distinguish it from the remainder of the signal. Then an approach to detection can be developed. The approach must be validated and then separately evaluated for its accuracy. Limitations are identified and quantitatively defined, and so the process continues. To illustrate this example data from a study examining preterm infant bottle feeding competency was used. The focus was placed on the detection of bottle sucking activity. Multiple approaches to event detection were explored.

A PATIENT SPECIFIC COMPUTATIONAL MODEL OF ADULT ACQUIRED FLATFOOT DEFORMITY. E.M. Spratley & J.S. Wayne, Dept. of Biomedical Engineering & Orthopaedic Surgery, VCU, Richmond, VA 23284. Computational modeling offers advantages over MRI and plane-film x-ray alone in the quantification of adult acquired flat foot deformity, (AAFD). As such, a population of solid body models was created for the purpose of replicating common radiographic tests used in the quantification of degenerating flat foot morphology. This was accomplished by acquiring a sample of sub-millimeter resolution MRI scans from a group of clinically diagnosed Stage II AAFD sufferers prior to surgery. The scans were imported into the medical imaging package, Mimics (Materialise, Ann Arbor MI), wherein the bony surfaces were isolated from the surrounding tissues and triangulated to form a solid bodies for each bone in the foot. Subsequently, the bodies were imported into SolidWorks (SolidWorks Corp., Concord MA) and templates recreating an oblique anteroposterior film x-ray view were constructed. This template allowed the talo-1$^{st}$ metatarsal angle (T1MT) and talo-navicular coverage angle (TN) to be calculated for each of the AAFD models as well as a non-flat foot cadaver-based model that served as the control. The normal model had a T1MT=5.35° and a TN=0.76°. The AAFD models had a mean T1MT=8.28 ±1.66° and a TN=5.15±4.65°. While these values are lower than those in the literature for T1MT and TN, the values for T1MT were within ranges reported clinically. Additionally, the sample set was able to capture the characteristic increase in the two angles for AAFD feet over those of non-afflicted feet. Further refinement of these models could lead to better classification of AAFD patients with the ultimate goal of improving the treatments prescribed.

## Botany

GROWTH AND NUTRIENT ACCUMULATION RESPONSES TO PHOSPHORUS DEFICIENCY IN CELLULOSE SYNTHASE MUTANTS OF *Arabidopsis thaliana*. Rob Harbert, Roanoke College. Cellulose synthase mutants of *Arabidopsis thaliana* are affected not only in the overall amount of cellulose they are able to produce, but also in the carbohydrate composition of their cell walls. These alterations in the composition of the cell wall may also impact the functions of other components of the cell wall and plasma membrane. The cellulose synthesis mutants JE100, *rsw1-1*, and *prc1*, as well as the Columbia and Wassilewskija (WS) wild types, have been used to see if changes in cell wall composition have any effect on how these mutants perform in phosphorus deficient conditions. The results indicate that JE100 plants respond differently to

phosphorus than the wild types or possibly the other mutants. The results suggests further, that cell wall alterations may have an effect on how nutrients enter roots, or how growth responses are processed. Ward et. Al. (2008) suggested that the phosphorus deficiency dependent growth responses occurred as a result of iron over-accumulation through an interaction that is not well understood at this time. This observation was used to test whether or not the cell wall alterations in the JE100 plants affect how nutrients get across the cell wall and into the root. To do this, phosphorus and iron content was measured in dried plant tissues for Columbia and JE100 plants grown on the four phosphorus conditions on ATS media. It was observed that while the JE100 plants follow the same iron accumulation trend as Columbia, the JE100 plants accumulated more of both nutrients in all scenarios than the Columbia plants do. While this observation does not explain the JE100 plant's relative insensitivity to phosphorus deficiency, it does imply that the JE100 mutation alters the cell wall in such a way that nutrient uptake and accumulation appear to be affected. It is, however, unclear what the nature of this interaction is, or if this affects how nutrient uptake across the cell wall (the apoplast) is affected.

STATUS AND TRENDS OF PHYTOPLANKTON POPULATIONS IN VIRGINIA WATERS AND CHESAPEAKE BAY. H.G. Marshall, T.A. Egerton, M. Semcheski, & M. Lane. Dept. Biological Sciences, Old Dominion University, Norfolk, VA 23529-0266. Results of monitoring phytoplankton populations the past 25 years was presented with emphasis placed on bloom producing species in Virginia tidal tributaries. Many of these blooms have been associated with reduced oxygen levels in these waters and fish kill events. Potentially harmful taxa, including known toxin producers, of major concern in these waters include *Cochlodinium polykridoides, Alexandrium monilatum, Karlodinium veneficum, Microcystis aeruginosa, Chattonella subsalsa,* and *Prorocentrum minimum*. *C. polykrikoides* and *K. veneficum* blooms were becoming more common, with *A. monilatum* and *C. subsalsa* blooms of more recent development regarding their regional impact. *P. minimum* has shown a significant long-term trend of increased abundance over the last 2 decades within the lower Chesapeake Bay. Algal blooms by a variety of other taxa also occurred seasonally. A survey of 19 Virginia lakes in 2010 also indicated presence of several potential toxin and bloom producing species at 8 of these lakes. These were *Anabaena spiroides, Aphanizomenon flos-aquae, Cylindrospermopsis raciborskii, Limnothrix redekei, Microcystis aeruginosa*, and *M. wesenbergii*. In summary, algal blooms are common in Virginia waters and Chesapeake Bay. They are produced by a diverse group of algae, some of which are toxin producers. There is evidence that several of these algae have expanded their range and duration of bloom formation; including the presence of bloom producing invasive species entering Virginia waters and the Chesapeake Bay. Funding support for this study came from VDEQ and VDH.

COMMUNITY-MEDIATED CONSERVATION IN THE SOUTH PACIFIC: HOW HUMAN INFLUENCE OVER THE PAST MILLENNIA HAS SAVED A RARE TREE SPECIES FROM POSSIBLE EXTINCTION. Helen K. McKinney[1], Ryan D. Huish[1] & Joseya Mateboto[2], [1]Department of Biology, Hollins University, Roanoke, Va, [2]Fiji Forestry Department, Kadavu Island, Fiji. Community-mediated

management strategies for indigenous resources, employed by various communities, have shown success on local levels despite overall trends of resource decline. While the history of sandalwood trade in the South Pacific is rife with over exploitation, ancient cultural practices and modern management techniques for native *Santalum yasi* by Fijian and Tongan communities may have actually enabled *S. yasi*'s survival despite the continuing threat of over harvesting and habitat destruction. Remaining wild *S. yasi* stands lack genetic insularity typical of island populations, suggesting significant migratory events, such as the pre-historic movement of seeds and seedlings across and between Tonga and Fiji via trade, and marriage practices as documented by early explorers to these regions. Furthermore, current strategies employed by a Fijian village in the management of *S. yasi* reveal foundational principles that can guide the development of effective management of other endangered economic resources and curtail common problems of implementation. The inclusion of all community members, in the benefits and responsibilities of resource tenure and stewardship, enables better prevention of poaching, and fiscal community interests. Further research and application of these, and similar practices in other areas, may help resolve current management challenges to the preservation of culturally and economically valuable species around the world.

ANTIMICROBIAL PROPERTIES OF THE TONGAN MEDICINAL PLANT *SYZYGIUMCORYNOCARPUM*: BIOASSAYS IN SUPPORT OF ETHNOBOTANICALLY-GUIDED RESEARCH. Erika Schooley & R. D. Huish, Dept of Biology, HU, Much of the traditional medicine of Tonga specifically treats infections. In a previous study, *Syzygium corynocarpum* not only showed significant inhibition rates of *Staphylococcus aureus* in laboratory bioassays, but was also the plant most frequently referenced by Tongan healers for use in treating infections. This correlation alludes to the benefits of ethnobotanically-guided drug research. Furthermore, in medicinal preparations, Tongan healers specifically use the young leaves of *S. corynocarpum*, which are a characteristic red-purple color changing to dark green at maturity. Extracts of mature leaves and bark, as well as the young leaves, are being tested for inhibition rates of *S. aureus* to compare efficacy and strengthen the case for ethnobotanically-guided research in the search for novel drugs.

CURRENT POPULATION DYNAMICS OF A RARE SANDALWOOD TREE (*SANTALUM YASI*) IN FIJI AND TONGA. Ryan D. Huish[1], L. Thomson[2], T. Faka'osi[3], H. Likiafu[3], M. Tuiwawa[4], J. Mateboto[5], & D. Little[6], [1]HU, [2]Secretariat of the Pacific Community, [3]Tongan Ministry of Forests, [4]USP, [5]Fiji Dept. of Forestry, [6]NYBG. Valued internationally for the aromatic oil found within its heartwood, Sandalwood (*Santalum*, Santalaceae) is one of the most heavily exploited groups of plants across its range—Oceania, Southeast Asia, and India. One of the most valued sandalwood species is *Santalum yasi,* harvested extensively in Fiji and Tonga. To help aid in conservation efforts for this now rare tree, population dynamics, current species distribution, and ecological threats were investigated. It was concluded that the few remaining wild stands display discontinuous size class structures, are under regenerative stress, and that the natural distribution has diminished significantly, even to local extinction in some areas. Several threats appear to be affecting the

population dynamics of *S. yasi*, including destructive harvesting and invasive species. It is suggested that Forestry and governmental efforts focus on the promotion of local involvement in assisted natural regeneration of wild stands through community-mediated conservation.

A METHOD FOR LONGLEAF PINE TIMBER IDENTIFICATION AND ITS APPLICATION TO RELICTS IN SOUTHEASTERN VIRGINIA. Thomas Eberhardt[1], Philip Sheridan[2], Arvind Bhuta[3], [1]USDA Forest Service, Pineville, LA, [2]Meadowview Biological Research Station, Woodford, VA, [3]College of Natural Resources & Environment, Virginia Tech. Longleaf pine (*Pinus palustris* P. Mill.) cannot be distinguished from the other southern pines based on wood anatomy alone. A method involving measurements of pith and second annual ring diameters, reported by Arthur Koehler in 1932, was revisited as an option for identifying longleaf pine timbers and stumps. Cross section disks of longleaf, loblolly (*P. taeda* L.), and shortleaf (*P. echinata* P. Mill.) pines were measured and the diameters of their piths and second annual rings plotted against each other. Longleaf pine could be differentiated from the other two pine species demonstrating that a method established with trees harvested more than 70 years ago is still applicable to standing timber today. No evidence was found to suggest that growth rate differences impact method applicability. In those situations where the second annual ring is intact, but not the pith, very large second annual ring diameters (> 40 mm) may provide an adaptation of the method to identify timbers with a lower probability of being longleaf pine. In addition to the identification of very old lightwood stumps as part of a longleaf pine restoration effort, both methods may be applied to timber identification in historic structures and the niche forest products industry involving the recovery and processing of highly prized longleaf pine logs from river bottoms. Measurements from relicts sampled in this study yielded results consistent with the purported range for longleaf pine in Virginia.

A CENSUS OF PURPLE PITCHER PLANT, *SARRACENIA PURPUREA* L., IN MARYLAND AND VIRGINIA. Philip M. Sheridan, Meadowview Biological Research Station, Woodford, VA. *Sarracenia purpurea* L. is a rare wetland plant in Virginia and a threatened species in Maryland, with two potential subspecies in the region. A census was performed of existing populations, all known historical data on the species compiled, reasons for the species demise investigated and dates of extinction predicted. Bloom phenology was examined to see if climate change may have influenced bloom period. Only 31% of purple pitcher plant (4 of 13) sites are extant on the western shore of Maryland and District of Columbia while 33% (14 of 42) remain in Virginia, with respective total populations of 46 and 513 clumps. Causes of regional extirpation include beaver flooding, succession, and development. Predicted pitcher plant population extinction dates, based on trend line from130 years of data, are 2015 (Maryland) and 2055 (Virginia). Disturbance, especially natural fire, played an essential role in maintaining purple pitcher plant historically in Maryland and Virginia. *Sarracenia purpurea* blooms May 8 – June 12 in Maryland and Virginia with a peak May 18-20. Peak bloom period of *S. purpurea* may have shifted as much as a week from historical dates, perhaps due to climate change.

STUDIES OF THE HEPATICAE AND ANTHOCEROTAE ALONG HAZEL RUN IN ALUM SPRING PARK, FREDERICKSBURG, VA – IMPLICATIONS OF CLIMATE CHANGE. Stephen W. Fuller, Biology Department, University of Mary Washington, Fredericksburg, VA 22401. Climate plays a large role in determining the distribution of species, especially through physiological thresholds of tolerance to temperature and precipitation. With general warming trends, the 'tolerance envelopes' are expected to migrate pole-ward, and upward in elevation. Studies of the biological impact of climate change have focused on the abundance and distribution of species; changes implying impact of these abiotic factors. More reliable geographical shift information can be ascertained by studying more sedentary species, considering local extinctions and new records. Fredericksburg experienced a prolonged period with little rainfall during the last half of August and September 2010. The drying effects of this period were compounded by relatively warmer temperatures. During the fall of 2008 and 2010 exhaustive sampling was used, from the top of the stream bank to the center of the stream, within which all plant materials were surveyed for the presence of liverworts and hornworts. Despite the paucity of rain during some of the warmest months of the growing season (warmer than during the previous study in 2008), the liverworts did not seem to have suffered. There was a single place where *Conocephalum conicum* plants had dried to the point of having dead edges along the thallus. Evidently the higher temperatures and paucity of precipitation were not inhibitory to these species' continued presence and success in this habitat.

EXAMINING POLAR AUXIN TRANSPORT EVOLUTION IN BRYOPHYTE GAMETOPHYTES**.** B.T. Piatkowski, G.A. Bader & D.B. Poli. Department of Biology, Roanoke College, Salem, VA 24153. Specialized cells in vascular and non-vascular plants can move auxin unidirectionally in a process termed polar auxin transport. Data collected from the liverwort, *Riccia fluitans*, suggests that simple diffusion is utilized for the transport of auxin into the cell. The hornworts, *Phaeoceros laevis* and *Anthoceros agrestis*, and the moss, *Rhizomnium sp.*, displayed facilitated diffusion influx. All four species displayed facilitated diffusion as the method of auxin efflux. *Rhizomnium* showed sensitivity to the influx inhibitor 1-naphthoxyacetic acid and the efflux inhibitor 1-N-naphthylphthalamic acid suggesting that bryophyte gametophytes contain protein carriers similar to those used in PAT in vascular plants but that the process may not be unidirectional and specialized yet.

EXAMINING POLAR AUXIN TRANSPORT IN THE MOSS GAMETOPHYTE OF *DICRANIUM SCOPARIUM*. Jessica N. Branning & DorothyBelle Poli. Dept. of Biol., Roanoke College, Salem VA 24153. Polar auxin transport is a process understood most in higher plants. Understanding where a physiological mechanism evolved requires examining the same process across the entire plant kingdom. Poli et al. (2003) examined polar auxin transport across the bryophyte sporophytes and learned that hornworts exhibit simple diffusion, liverworts exhibit facilitated diffusion, and mosses show active transport. However, examining polar auxin transport using traditional agar block methods has been limited in gametophytes. This

study examines the moss *Dicranium scoparium*. From Bader et al. (unpublished) it is expected that this terrestrial moss gametophyte should show facilitated diffusion. (Supported by: Jeffress Memorial Grant).

## Chemistry

DOES $CO_2$ WARM THE ENVIRONMENT? T.C. DeVore & D. Havey, Deptartment of Chemisdtry and Biochemistry, MSC 4501, James Madison University, Harrisonburg VA 22807. A series of laboratory exercises have been developed that let students investigate three postulates related to global warming: 1. burning fossil fuels creates $CO_2$, 2. $CO_2$ absorbs IR radiation, and 3. increasing the amount of $CO_2$ in the atmosphere increases the temperature of the environment. To test the first postulate, students use GC-MS and FTIR to compare the amount of $CO_2$ in a sample of automobile exhaust to the amount of $CO_2$ in ambient air. A vibrational and a rotational analysis of the spectrum for $CO_2$ and preparing a Beer's Law plot for $CO_2$ are used to test postulate 2. The Boltzmann distribution to determine the rotational temperature of the $CO_2$ in the cell is used to test postulate 3. By measuring the temperature of several different concentrations of $CO_2$, the effect of the concentration of $CO_2$ on the temperature inside the cell is established. If all parts of this project were done, students would learn about the combustion of hydrocarbons, the IR spectra and rotational analysis of linear tri-atomic molecules, Beer's Law, the measurement of rotational temperatures based on the Boltzmann distribution and the Greenhouse Effect.

DESIGN, SYNTHESIS AND INTERACTION STUDIES OF SULFATED ALLOSTERIC MODULATORS OF THROMBIN. Preetpal Singh Sidhu, Aiye Liang, Akul Y. Mehta, May Abdel Aziz, Qibing Zhou, & Umesh R. Desai, Dept. of Medicinal Chemistry, Virginia Commonwealth University, Richmond, VA-23219. We have synthesized a library of potent, small, aromatic allosteric inhibitors of thrombin. The sulfated benzofuran scaffold was designed from the structure of sulfated lignin and contained charged, polar and hydrophobic substitutions at the 2,3,5,6 positions, which provide diversity to the library of 15 sulfated monomers and 13 sulfated dimers. Due to presence of negatively charged sulfate and carboxylate groups, these molecules are completely water soluble. Synthesis of the library of benzofurans derivatives was achieved through a multiple step, highly branched strategy, which culminated with the introduction of sulfate group(s) using microwave-assisted chemical sulfation reaction. From the library of 28 potential inhibitors, 11 inhibited thrombin with reasonable potency. Structure activity relationship studies showed sulfation at the 5-position of the benzofuran scaffold was essential for targeting thrombin. The *t*-butyl derivative was found to be the most potent with an $IC_{50}$ of 7.3 μM under physiologically relevant conditions. Michaelis-Menten kinetic studies showed that these inhibitors do not affect the affinity of chromogenic substrate for thrombin ($_{Km}$) but greatly reduce the maximal velocity ($V_{max}$) of reaction, indicating the allosteric mechanism of inhibition. The results of plasma clotting assays suggest that these inhibitors prolong both the