RESULTS AND ISSUES ENCOUNTERED WHILE INVESTIGATING SOUTHERN FOREST INDUSTRY AND MARKET RESPONSES TO CHANGING ECONOMIC CONDITIONS

Andrew J. Hartsell, Thomas J. Brandeis, James W. Bentley, Consuelo Brandeis, and Donald Hodges[1]

Abstract.—Recent Forest Inventory and Analysis (FIA) studies revealed the impact that the recent economic downturn had on southern forest industries, markets, and forests. We used FIA data, timber product output (TPO) surveys, and IMpact analysis for PLANing (IMPLAN) output to quantify these impacts. This analysis involves comparing recent changes to the pre-downturn trend. IMPLAN analysis suggests that the total jobs associated with the wood products industry (direct, indirect, and induced employment) fell from 1.2 million jobs to 0.97 million jobs between 2004 and 2009. TPO results indicate that total softwood output declined 22 percent between 2005 and 2009, while hardwood total product output fell 30 percent over the same time period. Data collected from FIA Phase 2 plots suggests that landowners are performing less final harvests and more thinnings and other silvicultural treatments. Issues pertaining to correlating annual TPO data with moving average FIA inventory data will be discussed.

[1] Research Forester (AJH), U.S. Forest Service, Southern Research Station, 4700 Old Kingston Pike, Knoxville, TN 37919; Supervisory Research Forester (TJB) and Foresters (JWB and CB), U.S. Forest Service, Southern Research Station; Professor and Director Natural Resource Policy Center (DH), University of Tennessee, Knoxville, TN. AJH is corresponding author; to contact, call 865-862-2000 or email at ahartsell@fs.fed.us.

NONTIMBER FOREST PRODUCT HARVESTING ON FAMILY FORESTS: RESULTS FROM THE NATIONAL WOODLAND OWNER SURVEY

Marla R. Emery, Zhao Ma, Stephanie Snyder, and Brett J. Butler[1]

Abstract.—The 2002-2006 National Woodland Owner Survey asked a series of three questions about nontimber forest products (NTFPs) to assess the current status of their use on family forests. We report on responses to those questions. Logit models showed positive relationships between NTFP use and other forms of active engagement with family forests. Higher age and lower levels of educational attainment correlated negatively with likelihood of gathering, although not strongly. A history of gathering was the best predictor of future plans to do so.

[1] Research Geographer (MRE), U.S. Forest Service, Northern Research Station, 705 Spear St., Burlington, VT 05403; Assistant Professor (ZM), Department of Environment and Society, Utah State University; Operations Research Analyst (SS) and Research Forester (BJB), U.S. Forest Service, Northern Research Station. MRE is corresponding author: to contact, call 802-951-6771 or email at memery@fs.fed.us.

ASSESSING AND MITIGATING DENIED ACCESS ON FIA PLOTS

Brett J. Butler and Andrew Hill[1]

Abstract.—Nationally, field crews are denied access to approximately 11 percent of Forest Inventory and Analysis (FIA) forested plots that are privately owned. The denied access rate varies from less than 1 percent in Alabama, Georgia, Louisiana, Maine, South Carolina, and Virginia to more than 30 percent in Arizona, California, Colorado, Montana, New Jersey, Rhode Island, and Texas. The large disparity is due, in part, to state laws that govern access. We hypothesize that there are also significant differences in the socio-demographics of the private owners that are influencing access rates. The first part of this presentation will focus on the current patterns of denied access rates across the United States and present a model to help explain some of its causes. There is a rich body of literature, primarily related to surveys, that has theoretically and empirically examined ways for maximizing response rates. This literature deals with topics such as personalization of communications, financial and nonfinancial incentives, modes of contacts, and timing of contacts to name but a few. We believe these findings may be very useful for minimizing FIA denied access rates. The second part of our presentation will focus on a literature synthesis and experiment that we are conducting to identify best practices for minimizing denied access rates.

[1] Research Forester (BJB), U.S. Forest Service, Northern Research Station, 160 Holdsworth Way, University of Massachusetts, Amherst, MA 01003; Research Forester (AH), U.S. Forest Service, Northern Research Station. BJB is corresponding author; to contact, call 413-545-1387 or email at bbutler01@fs.fed.us.

DEVELOPMENT OF A REMOTE SENSING-BASED SYSTEM FOR MONITORING LANDSCAPE CHANGE

C. Kenneth Brewer, Sean P. Healey, Brian Schwind, and Kevin A. Megown[1]

Abstract.—The Landscape Change Monitoring System (LCMS) is an interagency remote sensing-based system under development for mapping and monitoring land cover and land use change in the United States. There is a growing need for landscape change information that is coherent across time, space, and different cover types. While a number of relevant datasets exist, work is needed to promote coordination and fill in critical gaps. Assessment of existing agency information requirements, data availability, and institutional activity suggests the greatest return on efforts to establish a national landscape change monitoring system will be in development of a Landsat-based information system. Characteristics that make Landsat data particularly well-suited to comprehensive change monitoring include the longest data record of any synoptic satellite sensor (1972 to present), relatively fine spatial resolution (30 m), spectral and radiometric properties that enable vegetation change detection, no-cost availability and accessibility, future data continuity, and a rich history of scientific investigation. Current activities in the development of LCMS include an independent needs assessment and the formation of a science team, which will evaluate and recommend design criteria and available Landsat-based change detection methodologies. These developments will be described in the presentation.

[1] Program Manager (CKB), U.S. Forest Service, 1601 N. Kent St., Arlington, VA 22209; Research Ecologist (SPH), U.S. Forest Service, Rocky Mountain Research Station; (BS and KAM), U.S. Forest Service, Remote Sensing Applications Center.

THE NORTH AMERICAN FOREST DYNAMICS STUDY: A DECADE OF LEARNING ABOUT U.S. FOREST DISTURBANCE

Samuel N. Goward, Warren B. Cohen, Chengquan Huang, Jeffery Masek, Gretchen G. Moisen, Rama Nemani, Karen Schleeweis, and Nancy Thomas[1]

Abstract.—The North American Forest Dynamics (NAFD) study is a core project of the interagency North American Carbon Program. The first step in the study, a prototype analysis carried out in the mid-Atlantic region, showed the potential of combining time series Landsat observations with the U.S. Forest Service Forest Inventory and Analysis (FIA) field measurements. With the assistance of FIA staff, the investigators began to explore merging the NASA/USGS Landsat observations with the FIA measurements in order to evaluate forest disturbance dynamics in the United States in the next 6 years the study demonstrated the difficulties encountered in sampling Landsat locations as a means to estimate U.S. national rates in disturbance. What was found is that disturbances occurring in specific Landsat locations dominated estimated national rates in given years. Further by examining Landsat observations every other year, significant low intensity disturbance events were missed. These “lessons learned” have led to NAFD phase III, in which we will conduct an annual, wall-to-wall analysis of the coterminous U.S. disturbance rates and underlying processes and will explore the potential for estimating regrowth rates. Further, we are now developing validation methodology which should permit estimates of the accuracy and precision of these national forest dynamics.

Throughout this decade of research, the NAFD team has maintained a strong partnership with the FIA and related U.S. Forest Service activities. What began as solely North American Carbon Program science goal has now developed a strong relation between NASA research activities and U.S. Forest Service operational responsibilities.

[1] Professor (SNG), University of Maryland, Department of Geographical Sciences, College Park, MD 20742; Research Forester (WBC), U.S. Forest Service, Pacific Northwest Research Station; (CH, KS and NT), University of Maryland, Department of Geographical Sciences; Biospheric Sciences Lab (JM), NASA Goddard Space Flight Center; Research Forester (GGM), U.S. Forest Service, Pacific Northwest Research Station; (RN), NASA Ames Research Center, Moffett Field, CA. SNG is corresponding author; to contact, call 301-405-2770 or email at sgoward@umd.edu.

VALIDATION STRATEGY FOR NAFD LANDSAT TIME SERIES FOREST CHANGE MAPS

Warren B. Cohen, Steve Stehman, Susmita Sen, Peder Nelson, Chengquan Huang, Karen Schleeweis, and Gretchen G. Moisen[1]

Abstract.—Landsat time series (LTS) contain detailed information about land use and cover change. To characterize forest disturbance, automated LTS algorithms are now being developed, tested, and applied over large areas. Because these algorithms are used over broad regions and periods up to 40 years, obtaining a statistically valid sample of independent reference data for map validation is both costly and prohibitively challenging. We present an alternative strategy based on human interpretation of the LTS for a sample of plots, both as image chip series and as spectral plots over time. In addition, we use Google Earth™ historical temporal snapshots of high resolution images to provide critical LTS interpretation support.

Our interpretation system, TimeSync, is being used for validation of Vegetation Change Tracker (VCT) maps for the conterminous United States as part of the North American Forest Dynamics (NAFD) project. Because the collection of validation data must precede the completion of map development, we designed a sequential two-step stratified-random approach with nonforest, undisturbed forest, and disturbed forest map strata. The first step of the sample selection is based on a preliminary VCT map, with approximately one half of the intended number of plots interpreted. When the VCT map stabilizes, after several iterations of the algorithm's implementation, the second step in the selection process will round out the sample to obtain the desired distribution of plots per stratum.

Our validation strategy includes interpretation of each plot by two separate interpreters. A third interpreter arbitrates disagreements to provide a final high quality reference dataset, which has built in confidence scoring, based on the integration over all interpreters. Once the plots are interpreted, an agreement matrix is constructed to assess VCT map accuracy. In our presentation, we present the validation strategy, as described above, and present preliminary results from a set of 10 LTS scenes distributed across the United States.

[1] Research Forester (WBC), U.S. Forest Service, Pacific Northwest Research Station, Corvallis, OR 97331; State University of New York (SStehman), Department of Forest and Natural Resources Management; Oregon State University (SSen, PN), Department of Forest Ecosystems and Society; University of Maryland (CH, KS), College Park, MD; U.S. Forest Service (GGM), Rocky Mountain Research Station. WBC is corresponding author: to contact, call 541-750-7322 or email at wcohen@fs.fed.us.

POST-DISTURBANCE RECOVERY ANALYZED FROM REMOTE SENSING TIME SERIES AND FIA DATA

Jeffrey Masek, Khaldoun Rishmawi, and Samuel N. Goward[1]

Abstract.—As part of the third phase of the North American Forest Dynamics project (NAFD), the fate of all patches disturbed between 1972 and 2010 in the conterminous United States is being investigated. While forest succession encompasses a wide range of ecological attributes, we are particularly interested in the accumulation rate of aboveground biomass during recovery from disturbance. Previous studies have noted the relative insensitivity of optical remote sensing for measuring biomass in mature stands. However, it has also been demonstrated that early recovery (e.g., the first 10-20 years following disturbance) can be tracked successfully via multispectral metrics. Our goal is to provide as much detail as possible on the early biomass recovery rate on a per-patch basis, while also providing spatially aggregated mean and variance of recovery rate across U.S. ecoregions. Of particular interest is whether recovery rates are changing through time (e.g., comparing the 1980s with the 2000s). Changes in management and growth enhancement in the eastern United States, as well as increased multiple interacting disturbances in the western United States, suggest the hypothesis that recovery rate distributions may not be stationary.

The project involves three approaches for assessing recovery rate: 1) empirical modeling using remeasured FIA plots and Landast spectral trajectories; 2) physical modeling of observed reflectance using canopy radiative transfer models parameterized with FIA attributes; and 3) correlation of time-since-disturbance with contemporary structural information from Lidar and stereo imaging. One innovation of the work is that temporal trends in the Landsat timeseries (rather than single-date reflectances) will be used to model contemporary biomass and biomass change rate. This presentation will review the science context for characterizing post-disturbance recovery, and provide initial results for a set of pilot frames across the United States.

[1] Landsat Project Scientist (JM), NASA, Biospheric Sciences Lab, Goddard Space Flight Center, Greenbelt, MD 20771; University of Maryland (KR and SNG), College Park, MD. JM is corresponding author: to contact, call 301-614-6629 or email at jeffrey.g.masek@nasa.gov.

THE DEVELOPMENT OF A LEGACY FIA REPORT SIMULATOR

Stephen P. Prisley, W. Brad Smith, and John W. Coulston[1]

Abstract.—The U.S. Forest Service Forest Inventory and Analysis Program (FIA) has a long history of providing crucial data on the nation's forest resources. Since 1928, the Forest Service has periodically conducted forest inventories and compiled and published data on the status and trends of the nation's forests. While more recent data is available digitally to the public, much of the historic data are available only in hardcopy publications, limiting its utility for computerized access and analysis. This presentation will describe a project begun in 2010 to compile information extracted from hundreds of published reports into a digital database we refer to as the FIA Legacy DB. This database contains tables of published estimates for common inventory parameters, such as timberland area by state and ownership, growing stock inventory, growth, removals, mortality, and species distributions. In addition to data tables containing estimates from published reports, interpolation routines were developed to provide estimates at common years by interpolation between report years. A set of reporting tools allows users to specify states or combinations of states, a time period, and then select from a variety of common reports. Example queries and reports will demonstrate the utility of this tool for quickly and easily delivering data previously available only in increasingly rare hardcopy reports.

[1] Associate Professor (SPP), Virginia Tech, Blacksburg, VA 24060; Research Forester (BS), U.S. Forest Service, Washington, DC; Supervisory Research Forester (JWC), U.S. Forest Service, Southern Research Station, Knoxville, TN. SPP is corresponding author; to contact, call 540-231-7674 or email at prisley@vt.edu.

NONTIMBER FOREST PRODUCTS OUTPUT INFORMATION SYSTEM

James Chamberlain, John Munsell, Stephen P. Prisley, and Tom Hammett[1]

Abstract.—Nontimber forest products (NTFPs) are important commodities and critical components of healthy forests. They have not been sufficiently monitored to assess population status or trends in the dynamics of supply and demand. Over the last decade, U.S. Forest Service Forest Inventory and Analysis (FIA) of the Southern Research Station has reported on the status of NTFPs in particular states through state reports and at the national level through RPA assessment and the Sustainable Forests reports. In 2011, FIA and Virginia Tech initiated an effort to develop a nontimber product output (NTPO) information system similar to the timber product output (TPO) system. The protocol will systematically monitor harvested NTFPs. The initial focus of this project is on medicinal NTFPs in central Appalachia. This work provides a starting point for developing a replicable output system that can periodically report on medicinal NTFP production for the entire Appalachian forest region. Findings from the analysis of medicinal forest products will be integrated into a geographic information system that will spatially depict biological, socioeconomic, infrastructure and political aspects of the medicinal forest products segment. The long-term goal of this effort is to create a mechanism whereby nontimber forest products outputs across the nation can be tracked regularly and more completely valued. Authors will present the status of NTFPs in the south and report progress on development of the NTPO system. We also will encourage dialogue and suggestions with the audience regarding future efforts.

[1] Research Scientist (JC), U.S. Forest Service, Southern Research Station, Blacksburg VA; Professors (JM and TH) and Associate Professor (SPP), Virginia Tech, Blacksburg, VA. JC is corresponding author; to contact, call 540-231-3611 or email at jchamberlain@fs.fed.us.

ADAPT, MOVE, OR DIE: FIA DATA IN ASSESSMENTS OF FOREST TREE GENETIC DEGRADATION RISK FROM CLIMATE CHANGE AND OTHER THREATS

Kevin M. Potter, Barbara S. Crane, and William W. Hargrove[1]

Abstract.—Changing climatic conditions may pose a severe threat to forest tree species, forcing three potential population-level responses: 1) toleration/adaptation, 2) movement to suitable environmental conditions, or 3) extirpation. All could have negative genetic consequences. It will be important, therefore, to safeguard existing adaptedness and to create conditions conducive for future productivity and evolution. To efficiently conserve the genetic variation of species, it is necessary to understand where climate change pressure will be greatest, and what species and populations are more highly predisposed to genetic degradation from climate change and other threats. Forest Inventory and Analysis (FIA) data represent an unmatched resource for conducting broad-scale, spatially explicit assessments of the risk posed by climate change and other threats to the genetic integrity of forest tree populations and species. We used FIA data to 1) generate 4 km^2 resolution maps predicting the genetic pressure that could be imposed by climate change on forest tree species; and 2) compile information about the biological attributes and genetic diversity of individual species. The first assessment tool, Forecasts of Climate-Associated Shifts in Tree Species (ForeCASTS), has generated climate change pressure maps for more than 300 North American tree species and quantifies potential climate change genetic pressure, as defined by the straight-line Minimum Required Movement (MRM) distance from the existing locations of each species to the nearest favorable future habitat. The second assessment tool, the Forest Tree Genetic Risk Assessment System (FORGRAS) framework, ranks the predisposition of forest tree species to genetic degradation, based on demographic and occurrence information, ecological and life-history traits, species-specific projections of climate change pressure, and predictions of pest and pathogen susceptibility. Both assessment tools should be valuable for scientists and managers attempting to determine which species and populations to target for monitoring efforts and for proactive gene conservation and management activities.

[1] Research Assistant Professor (KMP), North Carolina State University, Department of Forestry and Environmental Resources, Research Triangle Park, NC 27709; Geneticist (BSC), U.S. Forest Service, Southern Region; Research Ecologist (WWH), U.S. Forest Service, Southern Research Station. KMP is corresponding author: to contact, email at kevinpotter@fs.fed.us.

TREE SPECIES MIGRATION IN THE PACIFIC COASTAL UNITED STATES

Heather Lintz, Andrew N. Gray, Andrew Yost, and Vincente Monleon[1]

Abstract.—We analyzed mean changes in longitude, latitude, and elevation for tree species in the Pacific coastal United States (California, Oregon, and Washington). Our analyses show that species migration distance and direction is highly variable, and Pinus monticola and Cornus nuttallii are leading the pack in polar opposite directions. All drought tolerant species are moving northward. Tree species producing the greatest seed abundance are moving the farthest. The distance and direction of migratory gradients correspond to changes in both means and anomalies of summer relative humidity, summer vapor pressure deficit, summer growing season length, and summer precipitation.

[1] Assistant Professor Senior Research (HL), Oregon Climate Change Research Institute, 326 Strand Hall, Corvallis, OR 97330; Research Ecologist (ANG), U.S. Forest Service, Pacific Northwest Research Station; Forest Ecologist (AY), Oregon Department of Forestry, Salem, OR; Resource Monitoring and Assessment Program (VM), U.S. Forest Service, Pacific Northwest Research Station. HL is corresponding author: to contact, email at hlintz@coas.oregonstate.edu.

THE MYTH OF A BUSINESS-AS-USUAL BASELINE: A REVIEW OF FOREST INVENTORY PROJECTIONS

Stephen P. Prisley, W. Brad Smith, and John W. Coulston[1]

Abstract.—With the advent of forest carbon accounting schemes that compare projected forest carbon sequestration against a baseline, there is an increasing demand to project forest inventories into the future. Often, the desired comparison baseline is termed "business as usual", implying there is a known or anticipated trajectory of forest growth and harvests that will occur and against which we can compare alternate management scenarios. This raises the question "how well can we project forest inventories into the future?" The U.S. Forest Service has decades of experience with developing national projections of forest inventories for the Resources Planning Act (RPA) periodic assessments.

We have compiled some of the projections made in the 1965, 1974, 1982, and 1993 RPA assessments, including timberland area by region and ownership, and timberland growing stock, net growth, removals, and mortality by region and softwood/hardwood. These projections are compared with interpolated Forest Inventory and Analysis data for the same regions and years. Differences between projected and measured values are expressed as RMSEs to quantify the performance of projections by length of projection, spatial resolution (national versus regional), and quantity being projected (area, growth, removals, mortality, inventory).

Results demonstrate the challenge of making projections based on extrapolation of recent trends. We also discuss some of the primary reasons for discrepancies between projections and reality.

[1] Associate Professor (SPP), Virginia Tech, Blacksburg, VA 24060; Research Forester (BS), U.S. Forest Service, Washington, DC; Supervisory Research Forester (JWC), U.S. Forest Service, Southern Research Station. SPP is corresponding author; to contact, call 540-231-7674 or email at prisley@vt.edu.

INCORPORATING EVOLUTIONARY RELATIONSHIPS INTO REGIONAL ASSESSMENTS OF FOREST BIODIVERSITY ACROSS FOREST INVENTORY AND ANALYSIS PLOTS

Kevin M. Potter and Christopher W. Woodall[1]

Abstract.—Evolutionary diversity metrics may be more biologically meaningful indicators of forest biodiversity than traditional measures such as species richness, which treat all species as equally important. This is because measures that account for evolutionary relationships among species should be better surrogates of functional diversity within forest communities, given that taxonomically distinct species should contribute more to the diversity present within a community. One measure, phylogenetic diversity, has been linked to a variety of plant ecosystem processes, goods and services, supporting the argument that it is a more useful conservation criterion for management decisions. To investigate patterns of forest functional biodiversity across the United States, we calculated plot-level evolutionary diversity measures on approximately 125,000 Forest Inventory and Analysis plots. Most measures were not well-correlated with species richness, while others were decoupled with it at small and medium scales. Phylogenetic diversity was consistently better correlated than species richness with most plot-level measures of forest productivity, including trees per acre and relative density, although the results varied by region. Using data remeasured over time on a subset of the forest inventory plots, we detected broad-scale patterns of phylogenetic diversity change that were consistent with the expected early effects of climate change. Specifically, phylogenetic diversity change was greater among seedlings than trees, was associated in some locations with latitude and elevation, and was greater among species with high dispersal capacity. These findings demonstrate that demographic indicators of evolutionary diversity can refine our understanding of climate change impacts on forest community biodiversity and function across broad regions. The importance, statistical power, and geographic extent of such indicators will increase as repeated measurements occur on all 125,000 inventory plots across the United States.

[1] Research Assistant Professor (KMP), North Carolina State University, Research Triangle Park, NC 27709; Research Forester (CWW), U.S. Forest Service, Northern Research Station. KMP is corresponding author: to contact, call 919-549-4071 or email at kpotter@ncsu.edu.

RECENT TRENDS IN MAPLE AND OAK-HICKORY DISTRIBUTION FOR THE UNITED STATES

Michael Farrell[1]

Abstract.—Many researchers predict that climate change will cause maple-dominated forests to move northward and be replaced with oaks and hickories throughout much of their current range. Whereas there is strong evidence that the climate has been changing and will continue to do so, the current trends in these species abundance and distribution over the past 30 years are in direct contrast with many stated predictions. To date, human management has played a much larger role than climate in shaping the distribution of these tree species throughout the northeast. This presentation utilizes Forest Inventory and Analysis (FIA) data for 25 states in the eastern United States to examine the diameter distributions for sugar and red maples, oaks, and hickories since the 1980s. Oaks and hickories have had trouble regenerating throughout their established range whereas shade-tolerant sugar and red maples have been rapidly invading oak-hickory forest types. In fact, both sugar and red maples are becoming established much more rapidly along the southern and central states than they are in the northeast. Red maple is becoming even more dominant than sugar maple in almost every state, especially those along the southern and western ranges of sugar maple. This presentation explores the FIA data for the past 30 years on a state-level to determine what the future composition of maples, oaks, and hickories could be in the eastern United States if these trends continue. Implications for the maple syrup industry are explored, including where and what kind of trees will be tapped in the future.

[1] Extension Associate, Cornell University, 157 Bear Cub Lane, Lake Placid, NY 12946.
To contact, call 518-523-9337 or email at mlf36@cornell.edu.

ANALYSIS OF URBAN AND NATURAL FOREST COMPOSITION ACROSS THE UNITED STATES

Mark J. Ambrose[1]

Abstract.—It has been suggested that urban forestry tree planting practices are creating a homogenous urban forest, with the same limited number of species dominating urban landscapes across North America. There is also concern about urban forests as pathways for invasive pests and pathogens to adjacent natural forests. However, to date urban forest inventory data have been limited and data collected from different cities were often incompatible. To begin to address the issue of urban forest composition, tree species data were obtained 150 U.S. and Canadian cities which had conducted inventories for use with the i-Tree Eco (UFORE) or i-Tree Streets (STRATUM) models or which maintained comprehensive street tree databases. Relative basal area of each tree species was calculated by city and land use class and (where possible) for each city as a whole. Those data were combined with data from nearby natural forests from the U.S. Forest Service Forest Inventory and Analysis (FIA) Program. The data were then analyzed using PC-ORD to determine which cities' urban forests were most similar to one another (using cluster analysis) and how species composition related to large-scale environmental variables (using non-metric multi-dimensional scaling). Environmental and geographic explanatory variables used included latitude, longitude, elevation, total annual precipitation, and plant hardiness zone.

Preliminary analysis of urban forest data alone showed that urban forests as a whole clustered by species composition data along rough geographic and climatic lines. More intensively managed portions of the urban forest (e.g., street trees) tended to cluster in ways less closely related to geography and climate. Analyses of the urban data together with natural forest data indicate that urban forests are generally more similar to one another than they are to nearby natural forests. Street tree populations were most similar in their species compositions while other components of the urban forest showed greater variation. The more intensively managed segments of the urban forest were also less similar to adjacent natural forests. Urban forests also tend to resemble the natural forests of the eastern United States more than they resemble western forests.

[1] Research Assistant, North Carolina State University, Research Triangle Park, NC. To contact, call 919-549-4078 or email mambrose@fs.fed.us.

GAIN-LOSS ESTIMATION OF COMPONENTS OF CHANGE IN FOREST CARBON: AN EXAMPLE FROM OREGON

Andrew N. Gray, Thomas R. Whittier, and David L. Azuma[1]

Abstract.—Increases in carbon dioxide in the atmosphere are thought to be a main cause of changes in global temperature and sea level. There is thought to be a large carbon (C) sink on lands in the Northern Hemisphere, but the amounts and causes are not well known. Forests are a focus of efforts to understand changes in carbon storage over time because they accumulate larger amounts of carbon than other terrestrial ecosystems. Current "stock-change" estimates of forest carbon flux are based on a combination of field measurements, surveys, remote sensing classifications, and models. The goal of this study was to attempt to improve on existing carbon accounting methods by using the "gain-loss" method and directly tracking components of change in tree carbon across a large region with strong environmental gradients using field measurements. We used repeated Forest Inventory and Analysis (FIA) measurements on permanent plots to quantify tree carbon flux due to land use change, disturbance, and harvest on 1,067 plots across Oregon. Land use change resulted in a net increase of 1.1 x 10^5 ha of forest land in Oregon between 1986 and 1997. However, there was a net loss of 3.4 Tg of live tree C because most of the losses were on productive west-side forests and most of the gains were on east-side juniper woodlands. Live woody C decreased significantly in eastern Oregon (-14.4 Tg), with mortality and harvest exceeding growth. Much of the mortality and subsequent harvest was associated with severe defoliation by western spruce budworm. However, C stores increased significantly in western Oregon (19.2 Tg) due to large accumulations from growth on public lands, and harvest being balanced by growth on private lands. Patterns of C density associated with stand age differed by site productivity class and forest type. The increase in C density with stand age was greater on more productive sites due to higher growth rates in young stands, but contribution of those sites to growth decreased as harvest rates increased with stand age. We demonstrate that gain-loss accounting from a probabilistic field sample can produce detailed estimates of carbon flux that identify causes and components of change, and have the potential to produce more consistent estimates than combining alternative approaches.

[1] Research Ecologist (ANG), U.S. Forest Service, Pacific Northwest Research Station, 620 SW Main, Suite 400, Portland, OR 97205; Research Assistant (TRW), Oregon State University; Research Forester (DLA), U.S. Forest Service, Pacific Northwest Research Station. ANG is corresponding author; to contact, call 541-750-7252 or email at agray01@fs.fed.us.

MANAGING FOR CLIMATE BENEFITS IN DRY MIXED-CONIFER FORESTS: TRACKING THE CARBON IMPLICATIONS OF FUEL TREATMENTS AT LANDSCAPE SCALE

Jeremy S. Fried, Theresa Jain, Jonathan Sandquist, and Larry D. Potts[1]

Abstract.—Building on the statistically representative sample of a complex of forest types, often described as dry mixed conifer, provided by over 5000 annual Forest Inventory and Analysis (FIA) plots in seven western states, we modeled multiple indices of existing fire hazard and the extent to which implementation of mechanically focused fuels management programs could substantially improve these indices with respect to a range of objectives. Design of the generic/stylized fuel treatments tested in this study was guided my multiple, sometimes conflicting objectives: 1) leave behind a healthy, resilient stand; 2) reduce surface fire intensity; and/or 3) reduce crown fire potential, though results varied by pretreatment stand structure and forest type. Fuel treatment costs, including costs of on-site activities and transportation of harvested materials, and yields and values of merchantable and energy wood resulting from treatments under alternative policy scenarios were modeled or calculated, allowing estimation, by forest type, ecoregion, landowner class, stand density and size class of: 1) the area over which fuel treatment is capable of achieving one or more objectives and at what cost [or net revenue]; 2) the amount of carbon that fuel treatment can move into long-term storage as harvested wood products or into utilization as fossil-carbon-emission offsetting bioenergy; 3) the amount of live tree carbon remaining at risk in treated stands and the likelihood of that carbon leaving the live-tree pool in the event of a fire; and 4) the potential carbon dynamics of post-fire recovery that includes salvage harvest in treated or untreated stands. Results reveal that less than half of the dry mixed-conifer forest would benefit from the kinds of fuel treatments simulated in this study; however, nearly all the acres with potential benefit are on federal lands, and most can be treated so as to generate net revenue, useful products and carbon benefits. Although markets for energy wood are essentially absent in some regions where these forest types occur, most of the value derived from effective treatments flows from the sale of merchantable wood products, so markets for energy wood are rarely the determining factor as to fuel treatment feasibility. While clearly linked to fire incidence and return interval, the extent to which fuel treatments produce net carbon benefits also depends on how post-treatment carbon accumulation capacity is impacted by stocking reduction, the reduction in mortality achieved in the event of fire, and assumptions about the feasibility of post-fire salvage harvest.

[1] Research Forester (JSF), U.S. Forest Service, Pacific Research Station; Research Forester (TJ) and Forestry Technician (JS), U.S. Forest Service, Rocky Mountain Research Station; Information Technology Specialist (LDP), U.S. Forest Service, Pacific Research Station. JSF is corresponding author: to contact, call 503-808-2058 or email at jsfried@fs.fed.us.

APPROACHES FOR LANDSCAPE-SCALE FOREST CARBON ASSESSMENT

Richard Birdsey, Yude Pan, Kris Johnson, Fangmin Zhang, and Jing Chen[1]

Abstract.—Increasingly, public and private forest landowners need to estimate their carbon stocks and analyze the impacts of alternate management plans. Here we describe approaches designed to work at landscape scales: one involves estimating carbon stocks from existing Forest Inventory and Analysis (FIA) data; another involves downscaling results from a continental-scale biogeochemistry model known as InTEC; and the third uses Lidar remote sensing to provide high resolution biomass maps. Combining FIA data with a biogeochemistry model gives the most useful information for analyzing causes of historical trends, while the biomass maps support implementation of management decisions. Application of these approaches is illustrated by pilot studies in the eastern United States. Analysis of FIA data for northern Wisconsin revealed that private landowners held more than half of the forest carbon but that the rate of carbon sequestration had slowed dramatically over two decades. Causes of the decline were hypothesized to include increased harvesting, aging forests, and increasing disturbances. The InTEC model for the same region revealed trends over a much longer historical period as well as providing information about changes in soil C that are lacking in the FIA data analysis. The effects of long-term forest age dynamics and higher inter-annual climate variability became evident, and the model results suggest a significant increase of soil C stocks. Using this information base, we identified several ways to increase landscape-scale average forest carbon stocks: allow some forests to reach full maturity and highest carbon stocks; manage other forests to maximize carbon uptake and transfer of harvested carbon into wood products; and avoid conversion of existing forests to nonforest land uses. Strategic implementation of these kinds of management decisions can be facilitated with high resolution biomass maps.

[1] Program Manager (RB) and Research Scientist (YP), U.S. Forest Service, Northern Research Station, 11 Campus Blvd., Suite 200, Newtown Square, PA 19073; University of Toronto (FZ and JC), Ontario, Canada. RB is corresponding author: to contact, call 610-557-4092 or email at rbirdsey@fs.fed.us.

DENSIOMETERS AND CANOPY DENSITY MEASUREMENTS

Kenneth W. Stolte, Stanley J. Zarnoch, and Robert L. Eaton[1]

Abstract.—The productivity and vitality of forest ecosystems are dependent on the condition of tree canopies. Canopy cover and density are components in estimations of tree growth efficiency, fish and wildlife habitat, urban tree cover, composition of understory vegetation, soil erosion susceptibility, pollutant deposition, and other ecological factors. We found that a simple modification of a convex densiometer with standardized protocols eliminated two of three multiplicative measurement error factors and improved repeatability among observers. We tested this modification using Forest Inventory and Analysis (FIA) plot protocols under three scenarios in three geographical areas of North Carolina. One scenario consisted of 23 North Carolina State University undergraduate forestry students' measurements on three subplots in a pine seed orchard (piedmont geographic area). Another was the evaluation of pre- and post-harvest of 60 plots of loblolly pine in Croatan National Forest (coastal plain geographic area). The third was the adequate number of points on an FIA subplot to measure canopy density on two FIA subplots in each of eight long-term vegetation monitoring plots in pine and mixed-hardwood forests at Coweeta Experimental Forest (mountainous geographic area). We found that the variance components due to persons, points on subplots, and azimuth position of points was 5.3, 34.3, and 60.3 percent, respectively, indicating observer differences were a very small percentage of the overall measurement variance. We observed decrease in average canopy density from 90 percent to 64 percent in 60 plots at Croatan NF following an average thinning intensity of 42 percent of the number of trees in all plots. This shows the modified densiometer reflects known changes in canopy density. Four of seven sample points tested on FIA subplots were found to be adequate for measurement of canopy density at Coweeta Experimental Forest in western North Carolina. Measurements on only four of the seven points reduces the amount of time needed for data collection. These modifications of a convex densiometer meet criteria for a good indicator: high signal/noise ratio; applicable to large areas of different forest types; directly related to crown condition; and logistically feasible (e.g., weight, cost, time on plot).

[1] Research Ecologist (KWS), U.S. Forest Service, Southern Research Station, 3041 Cornwallis Road, Research Triangle Park, NC 27709; Mathematical Statistician (SJZ) and Biological Scientist (RLE), U.S. Forest Service, Southern Research Station. KWS is corresponding author; to contact call 919-549-4022, or email at kstolte@fs.fed.us.

NONNATIVE INVASIVE PLANT INVENTORY IN THE NORTHERN RESEARCH STATION: PATTERNS AND TRENDS

W. Keith Moser and Cassie M. Kurtz[1]

Abstract.—Nonnative invasive plants (NNIPs) are an important component of suite of biological disturbances that are influencing forests in the 24 state region of the Northern Research Station (NRS) of the U.S. Forest Service. Along with locally high deer populations and nonnative earthworms, NNIPs have the potential to impact the biodiversity of the ground flora, site productivity, wildlife habitat, and the composition and structure of forests, present and future. Northern Research Station Forest Inventory and Analysis Program (FIA) has several sets of data that can be used to evaluate NNIP. A select list of 25 species were measured on 100 percent of the panels in the 11 midwestern states from 2005 through 2006. About 20 percent of all plots were inventoried for the presence of 43 species from 2007 through 2010 for all 24 states of NRS-FIA. Our presentation discusses the results and the slightly different methodologies between the 2005-6 and 2007+ inventories, and examines the implications specifically for tree regeneration and future stand development.

[1] Research Forester (WKM), U.S. Forest Service, Northern Research Station, 1992 Folwell Ave., St. Paul, MN 55108; Natural Resource Specialist (CMK), U.S. Forest Service, Northern Research Station. WKM is corresponding author; to contact, call 651-649-5155 or email at wkmoser@fs.fed.us.

TRANSITIONING FROM PHASE 3 VEGETATION DATA TO PHASE 2+ VEGETATION DATA IN THE NORTHERN RESEARCH STATION

W. Keith Moser, Katherine Johnson, Cassie M. Kurtz, Cassandra Olson, and William H. McWilliams[1]

Abstract.—Phase 3 (P3) vegetation diversity and structure was measured in the Northern Research Station (NRS), U.S. Forest Service, intermittently between 2000 and 2010. Varying in intensity and location, these data provide a glimpse of native and invasive plants across portions of 24 states. Between 2007 and 2010, all NRS states were sampled largely on the same schedule and intensity. In 2011, an NRS-Forest Inventory and Analysis team evaluated a new sampling protocol (NRS Phase 2+ [P2+]), which includes vegetation composition and structure variables from the Phase 2 vegetation profile and the invasive plants protocols, combined with a regeneration sampling scheme first developed for the Pennsylvania "Regeneration Study." To compare the P3 and P2+ sets of variables, our presentation will apply NRS P2+ vegetation profile, invasive plants, and advance tree seedling regeneration variables to the previously collected P3 vegetation diversity and structure data and we will discuss the implications for customers of these data.

[1] Research Forester (WKM), U.S. Forest Service, Northern Research Station, 1992 Folwell Avenue, St. Paul, Minnesota 55108; Biological Scientist (KJ), Natural Resource Specialist (CMK), Ecologist (CO), and Research Forester (WHM), U.S. Forest Service, Northern Research Station. WKM is corresponding author; to contact, call 651-649-5155 or email at wkmoser@fs.fed.us.

A MODEL FOR QUANTIFYING FOREST VARIABLES OVER LANDSCAPES WITH UNCERTAIN FOREST AREAS

Andrew O. Finley, Sudipto Banerjee, and David W. MacFarlane[1]

Abstract.—We are interested in predicting one or more continuous forest variables (e.g., biomass, volume, age) at a fine resolution (e.g., pixel level) across a specified domain. Given a definition of forest/nonforest, this prediction is typically a two-step process. The first step predicts which locations are forested. The second step predicts the value of the variable for only those forested locations. Rarely is the forest/nonforest status predicted without error. However, the uncertainty in this prediction is typically not propagated through to the subsequent prediction of the forest variable of interest. Failure to acknowledge this error can result in biased estimates of forest variable totals within a domain. In response to this problem, we offer a modeling framework that will allow propagation of this uncertainty. Here we envision two latent processes generating the data. The first is a continuous spatial process while the second is a binary spatial process. The continuous spatial process controls the spatial association structure of the forest variable of interest, while the binary process indicates presence of a possible nonzero value for the forest variable at a given location. The proposed models are applied to geo-referenced National Forest Inventory (NFI) data and spatially coinciding remotely sensed predictor variables. Due to the large number of observed locations in this dataset, we seek dimension reduction not just in the likelihood, but also for unobserved stochastic processes. We demonstrate how a low-rank predictive process can be adapted to our setting and reduce the dimensionality of the data and ease the computational burden.

[1] Assistant Professor (AOF), Michigan State University, Departments of Forestry and Geography, East Lansing, MI 48824; Professor (SB), University of Minnesota; Associate Professor (DWM), Michigan State University. AOF is corresponding author: to contact, call 517-432-7219 or email at finleya@msu.edu.

INCORPORATING LOCAL STATISTICS BASED SPATIAL WEIGHT MATRIX INTO SIMULTANEOUS AUTOREGRESSIVE MODEL TO PREDICT THE DISTRIBUTION OF NONNATIVE INVASIVE SHRUBS IN THE UPPER MIDWEST

Weiming Yu, Zhaofei Fan, and W. Keith Moser[1]

Abstract.—In this study, we extended the spatial weight matrix defined by Getis and Aldstadt to a more general case to predict the distribution of invasive shrubs among the Upper Midwest counties in a simultaneous autoregressive (SAR) model context. The modified spatial weight matrix performs better than the original spatial weight matrix since it adjusts weights of observations based on the distance from other observations but still maintains the locally adaptive nature of the latter. Both the simulation study and the application to the Forest Inventory and Analysis (FIA) plot data for invasive shrubs collected in 2005-2006 proved that the modified spatial weight matrix outperform its original case in diagnostic statistics (e.g., AIC) and resultant invasion maps. Our results provided further evidence that misspecification of spatial autocorrelation structure in spatial data will result in misinterpretation of real ecological processes and bias estimation of coefficients for important covariates involved. The geographical distribution of invasive shrubs in the Upper Midwest was significantly associated with latitude; local clusters (a group of counties) of high abundance/presence of invasive shrubs was significantly determined by TRPF (a ratio of road density to percent of forest cover at the county level), a variable reflecting the intensity of human disturbance. Both the multiple linear regression model and the SAR model with the original spatial weight matrix incorporated tended to overestimate the effect of forest type (community) on invasive shrubs. However, the SAR model with the modified spatial weight matrix showed that distribution of invasive shrubs among forest types was only marginally different at the significance level of p = 0.05. This result conforms to the plot level study and is favorably supported by the data. As a conclusion, the SAR model incorporating the modified spatial weight matrix provides an applicable solution to map spatial data and estimate spatial autocorrelation structure and covariate effect in ecological studies.

[1] Associate (WY) and Assistant Professor (ZF), Mississippi State University, Department of Forestry, Thompson Hall, P.O. Box 9681, Mississippi State University, Mississippi State, MS 39762-9681; Research Forester (WKM), U.S. Forest Service, Northern Research Station.
ZF is corresponding author: to contact, call 662-325-5809 or email at zfan@cfr.msstate.edu.

PROJECTING CLIMATE CHANGE IMPACTS ON DOWN WOODY MATERIALS IN THE EASTERN U.S. FORESTS

Zhaofei Fan, Christopher W. Woodall, and Stephen R. Shifley[1]

Abstract.—Down woody material (DWM) is dead biomass that originates from tree/plant mortality in forest ecosystems. DWM is an indicator of forest ecosystem health and can be used to evaluate fire risk, wildlife habitat, and forest carbon stocks. Total DWM and components (coarse woody debris, fine woody debris, litter, and duff) are measured on the Forest Inventory and Analysis (FIA) Phase 3 plots. In this study we employed a two-stage modeling strategy to combine the Phase 2 and Phase 3 plots to map the distribution of major DWM components across the eastern United States. We first used data from the Phase 3 plots to develop a set of semiparametric penalized spline functions to estimate DWM components based on a set of covariates that were measured for both the Phase 3 and the Phase 2 plots. Then we used the derived spline models to estimate DWM components for all Phase 2 plots and map the distribution of DWM components at selected resolutions that are pertinent to management needs. We used multivariate classification and regression tree to evaluate the impact of climatic variables on distributional patterns of DWM components. By integrating design-based information and model-assisted inference this approach improves the efficiency of the estimators of DWM components compared to the design-based estimators. Finally, we explored the ecological implications of current patterns of DWM (by components) for major forest cover types and ecoregions in the eastern United States and discussed the potential impacts of management practices on hardwood forest ecosystems.

[1] Assistant Professor (ZF), Mississippi State University, Department of Forestry, Thompson Hall, P.O. Box 9681, Mississippi State University, Mississippi State, MS 39762-9681; Research Forester (CWW and SRS), U.S. Forest Service, Northern Research Station. ZF is corresponding author: to contact, call 662-325-5809 or email at zfan@cfr.msstate.edu.

SPREAD OF CHINESE TALLOW IN EAST TEXAS USING FIA DATA

Zhaofei Fan[1]

Abstract.—Chinese tallow tree (*Triadica sebifera* [L.] Small) is an invasive species that is replacing native ecosystems in areas of eastern Texas. It is imperative that the spatial pattern of the spread of this species be identified, as well as causal mechanisms. To that end, we seek to determine factors that contribute to the spread of Chinese tallow using autologistic regression. We also attempt to identify current locations and spread rates across eastern Texas using Forest Inventory Analysis (FIA) data within major forest types. Distance to roads, disturbances (natural and anthropogenic), and low slope were identified as major factors for the occurrence of Chinese tallow. The highest probability of occurrence and spread rate of Chinese tallow were found in the oak/gum/cypress forest type. Continued disturbance, from harvest events or natural disasters will allow the species to continue to spread throughout the region and could threaten overall forest productivity. We also discuss some implications of the continued spread of Chinese tallow on forest management. Forest managers could benefit from this analysis and use it as a guide for monitoring forest types with the highest risk of invasion.

[1] Assistant Professor, Mississippi State University, Department of Forestry, Thompson Hall, P.O. Box 9681, Mississippi State, MS 39762-9681. To contact, call 662-325-5809 or email at zfan@cfr.msstate.edu.

TEMPO-SPATIAL TRENDS OF OAK DECLINE AND MORTALITY UNDER PERIODIC REGIONAL DROUGHTS IN THE OZARK HIGHLANDS OF ARKANSAS AND MISSOURI

Shirley X. Fan, Zhaofei Fan, W. Keith Moser, Matin A. Spetich, and Stephen R. Shifley[1]

Abstract.—Oak decline and mortality trends for major oak species (groups) was explored in the Ozark highlands of Arkansas and Missouri at the forest landscape/region level, based on annual FIA plot data from 1999 to 2010. Oak decline has elevated cumulative mortality of red oak species to 11 and 15 percent in terms of relative density and basal area of standing dead oak trees, respectively; this rate is two to three times higher than for white oak group and non-oak species.

Oak decline and associated escalating mortality have occurred primarily within red oak species while white oak group maintain a relatively stable mortality rate comparable to non-oak species. Cross-correlation analyses indicate that mortality was significantly correlated with the growing season Palmer Drought Severity Index (PDSI) and usually lagged 2 to 3 years following single drought events. Moreover, based on the past 17 year's PDSI data, it appears that the cumulative impacts of drought may last up to 10 years. The Ozark highlands experienced a severe drought extending from 1998 to 2000 and another milder drought from 2005 to 2006. These drought events triggered the escalation of mortality starting around year 2000. Spatially, high mortality of red oak (hot spots proportional basal area mortality > 0.15) occurred mainly in the central area of the Ozarks. Moderate mortality (proportional basal area mortality of 0.10 to 0.15) was widely dispersed over most of the Ozark highlands, while low mortality was distributed around the outer perimeter of the Ozarks. In contrast, in the white oak group and non-oak species, high mortality was rare and moderate mortality was sporadic. Cumulative mortality of these species was predominant throughout the Ozarks.

[1] Associate (SXF) and Assistant Professor (ZF), Mississippi State University, Department of Forestry, Mississippi State, MS 39762; Research Forester (WKM), U.S. Forest Service, Northern Research Station; Research Forest Ecologist (MAS), U.S. Forest Service, Southern Research Station; Research Forester (SRS), U.S. Forest Service, Northern Research Station. ZF is corresponding author: to contact, call 662-325-5809 or email at zfan@cfr.msstate.edu.

ESTIMATING BIOMASS AND CARBON IN FORESTS OF THE PACIFIC STATES: STATISTICAL ISSUES

Andrew N. Gray and Hailemariam Temesgen[1]

Abstract.—Increasingly, large-scale estimates of biomass and carbon play significant roles in providing critical information to forest resource management and policy decisionmaking. Biomass and carbon estimates are required to monitor CO2 mitigation projects, characterize forest productivity, and estimate carbon flux. Yet, estimating biomass and carbon for large-scale inventory and monitoring is a difficult task. The amount of bias introduced by using locally developed equations to estimate biomass and carbon across large regions is not known. Equations are either not available or poorly developed for important species and important components of carbon storage like standing dead trees. In addition, the Pacific states are characterized by some of the largest trees and most remote landscapes in the country, which complicates sampling and measurement.

Using ground data collected from across a range of major forest types in Pacific Northwest, we demonstrate selected approaches that might improve regional biomass and carbon estimates. In this presentation, we discuss 1) the suitability and predictive abilities of selected methods to quantify biomass and carbon in different forest types of the Pacific Northwest; 2) the use of selected methods to quantify types and frequency of dead trees/snags and their contributions to biomass/carbon pools; and 3) the challenges and opportunities in estimating biomass and carbon. In addition, we will discuss existing gaps and emerging technologies that might offer opportunities to quantify biomass and carbon inventories.

[1] Research Ecologist (ANG), U.S. Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR; Associate Professor (HT), Oregon State University, Corvallis, OR. AG is corresponding author: to contact, call 541-750-7252 or email at agray01@fs.fed.us.

YELLOW BIRCH AND ACID DEPOSITION IN THE SOUTHERN APPALACHIANS

Kenneth W. Stolte, Walter C. Shortle, Kevin T. Smith, Michael Amacher, Charles H. Perry, Lindsay Majer, and Owen Carson[1]

Abstract.—Aerial observations of small clusters of large, standing dead trees in higher elevations of the southern Appalachians (SoApps) in 2005 were later identified as yellow birch (YB) growing in areas of low soil pH and calcium. Yellow birch is a common tree in the maple-beech-birch forests of the northeast United States and higher elevations of the SoApps. It cannot move calcium from older to newer growing tissues and low soil-calcium conditions cause reduced growth and increased vulnerability to damage and mortality from drought, insects, fungi, storms, and other stressors. Black cherry is a common associate with yellow birch but can translocate Ca within tissues and therefore is relatively tolerant of low soil calcium. We used FIA Phase 2 data to locate 48 survey sites in parts of ecoregion subsections M221Dc and M221Dd where larger diamater (>15 inches at breast height) YB were found. At each site we established polygons based on randomly located 5+ YB in each of three target size classes (5-12, 12-15, and >15 inches d.b.h.) in 2010. Yellow birch was evaluated for crown condition (dieback, transparency, ratio, position); damage (type, location, and severity); d.b.h and height; and seedling and sapling regeneration. We also recorded sites that had associated black cherry with d.b.h. >8 inches. Mineral soil samples from 2 depths (0-4 and 4-8 inches) were collected under three randomly selected largest diameter class YB trees and analyzed by the Northern Research Station Forest Inventory and Analysis soils laboratory. We found low soil pH and calcium, and high aluminum, Fe, S, and other toxins correlated with higher elevation sites. The largest diameter yellow birch trees had the highest damage index scores. Seedling and sapling regeneration was highly variable with little or no regeneration at many sites. In late summer of 2011, we obtained tree ring cores from a subset of 26 sites with large diameter yellow birch and black cherry trees for growth of the outer 1 inch of the largest diameter trees of both species, and created shallow wound holes in the same trees to evaluate would response over time. On average, 33 years were required to add 1 inch diameter of growth to yellow birch trees (n=126) and 14 years for black cherry trees (n=62). Shallow wounds on most black cherry had filled with sap, while most of the yellow birch wound holes remained dry 3 months later. A second evaluation of wound response and collection of soil humus for chemical analysis in autumn 2012 is scheduled.

[1] Research Ecologist (KWS), U.S. Forest Service, Southern Research Station, 3041 Cornwallis Road, Research Triangle Park, NC 27709; Plant Pathologists (WCS and KTS), U.S. Forest Service, Northern Research Station; Research Soil Scientist (MA), U.S. Forest Service, Rocky Mountain Research Station; Research Soil Scientist (CHP), U.S. Forest Service, Northern Research Station; Associates (LM and OC), Equinox Environmental, Asheville, NC. KS is corresponding author: to contact, call 919-549-4022 or email at kstolte@fs.fed.us.

IMPROVING LIDAR BASED PREDICTION OF FOREST BIOMASS USING MODELS WITH SPATIALLY VARYING COEFFICIENTS

Chad Babcock, Andrew O. Finley, and John B. Bradford[1]

Abstract.—Many studies and production inventory systems have shown the utility of coupling covariates derived from Light Detection and Ranging (LiDAR) data with forest variables measured on geo-referenced inventory plots through regression models. The objectives of this study were to propose and assess the use of 1) a new technique for LiDAR variable extraction using Singular Value Decomposition to obtain uncorrelated covariates; and 2) a Bayesian hierarchical modeling framework that accommodates both residual spatial dependence and non-stationarity of model covariates through the introduction of spatial random effects. We explore these objectives using three forest inventory datasets that are part of the North American Carbon Program each comprising point-referenced measures of aboveground forest biomass and discrete LiDAR. For each dataset, we considered three LiDAR variable extraction methods and three regression model specifications. Models were assessed based on fit criteria and predictive performance using a leave-one-out cross-validation. Results showed that among the LiDAR variable extraction methods, no single set of covariates offered a consistent advantage across the datasets. The addition of spatial random effects to the regression model intercept only improved fit and predictive performance in the presence of substantial residual spatial dependence. Allowing all regression slope parameters to vary spatially, via the addition of spatial random effects, greatly improved model fit and predictive performance across all datasets. The proposed Bayesian modeling framework also provides access to pixel-level posterior predictive distributions that are useful for uncertainty assessment.

[1] Graduate Student (CB), Michigan State University, Department of Geography, East Lansing, MI 48824; Assistant Professor (AOF), Michigan State University; Research Ecologist (JBB), U.S. Geological Survey. AOF is corresponding author: to contact, call 517-432-7219 or email at finleya@msu.edu.

HOT-DECK MATCHING OF ANNUAL INVENTORY PLOTS TO ENHANCE TRENDS AND PROJECTIONS

Paul C. Van Deusen[1]

Abstract.—Annual forest inventory plots awaiting remeasurement can be matched with plots that can serve as pseudo remeasurements using various hot-deck matching schemes. It will be shown that some matching approaches allow for short-term projections that reflect a business as usual (BAU) scenario and require few assumptions. These methods also allow for creating scenarios that reflect increasing frequency of particular events relative to what occurs in the BAU scenario. Scenarios are generated where increasing future harvest levels are controlled to demonstrate this capability. The moving average, as applied by U.S. Forest Service Forest Inventory and Analysis (FIA), is typically linked to an evaluation group. It is noted that this linkage is unnecessary and limits the value and flexibility of the method. The combination of short-term projections with an n-year moving average is suggested to provide trend estimates that encompass the current year and a few years into the future. These methods are not difficult to implement and they expand the utility of FIA data. As the number of FIA plots with multiple remeasurements increases, estimation methods should be enhanced to take advantage of the increasing value of the database. The methods are demonstrated with several operational size applications to FIA data.

[1] Principal Research Scientist (PCVD), National Council of Air and Stream Improvement, Tewksbury, MA 01876. To contact, email at pvandeusen@ncasi.org.