

VERBAL PRESENTATION ABSTRACTS: Atlantic White-cedar Symposium 2006
TUESDAY JUNE 6th 2006

8:50-9:10AM

Pehr (Peter) Kalm and Environmental Change: Deforestation and Atlantic White Cedar in the Mid-Eighteenth Century

Timothy E. Morgan, Christopher Newport University, Ret.

Pehr(Peter) Kalm, a Swedish theologian and botanist trained under Linne, came to Philadelphia in 1748 to conduct for Linne and the Swedish Royal Society research on North American plants adaptable to Sweden's environment, especially trees. Kalm commented extensively in his published report, called *Travels*, on Europeans' impact in the Delaware Valley during the century and one-half before he arrived. He was especially taken with what had happened to Atlantic White Cedar. He made numerous comments on the exploitation of the tree and its near-disappearance by the time of his arrival.

He spent two years in North America, compiling an extensive body of observations on his travels. The paper I propose to deliver will report and analyze his observations about the effects of deforestation in the valley, with special reference to AWC. The presentation will include PowerPoint views of Kalm, period maps, and views of some of his important finds.

9:10-9:30AM

Developing Management and Restoration Strategies for Atlantic White-cedar Based on Regional Patterns of Genetic Variation

Kristin A. Mylecraine¹, George L. Zimmermann², John E. Kuser³, Lena Struwe³, & Peter E. Smouse³,
Ohio State University¹, Richard Stockton College of New Jersey², Rutgers, the State University of New
Jersey³

Atlantic white-cedar, *Chamaecyparis thyoides*, is an important wetland tree species occurring along the Atlantic and Gulf of Mexico coasts. The economic and ecological importance of white-cedar, coupled with significant population decline, has led to increasing interest in its management and restoration. The geographic distribution of genetic variation is an important consideration for developing management and restoration strategies. We present an overview of rangewide genetic variation within white-cedar and combine this information with ecological and geographic data to identify management regions within the species. Among tree species, different sets of genetic markers and traits often exhibit different geographic patterns of variation, and this is also the case for white-cedar. Allozymes suggest significant regional structure, with three main regions and two additional subregions identified. Morphological variation and the distribution of cpDNA haplotypes correspond with previously published intraspecific varieties, and separate *C. t. henryae* in the western Florida panhandle and Alabama from the remaining *C. t. thyoides* populations. Provenance testing in New Jersey and North Carolina common gardens indicates significant latitudinal patterns in survival and growth traits, suggesting that populations are adapted to the climatic conditions at their latitude of origin. From these combined results, we identified three major geographic regions: (1) Atlantic coast, (2) Gulf of Mexico coast, and (3) Florida peninsula, with further division of Regions 1 and 2 each into three subregions. This pattern of variation should be taken into account when identifying populations for conservation, developing management and restoration plans, and selecting propagules for regeneration and restoration purposes.

9:30-10:30AM

Atlantic White-cedar Ecosystems: 'State-of-the-Resource'

Northeast region: Aimlee Laderman, Marine Biological Laboratory, Woods Hole

Mid-Atlantic region: Robert Williams, LandDimensions Engineering

South Atlantic region: Robert B. Atkinson, Christopher Newport University

Florida & Gulf Coast region: John W. McCoy, USGS, National Wetlands Research Center

Invited talk

This is an invited talk in which experts from different regions of AWC's range (defined using a more limited subset from Mylecraine's genetics work) will try to update the audience on the present state of cedar. Questions, answered by region, such as current estimates (or lack thereof) for cedar, potential acreage for cedar, how many acres have been restored, propagule sources, problems specific to the region, organizations who are working on cedar in a significant way, etc. will be addressed by the panel.

10:50-11:10AM

Growing Atlantic White Cedar Seedlings: Effect of Container Volume, Substrate, Fertilizer, and Irrigation Frequency

Scott Derby & Eric Hinesley, North Carolina State University

Efforts to restore Atlantic white cedar (AWC) to former sites in North Carolina in the last 20 years have had limited success owing, in part, to a lack of quality planting stock. Production of bare root seedlings in outdoor nursery beds has been inconsistent, and vegetative propagation is costly and has considerable risk. Our objective was to develop a protocol for producing containerized seedlings. Newly germinated seedlings were [*Chamaecyparis thyoides* (L.) B.S.P.] grown in factorial combinations of four container volumes (98 cm³ to 530 cm³), two substrates [N.C. Forest Service (NCFS) container mix (3 peat: 2 vermiculite: 1.5 perlite, by volume) and 3 pine bark: 1 peat], two controlled-release fertilizers (Osmocote 15N-9P2O5-12K2O, 12-14 month southern formulation, with micros; and Polyon 18N-6P2O5-12K2O with micros, 9-month formulation), and three irrigation frequencies (2, 3, or 4 times daily). Growth increased with container volume up to 530 cm³ (32 cubic inches), but the optimum was 164 to 262 cm³ (10 to 16 cubic inches). The NCFS substrate was best, probably owing to higher peat content and water holding capacity. Osmocote yielded larger and heavier plants than Polyon, apparently owing to more available phosphorus. Irrigation frequency was flexible, but the optimum was 3X daily, especially later in the season when plants were large in relation to container volume. Manipulation of container volume, substrate, fertilizer, and irrigation should yield high quality containerized Atlantic white cedar seedlings.

11:10-11:30AM

Fertilizing Containerized Atlantic White Cedar and Baldcypress

Eric Hinesley & Scott Derby, North Carolina State University

During the last 20 years, a shortage of Atlantic white cedar (AWC) [*Chamaecyparis thyoides* (L.) B.S.P.] planting stock has often hindered regeneration and restoration efforts. Seedlings of baldcypress [*Taxodium distichum* (L.) Rich.], another historically important tree species in southern swamps, have been more readily available, but information is needed for production of containerized plants. AWC seedlings were grown in 3:1 composted pine bark and peat (v/v), and fertilized with five rates (0.0, 2.4, 4.8, 7.2, and 9.6 kg/m³) of controlled-release fertilizers (CRF) [Osmocote 15N-9P2O5-12K2O, 12-14 month southern formulation, with micros; and Polyon 18N-6P2O5-12K2O, 9-month formulation, with micros]. In general, the response to increasing fertilization was quadratic, and Osmocote yielded larger plants than Polyon, probably owing to its higher P content. Osmocote (4.8 to 7.2 kg/m³) or Polyon (7.2 kg/m³) is suggested for container-grown seedlings the first year. With a substrate of composted pine bark, incorporated CRF (Osmocote 19N-6P2O5-10K2O; 8- to 9-month release) yielded better growth than weekly applications of soluble fertilizer (N = 0.5g/liter). Most of the potential height growth and plant dry weight were realized with 2.4 kg/m³ and 4.8 kg/m³, respectively, of CRF incorporated in the substrate.

11:30-11:50 PM

Pilot Atlantic White Cedar Restoration Project On A Reclaimed Cranberry Bog In The NJ Pine Barrens Emile D. DeVito & Louis J. Cantafio, New Jersey Conservation Foundation

The New Jersey Conservation Foundation (NJCF) in 2005 planted 2.5 acres of cranberry bog surface with 3777 seedlings of locally-collected Atlantic White Cedar (AWC), as a pilot to determine feasibility for 150 acres of future AWC restoration on agricultural bogs. Before planting, the highly compacted sand of the modern, level, cranberry bog surface had been reconstituted to resemble native soil by replacing original, stockpiled, hydric soil in 25 square foot mounds of 2 foot max height in a random fashion, covering about 40% of the site. This “bumpy” bog surface of 60% inorganic sand and 40% intervening organic, hydric soil mounds was then uncompacted, by loosening to 15” depth using a disk harrow. This allowed for water to move freely within the soil column. As a result, microsites in this bare, sandy, early successional environment varied greatly with respect to organic content, hydrology, and exposure, and by mid-summer there was also large variation in the height and density of grasses and sedges colonizing from the seed bank. 1 and 2 year AWC seedlings were planted randomly across the site in early June, and depending on seedling location, subjected to these variations in soil, moisture, exposure, and density and height of surrounding grass-like vegetation. Patterns of over-winter survivorship of AWC seedlings with respect to seedling size (age) versus soil type, exposure, hydrology, and protective cover will be presented, as well as insights gained toward maximizing both cost-effectiveness and first year survivorship in larger AWC restoration projects on restored cranberry bog surfaces.

11:50-12:10PM

Organochlorine Pesticide Residues And Restoration Considerations For Inactive Cranberry Bogs Of The Edwin B. Forsythe National Wildlife Refuge Clay Stern & Timothy J. Kubiak, U.S. Fish & Wildlife Service

A 1996 Baseline Contaminants Investigation of the U.S. Fish & Wildlife Service’s (Service) Edwin B. Forsythe National Wildlife Refuge revealed elevated sediment organochlorine pesticide residues down-gradient of abandoned cranberry bogs on Four-mile Branch and Ballinger Creek, Ocean County, New Jersey. Subsequently, an investigation was conducted to determine if abandoned bogs under Service ownership are a potential source of pesticide residues. Sediment samples for organochlorine analysis were collected from two bogs on the Service's Oxycocus Property in Stafford Township, Ocean County, New Jersey. The results of that analysis indicate that the abandoned cranberry bogs sediments contain elevated levels of organochlorine pesticide residues, especially DDT and its breakdown analogs, DDD and DDE. The organochlorine pesticide concentrations frequently exceed levels correlated with severe adverse impacts to benthic macroinvertebrates. In response to sediment results from the bog investigation the Service initiated a Cleanup Project in 2003 to further delineate sediments up- and down-gradient of the Oxycocus bogs and to evaluate another nearby bog on Cedar Run. As part of the Cleanup Project a hydrodynamic model of bog effluent flow was developed to evaluate the potential for sediment transport during high flow events. Further work under the Cleanup Project is being undertaken to evaluate fish contamination from organochlorine pesticides associated with the Oxycocus Property bogs to address potential ecological and human health risks in downstream Manahawkin Lake. The delineation of bog-sediment contamination relative to management decisions regarding remedial alternatives, habitat restoration alternatives, and the ramifications of future habitat management activities will be discussed.

1:40-2:00PM

The Atlantic White Cedar Peatlands Of Anne Arundel County, Maryland

Judy Broersma-Cole, MDE Wetlands and Waterways

A few populations of Atlantic White Cedar, *Chamaecyparis thyoides*, (AWC) are found in peatlands on the western shore of the Chesapeake Bay only in Anne Arundel County, Maryland. This study examines the vegetational communities in these rare peatlands and their landscape position on the Coastal Plain of Maryland. Rare communities often require specialized management practices to maintain their species composition and function. These peatlands are located within the Magothy geological formation, an outcropping of acidic sands that extends in a wide belt from Odenton eastward through Lake Shore in the northern part of the County. Since 1999, the Maryland Department of the Environment and other government agencies have been identifying, describing, delineating, and cataloging the vegetation of these peatlands. The interagency team has completed the delineations for each of the known peatlands and their contributory wetlands and streams. They are continuing their work on the identification of new peatlands, detailed descriptions of vegetation, soils, and hydrology. As of June 2005, the interagency team has identified 16 known peatlands including some having small populations of Atlantic White Cedar. Results indicate that although the appearance of each of these peatlands is very different, the suite of acidophilic plants growing within them is generally consistent. Additional research is needed on soil investigations of the different substrates to determine appropriate management techniques for the different peatlands. This information will be used in future restoration and preservation activities.

2:00-2:20PM

Observations on Atlantic White Cedar Ecosystem Reestablishment and Stream Restoration in the Coastal Plain

Kevin Smith, Maryland DNR

Stream restoration is firmly established as an important component of watershed restoration and is often required as mitigation for unavoidable impacts to aquatic resources. While the science of fluvial morphology has been studied by many researchers in many different geographic areas, the practical application of the science in the practice of stream restoration has been almost single-handedly launched into the nation's consciousness by a single man with a career focused in the mountain west. As a result, many stream restoration projects implemented throughout the country focus on the morphological characteristics necessary for safe conveyance of water in an open channel, and do not incorporate important ecological conditions, including re-establishment of important aquatic habitat. Until recently, many stream restoration projects in Maryland's Coastal Plain physiographic province were virtually identical to those constructed in the Piedmont physiographic province. Channels were sized to safely convey the bankfull storm, and though natural materials like boulders were used, the materials were not native to the coastal plain. However, with the restoration of Atlantic white cedar (AWC) ecosystems in Maryland's Anne Arundel County, a new paradigm for coastal plain stream restoration has been established. The restored streams associated with the reestablished AWC ecosystem has a channel designed to convey baseflow, with larger discharges exiting the channel and safely flowing through the floodplain. At baseflow, the channel is a series of large shallow vegetated pools linked by sections of vegetated riffles. This results in a wetland floodplain with high groundwater, numerous vernal pools, and diverse micro-topographical features which support multiple flow paths at different discharges. This approach to stream restoration 'fits' in the coastal plain, results in greater water resource benefits, and restores a type of wetland community estimated to currently occupy only 1 or 2 percent of its historic distribution.

2:20-2:40PM

Cypress Creek Savanna: A History Of Vegetative Changes

David E. Walbeck¹, Keith R. Underwood², Dennis F. Whigham³, & Karl D. Benedict² Maryland Dept. of the Environment¹, Underwood & Assoc.², Smithsonian Environmental Research Center³

Cypress Creek Savanna is located on a headwater tributary of the tidal Magothy River in Severna Park, MD. Nearly one hundred years of historical accounts of the site report an Atlantic white cedar (*Chamaecyparis thyoides* (L.) BSP) population and associated peatland species. Historical records of site vegetation indicate a significant loss of rare plant species that are being displaced by common invasive species. A dramatic reduction in the Atlantic white cedar population was recorded in 1988 and counts were conducted in 1997, 2003 and 2006 to document the status of the population. We calculated the rate of decline of the Atlantic white cedar population and analyzed potential reasons for the decline.

3:00-3:20PM

Constructed Seepage Wetlands - a New Opportunity for Imperiled Ecosystems

Keith R. Underwood, Underwood & Associates

Atlantic white cedar [*Chamaecyparis thyoides*] (AWC) exists only under a very narrow set of environmental conditions which are easily altered by common human activities. As a result natural populations of all rare plants associated with AWC in Maryland have declined over the past 200 years and the current rate of loss will lead to extirpation of most of these species, on extant sites on the western shore of the Chesapeake Bay this century.

Investigations of extant AWC ecosystems revealed that exfiltrating groundwater through sandy soils is, closely associated with these ecosystems. Efforts to restore populations of AWC on the Western Coastal Plain of Maryland in Anne Arundel County led to the development of a system of techniques and construction methods designed to re-create appropriate habitat for this rare biotic community. A designed system of created aquaculdes, seepage reservoirs, sand berms and shallow pools was developed to replicate these conditions within appropriate landscapes. This Seepage Wetland Ecosystem Restoration design approach has been adopted to address a diverse suite of problems and some notable partners and projects. The system has been used to address in part the infrastructure, stormwater management, nutrient reduction, educational, mine reclamation, stream restoration, reforestation, fish passage, wetland and forest mitigation, recreational, shoreline stabilization recreational and aesthetic needs in Anne Arundel County, Maryland. These methods, techniques and partnerships should be easily adaptable to other geomorphic settings and physiogeographic provenances where, they could enhance the chances of survival of AWC and other equally valuable ecosystems. We will discuss design details, methods, and specifications and discuss aspects of 10 projects that attempt to establish AWC in these created wetlands.

3:20 to 3:50PM

Water Quality Benefits Associated with Restoration of Atlantic White Cedar Seepage Wetland Creation

Joe A. Berg, Biohabitats

The creation of Atlantic white cedar (AWC) wetlands using a combination of pools, sand berms and cobble weirs results in a system of physical features, chemical processes, and biological mechanisms that can have dramatic effects on the hydrology of the project site, including water quality benefits. The physical modifications necessary to establish the sand seepage hydrology most suitable for the establishment of the AWC wetlands result in the creation of a series of well vegetated stilling pools, sand seepage beds replete with above and below-ground biomass, and associated flow paths through low areas dominated by peat forming Sphagnum. The physical effect of the pools and their many plant stems is to reduce water velocity and facilitate removal of suspended particles and their associated nutrients and/or contaminants. Uptake of dissolved nutrients and adsorption of oils and greases by the many plant stems present in the pools yields additional benefits. The cobble weirs set the surface water elevations and establish the head necessary to drive the sand seepage dynamic that supports so many bog species, including the AWC. In addition, the sand seepage bed supports microbial populations and processes which remove nutrients and contaminants which pass through the sand bed. Furthermore, the many roots present in the sand take up nutrients and provide sites for microbial attachment, contaminant adsorption, and long-term sequestration in the peat forming layer resulting from AWC annual root formation. Similarly, water flowing through the lower areas dominated by peat forming Sphagnum are subject to many of the same physical and chemical processes. Field data on sand seepage wetlands combined with literature reports on water quality treatment practices will be used to document the value of AWC sand seepage wetlands for watershed restoration.

3:50-4:10PM

Restoration of Atlantic White Cedars, Anne Arundel County Maryland

Ronald Bowen¹ & Stephen Barry². Director, Anne Arundel County Department of Public Works¹,
Coordinator of Environmental/Outdoor Education, Anne Arundel County Public Schools²

The preservation and restoration of the historical population of Atlantic White Cedar (*Chamaecyparis thyoides* (L.) BSP) and its habitat within Anne Arundel County has become a priority in conjunction with the County's Waterway Improvement Program. Storm water runoff and the resultant erosion of streams within the coastal plain from urbanization have degraded much of the Atlantic White Cedar ecosystem habitat.

Degradation of stream habitat and increased pollutant loads from non-point sources collectively contributed to the exceedence of water quality standards and the promulgation of total maximum daily loads (TMDL's) for County waterways. Restoration of degraded streams and non-point source pollutant load reduction within highly urbanized watersheds present significant challenge. Conventional stream restoration does not provide a sufficient management of storm water quality or quantity control. Utilizing the highly innovative Keith Underwood method of creating seepage wetlands to raise groundwater elevations and restore ecosystem habitat has provided Anne Arundel County the opportunity to restore thousands of Atlantic White Cedars and significantly reduce nutrient concentrations in storm water runoff.

Underwood's method draws on a sound foundation of engineering techniques combined with application of ecological principles. Another innovative aspect of this effort has been the unique partnership of county government and our county school system. Restoration of this important natural resource has also provided opportunity to educate thousands of elementary, middle school and high school students, along with their teachers, parents, family and neighbors. They have learned the value of Atlantic White Cedars, their role within our environment and the stewardship of moving to action in partnership with citizens, business and government to restore our watersheds. Students propagate Atlantic White Cedars and other rare and endangered species, raise them to appropriate size, participate in planting the created wetlands and initiate the evolution of healthy ecosystems which provide the full range of bio-diversity necessary to clean urban runoff and our waterways. Creation of seepage wetlands augmented with the restoration of Atlantic White Cedars maximizes environmental benefit to a cost ratio that exceeds that of traditional wetland and stream restoration.

VERBAL PRESENTATION ABSTRACTS
WEDNESDAY JUNE 7th 2006

8:10-8:30AM

Effects Of Hurricane Isabel On Atlantic White Cedar In The Great Dismal Swamp And Review Of Salvage Efforts

Robert T. Belcher¹ & Bryan Poovey², Malcolm Pirnie, Inc.¹, USFWS Great Dismal Swamp National Wildlife Refuge²

The Great Dismal Swamp National Wildlife Refuge (GDSNWR) has begun salvage logging of mature Atlantic white cedar (AWC) stands, which were severely impacted during Hurricane Isabel. High AWC seedling mortality has been reported in naturally-regenerating sites and optimum conditions and stocking density necessary for successful cedar restoration are poorly understood. Consequently, quantified structural parameters are needed to set goals and monitoring criteria for cedar regeneration. The purpose of this study was to compare AWC regeneration to pre-Isabel stocking levels. In 2006, permanent plots were reestablished on a 28-ha site within the GDSNWR, which was previously studied during a multiyear project funded by the USEPA. AWC seedlings were counted and measured within 25-m² (5m x 5m) plots in three discrete treatments (logged areas, skidder trails and control). Seedling height ranged from 5 to 75 cm, however 69 percent of all seedlings surveyed were less than 10 cm tall. The number of seedlings within each plot varied greatly from 0 to 77. Mean seedling density in the logged areas, skidder trails and control plots were 14,533; 4,400; and 0 stems/ha respectively; compared to 1,006 stems/ha in the pre-Isabel mature forest. The stem densities reported in this study were considerably less than what has been reported for similar-aged stands. However, densities would be similar to pre-Isabel AWC density provided that a minimum of 6.9 and 22.8% survivability in the logged areas and skidder trails, respectively, were maintained through active management.

8:30-8:50AM

Managing Atlantic White Cedar at Dare County Bombing Range History, Hopes and Aspirations

Scott B. Smith, U.S. Air Force, Dare County Bombing Range

The North Carolina Chapter of The Nature Conservancy, the North Carolina Natural Heritage Program and other stakeholders have a strong interest in protecting and conserving Atlantic white cedar (AWC) forests present on Dare County Bombing Range (DCBR). In 1984, a cooperative agreement was signed between the 4th Fighter Wing Commander (Seymour Johnson AFB) and the NC Natural Heritage Program. This agreement specified that there would be no change in title or loss of ownership rights by the Air Force; however, the Air Force agreed to limit any activities that would negatively impact areas designated as "significant natural areas" by the agreement. At the time this agreement was executed there was no forest management program in place at DCBR. Communication between DCBR natural resources managers and the stakeholders has been sporadic over the years. Correspondence from the stakeholders occurred as draft forest management plans were distributed for public comment. Some of the stakeholders objected to the proposed harvesting of old growth AWC and construction of new roads and ditches in the designated natural areas. There was also disagreement over what constituted stand and tree maturity on the DCBR. During September 2003, Hurricane Isabel wreaked havoc on DCBR destroying nearly 7,000 acres of forested ecosystems including 100 acres of a 630-acre AWC stand. The Air Force sponsored a stakeholders meeting in September 2005 to address the hurricane damage, review the draft DCBR Forest Management Plan and renew communication between the DCBR natural resources staff and the stakeholders. A series of meetings are planned to work toward consensus with the stakeholders on restoring the damaged AWC and future management goals of the AWC present on DCBR.

8:50-9:10AM

Response Of Atlantic White Cedar To Salvage Logging In The Great Dismal Swamp National Wildlife Refuge Following Hurricane Isabel: Preliminary Results

Robert T. Belcher¹, Robert B. Atkinson², Travis R. Comer¹, & E. Ben Salter¹ Malcolm Pirnie, Inc. ¹,
Christopher Newport University²

The Great Dismal Swamp National Wildlife Refuge (GDSNWR) has begun salvage logging of mature Atlantic white cedar (AWC) stands, which were severely impacted during Hurricane Isabel. High AWC seedling mortality has been reported in naturally-regenerating sites and optimum conditions and stocking density necessary for successful cedar restoration are poorly understood. Consequently, quantified structural parameters are needed to set goals and monitoring criteria for cedar regeneration. The purpose of this study was to compare AWC regeneration to pre-Isabel stocking levels. In 2006, permanent plots were reestablished on a 28-ha site within the GDSNWR, which was previously studied during a multiyear project funded by the USEPA. AWC seedlings were counted and measured within 25-m² (5m x 5m) plots in three discrete treatments (logged areas, skidder trails and control). Seedling height ranged from 5 to 75 cm, however 69 percent of all seedlings surveyed were less than 10 cm tall. The number of seedlings within each plot varied greatly from 0 to 77. Mean seedling density in the logged areas, skidder trails and control plots were 14,533; 4,400; and 0 stems/ha respectively; compared to 1,006 stems/ha in the pre-Isabel mature forest. The stem densities reported in this study were considerably less than what has been reported for similar-aged stands. However, densities would be similar to pre-Isabel AWC density provided that a minimum of 6.9 and 22.8% survivability in the logged areas and skidder trails, respectively, were maintained through active management.

9:10-9:30AM

Regeneration of Atlantic White Cedar (*Chamaecyparis thyoides* L.) Stands Following Harvesting in North Carolina Coastal Plain Forests

Robert A. Mickler & Andrew D. Bailey, Alion Science and Technology, Inc.

The historical regeneration of Atlantic white cedar in eastern U.S. coastal plain forests is thought to have been limited to geographic areas having catastrophic fire return intervals ranging from about 25 to 250 years. Successful regeneration has been observed following wildfire events when the water table was near the soil surface to prevent fire consumption of the organic soil horizons, a seed source was present from adjacent stands or stored in the upper few inches of soil, and fire created soil moisture conditions favorable for seedling establishment and subsequent hardwood competition. In the absence of natural wildfire regimes, catastrophic stand replacement of Atlantic white cedar occurs following commercial logging operations. This study describes regeneration success of Atlantic white cedar following the applications of Arsenal™ beginning in 1995 to mimic hardwood mortality following wildfire. Stand characteristics are described for adjacent treated and control plots on the Air Force Dare County Bombing Range and the US Fish and Wildlife Service Alligator River National Wildlife Refuge.

9:30-9:50AM

Atlantic White-cedar Ecosystems: 'Rare & Endangered Flora'

Gerry Moore, Director of Science, Brooklyn Botanic Garden

Invited talk.

Atlantic white cedar, *Chamaecyparis thyoides* (L.) Britton et al. (= *C. henryae* H.L.Li), occurs chiefly on the coastal plain from Maine and New Hampshire to Florida and Mississippi. Throughout this range Atlantic white cedar habitats support a significant number of globally rare and locally rare plant species. Also, of the seventeen states where *C. thyoides* occurs, 7 states (GA, MD, ME, MS, NY, PA, VA) track *C. thyoides* itself as a rare species. An overview is provided on the different Atlantic white cedar habitats and the rare plant species that are associated with these habitats. Comments are also provided on potential issues relating to the management of Atlantic white cedar wetlands with respect to habitat for rare plant species.

9:50-10:10AM

Predicting carbon storage in Atlantic white cedar (*Chamaecyparis thyoides*) from tree ring data and applying predictions to the restoration design for a 1,100 acre (440 hectare) Carolina bay

Herman Hudson III¹, Amy M. Seim¹, Robert B. Atkinson¹, Robert T. Belcher², & Brian H. Martin³
Christopher Newport University¹, Malcolm Pirnie, Inc.², MTM, Inc.³

Global warming is affected by increased levels of greenhouse gases, such as carbon dioxide, methane, nitrous oxide, and ozone. Concern regarding global warming has led to regulation of emissions and to emissions trading, specifically carbon trading. The purpose of this study was to develop predictions of carbon sequestration in Atlantic white cedar (cedar) ecosystems and determine the economic value of sequestration as incentive for restoration of cedar swamps. In this study, tree ring widths, DBH and allometric equations, litter fall, below ground biomass and cedar to non-cedar ratios were used to estimate amounts of carbon sequestered annually by cedar ecosystems. Compatible land use options were developed using Internet and other sources and were applied to a restoration design for a Carolina bay in North Carolina. Results suggest that more than 3.3 metric tons of C/ha/yr could be sequestered by cedar ecosystems. Recent prices of carbon are \$1.07 per metric ton C (US market) and \$12.6 per metric ton C (European market). Restoration of cedar in the 1,100 acres (445 ha) of agricultural land could annually earn \$1,560.23 in the US market and \$18,372.82 in the European market from carbon sequestration. State and federal conservation programs, private conservation groups, and stream and wetland mitigation banks were identified as possible funding sources for restoration of the rest of the site. Compatible land use options represent potential funding sources for cedar restoration but due to the current market carbon sequestration does not represent a substantial funding source for the restoration of this site but cedar swamps do represent an efficient way to reduce atmospheric carbon and satisfy current and future emissions regulations.

10:10-10:30AM

Carolina Bay Restoration To Atlantic White-cedar (*Chamaecyparis thyoides*)

Kenneth O. Summerville, NC Division of Forest Resources, Ret.

Carolina Bays in North Carolina are natural elliptical depressions located in the southeastern part of the state. These bays are of peat soil origin and have supported forests of AWC. The hydrology of these bays varies, some have high water levels and others do not. These bays have a sand ridge around an elliptical perimeter. In past years some of the bays have been cleared for farming or silvicultural activities. With peat soils and high moisture levels the bays are good sites for restoration to AWC. By total vegetation removal, herbicide application, and bedding these sites are being replanted to Atlantic White-cedar with anticipated harvest in 45 years or less.

10:50-11:10AM

Species Composition and Hurricane Damage in an Atlantic White Cedar Stand Near the Mississippi/Alabama Border

John W. McCoy & Bobby D. Keeland, USGS National Wetlands Research Center

Atlantic White Cedar (*Chamaecyparis thyoides* (L.) B.S.P, cedar) in coastal Mississippi is primarily located in Jackson County near the Alabama border. The entire area is dotted with individual cedar trees and small cedar stands primarily near waters edge. One of the larger stands in the area is located on Grand Bay National Wildlife Refuge, near the Mississippi/Alabama border. This site is bounded by a small longleaf pine stand and Interstate 10 to the South, the Escatawpa River to the West and North and the Mississippi Welcome Center to the East. The living cedars (usually less than 30 cm dbh) are restricted to sandy soils along a narrow slope, swamp, natural levee, and river edge. In addition to cedar other tree species found include Tupelo (*Nyssa aquatica* L.), Ash (*Fraxinus pennsylvanica* Marsh.), Bald cypress (*Taxodium distichum* (L.) Rich.), Buckwheat tree (*Cliftonia monophylla* (Lam.) Britt. Ex Sarg.), Sweetbay (*Magnolia virginiana* L.), Swampbay (*Persea palustris* (Raf.) Sarg.), Swamp titi (*Cyrilla racemiflora* L.), Red maple (*Acer rubrum* L.), Magnolia (*Magnolia grandiflora* L.), and American holly (*Ilex opaca* Ait.). The area was affected by flooding and wind damage from Hurricane Katrina in 1995, with many trees snapped or uprooted.

11:10-11:30AM

The Status Of Atlantic White Cedar (*Chamaecyparis thyoides* (L.) B.S.P) Along The Louisiana/Mississippi Gulf Coast

Bobby D. Keeland & John W. McCoy, USGS National Wetlands Research Center

The western range of Atlantic white cedar extends to Southwestern Mississippi. Small to large stands of cedar, in addition to numerous individual stems can be found on the banks of the Pascagoula River, Escatawpa River and Bluff Creek in Jackson County, along Davis Creek in Forest County, and scattered among hardwoods along Juniper Creek in Pearl River County. In total, cedar is found in five Mississippi counties. Although cedar grew in Louisiana several thousand years ago, it is now represented in that state by three small plantations in St Tammany Parish. These Louisiana plantations, along with a smaller planting at Bogue Chitto, NWR, MS, established in 1989/90 are the only known cedar plantings along the Gulf Coast. In one stand, in the Black Creek Swamp, Jackson County, MS, the hardwoods have been thinned to enhance cedar regeneration and growth as part of mitigation bank development. Most of the existing stands in Mississippi have limited to extensive natural regeneration, but for some stands no seedlings were noted. Degradation of cedar stands throughout Mississippi is resulting from urban development (including firing range development on Camp Shelby Military Reservation), fire, flood, insect/disease and hurricane winds.

11:30-11:50AM

Allometric Trends and Management Study of Atlantic White Cedar in North Carolina

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A study to be installed in 2006-2007 to research allometric trends and management of Atlantic White Cedar (*Chamaecyparis thyoides*) in the coastal plain of North Carolina will be presented. Atlantic white cedar is recognized as both an important wetland restoration species and a merchantable timber species. This research aims to address the effectiveness of establishing Atlantic white cedar on Pocosin soils and to model individual tree and stand level growth characteristics. Many fundamental questions about Atlantic white cedar are unanswered - optimal planting density, effectiveness of fertilizer and herbicides, and functional forms for growth and yield equations. As more emphasis is being placed on restoring Atlantic white cedar, forest land managers will need this information to make appropriate management decisions. Each replicate in the study will include six different spacings and a control and fertilizer treatment. The spacings will be combinations of 5 ft, 10 ft, 15 ft, and 20 ft plantings. The study design will be set up as a Split-Plot design with the fertilizer treatment being the whole-plots and the spacing in trees per acre being the subplots. Each spacing plot will be randomly assigned within each whole-plot. Each plot will consist of 96-100 measurement trees planted at densities ranging from 145 to 871 trees per acre. Buffers will be installed to reduce any adjacency effects from surrounding trees.

11:50-12:10PM

Atlantic White-cedar Ecosystems: 'Wetland Soils'

Chris Smith, Assistant State Soil Scientist, USDA-NRCS

Invited talk

An overview of wetland soils encountered on white-cedar sites, with updates on current classification and properties as well as resources for further information.

1:30-1:50PM

Effects of Salinity and Flooding on Atlantic White-cedar Seedlings

Ekaterina Sedia & George L. Zimmermann, Richard Stockton College of New Jersey

We investigated the effects of increased salinity, flooding and their interaction on Atlantic white-cedar seedlings. We determined that each of these factors, as well as their combination, is detrimental to survival and growth by the seedlings, and is a source of mortality. We subjected the seedlings to eight different treatments: control, three levels of salinity (low at 0.1%, medium at 0.2%, and high at 0.4%), flooding with fresh water, and flooding with salt water (at three salinity levels.) We observed the quickest mortality (2 months) in the combination of flooding and high salinity treatment. Other salt and flood treatments also resulted in 100% mortality, but the mortality curve was less steep (5 months in medium salinity treatment, and 8 months in low salinity). Quick mortality corresponded with low biomass accumulation (7.51 ± 0.77 g at low salinity level, 8.47 ± 0.49 g at medium salinity, and 4.19 ± 0.37 g at high salinity). As expected, the lowest mortality was observed in no flood, no salinity treatment (control group). The mortality in flooded with fresh water seedlings was low (lower than in high salinity, no flooding treatment), but the biomass accumulation was also quite low, compared to controls (18.77 ± 3.03 g). In the non-flooded salt treatments, biomass was also lower than in controls – 28.43 ± 1.56 g in low salinity, 18.75 ± 1.18 g in medium, and 9.71 ± 0.64 g in high. The highest total biomass was accumulated in controls (39.1 ± 2.74 g).

We also mapped mature Atlantic white-cedar forest mortality along South Jersey rivers while measuring and using past measurements of salinity. The data seem to confirm aspects of the greenhouse seedling study. We know from other areas such as historic accounts from Meadowlands in New Jersey and observations of mature freshwater cedar systems flooded by recent beaver activity, that salt has a detrimental and quicker effect on cedar than flooding by freshwater alone, thus adding to cedar's demise.

1:50-2:10PM

Evapotranspiration at a Wetland Site in the New Jersey Pinelands

Robert S. Nicholson & David Sumner, U.S. Geological Survey

Weekly values of evapotranspiration (ET) at a wetland site in the New Jersey Pinelands were estimated for a 12-month period (December 2004–November 2005) by using the eddy-correlation method and energy-budget variants of the method.

ET estimates are needed to characterize water fluxes at the land surface as part of an investigation of the ecological effects of withdrawals from the Kirkwood-Cohansey aquifer system in the New Jersey Pinelands. The source area contributing to measured evaporative flux is predominantly a forested wetland area of pitch pine lowlands and Atlantic white cedar swamps.

Eddy-correlation and meteorological instrumentation were mounted on a 24-meter tower extending above the forest canopy. Soil moisture and shallow-ground-water levels also were measured. Weekly ET values estimated by using eddy correlation and energy-budget variants were similar, indicating that energy-budget variant methods can provide reasonable estimates for periods when eddy-correlation values are missing or invalid.

Weekly ET ranged from less than 1 mm during the dormant season to as high as 41 mm during the growing season. Total ET during the 12-month period was 814 mm, or 67 percent of the 1,208 mm of precipitation measured at the site. The average evaporative fraction of available energy during the 12-month period was 63 percent. The weekly evaporative fraction decreased markedly during an extended period of low precipitation (August 10 - October 6, 2005), and rebounded following the onset of higher precipitation and the resulting increase in soil moisture, indicating a linkage between ET and available soil moisture during the growing season.

2:30-2:50PM

Atlantic White-cedar Ecosystems: 'Hydrologic Wetland Types'

Claude Epstein, Richard Stockton College of New Jersey

Invited talk

The water source that creates wetlands induces differences in the elevation at which these wetlands occur. In addition, different water sources are subject to different water quality and water quantity hazards that, in turn, lead to different management considerations. A study of Atlantic white cedar bogs in the New Jersey Pine Barrens reveals six distinct kinds of wetlands based on water source. The first two, ponded and perched wetlands, receive their water from surface runoff and occur closest to the watershed divide. The next two, groundwater discharge and artesian groundwater discharge wetlands, receive their water from groundwater and occur at intermediate elevations within a watershed. The last two, stream flooded and tidally flooded wetlands, receive their water from overbank flooding and occur at the lowest elevations within a watershed. Ponded and perched wetlands are the most vulnerable with respect to changes in water quantity and water quality. Groundwater discharge and artesian ground water discharge wetlands, while more resilient, and feel the impact of groundwater interception through well water withdrawals. Stream and tidally stream flooded wetlands are subject to episodic water quantity and water quality impacts.