted a 12-month study (2002-2003) on an urbanized, Class I/II wetland located in metropolitan Cleveland, Ohio. Natural headwater streams that once fed the wetland have been destroyed or altered and extensive urbanization has increased impervious surfaces in the surrounding catchment. Water samples were collected twice monthly from two major inflow tributaries, three dissipation sites, and the wetland outflow to investigate seasonal and stormwater effects on water quality entering and exiting the wetland. Water samples from each site were analyzed for nitrate, ammonium and orthophosphate. Our results indicate nutrient concentrations were highest at dissipation sites and wetland outflows were generally lower during times of regular water flow but that seasonal differences do occur. Outflow data indicates that the wetland appears to act as a nutrient source only during major storm events. Our research provides insight into seasonal changes in urban non-point source inputs to the wetland and indicates that urban wetlands may provide a valuable watershed function in nutrient and stormwater processing.

### **Aquatic Ecology**

#### **Enhanced swimming performance of blacknose dace from urban streams**

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Urbanization alters the hydrological dynamics of streams producing aberrantly strong flows during precipitation events and often reduced flows between precipitation events. We hypothesized that if fish inhabiting urban streams need to forage and move during storm events, they would have to compensate with improved locomotor performance. Blacknose dace is a species that persists in the most urbanized streams but is also an abundant component of marginally disturbed watersheds in the mid-Atlantic region. Thus, blacknose dace is an ideal species for testing hypotheses concerning non-lethal effects of urbanization. We compared locomotor performances of dace from urban streams in Baltimore with those of dace from nearby rural and semi-urban streams. Two separate swimming tests were used: 1) an incremental velocity test ( $U_{crit}$ ) which is largely a test of endurance, and, 2) a sprint performance test. Endurance swimming performance was size independent, significantly repeatable and depended significantly upon the base-flow of the stream locale fish were captured from. There was also a significant relationship between %impervious surface cover (%ISC) in the watershed and endurance performance. Sprint swimming performance was also significantly repeatable but also depended significantly upon size. Analysis of size-adjusted sprint performances showed that blacknose dace from urban environments had superior performances to those from less urban streams. Laboratory results suggest that superior locomotor performances of urban dace are due to phenotypic plasticity and not evolution.

### **Lipid cycling in blacknose dace (*Rhinichthys atratulus*) populations along a rural-urban gradient**

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Watershed urbanization results in increased impervious surface cover and major changes in stream hydrology, channel morphology, and ultimately, overall stream habitat quality. While many stream organisms cannot tolerate the habitat changes associated with urbanization, some species persist and even thrive in urban areas; how these populations adapt to urban environments remains largely unknown. As part of a larger study investigating adaptation of stream fish to urban environments we are comparing lipid cycling among populations of a small stream minnow, the blacknose dace (*Rhinichthys atratulus*), across a rural-urban gradient. Many stream fish store lipids during times of resource abundance for use during times of high-energy demand (e.g., reproduction) or resource scarcity (e.g., winter). Among the 447 dace examined to date, lean somatic dry weight of both males and females increased with urbanization. When all fish are considered collectively, physiological constraints appear to set an upper limit on lipid storage at approximately 25% of dry somatic weight. While temporal patterns of lipid content were qualitatively similar across the rural-urban gradient, during most months dace from urban environments had approximately twice the lipid content as dace from more rural environments. Only during winter was lipid content similar across the rural-urban gradient. Our results suggest that in urban streams resources may be more abundant or of higher quality, or both, and that dace in urban streams store proportionally more energy in the form of lipids.

### **Variation in Stream Fish Sexual Dimorphism Across a Rural-Urban Gradient**

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Sexual dimorphism is a common phenomenon involving development of different morphological characteristics between mature males and females of a species. Among many freshwater fishes, sexual dimorphism often involves differences in fin size. Specifically, males have larger paired ventral fins (pectoral and pelvic fins) and females have longer anal fins. These differences were examined in blacknose dace (*Rhinichthys atratulus*) from eight streams that extend across an urbanization gradient. Watershed urbanization results in changes in the physical habitat of streams and input of pollutants such as endocrine-disrupting chemicals. Because development of sexual dimorphic characteristic are under endocrine control and may be influenced by the physical habitat of streams, we expected to find differences in the degree of sexual dimorphism among rural and urban populations. Results to date indicate significant variation in the degree of sexual dimorphism in fin lengths among the eight populations. Furthermore, variation in degree of sexual dimorphism among populations was at least partially related to degree of watershed urbanization. Populations from the two most urbanized watersheds showed unique sexual dimorphisms and another urban population lacked sexual dimorphisms in anal fin length.

### **Implications of transgenic corn cultivation on the ecology of agricultural streams**

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Corn is a common transgenic crop made by introducing a gene that codes for a toxic protein from bacterium, *Bacillus thuringiensis*, into corn DNA. Genetically modified crops provide

internal resistance to herbivorous pests like the European Corn Borer (*Ostrina nubilalis*). With the use of transgenic crops on the rise, research is being done to consider its environmental effects on non-target taxa. Stream ecosystems occupy topographic low points in the landscape and thus are affected by agricultural land use, including Bt hybrids. In streams, the main energy source is from terrestrial organic detritus, mostly in the form of dead leaves and wood, delivered via wind or natural leaf fall. Stream insects consume this material, in turn creating biomass for predaceous insects, crustaceans, and fish. Given insect larvae are critical to the transformation of energy from detritus to higher trophic levels, the implications of detritus containing advanced pesticides like Bt may be substantial. Experiments were designed to reveal the effect of Bt vs. non-Bt leaf litter from corn in a stream ecosystem to answer the following questions: 1. Does Bt active corn detritus impact the feeding behavior of shredders? 2. Does the presence of Bt in corn litter alter decay rate in the stream? 3. Does shredder species composition present on decaying corn litter differ for Bt or non-Bt corn detritus?

### **Community Ecology**

#### **Salamanders in forest-floor food webs: effects of size-selective predation on invertebrate communities**

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Plethodontid salamanders are hypothesized to play a significant role in the regulation of invertebrate communities and decomposition within forest-floor food webs. We tested this hypothesis with a series of laboratory microcosm experiments. In an experiment of 3-month duration, the presence of red-backed salamanders, *Plethodon cinereus*, was associated with reduction in macroinvertebrates, increases in mesofauna, but no effect on decomposition in comparison to salamander-absent controls. We hypothesized that size-selective predation on larger prey resulted in reduced competition pressures upon and increased population growth among mesofauna, and that the contrasting effects on macro- and mesofauna resulted in no net change in the rate of litter breakdown by detritivores. We also hypothesized that effects of size-selective predation by salamanders should be most prominent in habitats characterized by large disparity in size among major detritivore taxa. We tested this hypothesis in a month-long experiment in which we compared invertebrate community responses to *P. cinereus* between substrates from macrofauna-dominated (isopods and millipedes) and mesofauna-dominated (Collembola) habitats. The results were consistent with regulation of competition by size-selective predation; increases in Collembola occurred only when salamanders were present, were most pronounced within macrofauna-dominated substrates, and were associated with significant reductions of isopods and millipedes. These findings suggest that plethodontids may buffer native mesofauna from impacts of non-native macrofauna, e.g., isopods and earthworms.

#### **Was American chestnut a dominant of eastern deciduous forest before European settlement?**

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American chestnut (*Castanea dentata*) is widely considered to have been a dominant species of eastern deciduous forests in North America before European settlement. A compilation of

witness-tree data from 196 early surveys of the region calls this assumption into question. Mean relative density of chestnut in areas where it was found was only 5.7%, and in 90% of the surveys, its relative density was less than 13%. In no state did its relative density exceed 10%. Comparison of witness-tree density estimates, mostly from the 1700s, with descriptions and quantitative estimates from the turn of the twentieth century just before the chestnut blight, suggests a large increase in chestnut's relative density between these two periods. Due to historical patterns of forest cutting and land use, chestnut went from being an uncommon species in pre-settlement times, to a forest dominant in the early twentieth century.

### **Effect of increasing CO<sub>2</sub> and temperature on species richness and productivity of agricultural weeds**

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A gradient of atmospheric CO<sub>2</sub> and air temperature along a rural-urban transect was used to investigate the change in plant diversity and productivity of agricultural weed communities over three years. Replicate plots of fallow agricultural soil were established in the following three locations: Baltimore Science Center (Urban), Carrie Murray Nature Center on the outskirts of Baltimore (Suburban) and an Organic Farm 50 km from Baltimore (Rural). Over the three years the urban site was 2.6 °C warmer and had an atmospheric CO<sub>2</sub> concentration elevated by 20% when compared to the rural site. Other environmental variables measured did not differ consistently across the transect. The first year of plant growth from a fallow soil was dominated by weedy annuals with significantly greater aboveground biomass at the urban site compared to the rural and suburban sites. After three years the ratio of perennial to annual species had increased for the urban site, suggesting a faster rate of secondary succession associated with elevated CO<sub>2</sub> concentration and temperature. The change in species richness may be associated with changes in above and belowground productivity and an increase in carbon and nitrogen cycling. Overall the increase in productivity and change in the ratio of perennials and annuals has significant implications for weed populations in urban areas.

### **Population Ecology**

#### **The differential use of ray flowers as visual attractants or landing structures by pollinator species**

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I investigated the coevolution of ligulate (ray) flowers in the family Asteraceae and their pollinators by conducting manipulative experiments in the tropical rainforests of northern Thailand. Specifically, I determined the effect of ligulate flowers of the clonal shrub *Tithonia diversifolia* (Asteraceae) on several pollinator species and the effect of them on the reproductive success of *T. diversifolia*. The most common visitors of *T. diversifolia* in descending order were bumblebees, vespid wasps, *Trigona* bees, and several Lepidopteran species. Removal of all ligulate flowers had no effect on visitation to disk flowers by bumblebees, reduced visitation of *Trigona* bees slightly, reduced visitation by vespid wasps greatly, and almost totally reduced visitation by Lepidoptera. Experimental removal of all ligulate flowers on half of the *Tithonia* inflorescences in an area had no effect on bumble bees, had very little effect on vespid wasps, and moderately reduced visitation by *Trigona* bees and Lepidoptera. Results of field behavioral studies showed that bees almost never used ligulate flowers as landing structures, while wasps used them sometimes and Lepidoptera usually landed on ligulate flowers before sucking nectar

from disk flowers. Removal of ligulate flowers had a very small negative impact on reproductive success of *T. diversifolia* because the removal of ligulate flowers had no impact on visitation behavior of the most common and most efficient pollinator, bumblebees. These results suggest that ligulate flowers probably evolved more as landing structures for pollinators than as visual attractants and perhaps during times when or in areas where Lepidopteran populations were greater.

### **Population Diversity and Dispersal of Two Species of Stoneflies (Order Plecoptera) Within Four Watersheds of Northeastern Ohio.**

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This study investigates the dispersal capabilities and genetic structure of two species of stoneflies within four watersheds in the Lake Erie drainage system of Northeast Ohio using genetic markers. It will determine if there is a link between population dynamics of these macroinvertebrates and the quality of stream habitat. *Alloctenia recta*, a winter emerging stonefly, is predicted to have genetic variability among all four watersheds due to its rudimentary wing structure and time of emergence. Relative distance among the four watersheds is predicted to be a major factor influencing genetic variation in the populations of *Leuctra tenuis*, a summer emerging stonefly. Populations collected at sites located in close proximity to each other are predicted to have the least genetic diversity (i.e. Chagrin and Cuyahoga Rivers). The 16s rRNA of the mitochondrial DNA are used to quantify the genetic heterogeneity of the two species in the four watersheds. This research will provide new genetic information on two understudied aquatic invertebrate species and provide a novel approach to determining impact of human land-use practices on species biodiversity. Preliminary data has shown that there are distinct polymorphisms that exist within the 16s region of *A. recta*.

### **Fragmentation of riparian amphibian distributions by urban sprawl in Maryland**

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Urban and suburban sprawl is a pattern of low-density development spread over previously rural landscapes. Adverse effects on air and water quality from sprawl have been well documented, but effects on riparian organisms such as amphibians have been little studied. We used amphibian species presence data from the statewide Maryland Biological Stream Survey (MBSS) to (1) describe the relationships of amphibian species presence with land use and impervious surface and (2) describe how amphibian assemblages change among urban, suburban, rural, and forested landscapes. Since 1995, the MBSS has recorded the presence of amphibians at more than 2,500 randomly selected stream sites across Maryland. The land use and impervious surface in the catchments draining to each of these sites is known, as is the chemical, physical, and biological status of each 75-m stream segment sampled. The biological condition of each segment is determined by reference-based Indices of Biotic Integrity (IBIs) for benthic macroinvertebrates, fish, and stream salamanders. We determined that certain amphibian species have very low tolerances to impervious surfaces in their watersheds. In addition, amphibian assemblages in urban and suburban areas have fewer species than in rural or forested landscapes. In Maryland, the effect of urban sprawl is to shrink the distributions of sensitive

amphibian species into more and more restricted areas.