

material must possess the following properties to help aid wound management. It must be an occluder and have good biocompatibility. It should have mechanical strength for insulation, wound protection and exudate removal from the injury site. Lastly, it must be absorptive, impermeable to bacteria and inexpensive. Many current wound dressing materials on the market possess the aforementioned properties but none have used arabinoxylan as a base material. Arabinoxylan should be considered as a wound dressing because of its high porosity and swelling properties which allow easy absorption and retention of wound exudate. This allows the injury site to stay moist. Similar carbohydrate based polymers as arabinoxylan have also shown an ability to modulate immune response which is critical during the inflammation stage of wound healing. The goal of this study is to investigate and highlight the material and biocompatible properties of arabinoxylan foams as a potential wound dressing material. D.A. is a recipient of SREB-State Doctoral Fellowship.

Posters

SUSTAINABLE MANUFACTURING THROUGH BIO-INSPIRED DESIGN. Jacquelyn K Nagel¹, Chris Graves¹, Austin Underhill¹, Katie McCullar² & Katie Kelly³, ¹Dept. of Engineering, ²Dept. of Biology, ³Dept. of Integrated Science & Technology, James Madison Univ., Harrisonburg VA 22807. Bio-inspired design, or biomimicry, is an approach to innovation by taking nature's patterns, forms, functions, processes, and materials and using them to develop engineering solutions. Biological systems exhibit multi-functionality from form and not material which offers inspiration for product life-cycle management. The goal is to better understand the connection between form and function as found in nature to re-design semi-recyclable products. Through application of bio-inspired design, to the manufacturing and disposal lifecycle phases, product recyclability is increased through minimization of material diversity while still achieving desired functions. One inspiring biological morphology that has been utilized across multiple biological kingdoms and in this research is variations in hardness and flexibility found in alternating layers that are used to provide strength, durability, distribution channels, and protection. Another inspiring morphology considered in this research is found on the neck membrane of the exoskeleton of a dragonfly, which consists of intricate folding that provides the functions of stiffness, elasticity, and low friction smoothness which increases maneuverability of the dragonfly's head. These multi-function forms have resulted in the redesign of a semi-recyclable product fabricated using additive manufacturing to create a product that is made from a single material yet still achieves all necessary functions.

Botany

AN ANALYSIS OF INFRASPECIFIC VARIATION WITHIN *ELEOCHARIS TENUIS* (CYPERACEAE). Lane D. Gibbons & Conley K. McMullen, Dept. of Biol., James Madison Univ., Harrisonburg VA 22807. The presence of subtle and often

vague variations in morphology that convolute specific and subspecific boundaries within the genus *Eleocharis* R.Br. (Cyperaceae) has resulted in lasting taxonomic uncertainty. As with many species of *Eleocharis*, taxonomic issues within the *E. tenuis* complex are made more difficult due to an array of diminutive morphological characters typical of the genus. As currently circumscribed, the varieties of *E. tenuis* present considerable levels of infra- and interspecific variation between the varieties of *E. tenuis* (Willd.) Schult. and its close congeners *E. compressa* Sullivant and *E. elliptica* Kunth. This suite of plants exhibits various morphological character states intermediate to one or more taxonomic entities which, has resulted in a provisional treatment of the group that remains to be elucidated. Multiple authors have added confusion to the complex by proposing various hypotheses for the infra- and interspecific relationships of *E. tenuis*. Though some proposed changes are notable and widely discussed, researchers have not yet generated the taxonomic data necessary to conclude such discussions. To evaluate fully infra- and interspecific relationships within the *E. tenuis* complex and elucidate species relationships in *Eleocharis*, a rigorous analysis of morphological variation within the species *E. tenuis* intent on determining the true presence and relative strength of intermediate characters as well as their correlation to taxonomic entities is currently in progress.

CLEISTOGAMOUS POLLINATION IN SUBTERRANEAN SPATHES OF *COMMELINA BENGHALENSIS* (COMMELINACEAE). Camille Fagan & W. John Hayden, Dept. of Biol., Univ. Richmond. *Commelina benghalensis* (Tropical Spiderwort) is an Old World species currently expanding its range in North America as a troublesome agricultural weed. We studied the anatomy of its subterranean cleistogamous flowers with the goal to understand better the reproductive process undertaken by these unusual structures. Only the three anterior stamens of cleistogamous flowers bear functional pollen grains, the three posterior stamens are non-functional. Tapetum is amoeboid and functional anthers bear a well-developed endothelial layer. The two anterior carpels each bear two ovules but the posterior carpel bears a single ovule. Ovules are orthotropous. In cleistogamous flower buds the style is straight; however, at the stage comparable to anthesis in a chasmogamous flower, the style elongates in a helical fashion as described in previous literature. Our observations suggest that helical style growth is an adaptation to facilitate rupture of anther sacs thus bringing pollen grains into contact with stigmas. Pollen tubes were observed within the acellular transmitting tissue of older styles.

ANATOMY OF HOMEOTIC MALE TO FEMALE INFLORESCENCES OF *ACALYPHA HERZOGIANA* (EUPHORBIACEAE). Carlee Evans, Joie Ha, & W. John Hayden, Dept. of Biol., University of Richmond. Whereas wild type *Acalypha herzogiana* produces terminal spikes bearing inconspicuous staminate flowers, cultivated forms produce terminal spikes of showy red pistillate flowers, putatively the result of a homeotic male to female mutation. We studied flower development in cultivated *A. herzogiana*; for comparison, ordinary male and female flowers of *A. wilkesiana* were also studied. The showy spikes of *A. herzogiana*, as is typical of the

genus, consist of a central axis bearing cyme-like clusters of flowers in the axils of inconspicuous bracts. Floral meristems first initiate four sepals, which subsequently enclose four (or more) primordia, initial stages of which we interpret to be consistent with stamen primordia. However, unlike typical stamens, these primordia expand laterally, eventually filling the space between the sepals, at which point ovule-like structures become detectable. Ongoing studies will focus on the transition from early stages resembling staminate flowers through the mature structure of homeotic pistillate flowers.

EFFECT OF LEAF AGE ON ANTIOXIDANT CONTENT IN *SALVIA OFFICINALIS* AND *LAVANDULA ANGUSTIFOLIA*. W. H. Deaver, W. J. Geyer & M. H. Renfroe, Dept. of Biol., James Madison Univ., Harrisonburg VA 22801. *Salvia officinalis* and *Lavandula angustifolia* are herbs that are known to have beneficial levels of antioxidants, which the human body uses to counteract harmful reactive oxidative species. Top, middle, and bottom leaves were sampled from the plants in order to test for differences in antioxidant values as aging in leaves progresses. Previous studies in the effects of foliar aging on antioxidant levels have shown a tendency for the newer leaves towards the top of the plants to have higher antioxidant levels. An ABTS decoloration assay was used to measure antioxidants extracted from fresh leaves of these two herbs. Acquired data was analyzed using a one-way analysis of variance followed by a Dunnett's T3 test to determine significance of differences of means at a 95% confidence interval. Analysis of fresh weight and dry weight values for both plants showed a significant difference in means for both hydrophilic antioxidants and total antioxidants within the plants. The most mature leaves contained the greatest concentration of hydrophilic antioxidants. Youngest leaves contained the least concentration of hydrophilic antioxidants. However, lipophilic antioxidants were not statistically significant and demonstrated more uniform levels throughout both plants. Our findings contradict previous studies and shed light on the unique distribution of antioxidants between newer and younger leaves of *S. officinalis* and *L. angustifolia* as well as raising consumer awareness about antioxidant dietary values.

ANALYSIS OF LIPOPHILIC AND HYDROPHILIC ANTIOXIDANTS IN COMMON CULINARY HERBS AND SPICES. C. R. Thiel, T. J. Mullins & M. H. Renfroe, Dept. of Biol., James Madison Univ., Harrisonburg VA 22801. Lipophilic and hydrophilic antioxidant contents were analyzed for basil, Mediterranean basil, parsley, cilantro, rosemary, gourmet rosemary, rubbed sage, oregano, chives, and thyme. Extracts were analyzed using an ABTS decoloration assay and reported as trolox equivalents. Among the dried spices that were tested, chives, parsley, and cilantro contained relatively low concentrations of hydrophilic antioxidants. Oregano and Mediterranean basil contained intermediate concentrations of hydrophilic antioxidants, and sage, rosemary, thyme, and basil contained high concentrations of hydrophilic antioxidants. Rosemary contained significantly more hydrophilic antioxidant than any other tested herb. When tested for lipophilic antioxidants, Mediterranean basil, basil, parsley, chives, cilantro, and oregano had relatively low

concentrations of antioxidant content. Thyme and sage had intermediate content, and rosemary and gourmet rosemary had the highest lipophilic antioxidant content. These results may be especially useful to dietitians preparing specialized diets for clients with particular health needs.

EFFECTS OF WEIR ESTABLISHMENT ON VEGETATION SURROUNDING LAKE TECUMSEH IN VIRGINIA BEACH, VA. Julie M. Slater¹, Willard Smith² & Robert B. Atkinson¹, ¹Department of Organismal & Environmental Biology, Christopher Newport University, Newport News, VA 23606 & ²U.S. Fish & Wildlife Service, Virginia Field Office, Gloucester, VA 23061. Lake Tecumseh (also known as Brinson Inlet Lake) is a shallow mesotrophic lake in Virginia Beach, VA within the watershed of Back Bay, a nationally significant estuary. In 2011, the US Fish and Wildlife Service established two submerged weirs on the lake in order to reduce silt discharge into the Back Bay estuary; however, regulatory authorities were concerned higher water levels resulting from weir operation could lead to shifts in the composition of the adjacent forested wetland community. The purpose of this study was to identify effects of the weirs on vegetation in and around the lake. In 8 10-m² plots (for trees) and 24 1-m² (for herbs) we monitored tree mortality, average percent herbaceous cover, percent open water, plant species richness, and percent canopy closure annually from 2009 to 2014; and bald cypress (*Taxodium distichum*) tree cores were collected in fall 2014. No directional shifts in the wetland plant community composition or tree ring widths were observed in wetlands adjacent to the lake.

THE EFFECT OF SALINITY AND ELEVATION ON TREE RING WIDTH OF LOBLOLLY PINE (*PINUS TAEDA*) AT FOUR TIDAL WETLAND SITES ALONG THE YORK RIVER ESTUARY, VIRGINIA. Brittany D. Bowen & Robert B. Atkinson, Dept. of Organismal & Env. Biol., Christopher Newport Univ., Newport News, VA, 23606. Loblolly pine, *Pinus taeda* L., is a dominant species in coastal plant communities throughout the southeastern US and occurs at elevations that are subject to the effects of rising sea level. The purpose of this study was to evaluate the effect of elevation and salinity on annual growth of 40 *P. taeda* trees located at super tidal (low elevation) and non-tidal (high elevation) positions at four sites along a salinity gradient present on the York River Estuary, Virginia. Tree cores were collected from 10 trees at each site using an increment borer and were dried, mounted, and measured. Elevation was measured at each tree using a Real Time Kinematic (RTK) Global Positioning System. No clear trends for the effect of elevation were noted. For trees at lowest elevation, ring widths of the first ten years were found to be significantly different among the four sites ($p=0.02$), with numerically lowest widths associated with highest salinity. The results of this study suggest that local elevation and position along the salinity gradient may influence stress exposure and alter structure in coastal forested communities. Special acknowledgments to the Rouse-Bottom Fellowship Program and the GK-12 Fellowship Program.

SAPLING RESPONSE TO BEAVER PREDATION IN A CREATED FORESTED WETLAND IN LOUDOUN, VA. B. Gerovac, E. Wright & R. B. Atkinson, Department of Organismal & Environmental Biology, Christopher Newport University, Newport News, VA 23606. Wetlands are known to be created by the American Beaver (*Castor canadensis*) via dam building and by anthropogenic activities, such as the creation of mitigation wetlands in accordance with the Clean Water Act of 1972. Beaver activities which influence the development of mitigation created wetlands, such as changes in hydrology or herbivory on planted trees, may hinder tree establishment in mitigation sites. In 2009, 17 plots consisting of three or four subplots were established in a mitigation site located at the eastern edge of Loudoun County. Each subplot was randomly planted with 7 tree species and 3 stock types (21 experimental units) with a total of 1092 trees. Survival and morphometric measurements, including stem diameter, canopy size, and tree height, were collected annually and in the spring of 2014 when girdling and/or stem removal by beaver were first discovered. Of the seven planted tree species, *Salix nigra*, though not the most prevalent species by 2014, did exhibit the greatest beaver predation (53%). *Platanus occidentalis* exhibited the lowest frequency of damage (3%). These findings are consistent with previously published literature demonstrating beaver selectivity for species of the genus *Salix* as well as other works that describe beaver preference being independent of tree species abundance.

THE FLORA OF VIRGINIA: THE FLORA APP AND NEW DIRECTIONS FOR THE PROJECT. Bland Crowder, Flora of Virginia Project, Richmond VA 232180512. The Flora Project was formed in 2001 to oversee production of the *Flora of Virginia*, published in 2012. In addition to authors Alan Weakley, J. Christopher Ludwig, and John Townsend, nearly 100 people worked in research, writing, advising, outreach, illustrating, and fund-raising. The *Flora* could not have been possible without the support of our designated partners, the Virginia Natural Heritage Program, the Virginia Academy of Science, the Virginia Native Plant Society, the Virginia Botanical Associates, and Lewis Ginter Botanical Garden, Richmond. Our phase-two mission is education, but it includes many kinds of students, K–12, college-level, and adult (each also diverse). It includes outreach, to increase awareness of the Project and the need for environmental stewardship. And it includes creation of our Flora App. The App will put the contents of the *Flora* into a truly portable format—smart phones and tablets—but it will be more than an eBook. The *Flora's* descriptions have been converted into a database with which six other environmental data sets will be merged. It will provide dichotomous keys, as in the book, but the new streamlined, graphic key will be a hallmark. The App will attract new users, like students in grades 6–12 who might otherwise use the *Flora* only as limited handouts, but also, via connection to social media (e.g., Facebook, Instagram), it will appeal to children as young as 6 in a way that parallels a popular computer game—but focusing on actual living organisms: Virginia plants.

THE FLORA OF VIRGINIA PROJECT: OVERVIEW OF EDUCATIONAL MODULES FOR COLLEGE STUDENTS AND ADULT LEARNERS. Marion B. Lobstein, Professor Emeritus, Northern Virginia Community College. The *Flora of Virginia* was published in December 2012 and the second printing with corrections in December 2013. The Foundation of the Flora of Virginia Project continues to pursue goals of the Flora Project. One of these goals is the development of teaching and learning modules at the K-12, undergraduate, and adult education levels. General background on the importance of education efforts pertaining to use of *the Flora of Virginia* and the efforts of the Education Committee of the Foundation of the Flora of Virginia Project was briefly discussed. This presentation outlined the following six modules under current development for undergraduate and adult education: overview of the layout of the *Flora of Virginia*, how to use the dichotomous keys of the *Flora*, taxonomy and how to use and interpret the synonymy used in the *Flora*, what is a plant and overview of basic botany of vegetative and reproductive structure as well as life cycles of groups covered in the *Flora*, characteristics of major plant families included in the *Flora*, and habitat information and how to use the information in the *Flora* chapter "Nature of Virginia Flora." Members of the Botany Section were encouraged to consider reviewing these modules for use at the undergraduate level and to complete a questionnaire indicating interest in assisting in this review process.

TREE GROWTH IN CREATED PIEDMONT WETLANDS IN RELATION TO VERTICAL VEGETATION STRUCTURE. Eli Wright & Robert Atkinson, Department of Organismal & Environmental Biology, Christopher Newport University, Newport News, VA 23606. In Virginia the most frequently destroyed wetland type is freshwater forested wetlands with many permitted projects requiring 2:1 mitigation. Success of created forested wetland mitigation sites is dependent in part on criteria related to tree growth, but the effect of interspecific competition on growth is poorly understood. In February of 2009, 1,596 trees composed of 7 species and 3 stock types were planted in 76 subplots across 3 constructed mitigation bank sites. Three morphometric growth parameters were collected annually through 2014. In summer of 2014, the extent of vertical vegetation densities was characterized within four strata for both planted saplings and colonizing herbaceous vegetation by utilizing a 2-meter tall vertical cover board divided into four, 0.5 m quadrants. Results indicate a negative linear correlation between increased extent of herbaceous vertical vegetation and tree growth. The strongest relationship observed ($r^2 = 0.2357$) occurred when the extent of strata co-occupation between tree canopy and herbaceous vegetation was characterized. These results suggest that competition between saplings and herbaceous vegetation for light, and possibly for other resources including nutrients and water, is likely influencing tree growth.

USING ARCGIS TO EVALUATE COMPETITION IN CREATION OF FORESTED WETLANDS IN VIRGINIA. P. Foote, E. Wright, & R. Atkinson, Department of Organismal and Environmental Biology, Christopher Newport University, Newport News VA 23606. The successful creation of forested wetlands is an important part in

the mitigation process of wetland permitting under the Clean Water Act. Tree establishment has often been cited as the most challenging objective. The purpose of this study was to assess the interspecific shade competition effects that could alter growth of planted trees within a created wetland utilizing the geographic software package, ArcGIS. In February 2009, 1596 trees representing 7 species and 3 stock types were planted in 76 subplots across 3 constructed mitigation bank sites in Loudoun County, Virginia. Height of surviving trees were measured each August since planting with average vegetation height and maximum vegetation height being measured at all planting sites during summer 2014. ArcMap 10.2 was utilized to georeference each tree location within a defined coordinate system to create graphic visualizations of relative height and growth of each planted tree and competing vegetation. Graphical outputs comparing average vegetation heights with height of planted trees successfully facilitated observations of trends heretofore only shown statistically; however, few other known relationships were graphically represented, indicating that GIS may have limited application in assessing interspecific competition in created forested wetlands.

Posters

REGENERATION AND RECRUITMENT IN A HEMLOCK-HARDWOOD FOREST AT SHENANDOAH RETREAT, VA. M. Phillips, J. Kincaid, & A. Landes, Env. Studies Program, Shenandoah Univ., Winchester, VA 22601. *Tsuga canadensis* (Eastern hemlock) dominates portions of eastern forests in North America but its distribution and abundance is changing as the result of the nonnative hemlock wooly adelgid (HWA, *Adelges tsugae*). Loss of *T. canadensis* may substantially alter ecosystem composition, structure, diversity, and function. The goal of this research is to characterize tree regeneration and recruitment in a hemlock-hardwood forest prior to significant change in forest composition and structure. A 20x50 meter plot consisting of 10x10 meter quadrats was established. Within each quadrat, all seedlings, saplings, trees and snags were counted and identified; cores extracted by increment borers were taken from all *T. canadensis* stems in the sample plot; tree rings were visually counted and dated. The forest is currently dominated by *T. canadensis*. Size and age structures indicate pulses of regeneration, but waning recruitment for *T. canadensis*. Lack of recruitment, largely resulting from observed HWA-induced mortality, suggests this forest will soon experience significant shifts in species composition and structure. The forest will likely experience increases in species such as *Acer rubrum*, *Quercus prinus*, and *Q. rubra*. Establishment of *Ailanthus altissima* is also cause for concern because this exotic tree easily displaces native vegetation in canopy gaps such as those created by *T. canadensis* mortality. As this forest shifts in composition and structure, we can also expect changes in the hydrology and ecology of the adjacent stream. Information presented by this research provides a baseline for forest monitoring and management efforts at Shenandoah Retreat, Virginia.

RADIAL GROWTH OF ATLANTIC WHITE CEDAR UNDER CONTRASTING HYDROLOGICAL CONDITIONS IN THE GREAT DISMAL SWAMP. K. M.

Kowalski & R. B. Atkinson, Dept. of Organismal & Env. Biol., Christopher Newport Univ., Newport News, VA, 23606. Atlantic white cedar, *Chamaecyparis thyoides*, is an obligate wetland tree that once dominated the Great Dismal Swamp (GDS). However, the species now exists in small, scattered stands. Portions of GDS contain ditches which have lowered the local water table. The purpose of this study is to assess radial growth of cedar in saturated and drained soils within a single system, the GDSNWR. Two perpendicular core samples were collected from ten mature cedars in the saturated site. One cross section sample was collected from ten downed cedar in the drained site. Samples were air dried before sanding with progressively finer sandpaper. Ring widths were measured using a sliding stage microscope connected to a computer with MeasureJ2X software. Mean ring width of the saturated site (2.35 ± 2.06 mm) differed from the drained site (2.80 ± 1.61 mm) ($p < 0.001$). The widest and narrowest mean annual ring widths occurred in 1949 (4.16 mm) and 2008 (1.0 mm) for the saturated site and 1975 (3.95 mm) and 1930 (1.05 mm) for the drained site (respectively). Results suggest that cedars grown in divergent hydrological conditions within the same swamp system have dissimilar patterns of radial growth. These data may be useful in evaluating historic hydrologic conditions in regions of swamps where historic hydrologic data may be lacking. Special acknowledgment to the NSF GK-12 program.

ATTEMPTING TO OVERCOME “PLANT BLINDNESS”: THE EFFECTS OF PARTICIPATING IN PEOPLE-PLANT INTERACTION ACTIVITIES ON COLLEGE STUDENT ATTITUDES AND INTEREST IN PLANTS. Lisa D. Williams, Dept. of Biol., Northern Virginia Community College, Annandale, VA 22003. New lecture materials and lab exercises for a mixed-majors general biology course focusing on people-plant relationships were developed. Students were initially surveyed regarding their interest in, knowledge of, and motivation to learn about plants. During the non-treatment unit, students participated in a traditional lecture method of instruction and lab exercises on plant structure and assessed thereafter. Topics covered during the treatment unit included medicinal plants and relationships amongst plants, soil, water and people. Plant examples were used to illustrate ecological principles. The lecture method, two short assessments, two out-of-class assignments, a drawing exercise, and creation of a woody plant portfolio were used to capture student interest. Students also participated in lab exercises on medicinal properties of plants and tea brewing and tasting. No change was found in student interest in plant-related topics over the course of this project. Student ability to identify common woody plants and vines significantly improved after developing the plant portfolio. Instructor motivation to teach this course was low-to-moderate at the beginning of the project but highly motivated after this project. A new botany course intended for non-science majors has been proposed using many of the materials and tools from this project.