



**College of Forestry and the
Oregon Forest Research Laboratory**

2005 Annual Bibliography





From the Director's Desk

Oregon's 'Living Legacy' is 28 million acres of forested land. This represents nearly half of the state's landmass. These forests provide a variety of economic, social, and environmental values that benefit Oregonians today and for future generations. The Oregon Forest Research Laboratory has a mission to continually enhance these values through research in the forest, biological, engineering, social, and economic sciences. This bibliography recaps the research efforts of our scientists.

Advancing our scientific knowledge is a never-ending process. Scientists develop questions from their observations, offer possible theories, set up experiments, collect and analyze data, draw conclusions regarding their theories, and then publish their results. This 'new' knowledge is then challenged by other scientists with differing theories or incorporated into research that seeks to expand upon the initial findings.

This annotated bibliography is designed to help the process by identifying the publications of Oregon Forest Research Laboratory scientists for the period January 1, 2005 to December 31, 2005. The listings are arranged by major areas of research. The research projects identified in this bibliography were supported by grants from public agencies and private industries, donors, Oregon appropriations, and Oregon Harvest Tax revenues. Reprints of many of these articles are available from the Forestry Communications Group at <http://fcg.cof.orst.edu/> or directly from the authors.

I believe a review of this document will show the broad spectrum of research conducted by our scientists. The knowledge they obtain and deliver is critical for forestry in Oregon, the nation, and the world. It helps inform policy decisions, educates other scientists and students, assists landowners and land managers, and helps forest-related businesses remain competitive.

Hal Salwasser

Research results find application in many areas as Oregon Forest Research Laboratory scientists and their cooperators publish their findings. Papers published between January 1, 2005 and December 31, 2005 are grouped here according to the Oregon Forest Research Laboratory's five program areas:

- Forest Regeneration
- Forest Ecology, Culture, and Productivity
- Integrated Protection of Forests and Watersheds
- Evaluation of Forest Uses, Practices, and Policies
- Wood Processing and Product Performance

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Forest Regeneration

Boys, J, M Cherry, and S Dayanandan.

2005. Microsatellite analysis reveals genetically distinct populations of red pine (*Pinus resinosa*, Pinaceae). *American Journal of Botany* 92: 833–841.

For tree geneticists and biotechnologists. Red pine, *Pinus resinosa* Ait., is considered one of the most genetically depauperate conifers in northeastern North America. The authors isolated and characterized 13 nuclear microsatellite loci from the species and analyzed >500 individuals from 17 populations. They identified five polymorphic microsatellite loci with nine alleles/locus, on average. All populations showed high levels of inbreeding. Population differentiation was high. Three populations in New Brunswick and Nova Scotia were genetically distinct from the other 14; isolation probably occurred during the most recent Pleistocene glacial period. Red pine may have evolved a highly selfing mating system in response to isolation and population bottlenecks.

Bradford, K, AV Deynze, N Gutterson, W Parrot, and S Strauss. 2005. Regulating transgenic crops sensibly: lessons from plant breeding, biotechnology, and genomics. *Nature Biotechnology* 23: 439–444.

For plant geneticists and biotechnologists. Commercialization of transgenic crops is currently very expensive because of the costs of meeting national and international regulatory requirements and market restrictions. The authors present arguments for the relaxing of regulatory restrictions to reduce costs and uncertainty in situations where a gene or trait has been shown to be safe. They propose that regulatory emphasis be on phenotypic, rather than genotypic, characteristics once safety has been established.

Burkett, VR, RO Draugelis-Dale, HM

Williams, and SH Schoenholtz. 2005. Effects of flooding regime and seedling treatment on early survival and growth of Nuttall oak. *Restoration Ecology* 13: 471–479.

For restoration ecologists. Three types of 1-0 seedlings [bareroot, container-grown, and container-grown and inoculated with *Pisolithus tinctorius* (Pers.) Coker] of Nuttall oak (*Quercus texana* Buckl.) were planted at two elevations on flood-prone former cropland with clay soil. The effects of flooding were observed after three and five growing seasons. The lower elevation site was flooded for 21 days during the first growing season; the higher elevation site did not flood during the study. Survival of all three types was highest at the lower elevation. Survival of inoculated seedlings was higher than that of uninoculated container seedlings at both sites in year 3. Bareroot and inoculated container seedlings did not differ significantly in survival at either elevation, but bareroot seedlings survived better than uninoculated container seedlings at the higher elevation. After 5 years, the bareroot seedlings at both elevations were taller than either type of container-grown seedlings. Since there were no differences in survival, bareroot seedlings seem the most economical choice.

Busov, V, A Brunner, R Meilan, S Filichkin, L Ganio, S Gandhi, and S Strauss. 2005. Genetic transformation: a powerful tool for dissection of adaptive traits in trees. *New Phytologist* 167: 9–17.

For tree geneticists and biotechnologists. Transgenic approaches have been widely adopted in studies of plant mo-

lecular biology and functional genomics, but their incorporation into ecological genetics and plant adaptation to natural environments has been slower. Nevertheless, transformation has a great deal of potential for establishing direct linkages between genes and adaptive phenotypes in trees, where several factors make production of near-isogenic lines and large experiments difficult. Poplars in particular offer several advantages as a model system for using transformation to gain insight into genes controlling adaptive traits. These advantages and transformation-based approaches to studying ecophysiological adaptation are discussed in detail.

Gray, AN, HSJ Zald, RA Kern, and M North. 2005. Stand conditions associated with tree regeneration in Sierran mixed-conifer forests. *Forest Science* 51: 198–210.

For silviculturists. Increased canopy cover, litter depth, and stem density resulting from fire suppression alter microsite conditions affecting tree regeneration. In this study of a mixed-conifer forest, most of the conifer species were on relatively moist soil and got relatively little sunlight. Seedlings established on intact litter and forest floor, as well as on mineral soil. Mortality of planted seedlings was high. Shrub-dominated patches had few young conifers. Large gaps appeared to be hostile environments for establishment of seedlings. Tree establishment may benefit from reduction in shrub cover, but reducing canopy cover may not be advantageous.

Additional Program Area: Forest Ecology, Culture, and Productivity

Haase, DL, DF Jacobs, SC Grossnickle, LS Rosner, and JH Taylor. 2005. Forest

seedling root development from the nursery to the field, Eugene, Oregon, USA, May 2004. *New Forests* 30:103–311.

For nursery personnel and silviculturists. This special issue contains 11 selected papers providing qualitative data on seedling root development applicable to modern nursery and field practices, as well as detailed research trials focusing on nursery and biological considerations of forest seedling development.

Howe, GT, and AM Brunner. 2005. An evolving approach to understanding plant adaptation. *New Phytologist* 167: 1–5.

For plant and evolutionary biologists. This article introduces a feature issue stemming from the 12th New Phytologist symposium, "Functional genomics of environmental adaptation in *Populus*". Trees present several advantages for genetics of adaptation, and studies of forest trees are expected to have an important niche as studies linking gene function molecular biology with whole-plant physiology, ecology, and evolution. The *Populus* system, in particular, has many characteristics useful in such studies. The authors discuss these advantages and point out that broad cross-disciplinary collaboration will be needed in order to form a complete understanding of the molecular genetic basis of adaptation.

Additional Program Area: Forest Ecology, Culture, and Productivity

Jacobs, DF, DL Haase, and R Rose. 2005. Growth and foliar nutrition of Douglas-fir seedlings provided with supplemental polymer-coated fertilizer. *Western Journal of Applied Forestry* 20: 58–63.

For silviculturists, forest managers, and tree nursery personnel. The coating technology used in producing controlled-release polymer-coated fertilizer

(PCF) differs by manufacturer and may affect release of nutrients over time. Douglas-fir seedlings were transplanted into containers containing one of two PCF products, each applied at one of four rates. Conventional water-soluble fertilizer was also applied periodically. Differences in seedling diameter growth were apparent between fertilizers at 4 months but had become negligible after 9 months. Seedling response among rates was marginal, indicating that PCF may provide little benefit when water-soluble fertilizer is also used. The PCF products appeared to differ in temporal patterns of nutrient release, which may affect seedling development over time. Growers must understand differences among products in order to formulate fertilizer prescriptions that optimize plant response.

Johnson, GR, and C Cartwright. 2005. Genotype x shade effects for western hemlock. *Canadian Journal of Forest Research* 35: 1496–1501.

For silviculturists, tree breeders and geneticists, and tree nursery personnel. As a result of forest management for multiple objectives in the Pacific Northwest, seedlings may be planted in a range of light, nutrient, and moisture conditions. Progeny tests in the region are usually established in open areas, leading to questions about the extent of genotype x shade interaction in different tree species. Families of western hemlock [*Tsuga heterophylla* (Raf.) Sarg.] were grown under different levels of shade for 2 or 3 years; one study was at a nursery in British Columbia and the other at a nursery in Oregon. Although differences were found for both levels of shade and families, there was no family x shade interaction. The authors conclude that families selected in full-sun conditions may also be suitable for planting in understory conditions.

Maas-Hebner, K, W Emmingham, D Larson, and S Chan. 2005. Establish-

ment and growth of native hardwood and conifer seedlings underplanted in thinned Douglas-fir stands. *Forest Ecology and Management* 208: 331–335.

For forest managers, silviculturists, and forest ecologists. Seven species of native trees (five conifers and two hardwoods) were planted in 30-year-old Douglas-fir plantations that had had one of three thinning treatments (252, 138, or 72 trees/acre) or been left unthinned (547 trees/acre). Mortality of both conifers and hardwoods was nearly total in unthinned stands 4 years after underplanting. After 8 years, survival of conifers in thinned stands ranged from 87% to 94%, and survival of hardwoods, from 61% to 94%. Underplanting was successful in wide or very wide canopy spacings, where light levels were higher. Western hemlock was ranked as the most suitable conifer for underplanting, followed by Sitka spruce, Douglas-fir, grand fir, and western redcedar. Red alder would also be suitable. Because bigleaf maple and western redcedar were heavily and repeatedly browsed, these species would require protection if underplanted.

Additional Program Area: Forest Ecology, Culture, and Productivity

Maguire, CC, WT Adams, and RG Kelsey. 2005. Additional studies using CFIRP treatments: Douglas-fir genetics and ambrosia beetle log colonization, pp. 104–121 in *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*, CC Maguire and CL Chambers, eds. Research Contribution 46, Forest Research Laboratory, Oregon State University, Corvallis.

For tree geneticists, forest entomologists, and phytochemical ecologists. Genetic analysis of allozymes showed that harvesting followed by natural regeneration had little impact on the

allozyme composition of the Douglas-fir stands studied, with the exception of rare alleles lost in two-story treatments. Under such a regime, trees left as parents of the new generation should include a range of sizes in order to maximize retention of allelic diversity. Gene dispersal studies in two-story stands showed that seeds from relatively few females capture much of the genetic diversity in a local population. Ethanol in felled logs appeared to function as an attack stimulant for ambrosia beetles. Retaining branches on logs can decrease ethanol concentrations and ambrosia beetle gallery formation.

Additional Program Area: Integrated Protection of Forests and Watersheds

Rose, R, and DL Haase. 2005. Root and shoot allometry of bareroot and container Douglas-fir seedlings. *New Forests* 30: 215–233.

For silviculturists, tree nursery personnel, and researchers and practitioners in reforestation. Differences between bareroot and container seedling root development were quantified at two diverse sites: raised beds under ideal environmental conditions and a field reforestation site. Container seedlings had more new roots and root and shoot growth than bareroot seedlings at several points during the spring following outplant. However, seedlings excavated in the fall showed no differences among stocktype. Although growth was much greater in the raised beds, relative differences between stocktypes were similar. Water content was significantly higher in container seedlings than in bareroot seedlings at the field site on all samples dates and on three dates (two in spring and one in fall) in the raised bed site.

Additional Program Area: Forest Ecology, Culture, and Productivity

Rose, R, and L Rosner. 2005. Eighth-year response of Douglas-fir seedlings to

area of weed control and herbaceous versus woody weed control. *Annals of Forest Science* 62: 481–492.

For silviculturists and forestland managers. Eight weed control treatments were applied at planting to coastal Douglas-fir at two sites, and the growth response of the trees was followed for 8 years. Six treatments involved total vegetation control around trees for distances ranging from 0.0 to 9.63 m²; one involved control of herbaceous competition only; and one, control of woody competition only. Douglas-fir growth gained the most when control was increased from 0.0 to 0.375 m² but continued to increase as area of control increased. Herbaceous control increased growth at both sites, but woody control was effective at only one site, which had a hardwood species with greater potential height growth.

Slavov, GT, GT Howe, and WT Adams. 2005. Pollen contamination and mating patterns in a Douglas-fir seed orchard as measured by simple sequence repeat markers. *Canadian Journal of Forest Research* 35: 1592–1603.

For tree geneticists and biotechnologists. Pollen contamination and patterns of within-orchard mating can be identified by using simple sequence repeat markers to identify both parents of each seed produced in the orchard. Seed samples were collected in 3 years from one block of an open-pollinated, clonal seed orchard in western Oregon, and nine SSR markers were used to determine pollen contamination and mating patterns. Pollen contamination, which apparently resulted primarily from cross pollination among orchard blocks, was consistently high across the years. Clones varied widely in levels of pollen contamination, and contamination was highest in clones with early female receptivity. Self-pollination was low. The clones differed more than 10-fold in relative paternal contributions. Floral

phenology showed a clear pattern of positive assortative mating.

Slavov, GT, GT Howe, AV Gyaourova, DS Birkes, and WT Adams. 2005. Estimating pollen flow using SSR markers and paternity exclusion: accounting for mistyping. *Molecular Ecology* 14: 3109–3121.

For forest geneticists and biotechnologists. Although genetic markers such as simple sequence repeats (SSRs) can be used to measure pollen flow, mistyping can substantially bias the resulting estimates. The authors used computer simulations to evaluate a direct method for estimating pollen immigration that accounts for mistyping and does not rely on assumptions about distribution of male reproductive success. From five to seven highly variable SSR loci were necessary to obtain reliable estimates of pollen immigration for a sampling scheme applicable to most conifers, and between five and nine were needed for a scheme applicable to all diploid plants. The pollen flow computer program developed by the authors can be used to generate unbiased, precise estimates of pollen immigration under a wide range of conditions.

St Clair, JB, NL Mandel, and KW Vance-Borland. 2005. Genecology of Douglas Fir in Western Oregon and Washington. *Annals of Botany* 96: 1199–1214.

For forest geneticists and regeneration foresters. In order to understand evolutionary processes and adaptation more fully and manage genetic resources, we must understand the geographical structure of genetic variation and its relation to environments. In spite of its ecological and economic importance, previous studies of the genecology of Douglas-fir have been inconclusive. Using an extensive and intensive sampling strategy, canonical correlation analysis, and GIS, the authors mapped genetic variation of growth and adaptive traits with respect to environment over the

entire range of coastal Douglas-fir in Washington and Oregon. Winter temperatures and frost dates were the most important factors in adaptation. Populations were quite different for adaptive traits. Variation in budset, emergence, and growth was related strongly to elevation and cool-season temperatures, whereas variation in budburst and partitioning to stem diameter versus height was related to latitude and summer drought. Growth and phenological differences between seedlings from the east and west side of the Washington Cascades were hypothesized to result from the presence of the interior variety of Douglas-fir on the east side. The methods used in mapping permitted easy visualization of a complex array of traits and their relationship to a complex group of environments.

Additional Program Area: Forest Ecology, Culture, and Productivity

Valkonen, S, and DA Maguire. 2005. Relationship between seedbed properties

and the emergence of spruce germinants in recently cut Norway spruce selection stands in Southern Finland. *Forest Ecology and Management* 210: 255–266.

For silviculturists and forestland managers. The effects of type and amount of ground vegetation and substrate and of removal of ground vegetation on germination and early survival of Norway spruce [*Picea abies* (L.) Karst] were assessed in uneven-aged stands of average site quality on mineral soil. Two permanent plots were set up, each at a different location, and each with a gradient in selection cut intensity and residual stand density. Regeneration and vegetation were surveyed in detail in each of the following 2 years. Spruce germinants/unit area were correlated positively with herb cover and negatively with total plant cover. Domination of sites by moss or plants with high light demand appeared to reduce germinant numbers, whereas germinants increased where there was a bare humus layer or decayed stumps. Practical ramifications of the results are discussed.

Zenner, EK, KJ Puettmann, and JA Krueger. 2005. Early growth responses of naturally regenerated eastern white pine (*Pinus strobus* L.) to partial release from juvenile aspen and pathological pruning. *Northern Journal of Applied Forestry* 22: 27–34.

For silviculturists and forestland managers. Growth responses of young white pine (7–12 years old) to partial release from 15-year-old aspen and pruning away of diseased or disease-susceptible branches were assessed over four growing seasons. Increasing aspen densities and pruning reduced growth rates of white pine ≤ 190 cm tall but did not affect growth rates of white pine >190 cm. Pruning affected small white pine only in the first 2 years after release. Upper stratum aspen responded vigorously to release. Early release from upper stratum juvenile aspen should allow conversion of an aspen cover to mixed aspen-white pine, but repeated interventions may be necessary. Pruning to prevent infections under a partial canopy many not be worth the expense.

Forest Ecology, Culture, and Productivity

Adams, W, S Hobbs, and N Johnson.

2005. Intensively managed forest plantations in the Pacific Northwest: Introduction. *Journal of Forestry* 103: 59–60.

For silviculturists and forestland managers. The authors introduce a set of papers synthesizing the presentations at a symposium treating the potential and roles of intensively managed forest plantations in the Pacific Northwest. The papers covered provocative topics about the biology, economics, environmental impact, and social issues surrounding intensively managed forest plantations.

Adams, W, S Hobbs, and N Johnson. 2005. Intensively managed forest plantations in the Pacific Northwest: Conclusions. *Journal of Forestry* 103: 99–100.

For silviculturists and forestland managers. The authors' remarks conclude a set of papers synthesizing the presentations at a symposium treating the potential and roles of intensively managed forest plantations (IMFPs) in the Pacific Northwest. The papers, presented in a dedicated issue of *Journal of Forestry*, covered provocative topics about the biology, economics, environmental impact, and social issues surrounding intensively managed forest plantations. In the context of questions proposed to the presenters as foci, the authors draw several conclusions about the need for IMFPs in maintaining competitiveness in world markets, the research and development required to advance their usefulness, and the social and environmental issues they raise.

Allen, M, C Crisafulli, S Morris, L Egerton-Warburton, J MacMahon, and J Trappe. 2005. Mycorrhizae and Mount

St. Helens: story of a symbiosis, pp. 221–231 in *Ecological Responses to the 1980 Eruption of Mount St. Helens*, V Dale, F Swanson, and C Crisafulli, eds. Springer, New York.

For plant ecologists and mycorrhiza researchers. Revegetation of the devastation zone resulting from the 1980 eruption of Mount Saint Helens depended on availability of mycorrhizal fungi. Invasion of these fungi into the tephra deposits was catalyzed by animals, especially elk, and happened faster than anticipated. The elk feces contained spores of endomycorrhizal fungi, which facilitated establishment of herbaceous plants and shrubs. Within a decade after the eruption, mycorrhizal plants and their fungi were well established and within two decades a high diversity of plants and mycorrhizal fungi had gained a foothold in the devastation zone, even on the initially sterile pyroclastic flow. These results strongly demonstrate the importance of interactions between plants, fungi and animals in establishment and functioning of ecosystems.

Amaranthus, M, M Nair, T Reid, and D Steinfeld. 2005. Improved *Rhizopogon* mycorrhizal colonization and foliar nutrient levels in ponderosa pine and Douglas-fir with Myconate®. *Journal of Sustainable Forestry* 20(3): 1–14.

For silviculturists and mycologists. Mycorrhizal inoculum is often used when forest trees are replanted, as mycorrhizae enhance establishment and growth of the seedlings. The ability of the isoflavonoid formononetin (7-hydroxy-4'-methoxy isoflavone), sold as Myconate, to increase colonization has been established for endomycorrhizae. This study compared colonization and foliar nutrient levels in seedlings inoculated

with the ectomycorrhizal fungus *Rhizopogon parksii*, seedlings inoculated with *R. parksii* plus Myconate, and untreated seedlings. Myconate increased mycorrhizal colonization of both species tested when applied at 60 mg/ml. In Douglas-fir, potassium content was highest in Myconate-treated seedlings; phosphorus and nitrogen levels were similar in both inoculated treatments and higher than in untreated seedlings. In ponderosa pine, only nitrogen was higher in the Myconate treatment. Caliper size of Douglas-fir was greater than the control in both inoculation treatments. Myconate treatment did not increase caliper size of ponderosa pine.

Andrews, LS, JP Perkins, JA Thrailkill, N Poage, and JC Tappeiner II. 2005. Silvicultural approaches to develop northern spotted owl nesting sites, central Coast Ranges, Oregon. *Western Journal of Applied Forestry* 20: 13–27.

For silviculturists, ornithologists, and ecologists. Using an individual-tree, distance-independent growth model to explore management scenarios for young Douglas-fir stands, the authors estimated which scenarios promoted development among forest patches that are similar to actual spotted owl nesting sites in the central Coastal Ranges of Oregon. They conclude that silvicultural activities in federally managed late-successional reserves may need to include alternatives beyond those permitted under current land use guidelines in order to speed up the development of stand structures required by spotted owls.

Aruga, K, J Sessions, A Akay, and W Chung. 2005. Simultaneous optimization of horizontal and vertical align-

ments of forest roads using Tabu search. *International Journal of Forest Engineering* 16(2): 137–151.

For forest engineers and harvest planners. Forest engineers often find it difficult to design the optimum road alignment, given the many diverse social, economic, and environmental factors involved. Programs available to help with optimal design usually optimize horizontal or vertical alignments, but ideally both alignments should be optimized simultaneously. In this study, the authors developed the Tabu Search algorithm into a forest road design model that uses a high resolution Digital Elevation Model (DEM) to optimize horizontal and vertical alignments separately. They then tested the model, using a DEM from part of the Capitol Forest in Washington State. The optimized alignment reduced road length by 19% and the total cost by 36% relative to the initial horizontal alignment.

Additional Program Area: Integrated Protection of Forests and Watersheds

Bachelet, D, J Lenihan, R Neilson, R Drapek, and T Kittel. 2005. Simulating the response of natural ecosystems and their fire regimes to climatic variability in Alaska. *Canadian Journal of Forest Research* 35: 2244–2257.

For ecologists and ecosystem modelers. The authors studied interactions among climate, fire, and ecosystems, using the dynamic global vegetation model MC1. Climate conditions were defined as historical (1992–1996) and future (1997–2100). Boreal and temperate forests were projected to replace 75%–90% of the area simulated as tundra in 1922 by the end of the 21st century. In the warmer climate-change scenario, projected carbon (C) loss to fire between 2025 and 2099 was greater than the C gained, whereas in the alternative scenario projected C loss to fire was only ~40% of C gained. Overall, simulated C gains increase during the 21st

century until, by the last decade, Alaska becomes a net C source.

Becerra, A, E Nouhra, D Graciela, L Dominguez, and D McKay. 2005. Ectomycorrhizas of *Cortinarius helodes* and *Gyrodon monticola* with *Alnus acuminata* from Argentina. *Mycorrhiza* 15: 7–15.

For mycologists and fungal taxonomists. Using morphological and anatomical features, the authors describe ectomycorrhizas of *Gyrodon monticola* Sing. and of a new species, *Corinarium helodes* Mosder, Matheny & Daniele. The ectomycorrhizas were collected on Andean alder, *Alnus acuminata* Kunth, on two alder forest sites in Tucuman and Catamarca provinces, Argentina. In addition, they conducted restriction fragment length polymorphism analysis of the nuclear rDNA internal transcribed spacer. Profiles obtained by this analysis were distinctive for each of the collections of fruiting bodies and the mycorrhizal morphotypes.

Beggs, LR, KJ Puettmann, and GF Tucker. 2005. Vegetation response to alternative thinning treatments in young Douglas-fir stands, pp. 243–248 in *Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry: Proceedings of a Conference, August 19–20, 2004, Portland, Oregon*, CE Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For silviculturists and forestland managers. Young managed forests often do not have structural components that are associated with old-growth forests and have been identified as providing key ecosystem services. They therefore may not be able to support a diversity of species that depend on late-successional habitat. The Young Stand Thinning and Diversity Study, established in the lower Cascade Range in Oregon, was set up to determine whether

alternative thinning regimes applied to young managed stands could accelerate development of such habitat, promote biodiversity, and allow fulfillment of wood production goals. Four thinning treatments were used: unthinned, heavy thin, light thin, and light thin with gaps. Overstory diversity was maintained. Data were gathered on responses of vegetation, bird and small mammal populations, mushroom production, and other factors. Only heavy thinning maintained open canopies over time and enhanced development of large trees. Thinning decreased density-related mortality of Douglas-fir. Vertical canopy structure had as yet shown no difference among treatments.

Berger, CA, and KJ Puettmann. 2005. Development of stand structure in young Douglas-fir plantations, pp. 65–68 in *Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry: Proceedings of a Conference, August 15–20, 2004, Portland, Oregon*, CE Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For silviculturists, ecologists, and forest managers. Early growth rates in old-growth stands of Douglas-fir in the Oregon Coast Range indicate that their initial densities may have been lower than those of current plantations. This has raised concerns that current plantations may not develop into forests providing late successional habitat and that the landscape may become dominated by stems in the late exclusion phase. This study was established to study whether density management can prevent or lessen undesirable aspects of the stem exclusion phase. Tree characteristics and understory vegetation, considered important for diversity of plant life and wildlife habitat, were measured in 39 Douglas-fir plantations, 6 to 20 years old, in three districts in western Oregon. Initially growth was

better in stands with higher basal areas, but density negatively affected tree characteristics before age 20. Over time, understory herb cover decreased and shrub cover increased. Composition of understory vegetation was quite variable, likely influenced by a variety of stand conditions. Maintaining low-density areas in young plantations may allow diverse within-stand conditions favorable to ecosystem function while allowing flexibility in management of high density areas for purposes such as timber production.

Berterretche, M, A Hudak, W Cohen, T Mairersperger, S Gower, and J Dungan. 2005. Comparison of regression and geostatistical methods for mapping Leaf Area Index (LAI) with Landsat ETM+ data over a boreal forest. *Remote Sensing of Environment* 96: 49–61.

For ecologists and those interested in remote sensing. Orthogonal regression analysis (RMA) and two geostatistical techniques, kriging with external drift (KED) and sequential Gaussian conditional simulation (SGCS), were compared with respect to their ability to predict maximum growing season leaf area index (LAI) maps. Consistent with theory, SGCS best preserved the distribution of measured LAI values and preserved anisotropy in semivariograms of measured LAI, and KED reduced anisotropy and lowered global variance. Where spatial prediction is needed, KED appears to be more useful when local accuracy is important, but global pattern is better indicated by SGCS. The RMA method is the most practical for modeling net primary production where inputs have coarse resolution.

Beschta, B. 2005. Reduced cottonwood recruitment following extirpation of wolves in Yellowstone's northern range. *Ecology* 86: 391–403.

For ecologists and wildlife biologists. Long-term recruitment and stand dynamics of cottonwood (*Populus*

sp.) were studied at five sites in Yellowstone's northern range in order to assess potential impacts of herbivory by wild ungulates after gray wolves had been removed from the area. Wild ungulates, principally elk, were determined to be the cause of the relatively small stature and hedged appearance of the Yellowstone cottonwoods. The results of this report, along with related research, point to the loss of wolves at Yellowstone as having a major impact on the recruitment of cottonwood and other woody browse species.

Black, B. 2005. Using tree-ring crossdating techniques to validate age in long-lived fishes. *Canadian Journal of Fisheries and Aquatic Sciences* 62: 2277–2284.

For fisheries biologists. Estimates of fish age obtained by the common technique of counting annual growth increments in otoliths are of great importance in fisheries management, but are subject to significant errors. Several age-validation techniques have been used to reduce such errors, but all have limitations. The authors use a technique, crossdating, commonly used in dendrochronology, or tree-ring analysis. In this technique, growth patterns among samples are cross-matched to assign the correct calendar year to each growth increment. Crossdating was done according to a two-step process: (1) the dates of narrow and wide growth increments were visually checked for general agreement among samples and (2) data were statistically verified by cross-correlating growth increment measurements among samples. Average growth of all 50 samples was significantly correlated with an upwelling index, the Pacific Decadal Oscillation, and the Northern Oscillation Index. Climate appears to induce natural markers in the otolith time series. The authors propose that, especially with research on other species, this technique may be applicable to a variety of long-lived species in marine and freshwater systems.

Black, BA, and MD Abrams. 2005. Disturbance history and climate response in an old-growth hemlock-white pine forest, central Pennsylvania. *Journal of the Torrey Botanical Society* 132(1): 103–114.

For disturbance ecologists and dendrochronologists. Old-growth forests provide historical perspectives on long-term stand dynamics and development and land use that are accessible by dendroecological analysis.

Bollmer, JL, NK Whiteman, MD Cannon, JC Bednarz, T De Vries, and PG Parker. 2005. Population genetics of the Galapagos hawk (*Buteo galapagoensis*): Genetic monomorphism within isolated populations. *Auk* 122: 1210–1224.

For population geneticists, ornithologists, and island ecologists. Samples of DNA were collected from nine island populations of Galápagos hawk that covered its range. Within-island genetic diversity and between-island genetic diversity were calculated by use of neutral minisatellite DNA markers. Reported genetic uniformity of individuals within islands was the highest of any natural bird population. No association between degree of polyandry and genetic variability was found. Most populations were genetically distinct. Genetic similarity was higher between nearby populations. Gene flow among the populations appeared to be negligible. Genetic drift appears to be a major factor in determining structure of the minisatellite loci.

Bower, A, W Adams, D Birkes, and D Nalle. 2005. Response of annual growth ring components to soil moisture deficit in young, plantation-grown Douglas-fir in coastal British Columbia. *Canadian Journal of Forest Research* 35: 2491–2499.

For silviculturists. Increment cores of 16- and 17-year old coastal Douglas fir on

six sites were examined to determine the response of 10 annual growth ring variables to drought over 11 years. A drought response coefficient for each variable and site was derived from the linear regression of the variable against the log of the growing season soil moisture deficit for the same year. Soil moisture deficit apparently influenced ring variables only on the driest of the six sites, where 8 of the 10 variables were significantly related to SMD. Response of annual growth ring variables to drought may allow evaluation of drought hardiness in breeding programs on sites where seasonal soil moisture deficit is high enough to elicit such a response.

Boyle, J. 2005. Forest soils, pp. 73–79 in *Encyclopedia of Soils in the Environment*, D Hillelher, ed. Elsevier, Oxford, UK.

For soil scientists and ecologists. The components and functions of soils are essential to forest productivity and sustainability. After characterizing forest soils, the author discusses roots and mycorrhizae, litterfall and litter with respect to organic matter recycling, biogeochemistry and hydrology, and disturbance and human effects on forest soils. He then discusses ecosystem services of forest soils and criteria and indicators for soils conducive to forest sustainability.

Cairns, MA, and K Lajtha. 2005. Effects of succession on nitrogen export in the west-central Cascades, Oregon. *Ecosystems* 8: 583–601.

For soil scientists and forest managers. Nitrogen (N) deposition affects forest biogeochemical cycling, and N excess has many deleterious effects in forested watersheds. The authors studied the impacts of succession on N export from 20 headwater stream systems in the west central Cascades of Oregon, where little N export results from human activities. Differences in total dissolved N (TDN)

were driven by the seasonal and successional patterns of nitrate concentrations; ammonium concentrations were very low, and concentrations of dissolved organic nitrogen (DON) varied less than those of nitrate. DON accounted for 24, 52, and 51% of the overall mean TDN concentration of young, middle-aged, and old-growth watersheds, respectively. All young successional watersheds >10 years old lost significantly more N, primarily as nitrate, than did watersheds containing more mature forests, even though all forest floor and mineral soil C:N ratios were well above previously reported levels for leaching of dissolved inorganic nitrogen. Alder, which was present at low levels, may have had some influence on these results. Only the youngest watersheds, with the highest nitrate losses, showed increased summer uptake by vegetation and flushing at the onset of fall freshets. Both vegetation and hydrology may be involved in N retention and loss.

Additional Program Area: Protecting Forests and Watersheds

Caldwell, B. 2005. Enzyme activities as a component of soil biodiversity: a review. *Pedobiologia* 49: 637–646.

For soil biologists and biochemists. Microbes in soils perform an essential function by processing and recovering key nutrients from detritus and soil organic matter. Maintaining this and other critical functions may be more important than species diversity in supporting soil and forest health and productivity. Extracellular enzymes are often critical in carrying out nutrient recovery. In this article, the author reviews selected literature with data about soil enzymes that could be useful in distinguishing enzyme sources and substrate specificity within and between major nutrient cycles. The discussion includes substrate specificity, reaction mechanisms, sources of soil enzyme activities, approaches to interpreting soil enzyme functional

diversity, and optimizing available methodologies.

Campbell, JL, and BE Law. 2005. Forest soil respiration across three climatically distinct chronosequences in Oregon. *Biogeochemistry* 73: 109–125.

For biogeochemists, soil biologists, ecologists. This study had three objectives: to quantify annual soil respiration for a full range of age classes in three edaphoclimatically distinct forest types, to determine which of the variables typically used to predict soil respiration at the plot level were the most important sources of regional variation in soil respiration, and to determine how much regional variation can be attributed to disturbance history and how much to edaphoclimatic differences between forest types. Annual soil respiration was affected by forest types, forest age, and type x age interactions. Regional variation in annual soil respiration seemed to depend most on summer base rates (soil respiration normalized to a common temperature) and much less on the site-specific temperature response curves and soil degree-days.

Cazares, E, J Trappe, and A Jumpponen. 2005. Mycorrhiza-plant colonization patterns on a subalpine glacier forefront as a model system of primary succession. *Mycorrhiza* 15: 403–416.

For plant ecologists, mycologists, and mycorrhizologists. Establishment of plants on the forefront of the receding Lyman Glacier of the North Cascade Mountains in Washington relates to availability of propagules of mycorrhizal fungi. This is a primary successional site: the glacial outwash revealed as the glacier recedes has not supported plants before. The earliest plants to establish are those that can survive and reproduce without mycorrhizae, mostly sedges, rushes, and *Saxifraga* spp. Next come willows and ectomycorrhizal conifers, associated with ectomycorrhizal fungi that disperse spores by air.

These spores entered the forefront from adjacent subalpine parkland communities of mountain hemlock, subalpine fir, and subalpine larch. Last to establish are the endomycorrhizal plants, such as bunchgrasses and various herbs; the endomycorrhizal fungi are dispersed by movement of spore-containing soil, which reaches the forefront on feet of visiting deer, elk and mountain goats or by avalanching from cliffs adjacent to the upper forefront.

Chambers, CL, and BC McComb. 2005. *Wildlife responses*, pp. 63–87 in *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*, CC Maguire and CL Chambers, eds. Research Contribution 46, Forest Research Laboratory, Oregon State University, Corvallis.

For wildlife biologists and silviculturists. This chapter reports the responses of wildlife to different levels of disturbance caused by timber removal. The focus was on birds and small mammals. In both breeding seasons and winter, the wildlife community in group selection stands, where there is less disturbance, was most similar to that in uncut control stands, whereas in two-story stands it was most similar to that in clearcuts. Two-story stands appeared to provide the greatest range of habitats. Considerations for land managers in applying results of the CFIRP projects are discussed in detail.

Chambers, CL, RL Johnson, LD Kellogg, JS Ketchum, and WH Emmingham. 2005. *Study area and methods*, pp. 24–44 in *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*, CC Maguire and CL Chambers, eds. Research Contribution 46, Forest Research Laboratory, Oregon State University, Corvallis.

For ecologists, silviculturists, and social scientists. This chapter describes the

study area in which the CFIRP program was carried out and the silvicultural treatments, snag treatment, implementation, research strategy, social and recreational research, and data management used in the project.

Claridge, A, and J Trappe. 2005. *Sporocarp mycophagy: nutritional, behavioral, evolutionary and physiological aspects*, pp. 599–611 in *The Fungal Community—Its Organization and Role in the Ecosystem*, J Dighton, J White, and P Oudemans, eds. Taylor & Francis, Boca Raton FL.

For forest and wildlife ecologists and mycologists. Mycophagy, the use of fungal fruit-bodies as food by animals, is an important feature of forests around the world. Animals such as northern flying squirrels in North America and long-footed potoroos in Australia subsist primarily on truffles and truffle-like fungi. Other animals, from deer mice to elk, eat truffles opportunistically. The fungi, which form a vital mutualistic symbiosis with trees, have evolved to disperse their spores by the animals that eat them and are highly nutritious.

Coops, NC, RH Waring, and BE Law. 2005. *Assessing the past and future distribution and productivity of ponderosa pine in the Pacific Northwest using a process model*, 3-PG. *Ecological Modelling* 183: 107–124.

For scientists interested in comparing predicted potential shifts in tree distribution to modeled past growth responses. Climate variability has the potential to change the structure and productivity of natural and managed plant communities and geographic distribution of important species. Using data sets from the ponderosa pine forest type and a simple physiological model, the authors estimated leaf area index (LAI) and water use over the past and present centuries and mapped the potential area that ponderosa pine might or might not

dominate. Decadal averages showed significant actual or potential climatic variation over the period assessed, with shifts in the suitability of the landscape to support ponderosa pine. Predictions indicate that the current range of the *P. ponderosa* type will be reduced along the western Cascade Range but will increase along the east side and inland Pacific Northwest. Pine dominance should increase between 5% and 10% over the next century, especially inland.

Curran, MP, RE Miller, SW Howes, DG Maynard, TA Terry, RL Heninger, TN Niemann, K van Rees, RF Powers, and SH Schoenholtz. 2005. *Progress towards more uniform assessment and reporting of soil disturbance for operations, research, and sustainability protocols*. *Forest Ecology and Management* 220: 17–30.

For soil scientists, ecologists, and hydrologists. Although international protocols specify outcomes to be achieved, they do not delineate what is required to achieve the specified outcomes. The authors discuss recent progress on three topics that they feel will make development of and reporting in sustainability protocols easier. These are common terms and comparable guidelines for soil disturbance, reliable and cost-effective techniques for assessing soil disturbance, and improvement in ways to rate soils for risk of detrimental disturbance. The practical consequences of forest practices should be traced in research and operations databases that can be used to address values specified by protocols, define detrimental soil disturbance, develop risk-rating systems for operations, and improve best management practices and treatments to minimize detrimental disturbances.

Curtis, RO, and DD Marshall. 2005. *Permanent-plot Procedures for Silvicultural and Yield Research*. General Technical Report PNW-GTR-634, USDA Forest

Service, Pacific Northwest Research Station, Portland OR.

For silviculturists and forest managers. This paper revises and updates a 1983 publication. Purposes and procedures for establishing and maintaining permanent research plots, sampling and plot design, procedures for measuring and recording data, and common errors are reviewed.

Czarnomski, NM, GW Moore, TG Pypker, J Licatra, and BJ Bond. 2005. Precision and accuracy of three alternative instruments for measuring soil water content in two forest soils of the Pacific Northwest. *Canadian Journal of Forest Research* 35: 1867–1876.

For ecologists, physiologists, and soil scientists. The accuracy, precision, and temperature sensitivity of three instruments (a capacitance instrument, a time domain reflectometry cable tester, and a water content reflectometer) used for measuring soil water content were compared in both natural and repacked soils. The new calibrations that were developed for each instrument adequately predicted soil moisture, regardless of location or soil type; predictions were in general higher than those obtained by equations commonly found in the literature or manufacturers' suggestions. Temperature influenced only the capacitance instrument. The capacitance instrument, which was least expensive, performed nearly as well as the cable tester, and both of these performed better than the water content reflectometer, which was most expensive.

Additional Program Area: Evaluating Forest Uses and Practices

Dale, V, C Crisafulli, and F Swanson. 2005. 25 years of ecological change at Mount St. Helens. *Science* 308: 961–962.

For ecologists. The eruption of Mount St. Helens in Washington State on May 18, 1980, profoundly changed the

surrounding landscape. During the 25 years following, many studies have documented the ecological responses of the organisms in the immediate blast zone and in adjacent areas. The authors discuss the responses of different groups of organisms, the factors affecting survival and recolonization, and the lessons these studies offer.

Dale, V, F Swanson, and C Crisafulli, eds. 2005. *Ecological Responses to the 1980 Eruption of Mount St. Helens*. Springer, New York.

For ecologists. This 20-chapter volume covers many aspects of ecological succession in the area surrounding Mt. St. Helens, including survival and establishment of plant and animal communities, responses of ecosystem processes, and lessons learned from 25 years of ecological studies. Background is provided by substantial introductory chapters. In addition to editing the volume, the editors each contributed to several chapters.

Domec, J-C, ML Pruyn, and BL Gartner. 2005. Axial and radial profiles in conductivities, water storage and native embolism in trunks of young and old-growth ponderosa pine trees. *Plant, Cell & Environment* 28: 1103–1113.

For plant physiologists and ecologists. Axial and radial specific conductivity (k_s), leaf-specific conductivity (LSC) and conductance (k_l), native embolism, and the compartmentalization of sapwood water storage were characterized in young and old-growth tree trunks. Native embolism, k_s , and LSC were lower in young trunks, but k_l was 3.5x higher than in old-growth trunks. This finding supports the hypothesis that ability to transport water to leaves is reduced in tall trees. Water storage of young trees did not differ significantly from that in the base of old trees. For a given cambial age, k_s , LSC and k_l were similar in the top of old-growth trees and the young trees, but native embolism was

higher and water storage was lower. Native embolism did not differ significantly among outer, middle, and inner sapwood at the base of old trees. Inner sapwood was more saturated than outer during the dry season, but the outer sapwood contributed up to 60% of stored water. Safer xylem and higher capacitance and k_l may allow young trees, with their less well-developed root systems, to regulate their water resources.

Espinosa, M, E Acuña, J Cancino, F Muñoz, and DA Perry. 2005. Carbon sink potential of radiata pine plantations in Chile. *Forestry* 78: 11-19.

For silviculturists and those interested in global warming and carbon sequestration. Increasing amounts of atmospheric CO₂ are causing great social, scientific, and political concern. Young, rapidly growing trees have the potential to capture CO₂ and sequester the carbon (C). In this study, the potential amount of C accumulated in bolewood of plantation-grown *Pinus radiata* was determined. A model was developed to estimate uncertainty in the prediction. The mean predicted value for nationwide accumulated C increased from 67 Mt in 2000 to 169 Mt in 2060. An average of 2.3 Mt of C was removed by harvesting in 2000, which increased to 13.8 Mt in 2060; this removal rate was close to 11%, which would yield a positive net balance. The projected rate of removal implies a 91% increase in area harvested from 2000 to 2060.

Fahey, T, T Siccama, C Driscoll, G Likens, J Campbell, C Johnson, J Battles, J Aber, J Cole, M Fisk, P Groffman, S Hamburg, R Holmes, P Schwarz, and R Yanai. 2005. The biogeochemistry of carbon at Hubbard Brook. *Biogeochemistry* 75: 109–176.

For biogeochemists and ecologists. Long-term studies of the biogeochemical behavior of carbon (C) in the Hubbard Brook Experimental Forest showed

that most of the C in the reference watershed was in the mineral soil organic matter (43% of total ecosystem C) and living biomass (40.5%). The rest was in surface detritus. None of the pools appeared to change significantly in the late 1990s, indicating that net ecosystem productivity was near zero. Between the late 1950s and the late 1990s, aboveground net primary productivity declined 24%. The article includes detailed discussions of ecosystem C pools, fluxes, and budgets; forest disturbance and ecosystem dynamics; environmental and biotic constraints on C biogeochemistry; spatial variation in C pools and fluxes; the role of C in soil formation and mineral weathering; and regional perspectives and future prospects in C biogeochemistry. The authors conclude that the least understood aspects of the C cycle in northern hardwood forests are soil pool size changes, woody litter deposition, and rhizosphere C flux processes.

Ferdman, Y, S Aviram, N Roth-Bejerano, JM Trappe, and V Kagan-Zur. 2005. Phylogenetic studies of *Terfezia pfeilii* and *Choiromyces echinulatus* (Pezizales) support new genera for southern African truffles: *Kalaharituber* and *Eremiomyces*. *Mycological Research* 109: 237–245.

For taxonomic and molecular mycologists. Two desert truffles in southern Africa have been traditionally put in fungal genera typified by European species. Recent studies indicate that many Southern Hemisphere species differ enough genetically from Northern Hemisphere species to merit placement into separate genera, even when they appear morphologically similar. DNA analysis proved this to be the case for the two species in question, so new genera were established for them.

Fonte, SJ, TD Schowalter, and M Bustamante. 2005. The influence of a neotropical herbivore (*Lamponius por-*

***toricensis*) on nutrient cycling and soil processes. *Oecologia* 146: 423–431.**

For ecologists and soil scientists. Herbivores may influence ecosystems by changing the pattern of litterfall and its associated nutrients from the canopy to the forest floor. Levels of herbivory of *Piper glabrescens* by *Lamponius portoricensis* were manipulated in a lower montane tropical rain forest in Puerto Rico. The four treatment levels encompassed a full range of leaf area removal, from no herbivory to complete defoliation. Total leaf area removed, greenfall production, and frass-related inputs were used as measures of herbivory. There was a significant positive regression between each of these measures and the concentration of NO captured by ion-exchange resin bags in the litter. There was no relationship between any herbivory component and concentration of NH or PO captured by the resin bags. Frass-related herbivore inputs significantly affected rates of litter decay. The authors call for further consideration of the influences of insect herbivores on forest floor nutrient dynamics.

Fujimura, KE, JE Smith, TR Horton, NS Weber, and JW Spatafora. 2005. Pezizalean mycorrhizas and sporocarps in ponderosa pine (*Pinus ponderosa*) after prescribed fires in eastern Oregon, USA. *Mycorrhiza* 15: 79–86.

For forest researchers and mycologists. In order to determine whether fungi that typically fruit after fire are mycorrhizal, sporocarps of Pezizales and mycorrhizal root tips were collected after prescribed fires in the Blue Mountains of Oregon. Two genera of Pezizales were relatively common mycorrhizal symbionts on ponderosa pine after fire.

Ganio, LM, and KJ Puettmann. 2005. Design challenges in large-scale management experiments, pp. 35–39 in *Balancing Ecosystem Values: Innovative Experiments of Sustainable Forestry: Proceedings of a Conference, August*

19–20, 2004, Portland, Oregon, CE Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For silviculturists and forestland managers. Large-scale management experiments are typically long term and include multiple investigators, objectives, scales, and natural resource issues. Designing such studies presents special challenges that must be addressed by proper experimental design and setup. The authors treat the prioritization of multiple objectives and their associated scope of inference, general spatial and temporal considerations, spatial and temporal effects on treatment definitions, and sampling within treatment units. They emphasize the importance of coordination, communication, and planning among and by all participants during design and implementation so that an optimal study will result.

Additional Program Area: Forest Ecology, Culture, and Productivity

Garber, S, and DA Maguire. 2005. Vertical trends in maximum branch diameter in two mixed-species spacing trials in the central Oregon Cascades. *Canadian Journal of Forest Research* 25: 295–307.

For silviculturists and forestland managers. Crown structure exerts a major influence on forest productivity, growth efficiency, and wood quality. Previous work has indicated that crown structure, including branch diameter, likely is influenced by stand density and species composition. In this study, two existing mixed-species trials (one with *Pinus contorta* and *Pinus ponderosa*, the other with *Abies grandis* and *P. ponderosa*) were used to examine the influence of spacing and species composition on vertical patterns of branch diameter. Tree variables accounted for most stand conditions, but models with treatment variables representing

spacing and species composition were superior. Maximum branch diameter profiles increased with spacing in mixed stands and showed evidence of species composition effects across spacing. Profiles of the subordinate species in mixtures responded more to increased spacing than they did in adjacent pure lots. The dominant species showed a larger spacing response in pure than in mixed plots.

Garber, SM, and DA Maguire. 2005. The response of vertical foliage distribution to spacing and species composition in mixed conifer stands in central Oregon. *Forest Ecology and Management* 211: 341–355.

For silviculturists and forestland managers. Mixed species plantations and natural stands are of great interest to forestland managers in the Pacific Northwest, but much research is needed on their silviculture. This study examined how initial spacing and species composition affect vertical foliage distribution in two mixed-species spacing trials. Branch-level leaf area models were developed for grand fir, lodgepole pine, and ponderosa pine and foliage distribution was estimated for the crowns, allowing estimation of relative and absolute foliage distributions of individual trees. In all species, branch leaf area declined at the base of the live crown. Foliage distributions differed by initial species, species composition, and tree social position. As spacing increased, species and social position had less effect.

Additional Program Area: Forest Regeneration

Garber, SM, JP Brown, DS Wilson, DA Maguire, and LS Heath. 2005. Snag longevity under alternative silvicultural regimes in mixed-species forests of central Maine. *Canadian Journal of Forest Research* 35: 787–796.

For silviculturists and ecologists. Snags provide ecosystem services, including

nutrient cycling and wildlife habitats. Better knowledge of snag dynamics and, ideally, incorporation of the information into decision-making models, is required to allow design of silvicultural regimes that can effectively utilize and manage this resource. This study examined the effects of several factors on snag longevity. Data were obtained from USDA Forest Service inventories covering 1981–1997 in a long-term silvicultural study. Species, snag diameter, stand density, agent of mortality, and silvicultural system significantly influenced snag longevity. The Weibull model that best fit the data showed a significant lag time, followed by rapid fall rates. *Thuja occidentalis* had the longest half-time and *Picea* species, the shortest. Longevity increased with increasing diameter but decreased as stand density decreased. Two models for predicting snag survival were developed, one specific to the Maine study and one incorporating predictor variables available in most standard inventories.

Garman, SL. 2005. Design and evaluation of a forest landscape change model for western Oregon. *Ecological Modelling* 175: 319–337.

For landscape ecologists and modelers. The forest landscape model, LandMod, described in this paper was designed to simulate forest dynamics of periods >500 years and areas >18,000 ha at a 0.04- to 1.0-ha grain. LandMod was parameterized for the three dominant forest types of the western Oregon Cascades and tracks diameter growth, death, and regeneration of individual tree species. Performance assessments showed that predictions obtained with LandMod are reasonable. Reasons for prediction error are discussed and ways to improve the model are suggested. The models can be used to provide ecological assessments of land-use strategies, as well as research assessments of landscape patterns and processes that require consideration of forest structure.

Gartner, BL. 2005. Assessing wood characteristics and wood quality in intensively managed plantations. *Journal of Forestry* 103: 75–77.

For plantation managers, silviculturists, and wood products manufacturers. Because wood quality is a poorly defined term, discussion of the effects of silvicultural treatments on wood quality is difficult. It is even more difficult for users to communicate their research needs to scientists and for scientists to communicate what is known. The discussion in this article separates wood characteristics resulting from tree growth from the wood quality that users value. Wood properties important to each of the major product groups are listed, as are the biological and chemical characteristics affecting specific wood properties. The potential impacts of decreased rotation age on wood characteristics important in Douglas-fir dimension lumber are also outlined. The author concludes that plantation wood may be of lower quality for some uses, but ingenuity in forest management, manufacturing, and tree genetics can affect the extent of such reduction.

Additional Program Area: Wood Processing and Product Performance

Gray, A. 2005. Eight nonnative plants in western Oregon forests: associations with environment and management. *Environmental Monitoring and Assessment* 100: 109–127.

For ecologists, forestland managers, conservationists, and restoration biologists. The spread of nonnative organisms into new regions, usually through human activity, has greatly affected both human and ecological communities, reducing economic viability of some land uses, requiring costly eradication, causing extinction of native species and excluding desired species, and changing disturbance cycles. Nevertheless, understanding of spatial distribution and temporal trends of non-

native plant populations, attributes that contribute to invasiveness of species, and the vulnerability of ecosystems to invasion is limited. This study examined associations between vegetation type, climate, site quality, and management history and the distribution and abundance of eight nonnative species (three forbs, three deciduous shrubs, and two evergreen shrubs) in forests in western Oregon. One or more of the nonnative taxa were recorded on 40% of the stands and 20% of the forested subplots surveyed. The selected nonnative taxa generally were more frequent in forestlands in the Willamette Valley than in the Cascades, Klamath, or Coast Ranges ecoregions. Elevation was the most important site variable associated with distribution of the nonnative species. Stand density variables were associated with frequency and cover of all species. Climatic variables were not as important in most models of species frequency or cover as the other variables assessed, and distribution of most taxa was associated more closely with low overstory density than with climate.

Additional Program Area: Integrated Protection of Forests and Watersheds

Gray, AN, and DL Azuma. 2005. Repeatability and implementation of a forest vegetation indicator. *Ecological Indicators* 5: 57–71.

For ecologists and land managers. Assessments of forest health often are conducted by using a vegetation indicator such as that designed for the national Forest Inventory and Analysis (FIA) Program. These indicators take into account changes in species and structural diversity and the abundance of nonnative species. The objectives of this study were (1) to examine the repeatability and practicality of the FIA field techniques as conducted independently by two botanists and (2) to examine interpretation of forest health indicators from 2 years of data from 110 plots in Oregon. Plant identification by the two botanists was

similar, and agreement between them on species richness and abundance of nonnative species was high. Species detection was much higher in the subplot search than in the quadrat search. The ecological regions of the state differed markedly in patterns of plant diversity. The highest species turnover and high plot richness were found in plots in the Blue Mountains. The proportion of cover made up of nonnative species was highest in juniper and ponderosa pine forest and lowest in high-elevation conifer stands. The FIA vegetation indicator appears to be robust and useful for forest health assessment.

Additional Program Area: Forest Regeneration

Griffiths, R, M Madritch, and A Swanson. 2005. Conifer invasion of forest meadows transforms soil characteristics in the Pacific Northwest. *Forest Ecology and Management* 208: 347–358.

For forest ecologists and soil scientists. Soil properties often change in the course of vegetational succession. This study measured changes in chemical and geological characteristics of high-elevation mountain meadows being invaded by adjacent forests. Properties were measured along transects from the meadow through transition zones into the mature forest. The data obtained indicate that nitrogen is more available in meadow soils than in forests and that invasion of meadows by trees may alter nitrogen pools and cycling. The pattern of B-glucosidase activity suggests that microbial populations were changing qualitatively along the transect in response to changes in litter quality. Litter depth was highly correlated with most variables in meadow soil, but not in transition zone or mature forest soil; litter may control some aspects of biogeochemical cycling in meadows. Change-point analysis showed that most variables changed significantly from mean meadow values at or near the meadow-transition zone edge.

Grubisha, L, J Trappe, and T Bruns. 2005. Preliminary record of ectomycorrhizal fungi on two California Channel Islands, pp. 171–183 in *Sixth California Island Symposium*, DK Garcelon and CA Schwemm, eds. National Park Service Technical Publication CHIS-05-01, Arcata, California, Ventura, California.

For taxonomic and ecologic mycologists. Channel Islands National Park off the coast of southern California has a number of endemic plants and animals but had seldom been explored for fungi. Collecting trips by mycologists have produced a preliminary inventory of the mycorrhizal fungi on Santa Cruz and Santa Rosa Islands of the Park. Several new species were included in the collections.

Grubisha, L, J Trappe, A Beyerle, and D Wheeler. 2005. NATS truffle and truffle-like fungi 12: *Rhizopogon ater* sp. nov. and *R. brunsi* sp. nov. (Rhizopogonaceae, Basidiomycota). *Mycotaxon* 93: 345–353.

For fungal taxonomists and mycorrhiza researchers. Two new species of ectomycorrhizal truffles are described and named. *Rhizopogon ater* (meaning “the black *Rhizopogon*”) is associated with Douglas-fir in western Oregon and southwestern Washington. *Rhizopogon brunsi* (named in honor of the University of California mycologist and collector of the species, Tom Bruns) forms mycorrhizae with Bishop pine, Torrey pine, and Monterey pine in natural forests and plantations.

Guzmán, G, and JM Trappe. 2005. The hallucinogenic and non-hallucinogenic species of *Psilocybe* in Washington State, USA: new records and a new species. *International Journal of Medicinal Mushrooms* 7: 583–589.

For fungus taxonomists and ecologists. Twenty species of mushrooms in the decomposer genus *Psilocybe* had been reported from Washington State before now. This paper adds four more species from the North Cascade Mountains of

Washington, including a new species, *P. semiinconspicua*.

Haig, SM, CL Ferland, FJ Cuthbert, J Dingleline, JP Goossen, A Hecht, and N McPhillips. 2005. A complete species census and evidence for regional declines in piping plovers. *Journal of Wildlife Management* 69(1): 160–173.

For ornithologists and conservationists. In 2001, an international breeding and winter census of piping plover was carried out through the species range. More than 2,200 sites along 11,836 km of shoreline habitat were visited. In the winter census, one-third of the potential plover sites had plovers present; more than half the sites had 10 or fewer birds. In total, 2,389 birds were counted. The breeding census found 41.1% of the potential sites occupied, with >80% of the sites having 10 or fewer birds. A total of 5,945 adults were counted. Numbers had increased 8.5% since a 1991 census, but only 0.2% since 1996. Since 1991, breeding bird numbers increased on the Atlantic coast and the Great Lakes, but declined in prairie and eastern Canada and the US northern Great Plains. The availability of three complete species censuses is essential to conservation planning and assessment.

Halász, K, Z Bratek, D Szeg, S Rudnóy, I Rácz, D Lásztity, and J Trappe. 2005. Tests of species concepts of the small, white, European group of *Tuber* species based on morphology and rDNA sequences with special reference to *Tuber rapaeodorum*. *Mycological Progress* 4: 291–298.

For fungal taxonomists and truffle researchers. A group of five closely related small white truffle species in Europe has presented taxonomic and identification problems. The DNA sequences of these species were compared with morphological characterization to determine species boundaries and morphological variability. The results confirmed the genetic differentiation of the spe-

cies and indicated what morphological characters are most reliable for their correct identification.

Halofsky, JE, and LH McCormick. 2005. Effects of unseeded areas on species richness of coal mines reclaimed with municipal biosolids. *Restoration Ecology* 13: 630–638.

For restoration and plant ecologists. Applying municipal biosolids to coal mine spoils can benefit vegetation establishment but leads to domination by early successional species. Low establishment of woody and volunteer species reduces the potential for forest establishment after mining. This study examined the effects of unseeded strip width on species richness and growth of seedlings planted in strips not seeded with grass. The effect of unseeded strip width on seedling growth could not be determined because mortality of planted seedlings was high. Natural plant invasion and species richness were highest in unseeded strips that were 4 m wide. Leaving such strips, together with improved seedling planting practices and stocks, would help promote development of a richer plant community during mine reclamation with biosolids.

Halpern, CB, D McKenzie, SA Evans, and DA Maguire. 2005. Initial responses of forest understories to varying levels and patterns of green-tree retention. *Ecological Applications* 15: 175–195.

For silviculturists, forest ecologists, and forest managers. Although standards for “green tree” retention during timber harvest have been adopted on federal forests in the Pacific Northwest, systematic assessments of ecosystem response to retention have not been undertaken. This study examined short-term responses (1–2 years) of vascular understory communities to retention at six locations in western Oregon and Washington under two levels of retention (15% or 40% of initial basal area) and two spatial patterns (dis-

persed or aggregated). Compositional change was greater at 15% than at 40% retention at all locations; direction of compositional change was similar among treatments at each location but was not materially affected by spatial pattern. Declines in abundance or richness of many understory groups were significantly greater at 15% retention, but pattern again had little effect. The authors propose that initial responses were influenced by patterns of disturbance and slash accumulation associated with level and pattern of retention and that canopy structure will become more influential in understory composition and structure as effects of disturbance diminish over time.

Hayes, JP, SH Schoenholtz, MJ Hartley, G Murphy, RF Powers, D Berg, and SR Radosevich. 2005. Environmental consequences of intensively managed forest plantations in the Pacific Northwest. *Journal of Forestry* 103: 83–87.

For silviculturists, forest managers, and environmental scientists. The authors review what is known about the environmental consequences of intensively managed forest plantations (IMFPs), especially in terms of their influences on biodiversity, soils, and water resources. The authors discuss environmental consequences of IMFPs at local and stand scales, including truncation of stand development, soil disturbance, hydrology and water quality, dead wood and organic matter, vertical and horizontal heterogeneity within stands, and maintenance or establishment of forest cover. At landscape and watershed scales, they treat roads and transportation networks, watersheds, and biodiversity. They also discuss environmental consequences at regional and global scales.

Additional Program Area: Forest Regeneration

Healey, SP, WB Cohen, Y Zhiqiang, and ON Krankina. 2005. Comparison of

Tasseled Cap-based Landsat data structures for use in forest disturbance detection. *Remote Sensing of Environment* 97(3): 301–310.

For remote sensing specialists and ecologists. The Tasseled Cap (TC) transformation for Landsat data is useful for disturbance mapping because it can highlight relevant vegetation changes. The authors tested the ability of multi-date variants of the TC transformation, or data structures, to facilitate identification of stand-replacing disturbance. Four data structures were tested: one with all three TC indices (brightness, greenness, wetness), one with brightness and greenness, one with wetness alone, and a new combination of the three TC indices, called the Disturbance Index (DI). Tests were done in the St. Petersburg region of Russia and in two ecologically distinct regions of Washington State. The TC variants almost always resulted in more accurate change classifications than did multi-date stacks of the original Landsat data. The data structures differed little overall in performance, but the DI performed best at the Russian study area and, with wetness, worse at one of the Washington sites. These differences were attributed to differences in succession rates and productivity; in the case of the Washington site, length of monitoring interval was also a factor. The authors conclude that both forest recovery rates and the resampling interval should be considered in choosing a Landsat transformation for detecting stand-replacing disturbance.

Hibbard, KA, BE Law, M Reichstein, and J Sulzman. 2005. An analysis of soil respiration across northern hemisphere temperate ecosystems. *Biogeochemistry* 73: 29–70.

For soil scientists, ecologists, and others interested in soil carbon storage and flux. The authors use an integrated measured and modeled process-oriented to analyze soil respiration (Rs) data assembled from 31 AmeriFlux and

CarboEurope sites representing deciduous broadleaf, evergreen needleleaf, grasslands, mixed deciduous/evergreen and woodland/savanna ecosystem types. Soil respiration rates averaged over the growing season ranked grassland and woodland/savanna < deciduous broadleaf forests < evergreen needleleaf and mixed deciduous/evergreen forests. Growing season soil respiration differed significantly between forested and nonforested biomes. Peak respiration rates during the growing season occurred in March/April in grasslands and July-September in all other biomes. The strongest relationship between soil respiration and soil temperature was found in the deciduous and mixed forests. The results suggest that empirical relationships with temperature or moisture may not be adequate to characterize soil CO₂ effluxes across space and time. Information is needed on the timing and phenological controls of substrate availability, such as fine roots and leaf area index, and inputs, as such root turnover or litterfall, if the relationships between soil CO₂ effluxes and carbon substrate storage are to be quantified accurately.

Hobbie, EA, A Jumpponen, and J Trappe. 2005. Foliar and fungal ¹⁵N: ¹⁴N ratios reflect development of mycorrhizae and nitrogen supply during primary succession: testing analytical methods. *Oecologia* 146: 258–268.

For forest ecologists, physiologists and mycorrhiza researchers. Use of nitrogen isotope ratios in plant tissues can be used to probe nitrogen dynamics between mycorrhizal fungi and their associated plants. These relationships were explored for plants and their mycorrhizal fungi on a young primary successional plant community on the forefront of a receding glacier in comparison with adjacent mature, subalpine communities. The results showed that under N-limited conditions, such as on the glacier forefront, mycorrhizal fungi may retain up to two-thirds of the N

captured in the system, and that host-specific fungi may transfer more N to their plant hosts than do non-host-specific fungi.

Holub, SM, K Lajtha, JDH Spears, JA Tóth, SE Crow, BA Caldwell, M Papp, and PT Nagy. 2005. Organic matter manipulations have little effect on gross and net nitrogen transformations in two temperate forest mineral soils in the USA and central Europe. *Forest Ecology and Management* 214: 320–330.

For soil scientists and those interested in nutrient cycling. Using organic matter manipulation in disparate sites in western Oregon, USA, and Hungary, the authors draw specific insights into the relationship between nitrogen (N) and carbon (C) transformations in soil. Their objectives were twofold: to explain the effect of organic matter level and quality on net and gross N processing in mineral soil, and to discover whether these effects fluctuate in various climates, soils, levels of vegetation, and N deposition level. Gross and net N cycling were affected minimally or not at all by organic matter manipulation or C:N ratio. Tree roots and litter immobilization appeared to affect soil ammonium levels under high, but not low, N deposition.

Homann, PS, M Harmon, S Remillard, and EAH Smithwick. 2005. What the soil reveals: Potential total ecosystem C stores of the Pacific Northwest region, USA. *Forest Ecology and Management* 200: 270–283.

For ecologists, soil scientists, and those interested in nutrient cycling. Determining the natural storage capacity of organic carbon (C) in an ecosystem can be difficult when the vegetation has changed due to land management. A regional distribution of potential maximum organic C storage was derived by synthesizing spatial distribution of soil properties with empirical measurements of ecosystem C in old-growth forest. The

total ecosystem organic C stores (TEC) were between 185–1200 Mg C/ha, with 63% being in the vegetation, 12% in woody detritus, 3% on the forest floor, 7% in upper mineral soil, and 13% in deeper mineral soil. In the upper mineral soil, TEC and soil organic C were strongly related. This relationship and the SOC spatial distribution provided an estimate of potential regional TEC storage of 760 Mg C/ha, higher than previous estimates or current regional stores.

Horton, TR, R Molina, and K Hood. 2005. Douglas-fir ectomycorrhizae in 40- and 400-year-old stands: mycobiont availability to late successional western hemlock. *Mycorrhiza* 15: 393–403.

For mycologists, silviculturists, and soil biologists. Molecular approaches were used to identify ectomycorrhizal fungi from roots of Douglas-fir and western hemlock in mixed stands in early seral and late seral stage forests. In the early seral stage forest, fungal species colonizing 95% of the western hemlock root tips also colonized Douglas-fir roots. There were also fungi colonizing Douglas-fir exclusively. In the late seral stage forest, only 14% of western hemlock root tips were colonized by fungi also associated with Douglas-fir, although the authors feel this estimate of multiple host fungi is conservative. Fungi specific to Douglas-fir colonized 25% of its root tip biomass in the late seral stage forest. The results of this study support earlier findings that suggest a predominance of multiple host fungi in mixed communities of ectomycorrhizal plants. The role of host-specific fungi is unclear.

Horváth, L, E Führer, and K Lajtha. 2005. Nitric oxide and nitrous oxide emission from Hungarian forests: link with atmospheric N deposition. *Biogeosciences Discussions* 2: 703–723.

For biogeochemists and others interested in nutrient cycling. Although forest soils emit nitrogen oxides in significant quantities, these emissions are often

omitted in figuring ecosystem nitrogen budgets. In this study, nitric oxide and nitrous oxide emissions from sessile oak and Norway spruce forest soils in northeast Hungary were measured over the course of 1 year. In spruce soils, average soil emissions were 1.2 $\mu\text{g N/m}^2/\text{h}$ as nitric oxide and 15 $\mu\text{g N/m}^2/\text{h}$ as nitrous oxide. In oak soils, average soil emissions were 2.1 $\text{N/m}^2/\text{h}$ as nitric oxide and 20 $\text{N/m}^2/\text{h}$ as nitrous oxide. Recalculation of the previously determined nitrogen balance between the atmosphere and the forest ecosystem with these figures indicated that about 10–13% of N compounds deposited to the soil are transformed in the soil and reemitted to the atmosphere, primarily as nitrous oxide, a greenhouse gas.

Irvine, J, BE Law, and MR Kurpius. 2005. Coupling of canopy gas exchange with root and rhizosphere respiration in a semi-arid forest. *Biogeochemistry* 73: 271–282.

For ecophysicologists and those interested in carbon cycling. Coupling of canopy gas exchange with root and rhizosphere respiration were examined in seasonally drought-stressed ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.), approximately 15 years old. Part of the root systems was watered to reduce water stress and part was left dry; controls were not watered. Soil CO_2 efflux measured on the dry side of the watered trees was compared with efflux under control trees. After about 40 days, the efflux rate relative to conditions before treatment was twice as high in watered trees as in controls; this difference was attributable to root and rhizosphere respiration and was strongly correlated with differences in transpiration rates. Photosynthesis was also higher in the irrigated treatment and paralleled patterns of transpiration. Autotrophic and heterotrophic respiration showed no difference in response to temperature. Patterns of soil CO_2 released appeared to be strongly cor-

related with recent carbon assimilation. The authors suggest that modelers of soil respiration consider added canopy processes to their models.

Izzo, A, M Meyer, J Trappe, M North, and T Bruns. 2005. Hypogeous ectomycorrhizal fungal species on roots and in small mammal diet in a mixed-conifer forest. *Forest Science* 51: 234–254.

For forest and wildlife ecologists and mycologists. The abundance of hypogeous (below-ground fruiting) fungi as mycorrhiza formers in western conifer forests is difficult to compare with epigeous fungi (mushrooms) because the former fruit deeply in the soil. Sampling of fruiting bodies and mycorrhizae in a forest of the central Californian Sierra Mountains showed truffles accounted for about 20% of the mycorrhizal fungus species in the stand and nearly 40% of the mycorrhizal biomass. Spores in fecal pellets deposited by animals that eat the truffles accumulate in the soil to form a spore bank available for mycorrhiza formation with new roots.

Janisch, JE, ME Harmon, H Chen, B Fasth, and J Sexton. 2005. Decomposition of coarse woody debris originating by clearcutting of an old-growth conifer forest. *Ecoscience* 12: 151–160.

For ecologists and forest managers. Constants of decomposition, k , were determined for logs, stumps, and sub-surface coarse roots along a 70-year chronosequence of clearcut old-growth forest, primarily of *Pseudotsuga menziesii* and *Tsuga heterophylla*, in the Wind River Ranger District in Washington. When stand age was taken into account, log and stump density did not differ within species, but both above- and belowground parts of *P. menziesii* decomposed more slowly than those of *T. heterophylla*. Small-diameter roots decomposed more rapidly than large-diameter roots in both species. Decomposing coarse woody debris was estimated to be releasing 0.3–0.9

Mg C/ha from *P. menziesii* and 0.8–2.3 Mg C/ha/yr from *T. heterophylla* into the atmosphere. Including coarse roots would increase the calculated losses to 0.5–1.9 Mg C/ha/yr from *P. menziesii* or 1.0–3.5 Mg C/ha/yr from *T. heterophylla*. On the basis of the results of this study, log decomposition constants could be substituted for stump decomposition constants in C flux models when stump decomposition constants are unknown. Substituting log *k* for coarse root *k*, however, might result in substantial overestimation of C flux to the atmosphere.

Jones, J, B Bond, G Moore, and K McGuire. 2005. Climate changes and feedbacks from vegetation succession: Evidence from long-term ecological research sites, pp. n.a. in *Proceedings of the World Water and Environmental Resources Congress 2005: Impacts of Global Climate Change May 15–19, 2005, Anchorage, Alaska, R Walston, ed. American Society of Civil Engineers, Reston VA.*

For ecologists and those interested in climate change. Long-term records of climate, stream flow, and vegetation are available from long-term ecological research (LTER) sites. In this study, the authors investigated whether effects of vegetation change on stream flow can be quantified and separated from those caused solely by climate change. Findings from long-term watershed experiments involving forest removal and regrowth in the eastern and northwestern United States imply that water fluxes both to the atmosphere and to streams will change with successional changes in vegetation. Using records from several LTER sites, the authors examined the relationship between stream flow and climate over decades of forest vegetation succession. In stands ≤ 50 years old, vegetation water use appeared to increase rapidly and was not coupled with water availability. In stands 400–500 years old, however, vegetation

water used seemed to decline and to be coupled to water availability.

Kennedy, RSH, and TA Spies. 2005. Dynamics of hardwood patches in a conifer matrix: 54 years of change in a forested landscape in coastal Oregon, USA. *Biological Conservation* 122: 363–374.

For silviculturists, forest planners, and conservationists. Patches of hardwoods within conifer-dominated forests provide species diversity, nutrients, and microclimates, but their response to forest management is not well understood. Using aerial photographs and a GIS, the authors compared hardwood patch conditions in conifer-dominated present-day and post-settlement historical forests in the central Coast Range of Oregon, taking into account ownership and environmental gradients. Over time, the size, number, total area, and within-patch cover-type heterogeneity of hardwood patches declined and the patches became more irregular in shape and more fragmented. Most historical patches had disappeared. Hardwoods declined on USDA Forest Service lands, increased on nonindustrial private lands, and stayed about the same on private forest industry lands. Both human and environmental factors contributed to the dynamics of hardwood patches.

Ketchum, JS, and JS Tappeiner. 2005. Early Douglas-fir, grand fir, and plant community responses to modified clearcut, two-story, and small patch cut silvicultural treatments, pp. 52–62 in *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*, CC Maguire and CL Chambers, eds. Research Contribution 46, Forest Research Laboratory, Oregon State University, Corvallis.

For silviculturists. After a brief discussion of plant community responses to harvesting and conifer regeneration, the authors describe the research strategy

and results of the vegetation studies carried out on the College of Forest Integrated Research Project (CFIRP). Species composition of understory vegetation cover changed markedly after harvest, although the understory returned to preharvest levels within a year. Exotic species increased and native plants decreased in all treatments. Successful regeneration of Douglas-fir and grand fir appeared possible under the silvicultural treatments studied, although continued reduction of overstory density is required.

Knowe, S, S Radosevich, and R Shula. 2005. Basal area and diameter distribution prediction equations for young Douglas-fir plantations with hardwood competition: Coast Ranges. *Western Journal of Applied Forestry* 20: 77–93.

For silviculturists, forest yield modelers and planners. Data from 84 plots were used to build a stand-level modeling system for young Douglas-fir plantations. Stand- and tree-level equations included effects of hardwood competition and site preparation, competition release, and precommercial thinning. Stand-level equations explained at least 92% of the variation observed except in the case of minimum dbh. Simulation of basal area dynamics through plantation age 20 years indicated that site preparation must reduce hardwood basal area at plantation age 5 years by at least 75% if Douglas-fir basal area is to be increased. Competition release yielded a positive Douglas-fir response at 50% efficacy or more.

Additional Program Area: Forest Regeneration

Krankina, ON, RA Houghton, ME Harmon, EH Hogg, D Butman, M Yatskov, M Huso, RF Treyfeld, VN Razuvaev, and G Spycher. 2005. Effects of climate, disturbance, and species on forest biomass across Russia. *Canadian Journal of Forest Research* 35: 2281–2293.

For ecologists and silviculturists. The effects of disturbance and climate on biomass accumulation were assessed across the forest zone of Russia. Attributes of biomass accumulation were significantly but weakly related with climatic and disturbance attributes. Percent clearcut and percent old forest, the most influential disturbance attributes, exerted at least as strong an effect as climatic attributes. Tree species had less effect than climate or disturbance. The models were generally improved by combining climate, disturbance, and species attributes. The tendency to harvest more productive forest stands of commercially valuable species caused disparity in productivity among age cohorts and influenced patterns of biomass change in chronosequences. The apparent link between forest disturbance attributes and patterns of biomass accumulation may be useful in broadscale modeling of forest biomass with remote sensing data.

Kretzer, AM, S Dunham, R Molina, and JW Spatafora. 2005. Patterns of vegetative growth and gene flow in *Rhizopogon vinicolor* and *R. vesiculosus* (Boletales, Basidiomycota). *Molecular Ecology* 14: 2259–2268.

For biotechnologists and mycological geneticists. Sporocarps and tuberculate ectomycorrhizae of *Rhizopogon vinicolor* and *R. vesiculosus* were collected from three plots, about 1 km to 5.5 km apart, in the Oregon Coast Range. Previously developed microsatellite markers were used to map the approximate size and distribution of genets of both species. Spatial autocorrelation analysis was used to determine genetic structure within plots. Isolation by distance within plots did not appear to occur in either species. Clonal propagation was significantly more prevalent in *R. vesiculosus*. There was significant genetic differentiation between some of the plots, which appeared greater in *R. vesiculosus*. Parentage analysis, which

does not seem to have been done before in these fungi, detected seven likely parent/offspring pairs in *R. vinicolor* and four in *R. vesiculosus*. Only two of the 11 possible pairs, both *R. vinicolor*, were still supported as parent/offspring when tested against the alternative hypothesis of being full siblings.

Kujimura, KE, JE Smith, TR Horton, NS Weber, and JW Spatafora. 2005. Pezizalean mycorrhizae on ponderosa pine (*Pinus ponderosa*) after prescribed fires in eastern Oregon, USA. *Mycorrhiza* 15: 79–86.

For researchers and managers in forest ecology and soils. In order to determine the function of a group of fungi that commonly fruits after fire, DNA sequences from mycorrhizal roots and aboveground fruiting bodies were compared. Although no root tips were found colonized by post-fire Pezizales fruiting at the site, analyses indicated that several root mycobionts belonged to genera within the Pezizales.

Lajtha, K, S Crow, Y Yano, SS Kaushal, EW Sulzman, P Sollins, and JDH Spears. 2005. Detrital controls on soil solution N and dissolved organic matter in soils: a field experiment. *Biogeochemistry* 76: 261–282.

For soil biologists and biochemists. The authors investigated the control of soil organic matter accumulation and stabilization by detrital quality and quantity in a long-term field study in an old-growth coniferous forest. Plots received one of five treatments: double leaf litter, double woody debris, litter inputs excluded, root inputs removed, or control. Soil solution chemistry and relative amounts and lability of soil carbon pools were examined. Additional woody debris increased dissolved organic carbon (DOC) in leachates from the O-horizon and 30 cm deep, but not from 100 cm deep. Dissolved organic nitrogen (N) decreased through the soil profile in all plots, but to a lesser extent than DOC.

Total dissolved N increased in both treatments without roots, but concentrations of DOC decreased. In long-term incubations, soils from litter-excluded plots trended toward lower rates of loss of DOC, but not lower respiration rates. In soils from added-wood plots, respiration and DOC loss rates were similar to controls, even though field observations showed additional DOC sorption in these soils.

Larsen, EJ, and WJ Ripple. 2005. Aspen stand conditions on elk winter ranges in the northern Yellowstone ecosystem. *Natural Areas Journal* 25: 326–338.

For ecologists and wildlife biologists. A lack of overstory recruitment has been observed in stands of aspen (*Populus tremuloides*) in Yellowstone National Park. In this study, remote sensing and field-collected data from stands inside the park were compared with data from stands in the Gallatin National Forest and the Sunlight/Crandall elk wintering area in the Shoshone National Forest. Aspen canopy coverage declined over 40 years in all three sites but declined proportionately more in Yellowstone. Density of live overstory stems also was lower in Yellowstone. Live stems at least 10 cm in diameter at breast height were found only on scree in Yellowstone but were not so limited on the national forest sites. The three areas did not differ in density of aspen ramets, the percentage browsed, or conifer density within aspen stands, but the percentage of taller ramets was higher and the incidence of bark scarring was lower on the national forest sites. Whereas recruitment of replacement overstory stems was successful on the national forest sites, recruitment in Yellowstone was successful only in areas protected from ungulate browsing.

Lefsky, M, A Hudak, W Cohen, and S Acker. 2005. Geographic variability in lidar predictions of forest stand struc-

ture in the Pacific Northwest. *Remote Sensing of Environment* 95: 532–548.

For forest modelers and ecologists.

Remote sensing, lidar in particular, is expected to help address the need to estimate the carbon stored in forests and elucidate the global carbon cycle. The authors compare the relationships between lidar-measured canopy structure and coincident field measurements of forest stand structure at five locations in the Pacific Northwest with contrasting composition. Equations for 8 of the 17 stand structure variables considered were developed that were valid for all sites, including two (aboveground biomass and leaf area index) generally considered to be highly important. The other six were related to either height or diameter at breast height. Four additional equations (a total of 12) were applicable to all sites where Douglas-fir, western hemlock, or Sitka spruce was dominant but had biases in sites dominated by true fir or ponderosa pine. Only 2 of the 17 equations (maximum diameter at breast height, stem density) incorporated productivity-related variables describing the edaphic, climatic, and topographic environment of the sites.

Lefsky, MA, AT Hudak, WB Cohen, and SA Acker. 2005. Patterns of covariance between forest stand and canopy structure in the Pacific Northwest. *Remote Sensing of Environment* 95: 517–531.

For forest modelers and ecologists.

Lidar (light detection and ranging) has proven to be extremely useful in remote measurements of forest canopies. The authors used canonical correlation analysis of coincident lidar and field datasets in western Oregon and Washington to define seven statistically significant pairs of canonical variables, each defining an axis of variation that stand and canopy structure share. Their goal was to group redundant canopy and stand indices and rank significantly covarying

aspects of canopy and stand structure. Three factors (mean height, cover or leaf index area, height variability) represent the same kind of enhancement of lidar data as tasseled cap indices. Each method summarizes many potential variables into a few indices that can be used to quickly assess the information in the total dataset. Verification in other forest types and adaptation to other sensors is needed.

Lefsky, MA, DP Turner, M Guzy, and WB Cohen. 2005. Combining lidar estimates of aboveground biomass and Landsat estimates of stand age for spatially extensive validation of modeled forest productivity. *Remote Sensing of Environment* 96: 549–558.

For forest productivity modelers and ecologists. Net aboveground primary production of wood ($NPPA_w$), a major component of net primary production (NPP), is often closely related to net ecosystem production, so estimation of $NPPA_w$ is very important in understanding the carbon cycle. Remote sensing of NPP and $NPPA_w$ is generally based on light use efficiency or process-based biogeochemistry models, which present major problems in validation. This paper describes an independent approach to estimating $NPPA_w$ that is based on stand age and biomass and could be used in validation efforts over a large area. Productivity estimates made for western Oregon with this method compared well with forest inventory estimates and differed significantly from estimates from a spatially distributed biogeochemistry model. This approach could be widely applicable to landscapes with stand-replacing disturbances, especially where forest inventories are not routinely maintained.

Loescher, HW, T Ocheltree, B Tanner, E Swiatek, B Dano, J Wong, G Zimmerman, J Campbell, C Stock, L Jacobsen, Y Shiga, J Kollas, J Liburdy, and BE Law. 2005. Comparison of tempera-

ture and wind statistics in contrasting environments among different sonic anemometer-thermometers. *Agricultural & Forest Meteorology* 133: 119–139.

For micrometeorologists. Although sonic anemometers (SATs) are often used in micrometeorology, the accuracy and precision of different models under different ambient conditions have not been analyzed previously. In this study, mean temperature in an acoustically isolated chamber, mean vertical wind speed in a low-speed wind tunnel, and wind statistics with data collected over a research field were compared for eight SAT models, and differences in buoyancy flux that might be caused by differences in responses to changes in air temperature were assessed. Measurements obtained with different SATs differed, and comparability even of measurements by SATs from the same manufacturer may be uncertain. The authors discuss estimation of these uncertainties and their implications in the use of SAT-derived data.

Luoma, DL, and JL Eberhart. 2005. Results from green-tree retention experiments: ectomycorrhizal fungi, pp. 257–264 in *Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry: Proceedings of a Conference, August 19–20, 2004, Portland, OR*, CE Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forest ecologists, silviculturists, and forest managers. Ectomycorrhizal fungi (EMF) and ectomycorrhizal associations are critical to most vascular plants and to the success of forest regeneration. The authors examined the effects of structural retention on biodiversity and sporocarp production of EMF. Sporocarp production was significantly reduced by overstory removal but, unexpectedly, not always in proportion

to retained basal area. Spatial retention pattern varied in effect, depending on retention level and mushroom and truffle sporocarp groups. The authors also point out that fire is apparently important in reproductive evolution of EMF and hypothesize that fire suppression may favor mushroom over truffle production. Management strategies need to recognize the different responses to forest disturbance among EMF groups and consider EMFs in efforts to restore forest health after fire suppression. Sporocarp production may be best maintained by combining dispersed green-tree retention with aggregated retention. Long-term silvicultural experiments to monitor trends in the EMF community are needed.

Maguire, CC, and A Bennett-Rogers. 2005. CFIRP management and research overview, pp. 122–134 in *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*, CC Maguire and CL Chambers, eds. Research Contribution 46, Forest Research Laboratory, Oregon State University, Corvallis.

For silviculturists, ecologists, and social scientists. This final chapter outlines the results of the first decade of CFIRP Research, presents an overview of subsequent studies and studies in progress that utilize CFIRP stands, reviews harvest recommendations for the next phase of research, and outlines the general management structure of CFIRP.

Maguire, CC, and CL Chambers, eds. 2005. *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*. Research Contribution 46, Forest Research Laboratory, Oregon State University Corvallis.

For silviculturists, forest managers, and forest ecologists. The College of Forestry Integrated Research Project

(CFIRP), started in 1989, is an ongoing experiment in the eastern Coast Range foothills of western Oregon. Scientists, resource managers, and students at Oregon State University designed and implemented silvicultural alternatives to clearcutting that aimed to create and retain features of mature and old-growth Douglas-fir forests while producing timber. Fine-, moderate-, and large-scale natural disturbance patterns served as the basis for prescriptions. In this book, CFIRP scientists describe harvest challenges and economics; short-term (10-year) responses of vegetation, wildlife, and humans to silvicultural treatments; and additional studies conducted on CFIRP study sites. A synopsis of past and present research and management directions is included. Data from previous studies are available to other researchers. Comparing characteristics of forests under different silvicultural systems will allow better assessments of their potential economic, social, and ecological contributions to managed forest landscapes.

Additional Program Area: Evaluation of Forest Uses, Practices, and Policies

Maguire, CC, T Manning, SD West, and RA Gitzen. 2005. Green-tree retention in managed forests: post-harvest responses of salamanders, pp. 265–270 in *Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry: Proceedings of a Conference, August 19–20, 2004, Portland, Oregon*, CE Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For silviculturists, forestland managers, and amphibian biologists. Salamanders exhibit high site tenacity and environmental sensitivity and are therefore often proposed as indicators of the ecological effects of forest management. The authors analyzed responses

of salamanders to level and pattern of live tree retention during harvest in the Douglas-fir region of the Pacific Northwest. None of the four most abundantly captured species showed any association between capture trends and level and pattern of basal area retained, up to 2 years after harvest. Salamanders did seem to be most frequent in areas of high volume of coarse woody debris or herb cover; basal area was of secondary importance. The ability of silviculturists to manipulate forest ground conditions should allow both maintenance of structural features favorable to salamanders and timber extraction.

Maguire, D. 2005. Uneven-aged management: panacea, viable alternative, or component of a grander strategy? *Journal of Forestry* 103: 73–74.

For silviculturists and forestland managers. Uneven-age and even-age systems of managing plantations of ponderosa pine were compared through simulation. Several differences in growth-and-yield patterns between the two systems were apparent. Uneven-age regimes can produce as much cubic volume as even-age, but prolific regeneration is required and much of the yield is from trees <12 inches in diameter. At lower levels of regeneration and recruitment, trees are larger but total stand production is reduced. Even-aged stands showed higher peak annual increments, but they were of short duration and accompanied by periods of very low periodic annual increment. In uneven-aged stands, periodic annual increment was relatively constant. Maintaining stand structures in uneven-age stands that will yield productivity comparable with that of even-age systems presents several challenges and often requires intensive effort, possibly conflicting with the values motivating the shift to uneven-age systems.

Additional Program Area: Forest Regeneration

Maguire, D, S Canavan, S Halpern, and K Aubry. 2005. Fate of taxa after variable-retention harvesting in Douglas-fir forests of the northwestern United States, pp. 271–279 in *Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry: Proceedings of a Conference, August 19–20, 2004*, Portland, Oregon, C Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For ecologists and forestland planners. The efficacy of variable-retention harvesting in conserving biodiversity in forests is largely untested. The Demonstration of Ecosystem Management Options (DEMO) was set up to evaluate the effects of levels and patterns of retained trees on herbs, ectomycorrhizal sporocarps, canopy arthropods, amphibians, forest-floor small mammals, and breeding birds. The authors analyze the probability that taxa detected before treatment were also detected after treatment. The probability of detecting mushroom, truffle, and bird taxa was related directly to the proportion of live trees retained. Most treatment effects could be attributable to differing retention levels. Fewer bird species were detected postharvest in dispersed retention treatments than in aggregated retention treatments. Probability of detection failure was significantly greater for all groups in lower residual stand densities. Differences in vertical structure appeared to account for some of the variation in the response of canopy arthropods and birds.

Maton, C, and BL Gartner. 2005. Do gymnosperm needles pull water through the xylem produced in the same year as the needle? *American Journal of Botany* 92: 123–131.

For plant physiologists. In order to elucidate the spatial use of sapwood for water transport, the authors studied how long functional connections between leaf traces and stem xylem

were maintained. They determined the growth ring through which water flows to 1- and 2-year-old needles in 14 evergreen conifers and 2 deciduous species. They also used 4- to 6-year old saplings of Douglas-fir to determine whether needle fall is related to needle age or to diameter of the stem to which the needles are attached. In three species, no pattern could be determined. In most of the other species, the year-1 and year-2 foliage generally pulled water through different growth rings. There were four exceptions: the two deciduous species, which pulled water mostly through the current year growth ring; *Cedrus deodara*, in which both year-1 and year-2 foliage pulled mostly through the year-1 growth ring; and *Sequoia sempervirens*, in which year-1 and year-2 foliage pulled mostly through the current year growth ring. Larger stems had lower needle retention, and retention appeared to be more related to diameter than to age.

McComb, BC, and CL Chambers. 2005. Introduction, pp. 13–23 in *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*, CC Maguire and CL Chambers, eds. Research Contribution 46, Forest Research Laboratory, Oregon State University, Corvallis.

For ecologists, silviculturists, and social scientists. This chapter introduces a multichapter work detailing the current status of research being carried out under the College of Forestry Integrated Research Project (CFIRP). The project was set up to increase understanding of tradeoffs associated with alternative management approaches ranging from even-aged with retention to uneven-aged to uncut mature forests.

Additional Program Area: Forest Regeneration

McCulloh, K, and J Sperry. 2005. Patterns in hydraulic architecture and their

implications for transport efficiency. *Tree Physiology* 25: 257–267.

For plant physiologists, ecologists, and evolutionary biologists. Because carbon and water fluxes are coupled in plants, transport efficiency could affect carbon uptake and tree height and productivity. The authors identify and discuss five patterns of hydraulic architecture, which may coexist in many combinations: area-preserving branching; variable trunk versus twig sap velocity; distally decreasing leaf specific conductivity (KL) and conduit diameter; and a decline in leaf specific conductance (kL) of the entire plant with maturation. The diversity of such combinations is not accounted for in the model put forth by West and colleagues (the WBE model). The authors used Murray's law, which was originally developed for animal cardiovascular systems and predicts the optimal tapering for a given branching architecture and energy investment, to identify the conduit taper that maximizes kL for a given vascular investment. They discuss the efficiencies of the anatomies of a coniferous, a diffuse-porous, and a ring-porous species. They conclude that the architectural patterns are consistent with maximization of transport efficiency, given mechanical restraints, and suggest that a comprehensive theoretical model of hydraulic efficiency remains to be established.

McCulloh, K, and JT Sperry. 2005. The evaluation of Murray's law in *Psilotum nudum* (Psilotaceae), an analogue of ancestral vascular plants. *American Journal of Botany* 92: 985–989.

For plant physiologists, ecologists, and evolutionary biologists. Little is known about the tradeoffs and constraints important in plant transport networks. Murray's law, which predicts the taper of conduits that is required to maximize hydraulic conductance for a given vascular volume and branching topography, has been used in assessing the efficiency of plant vascular systems. Ac-

According to this principle, the sum of the conduit radii cubed should decrease in direct proportion with the volume flow rate to maximize the hydraulic conductance per unit vascular investment. The law is applicable in seed plants where the conduits do not provide structural support. The authors tested its applicability in *Psilotum nudum*, a seedless vascular plant with a simple shoot structure and a nonsupport-providing central stele. Their results were consistent with applicability of Murray's law, showing that plants with tracheids that do not provide support can follow Murray's law as well as vessel-bearing angiosperms. The results are discussed in terms of hydraulic efficiency and plant evolution.

McDade, K, and C Maguire. 2005. Comparative effectiveness of three techniques for salamander and gastropod land surveys. *American Midland Naturalist* 153: 309–320.

For amphibian and gastropod biologists and ecologists. The effectiveness of pit traps, ground searches, and cover boards in trapping terrestrial salamanders and gastropods was assessed in eighteen forest stands with three management histories in southern Oregon Cascades forests. On the basis of number of individuals and number of species captured, pitfall traps were more efficient than ground searches in capturing amphibians, but less efficient in capturing gastropods, under all three stand conditions. Cover boards were not effective for capturing either salamanders or gastropods.

McDowell, NG, J Licata, and BJ Bond. 2005. Environmental sensitivity of gas exchange in different-sized trees. *Oecologia* 145: 9–20.

For ecologists and plant physiologists. Using a detailed process model that incorporates size-related hydraulic conductance and empirical measurements from wet and dry periods, the authors

studied environmental sensitivity of gas exchange in different-sized Douglas-fir trees. As predicted, differences in size-associated gas exchange were greatest in wet and mild environments and minimal in drought. Because net ecosystem exchange in Pacific Northwest forests is at a maximum in spring, hydraulic limitation in spring may be important in differences in carbon uptake with stand age. The results imply that climate change impacts of forest tree growth and physiology will depend on the age and size of the forest.

McFarlane, E, D Pilz, and N Weber. 2005. High-elevation gray morels and other *Morchella* species harvested as non-timber forest products in Idaho and Montana. *Mycologist* 19(2): 62–68.

For foresters, mycologists, and mushroom harvesters. This article discusses the post-fire morels of Idaho and Montana, especially the "gray" morels. Information gathered included ecological and genetic data and interviews with commercial mushroom harvesters and buyers. Gray morels fruited exclusively in high-elevation spruce and fir forests that had burned the preceding summer. They were mostly found in areas of moderate fire intensity as indicated by the "red needle" zone, a layer of dead conifer needles on top of the fire ash. Genetic analysis revealed five varieties of morels among our specimens. Gray morels are economically important because they are larger, heavier, and more durable than other species.

McFarlane, KJ, and RD Yanai. 2005. Measuring nitrogen and phosphorus uptake by intact roots of mature *Acer saccharum* Marsh., *Pinus resinosa* Ait., and *Picea abies* (L.) Karst. *Plant & Soil* 279(1/2): 163–172.

For plant physiologists and ecologists. Uptake of nutrients by intact roots is often measured by the depletion method. The basic method involves separating intact fine roots from soil,

placing them in nutrient solution, and determining the difference between initial and final amounts of nutrient in the solution. There are several variations in this method, including applying pretreatment solutions, training roots to grow into bags or trays, and varying concentrations of nutrient solution. The authors tested the effect of method variation on uptake of NH, NO, and PO in intact roots of 60-year-old sugar maple, red pine, and Norway spruce. Roots were either "trained" in a sand-soil mixture, excavated and allowed to recover in nutrient solution for 2 or 4 days, or excavated and used immediately. No significant difference in net uptake rate between pretreatments was observed. Measured uptake rates were affected by initial nutrient solution concentration.

Meinzer, FC, BJ Bond, JM Warren, and DR Woodruff. 2005. Does water transport scale universally with tree size? *Functional Ecology* 19: 558–565.

For plant physiologists and anatomists. The dependence of water use and cross-sectional xylem area on tree size was studied in several angiosperm and conifer species. The results were consistent with a 3/4-power scaling of water transport with estimated above ground biomass. Angiosperms, however, transported considerably more water than conifers of the same size. Sigmoid functions, rather than a power function, best described the scaling of water transport with sapwood area, stem diameter, and aboveground biomass. Relationships between sapwood area and stem basal area fell into at least three species groupings. A power function described scaling of sapwood area with stem radius well, but in two of the three species groups the exponents obtained differed from a recently proposed theoretical value.

Moore, JR, and DA Maguire. 2005. Natural sway frequencies and damping ratios of trees: influence of crown

structure. *Trees: Structure and Function* 19: 363–373.

For silviculturists. Natural frequency and damping ratios were determined for nine Douglas-fir trees grown in plantation under different levels of crown removal. Natural frequency of trees was linearly related to the ratio of diameter at breast height to the square of the total tree height, whether the trees were unpruned or totally debranched. This would be expected from the theory governing oscillation of a cantilever beam. At least 80% of the crown mass had to be removed before an increase in natural frequency was apparent. An equation to predict the natural frequency of a tree of given size and pruning intensity was developed. Levels and trends of damping ratio are discussed. Finite-element analysis indicated that natural frequency changes resulting from pruning are due to changes in mass distribution, rather than damping ratio, and that it may not be appropriate to treat branches as lumped masses rather than individual cantilevers attached to the main stem.

Moore, JR, BA Gardiner, GRA Blackburn, A Brickman, and DA Maguire. 2005. An inexpensive instrument to measure the dynamic response of standing trees to wind loading. *Agricultural & Forest Meteorology* 132: 78–83.

For silviculturists and forestland managers. An inexpensive caliper type strain-gauge transducer was used to measure the behavior of tree stems and branches under wind loading. The transducer produced a voltage that was linearly proportional to the strain it experienced, and the strain was linearly proportional to the displacement of the branches. The transducer could also be used to measure dynamic oscillations of trees.

Murphy, G, and PW Adams. 2005. Harvest planning to sustain value along the forest-to-mill supply chain, pp. 17–23

in *Productivity of Western Forests: a Forest Products Focus*, CA Harrington and SH Schoenholtz, eds. General Technical Report PNW-GTR-642, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For harvest planners and economists. Harvesting a stand takes only a few days, but that short time involves more cost, more revenue, and potentially greater environmental impact that did the decades during which the stand was managed. Revenues can be maximized and future productivity protected by careful design, management, and follow-up of the harvesting operation. Harvest planning matches equipment and crew capabilities to the operating environment while meeting production goals. Effective planning requires situation-specific information on such factors as topography, soil characteristics, tree characteristics, and areas to be preserved or protected. Forest managers must continually improve current harvesting practices based on lessons learned from monitoring the effects of past practices sometimes over long periods. Where possible, the effects should be measured in terms of direct effects on trees. Such measurements would show the range of effects on site productivity and net value recovery resulting from disturbance and soil changes operations, whether they be negative, insignificant, or positive.

Murphy, G, HD Marshall, and AW Evan-son. 2005. Production speed effects on log-making error rates and value recovery for a mechanized processing operation in radiata pine in New Zealand. *Southern African Forestry Journal* 204: 23–35.

For logging engineers and harvest planners. In mechanized processing operations, changes to work practices can affect both machines and their operators. The authors examined the effect of production speed on decision making by an experienced operator

and on machine measurement accuracy and precision. Production speeds from 430 to 610 m³/day did not impact gross value recovery, the types of logs cut, or log-making error rates. Length measurement precision decreased with higher speeds, but net value recovery increased.

Murphy, G, H Marshall, and B Hock. 2005. Meeting order-book constraints by adaptive control of bucking on harvesters, pp. 239–247 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium, October 7–9, 2003, Stevenson, Washington, M Bevers and TM Barrett, eds. General Technical Report PNW-GTR-656, USDA Forest Service, Pacific Northwest Research Station, Portland OR.*

For forest engineers and harvest managers. Mechanized harvesters now often have sensors to measure stem dimension and computers that can optimally buck each stem. Yields obtained by optimal bucking of individual stems, however, are unlikely to meet order book constraints at either the harvest unit or the forest level. The authors developed an adaptive control heuristic that embedded a dynamic programming procedure for optimal bucking of individual stems in a threshold accepting algorithm. The algorithm adjusts relative prices and minimum small end diameters to meet order book constraints. Its performance was tested on four stands in New Zealand. The relative prices and log specifications provided by the adaptive control heuristics met order book constraints better than did using market prices and specifications. Stem information collected by the harvester in the course of harvesting was better than information from preharvest inventory for adjusting prices and specifications.

Nonaka, E, and T Spies. 2005. Historical range of variability in landscape structure: a simulation study in Or-

egon, USA. *Ecological Applications* 15: 1727–1746.

For landscape ecologists and modelers, forestland managers, and policymakers. The objectively defined references required for use in landscape assessments are hard to find. One guide frequently proposed is the historical range of variability (HRV) in forest landscape structure created by natural disturbances, but few studies rigorously quantify HRV. The study had three specific objectives: (1) to establish the HRV of landscape structure under natural disturbance regimes at the scale of a physiographic province (Oregon Coast Range, 2 million ha), (2) to compare the current landscape condition with the HRV, and (3) to evaluate the similarity of alternative future landscapes to HRV. The alternative policy scenarios were simulated by two spatially explicit simulation models: (1) current management policies for 100 years into the future and (2) wildfire with no active management until it reached the HRV. The results indicated that historical landscapes of the province were dynamic. The current landscape was outside the HRV, and landscape did not return to the HRV in the 100 years under either scenario. Under the current policy scenario, the vegetation pattern after 100 years reflected the ownership and consequent management patterns. During the first century the wildfire scenario moved the landscape away from the HRV; it subsequently moved toward the HRV but required many more centuries to reach it. The authors discuss management implications of their findings in some detail.

Nouhra, ER, LS DomÍnguez, AG Becerra, and JM Trappe. 2005. Morphological, molecular and ecological aspects of the South American hypogeous fungus *Alpova austroalnicola* sp. nov. *Mycologia* 97(3): 598–604.

For mycorrhizal researchers and fungal taxonomists and ecologists. A new truffle species associated with *Alnus acuminata* in the Argentinian Andes

is described and named *Alpova austroalnicola*. It is related to the Northern Hemisphere *Alpova diplophloeus*, which is associated with various alder species in North America and Europe. *Alpova austroalnicola* spores are disseminated by the nine-banded armadillo, which feeds on the truffle fruit-bodies.

Oester, PT, WH Emmingham, and P Larson. 2005. Thinning alternatives for ponderosa pine: tools and strategies for family forest owners. *Western Journal of Applied Forestry* 20: 216–223.

For family forest owners, forestland planners, and silviculturists. Forests of ponderosa pine (*Pinus ponderosa*) require thinning in order to control beetle infestation, reduce wildfire risk, and capture financial, aesthetic, and ecological values. A trial of three thinning regimes and an unthinned control was installed in 80- to 100-year old stands in the Wallowa Mountains of northeast Oregon. After 13 years, mean diameter growth and board foot volume of trees with diameter ≥ 8 in. were significantly greater in the “wide” and “free” treatments than in the “narrow” and “control”. Although wood fiber production was significantly greater in the “narrow” and “control” treatments, fire risk and risk of mortality from mountain pine beetle were much greater than in the “wide” and “free” treatments. The results of this study agree with those of previous work and can be used in conjunction with the stand density index by family forest owners to evaluate thinning options.

Additional Program Areas: Integrated Protection of Forests and Watersheds

Olson, GS, RG Anthony, ED Forsman, SH Ackers, PJ Loschl, JA Reid, KM Dugger, EM Glenn, and WJ Ripple. 2005. Modeling of site occupancy dynamics for northern spotted owls, with emphasis on the effect of barred owls. *Journal of Wildlife Management* 69: 918–932.

For ecologists, conservation biologists, and ornithologists. Previous studies of northern spotted owl site occupancy have assumed that detectability is high and not variable and did not consider temporal variation. The authors used relatively new methods that did not have these limitations to model site occupancy, including temporal variation, extinction, and colonization probabilities. They also examined how the presence of barred owl affected these parameters. Data were obtained from spotted owl surveys from 1990 to 2002 on three study areas in Oregon. Site occupancy models were developed and analyzed with the program MARK. Per-visit detection probabilities averaged <0.7 , varied greatly among study years and areas, and were negatively affected by presence of barred owl. Barred owl presence either affected local extinction probabilities positively or colonization probabilities negatively. In future analyses, imperfect and variable detectability and barred owl presence must be accounted for if results are to be interpreted properly. Increased presence of barred owl in the range of northern spotted owls is expected to further reduce the proportion of sites occupied by the latter. Site occupancy was mostly stable through time.

Olszyk, D, M Apple, B Gartner, R Spicer, C Wise, E Buckner, A Benson-Scott, and D Tingey. 2005. Xeromorphy increases in shoots of *Pseudotsuga menziesii* (Mirb.) Franco seedlings with exposure to elevated temperature but not elevated CO₂. *Trees—Structure and Function* 19: 552–563.

For tree anatomists and physiologists. Genetics determines general tree structure, but environmental factors such as climate and CO₂ determine structural expression, even in seedlings. Seedling structure in turn determines the competitiveness of trees for resources and their potential productivity. Seedlings of Douglas-fir were grown outdoors under

realistic simulated field environment conditions in sunlit chambers under climate-change scenarios of ambient or elevated CO₂ plus ambient or elevated temperature. After 4 years, allocation of total mass to branches, rather than stems and leaves, increased, as did the ratio of sapwood area to height and the number of growing points relative to seedling size. Stem and branch length and mass for sections initiated through the three full CO₂ and temperature seasons decreased. Elevated temperature did not affect stem or leaf anatomy. Elevated CO₂ had few effects other than increased specific mass of leaves. There were no temperature x CO₂ interactions.

Parks, CG, SR Radosevich, BA Endress, BJ Naylor, D Anzinger, LJ Rew, BD Maxwell, and KA Dwire. 2005. Natural and land-use history of the Northwest mountain ecoregions (USA) in relation to patterns of plant invasions. *Perspectives in Plant Ecology, Evolution & Systematics* 7(3): 137–158.

For plant and restoration biologists and conservation biologists. Invasions of nonnative plant species are increasing in the mountainous areas of the Pacific Northwest. Historic and current land use and complex variation in landscape structure affect both the ability of invasive plant species to expand and the susceptibility of plant communities to invasion. The authors examined the literature to determine the factors influencing plant invasions in the mountain ecoregions of the Northwest. Altered riparian systems and disturbed forests appeared to be especially vulnerable to invasion, whereas alpine and wilderness areas seem to be relatively unaffected. Both riparian and alpine communities are ecologically significant and need special protection from invasive plants as human settlement at low elevations and intense land use of upland forests increase the possibility of invasive plant introductions. Management to provide such protection will require knowledge

of the relationships between biological and environmental factors, disturbance, and land use.

Perakis, S, JE Compton, and LO Hedin. 2005. Nitrogen retention across a gradient of ¹⁵N additions to an unpolluted temperate forest soil in Chile. *Ecology* 86: 96–105.

For soil ecologists and silviculturists. Understanding nitrogen (N) processing in soils is critical to understanding N cycling, retention and loss in forest ecosystems. Nitrogen was added in the form of ¹⁵NH₄¹⁵NO₃ in a geometric sequence of nine treatment levels to an unpolluted old-growth temperate forest in southern Chile. About half of the tracers were recovered in the top 25 cm of soil, primarily in the top 10 cm. Nitrogen leaching increased sharply at inputs >160 kg N ha⁻¹yr⁻¹. Soil organic matter retained most of the tracer at low N input, but, as N supply increased, coarse roots and particulate matter increased in importance to retention and may explain much of the “missing N” often reported in studies of N inputs to forests. Added nitrogen did not stimulate gross N cycling, potential denitrification, or populations of ammonium oxidizers but did induce a marked decrease in microbial biomass C:N. All measured sinks accumulated tracers across the full gradient of N application.

Phillips, DL, SD Newsome, and JW Gregg. 2005. Combining sources in stable isotope mixing models: alternative methods. *Oecologia* 144: 520–527.

For ecologists and watershed scientists. When source contributions to a mixture are being determined with stable isotope mixing models, there often are too many sources to permit a definitive solution. The authors present two options in approaching this problem: aggregating sources with similar signatures in order to decrease the number of sources sufficiently to provide a unique solution, or using the IsoSource

mixing model to find all feasible solutions consistent with isotopic mass balance. They discuss the situations in which each approach is appropriate and examples of their use.

Additional Program Area: Integrated Protection of Forests and Watersheds

Poage, N, and JT II. 2005. Tree species and size structure of old-growth Douglas-fir forests in central western Oregon, USA. *Forest Ecology and Management* 204: 329–343.

For forest ecologists and silviculturists. The structure of 91 old-growth forests were characterized from inventory data from 1985–1981 timber sales. Douglas-fir accounted for 79% of the total basal area of all species across all sites. On average, density of trees >100 cm dbh was 19 trees/ha; Douglas-fir made up 90% of such trees. Other species accounted for most of the structural variation between sites, even though they made up only about 20% of total basal area at each site. Six structural groups were characterized in terms of basal area in different species-diameter classes. The structural differences were associated with moisture, temperature, and elevation gradients. Such analyses are useful in planning for growing forests with old-growth characteristics.

Pruyn, ML, BL Gartner, and ME Harmon. 2005. Storage versus substrate limitation to bole respiratory potential in two coniferous tree species of contrasting sapwood width. *Journal of Experimental Botany* 56: 2637–2649.

For ecologists and plant physiologists. Tissue-level respiration (respiratory potential) was measured from multiple positions in mature (>100 yr) boles of ponderosa pine and Douglas-fir, species with contrasting sapwood width. Total nitrogen content (N) and total non-structural carbohydrate content (TNC) were 2–6 times higher in inner bark than they were in sapwood. TNC varied

seasonally and was about twice as high in ponderosa pine as in Douglas-fir. Both N and TNC were often correlated with sapwood respiratory potential, whereas ray cell abundance was not, implying that substrate, rather than storage space, was more limiting to respiratory potential. When scaled from cores to boles, potential net CO₂ efflux was positively correlated with live bole volume, live bole ray volume, and N and TNC mass. This relationship did not differ between species for N mass but did differ for the other three measures, indicating that N mass is a good predictor of bole respiratory potential. Bole net CO₂ efflux/live bole volume was 20–25% lower than that of comparable Douglas-fir. Differences between species in net CO₂ efflux were explainable to a great extent by the relative amounts of bole storage space or substrate mass.

Puente, ME, MC Rodriguez-Jaramillo, CY Li, and Y Bashan. 2005. Image analysis for quantification of bacterial rock weathering. *Journal of Microbiological Methods* 64(2): 275–286.

For soil ecologists. Microbial weathering of rocks is common in many climates and regions. The authors developed an electronic image analysis technique to assess bacterial rock weathering. Two bacteria, *Pseudomonas putida* R-20 and *Azospirillum brasilense* Cd, were used to test the method; slurries of ground marble, granite, apatite, quartz, limestone, and volcanic rock were used as substrates. Degree of weathering corresponded directly to the hardness of the rock. The method is fast, quantitative, and indicative of potential damage from microbial weathering, but it does not evaluate the actual rate of weathering under conditions that are not conducive to microbial growth.

Puettmann, KJ. 2005. Do innovative experiments lead to innovative silvicultural systems, pp. 49–53 in *Balancing Ecosystem Values: Innovative*

Experiments for Sustainable Forestry, August 19–20, 2004, CE Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For silviculturists. Large-scale management experiments (LSMEs), established in response to concerns that traditional silviculture did not satisfy the range of landowner objectives, employ an innovative experimental approach. They include multiple objectives that cover a variety of scales and disciplines and are applied to large experimental units. Results can be transferred directly to standard management operations. LSMEs usually follow one of two approaches: comparing effects of implementing different silvicultural systems, or improving understanding of processes important for developing and implementing silvicultural systems. They may involve large-scale, long-term assessments of treatments or small-scale assessment of ecosystem processes. If LSMEs are to be truly effective, researchers must coordinate their efforts, standardize experimental designs and treatments, and work to integrate the results.

Additional Program Area: Evaluation of Forest Uses, Practices, and Policies

Pypker, TG, BJ Bond, TE Link, D Marks, and MH Unsworth. 2005. The importance of canopy structure in controlling the interception loss of rainfall: examples from a young and an old-growth Douglas-fir forest. *Agricultural and Forest Meteorology* 130(1/2): 113–129.

For ecologists, silviculturists, and hydrologists. Both short-term and long-term changes in the canopy of a Douglas-fir forest influence canopy water storage capacity, direct throughfall fraction, the ratio of evaporation to rainfall intensity, and interception loss. In this study, gross and net precipitation were measured in

a 25-year-old Douglas-fir forest and the results were compared with those of an earlier study carried out in a nearby old-growth Douglas-fir forest. Water storage capacity and direct throughfall fraction were significantly lower in the young forest. As a result, interception loss was only slightly lower in the old-growth forest. The ratios of evaporation to rainfall intensity were similar in the two forest types. The Gash rainfall interception model successfully predicted interception loss in the young forest over a season, but errors for individual storms were larger. Errors were improved when the model included seasonal variations in canopy characteristics.

Additional Program Area: Integrated Protection of Forests and Watersheds

Rastetter, EB, SS Perakis, GR Shaver, and GI Agren. 2005. Terrestrial C sequestration at elevated CO₂ and temperature: the role of dissolved organic N loss. *Ecological Applications* 15: 71–86.

For ecologists and others interested in carbon sequestration. The authors assessed the responses of ecosystems to elevated CO₂ and to elevated CO₂ plus warming in ecosystems differing in the ratio of dissolved organic nitrogen (DON) to dissolved inorganic nitrogen (DIN) loss. Carbon sequestration was little affected by how N was lost in the short term, but in the long term (>60 years), carbon sequestration was lower when DON losses were high. Carbon sequestration in the short term was about 3X greater when warming was coincident with elevated CO₂ and was driven by redistribution of N from soils to vegetation and by increases in C:N ratios of soil and vegetation. After 60 years, warming did not affect the rate of sequestration when CO₂ was elevated, and net accumulation of N was the factor affecting C sequestration. They concluded that long-term changes in C sequestration depend on both the size and the form of N losses.

Ripple, WJ, and RL Beschta. 2005. Linking wolves and plants: Aldo Leopold on trophic cascades. *BioScience* 55: 613–621.

For ecologists and those with an interest in ecology and conservation. Wolves have largely been exterminated from the conterminous United States, but recent reintroductions and range expansion now make it important to understand their roles in forest and rangeland ecosystems. As predators, their presence significantly affects herbivores, which in turn influences vegetation, setting in motion a trophic cascade. During the 1930s and 1940s, Aldo Leopold maintained that the loss of wolves and other large carnivores would lead to ungulate irruptions and consequent ecosystem damage. In this paper, the authors synthesize the historical record on the potential effects of wolf extirpation in the context of recent research. Leopold's work provides important perspective for understanding the influence of large carnivores on forest and range plant communities and supports the idea that present-day interactions between ungulates and plants in the United States have been driven largely by the elimination of wolves and other large carnivores.

Ripple, WJ, and RL Beschta. 2005. Willow thickets protect young aspen from elk browsing after wolf reintroduction. *Western North American Naturalist* 65(1): 118–122.

For ecologists and naturalists. The authors hypothesized that taller willow might aid growth of aspen (*Populus*) in a winter range of the ungulate *Cervus elaphus* (elk). During August 2003, they measured height of annual terminal bud scars for the previous 3 years in aspen growing in clumps of tall willow (*Salix bebbiana*, *S. boothii*, and *S. geyerana*) along a 500-m reach of Crystal Creek in Florida. Aspen growing in willow clumps were significantly taller than those growing in the open but were

about the same height as their protecting willows. There was a strong linear relationship between willow height and height of aspen growing within the same willow clump. Aspen growing in willow clumps were significantly taller than aspen growing adjacent to willow clumps in all three years. Leaders browsed ranged from 81 to 100% for willow, 73 to 94% for aspen growing in willow, and 93 to 100% for aspen growing in the open. Tall willow appears to increase recruitment success of aspen recruitment success by providing protection from ungulate browsing. The authors proposed that willows along Crystal Creek are growing taller because wolf reintroduction has resulted in decreased browsing by elk.

Ripple, WJ, and RL Beschta. 2005. Refugia from browsing as reference sites for restoration planning. *Western North American Naturalist* 65(2): 269–273.

For ecologists and restoration biologists. Deciduous woody species, which have been declining, are important in the functioning of riparian ecosystems. A major contributor to their decline or change in community structure, leading to degradation of ecosystem structure and function, has been herbivory by domestic ungulates. Needed restoration of deciduous woody species at landscape scale would be easier if reference sites little impacted by ungulate herbivory could be identified and maintained. Such sites would allow understanding of vegetation dynamics unaffected by herbivory, define the degree and extent of degradation for other parts of a landscape, help in setting priorities for restoration, and provide targets for restoration programs. Impediments to browsing can contribute to persistence of refugia, as well as their number, size, and spatial distribution. Such impediments include physical barriers, human hunting (as a form of predation), and enhancing physical barriers and terrain

features that affect perceived risk of predation by herbivores.

Rosenberger, RS, Y Sneh, TT Phipps, and R Gurvitch. 2005. A spatial analysis of linkages between health care expenditures, physical inactivity, obesity and recreation supply. *Journal of Leisure Research* 37(2): 216–235.

For recreation planners and health care professionals. The authors examined linkages among physical inactivity, obesity, expenditures for treatment of circulatory problems, and availability of recreation opportunities. Using a spatial econometric mode, they found a positive relationship between costs for treatment of circulatory problems and physical activity. Availability of recreational opportunities was negatively related to inactivity but not to obesity. Physical inactivity explained spatial patterns of obesity, but the opposite was not the case. Increasing physical activity by increasing recreational opportunities could decrease obesity and related health care costs.

Ryan, MG, and BE Law. 2005. Interpreting, measuring, and modeling soil respiration. *Biogeochemistry* 73: 3–27.

For biogeochemists, soil scientists, and ecologists. The authors review the role of soil respiration, the largest component of ecosystem respiration, in determining ecosystem carbon (C) balance and the conceptual basis for measuring and modeling soil respiration. This article, part of a special journal issue on soil respiration, also synthesizes results of a workshop. Soil respiration is strongly related to plant metabolism, photosynthesis, and litterfall and could be an indicator of ecosystem metabolism. They discuss the complications involved in using soil respiration to understand changes in ecosystem C storage and describe the areas in which information is most needed to help develop an understanding of the belowground C cycle and of the response

of different aspects of that cycle to the environment.

Sarr, DA, DE Hibbs, and MA Huston. 2005. A hierarchical perspective of plant diversity. *Quarterly Review of Biology* 80: 187–212.

For plant biologists and ecologists. Questions pertaining to the causes, controlling mechanisms, scales of operation, and predictability of the tremendous range in plant diversity from site to site and region to region have been central in theoretical plant ecology, biogeography, and conservation biology for well over 100 years and are still much discussed. The authors review existing hypotheses about factors controlling plant diversity, including a variety of both equilibrium and nonequilibrium models. They then put forth a multiscale conceptual model that outlines the strongest predictive factors, using data obtained at a macroscale (global to region), a mesoscale (region to landscape), and a microscale (landscape to plot level). At the macroscale, climate was a strong predictor of tree diversity, but area was better for predicting overall vascular plant diversity (considered primarily as species richness). Climate was still important at the mesoscale, but topography was the primary predictor of shrub and annual plant diversity and was positively correlated with diversity of trees, shrubs, and herbs. At microscales, spatial patterns of diversity showed a clear pattern along a climate-driven productivity gradient. Competitive controls appear to override climatic controls at the most productive sites. The authors conclude that their model is a sound basis for analyzing plant species diversity and suggest that mesoscale studies will probably be most informative about the mechanisms maintaining diversity.

Schwarz, P, DA Maguire, and D Mainwaring. 2005. Projections of future overstory stand structure and composition following variable-retention harvests in the northwestern United States,

pp. 201–214 in *Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry: Proceedings of a Workshop, August 19–20, 2004, Portland, Oregon*, C Peterson and D Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For silviculturists and forestland managers. The 1994 Northwest Forest plan placed all federal lands in the Douglas-fir region of the Pacific Northwest under guidelines that emphasize ecosystem management. The plan called for variable-retention harvests with at least 15% of the area in each unit made up of retained green trees in both dispersed and aggregated patterns. The multidisciplinary Demonstration of Ecosystem Management Options (DEMO) study was set up to gather information on the efficacy of variable-retention harvests in providing wildlife habitat. Six treatments, specified by percentage of retained basal area, were established on 13-ha units in six blocks throughout Oregon and Washington: 100%, 75% aggregated, 40% dispersed, 40% aggregated, 15% dispersed, and 15% aggregated. The ORGANON growth-and-yield model was used to project the structure of the stands under different management regimes, and Envision software was used to provide visual representation of future stand structure. These projections and visual representations will be useful to the DEMO team in designing the next set of treatments.

Skov, K, TE Kolb, and KF Wallin. 2005. Difference in radial growth response to restoration thinning and burning treatments between young and old ponderosa pine in Arizona. *Western Journal of Applied Forestry* 20: 36–43.

For silviculturists, ecologists, and forest managers. Management of ponderosa pine forests in the southwestern United States seeks to reinvigorate declining old trees, stimulate growth of young

trees, improve forest health, and reduce fire and insect outbreaks. Some have suggested that returning stands to conditions common before Euro-American settlement should be the model for modern management. The authors compared tree growth of trees established before and after Euro-American settlement under three levels of thinning, followed by low-intensity prescribed fire, with unburned and unthinned controls. Comparisons were made for 3 years after thinning. Thinning did not generally affect growth of presettlement trees. In postsettlement trees, thinning increased radial growth in all years, with growth response being negatively correlated with posttreatment stand basal area. The postsettlement trees did not show “thinning shock”, though they had grown at high density for 80 years. Previous management history affected response of postsettlement trees.

Additional Program Area: Integrated Protection of Forests and Watersheds

Smiley, Jr, PC, ED Dibble, and SH Schoenholtz. 2005. Fishes of first-order streams in north-central Mississippi. *Southeastern Naturalist* 4(2): 219–236.

For aquatic ecologists and fish biologists. Fishes were sampled and their physical habitat was measured in 14 streams in order to determine the characteristics of the fish communities and their relationships to those of the physical habitat. Nearly 7000 fish were captured, belonging to 36 species and 11 families. The five most abundant species were creek club, least brook lamprey, blackspotted topminnow, creek chubsucker, and green sun-fish. Most streams were dominated by Cyprinidae, fish with a maximum body size of 300–399 mm, insectivores, and guarder-nest spawners. The fish species composition and the relationship between fish communities and physical habitat in the 14 streams were similar to those in other streams in the Gulf coastal plain.

Smith, J, D McKay, G Brenner, J McIver, and JW Spatafora. 2005. Early impacts of forest restoration treatments on the ectomycorrhizal fungal community and fine root biomass in a mixed conifer forest. *Journal of Applied Ecology* 42: 526–535.

For forest researchers, forest managers, and mycologists. The response of ectomycorrhizal fungi species richness and live fine root biomass to thinning and burning was investigated in mixed conifer forest stands in the Blue Mountains of Oregon. Understanding how mycorrhizal fungi respond to prescribed fire and thinning will assist forest managers in selecting fuel-reducing restoration treatments that maintain critical soil processes. This study shows that prescribed fire results in a short-term reduction in mycorrhizal species richness and live root biomass and may influence whether managers can achieve the desired future condition of stands with large-tree retention and low fuel loads. These results, along with the recovery potential of a site and the impending risk of stand-replacing wild-fire in stands differing in structure from historic conditions, bear consideration when reintroducing fire.

Smith, M, J Trappe, and D Rizzo. 2005. NATS truffle and truffle-like fungi 11. *Hymenogaster raphanodorus* sp. nov. (Cortinariaceae). *Mycotaxon* 93: 241–246.

For fungal taxonomists and mycorrhiza researchers. This new truffle species was found in a xeric mixed woodland on the lower slopes of the central Californian Sierra Mountains. It occurred under a mix of blue oak, gray pine, and manzanita, probably an ectomycorrhizal fungus (others in the genus are). Because the roots of these plants were intermingled, the plant or plants that host the truffle could not be determined. The species name, raphanodorus, means “with a radish odor”.

Splechtna, BE, G Gratzler, and B Black. 2005. Disturbance history of a gap-phase, mixed-species forest in Central Europe, applying the boundary-line approach. *Journal of Vegetation Science* 16: 511–522.

For disturbance ecologists and dendrochronologists. Knowing the disturbance regime of an ecosystem is necessary to understanding its vegetation dynamics. In the case of Central European old-growth forests, very limited quantitative information is available on disturbance regimes, both because such forests are scarce and because influence of site, rather than disturbance, has been emphasized. The authors investigated if and how variation in frequency or size of disturbances affects the dynamics of a montane old-growth forest in lower Austria. Codominant species are *Fagus sylvatica*, *Picea abies*, and *Abies alba*. They inferred the occurrence of disturbances from rapid early growth and release events, as determined from cores obtained from 100 trees on each of four plots. The disturbance histories revealed considerable variation in disturbance frequency or severity, some decades having disturbance peaks and others showing extended periods with no disturbance. Most disturbances tended to thin the stand, rather than to clear large areas. Disturbance led either to gap expansion or to gap closure, likely depending on stand history.

Stoddard, M, and J Hayes. 2005. The influence of forest management on headwater stream amphibians at multiple spatial scales. *Ecological Applications* 15: 811–823.

For ecologists, amphibian biologists, and forest managers. Information about vertebrate habitat structure that includes multiple spatial scales and taxa is essential to effective conservation of wildlife diversity, but most studies to date have been of single species, studied by single approaches. This study examined habitat relationships of three

species of amphibians at three spatial scales (2-m sample unit, intermediate, and drainage). The amphibians and life stages included were larval and neotenic Pacific giant salamanders (*Dicamptodon tenebrosus*), larval and adult Pacific tailed frogs (*Ascaphus truei*), and torrent salamanders (*Rhyacotriton* spp.). Species-habitat associations, both positive and negative, differed at the different scales. The results suggest that geophysical and ecological characteristics can be used with measures of instream habitat to determine the most important conservation areas for stream amphibians.

Stubbs, MM, and DA Pyke. 2005. Available nitrogen: a time-based study of manipulated resource islands. *Plant and Soil* 270(1/2): 123–133.

For ecologists and soil scientists. According to the resource island theory, resources such as nitrogen and other nutrients are present in higher quantities under tree and shrub canopies than they are between them. The resulting heterogeneity of available nitrogen contributes significantly to the distribution and abundance of the biota in an ecosystem. The authors examined temporal variation in soil nitrate (NO_3^-) and ammonium (NH_4^+) concentrations before and after fire and woody plant removal in four juniper-sagebrush sites along a precipitation gradient in central Oregon. Concentrations of NO_3^- and NH_4^+ were higher under the canopy than in the interspace and higher in burned treatments than in unburned. Woody plant removal did not affect their concentrations. In untreated control areas, concentrations of both were higher under junipers in nearly all months. Differences between canopy and interspace concentrations were less and were more ephemeral in the two wetter sites.

Sulzman, E, JB Brant, RD Bowden, and K Lajtha. 2005. Contribution of above-ground litter, belowground litter, and

rhizosphere respiration to total soil CO₂ efflux in an old growth coniferous forest. *Biogeochemistry* 73: 231–256.

For biogeochemists, soil scientists, and those interested in carbon flux. Sources of soil respiration were determined by manipulating aboveground litter and terminating live root activity. Belowground litter decomposition contributed the greatest amount (58%) to total soil CO₂ efflux; root and rhizospheric respiration contributed 23%, and aboveground litter decomposition, 19%. These values generally agree with those reported elsewhere; the relatively high estimate of belowground litter contribution likely reflects the high mycorrhizal association and low nutrient status of the ecosystem. Plots with doubled needle litter showed fluxes beyond what was expected on the basis of the additional carbon added, resulting in a 34% increase in total carbon flux. The results show that increases in net primary productivity do not necessarily translate into additional belowground storage.

Swanston, CW, MS Torn, PJ Hanson, JR Southon, CT Garten, EM Hanlon, and L Ganio. 2005. Initial characterization of processes of soil carbon stabilization using forest stand-level radiocarbon enrichment. *Geoderma* 128: 52–62.

For soil scientists and ecologists. Soil carbon (C) dynamics can be followed by using radiocarbon as a tracer and practical fractionation techniques. The authors examined the rate of C cycling in temperate forest soils in a stand that had been inadvertently labeled with ¹⁴C by an industrial release. Their fractionation scheme separated soil organic matter into three fractions: interaggregate particulate organic matter (free light fraction), particulate organic matter occluded within aggregates (occluded light fraction), and organic matter complexed with minerals (dense fraction). Carbon concentration and C:N ratios were higher in the occluded light fraction than in the free light fraction. In

both light fractions, the C concentration was 10X that of the dense fraction, so that the light fractions together accounted for <4% of the soil by weight in the 0–15 cm soil increment and less than 1% in the 15–30 cm soil increment, but contained 40% of the soil carbon in the former and >35% in the latter. The free light fraction had the shortest mean residence times in all cases. There was a significant depth x fraction interaction for ¹⁴C, indication that the relative importance of aggregation and organic mineral interactions in overall C stabilization changes with depth. Labeled C was incorporated rapidly into the dense fraction, indicating that this fraction contains highly stable material, as well as more recent inputs.

Taft, OW, and SM Haig. 2005. The value of agricultural wetlands as invertebrate resources for wintering shorebirds. *Agriculture, Ecosystems & Environment* 110: 249–256.

For wildlife biologists and aquatic resource managers. Shorebirds regularly winter on wetlands dispersed through the agricultural lands of the Willamette Valley of Oregon. Although benthic invertebrates are a critical food source, the abundance of such invertebrates in agricultural wetlands has not been quantified. The authors determined density, biomass, and community composition of invertebrates at Willamette Valley sites during a wet and a dry winter. Overall, biomass and density were similar in the two years. Aquatic oligochaetes made up ~80% of total invertebrate communities. Estimates of food abundance obtained in this study were similar to those observed in other North American freshwater wintering areas.

Additional Program Area: Integrated Protection of Forests and Watersheds

Talbert, C, and D Marshall. 2005. Plantation productivity in the Douglas-fir region under intensive silvicultural practices: Results from research and

operations. *Journal of Forestry* 103: 65–76.

For silviculturists and forest land managers. The authors review roots of and trends in silvicultural practice and underlying management philosophy in the Pacific Northwest. They discuss trends in plantation management and culture of young stands and the current competitive position of tree growing in the region. They then outline prospects for the future and state and discuss three imperatives crucial to long-run competitiveness: (1) significantly increasing value or shortening rotation length required to produce competitive yields and a competitive log mix, (2) significantly reducing cost of producing a unit of merchantable volume, and (3) continuing to earn and maintain the public's trust and willingness to allow operations to continue.

Additional Program Area: Evaluation of Forest Uses, Practices, and Policies

Temesgen, H, and S Mitchell. 2005. An individual-tree mortality model for complex stands of southeastern British Columbia. *Western Journal of Applied Forestry* 20: 101–109.

For silviculturists, modelers, and forest managers and planners. Data were obtained for nearly 30,000 trees in permanent plots in British Columbia. Using data from approximately 70% of the trees, the authors developed an individual-tree mortality model for eight major tree species in multi-cohort, multiaged, and mixed-species stands. Data from the other 30% were used for model evaluation, after which all trees were used in fitting the final model. Mortality was related to tree size, competition, and relative stand partition with a generalized logistic model, which appeared to be well-behaved and robust for the eight species considered.

Additional Program Area: Evaluation of Forest Uses, Practices, and Policies

Temesgen, H, V LeMay, and SJ Mitchell. 2005. Tree crown ratio models for multi-species and multi-layered stands of southeastern British Columbia. *Forestry Chronicle* 81: 133–141.

For silviculturists, modelers, and forest managers and planners. Crown ratio (CR) is often used as an important predictor variable for tree-level growth equations and, as an indicator of tree vigor, wood quality, stand density, competition, survival potential, and wind firmness, can be an important habitat variable as well. Unfortunately, measuring crown ratio for each tree can be time-consuming and difficult in many situations. In this research, a crown ratio prediction model was developed for several conifer and one hardwood species growing in complex stands of southeastern British Columbia. Possible predictor variables were tree size, stand-level competition, site variables, and basal area of larger trees. The expected relationships of CR decreased with increasing height and with increasing competition. Height was an important predictor for all models. Basal area of larger trees, a measure of stand competition, contributed significantly to predicting crown ration. Much of the variability in crown ratio was not accounted for. Other variables thus seem to be important for explaining CR changes in complex stands such as these.

Additional Program Area: Evaluation of Forest Uses, Practices, and Policies

Temesgen, H, PJ Martin, and DA Maguire. 2005. Effects of different levels of canopy tree retention in stocking and yield of the regeneration cohort in the southern interior of British Columbia, pp. 215–224 in *Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry: Proceedings of a Conference, August 19–20, 2004, Portland, OR*, CE Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service,

Pacific Northwest Research Station, Portland Oregon.

For silviculturists and forestland managers. Under the variable retention silvicultural strategy, trees are retained to add to the structural complexity of the postharvest stand, help conserve postseral species, and provide wildlife habitat and shelter for regenerating and understory vegetation. The retained trees can affect the stock and yield of the young trees, depending on site, whether retention is group or dispersed, attributes of retained trees, and other factors. Accurate growth-and-yield predictions for the two-tiered stands resulting from variable retention are required. The effects of retained trees on seedling stocking and future yield were simulated for pure stands of lodgepole pine (*Pinus contorta*) and interior spruce (*Picea engelmannii* x *glauca*) in British Columbia. Regeneration stocking was 0.3% to 6.5% lower when trees were retained than in clearcut scenarios. The final yield of the understory cohort was reduced by 8% to 32%, depending on the level of retention.

Additional Program Area: Evaluation of Forest Uses, Practices, and Policies

Trappe, J. 2005. On the nutritional dependence of certain trees on root symbiosis with belowground fungi (an English translation of A.B. Frank's classic paper of 1885). *Mycorrhiza* 15: 267–275.

For mycorrhiza researchers, tree physiologists, ecologists, and historians of science. This is a translation from German of Prof. A. B. Frank's first report of the fungus-root symbiosis typical of trees in temperate and boreal forests. Frank coined the term "mycorrhizae" in this paper and hypothesized its significance. In so doing he opened important new insights on how forests function through the means of symbioses.

Trappe, JM. 2005. A.B. Frank and mycorrhizae: the challenge to evolutionary and ecologic theory. *Mycorrhiza* 15: 277–281.

For mycorrhiza researchers, tree physiologists, ecologists, and historians of science. In 1885, the German botanist Albert Bernhard Frank published a paper that totally changed the understanding of how forests function. He had discovered that feeder rootlets of trees were enveloped in mantles of fungi, which grew into the roots without damaging them to form dual organs, which he termed "mycorrhizae," i.e., "fungus roots." By some simple experiments and large amounts of careful observation and thought, Frank hypothesized the function of these "fungus roots." Nearly everything he proposed has since been confirmed by modern scientific methodology, and mycorrhizae are now recognized as a universal phenomenon in the world's forests. The trees and fungi have co-evolved so that neither can survive and reproduce without the other. Frank's lucid explanation of this symbiosis, a term that he originated years earlier, remains little appreciated by many ecologists and evolutionists despite many thousands of papers published about it. This strange reaction in the scientific community deserves study by sociologists to better understand how science operates in modern society.

Trappe, J, and A Claridge. 2005. Hypogeous fungi: evolution of reproductive and dispersal strategies through interactions with animals and mycorrhizal plants, pp. 613–623 in *The Fungal Community-Its Organization and Role in the Ecosystem*, J Dighton, J White, and P Oudemans, eds. Taylor & Francis, Boca Raton FL.

For forest and wildlife ecologists and mycologists. Hypogeous fungi (truffles and false truffles, descended from mushroom-forming fungi) have evolved independently in forests of both the Northern and Southern

Hemispheres. Dry climates, as exemplified by Australia with its extraordinary diversity of truffles, are likely a major selection pressure for fungi to fruit below ground, although other climatic and ecological factors also play a role. Moreover, to attract animals to feed on them and thereby disperse their spores, truffles have evolved production of complex aromatic compounds. The truffles depend on mycorrhizal symbiosis with trees from which they obtain energy in the form of photosynthesized sugars. The interdependency of trees, truffles, and animals has evolved around the world in much the same way with much the same functions but with different trees, fungi, and animals from one place to another: the same play but different actors.

Trappe, JM, AW Claridge, and A Jumpponen. 2005. Fire, hypogeous fungi and mycophagous marsupials. *Mycological Research* 109: 516–518.

For forest and wildlife ecologists and mycologists. The speculation that prescribed burning enhances fruiting of hypogeous fungi (truffles and truffle-like fungi) and thus improves habitat for the animals that feed on them is shown to be false. Some fungi are fire-adapted and may seem to be more abundant after fire. Those few species, however, are eaten more by animals after fire simply because fire suppresses fruiting of other fungi. Hence, only the fire-adapted species that survive are available to the animals.

Turner, DP, WD Ritts, WB Cohen, TK Maeirsperger, ST Gower, AA Kirschbaum, SW Running, M Zhao, SC Wofsy, AL Dunn, BE Law, JL Campbell, WC Oechel, HJ Kwon, TP Meyers, EE Small, SA Kurc, and JA Gamon. 2005. Site-level evaluation of satellite-based global terrestrial gross primary production and net primary production monitoring. *Global Change Biology* 11: 666–684.

For forest modelers and ecologists. Evaluating trends in biospheric behavior, understanding the role of the biosphere in the global carbon cycle, and determining large-scale patterns in food and fiber production requires regular monitoring of global terrestrial net primary production (NPP) and gross primary production (GPP). Imagery from the satellite-borne Moderate Resolution Imaging Spectroradiometer (MODIS) sensor is now being used to carry out such monitoring. This paper reports results of a study that evaluated MODIS NPP/GPP and ground-based products at six sites ranging widely in climate, land use, and vegetation characteristics. There was no consistent over- or underprediction of NPP across sites. The closest agreements in NPP and GPP were at the temperate deciduous forest, arctic tundra, and boreal forest sites. MODIS products gave moderate underestimation at the agricultural field site and strong overestimation at the desert grassland and at the dry coniferous forest sites. The fraction of photosynthetically active radiation absorbed by the vegetation canopy, the maximum light use efficiency, and the climate data underlay the faulty estimates.

van Tuyl, S, BE Law, DP Turner, and AI Gitelman. 2005. Variability in net primary production and carbon storage in biomass across Oregon forests—an assessment integrating data from forest inventories, intensive sites, and remote sensing. *Forest Ecology and Management* 209: 273–291.

For ecologists and those interested in carbon cycling. Inventory data, chronosequences, supplementary data, and remote sensing were used to estimate biomass and net primary production (NPP) for four forested ecoregions in western Oregon: the Coast Range, the West Cascades, the East Cascades, and the Klamath Mountains. There were fewer old stands in the Coast Range and the East Cascades, and fewer old

stands on nonfederal than on national forest lands. Estimated biomass tended to stabilize after about 200 years. Peak biomass in the East Cascades, which are semi-arid, was about one-third that of the other, more mesic ecoregions. The Coast Range forests reached maximum NPP before 30 years of age, whereas the East Cascades reached maximum NPP between 80 and 100 years. The East Cascades also differed from the other ecoregions in that the oldest stands had the highest NPP and the NPP allocated belowground decreased with stand age. Combining data from intensive and extensive measurement sites improved estimates of carbon stocks and fluxes and parameterization of models used in scaling carbon flux.

Wagner, RS, MP Miller, CM Crisafulli, and SM Haig. 2005. Geographic variation, genetic structure, and conservation unit designation in the Larch Mountain salamander (*Plethodon larselli*). *Canadian Journal of Zoology* 83: 396–406.

For conservationists and those interested in amphibian biology. Habitat destruction is threatening the Larch Mountain salamander. Differences among populations of the species were examined through the use of DNA sequences and RAPDs (rapidly amplified polymorphic DNA). Three clades were identified by phylogenetic analysis of cytochrome b. There was less nucleotide diversity in northern than in southern populations. The authors discuss likely colonization scenarios and suggest that separate management units for different regions may help in conservation efforts for this species.

Walter, ST, and CC Maguire. 2005. Snags, cavity-nesting birds, and silvicultural treatments in western Oregon. *Journal of Wildlife Management* 69: 1578–1591.

For forest managers, ecologists, and ornithologists. Use of natural snags

and 10- to 12-year-old snags, created by topping mature conifers, by cavity-nesting birds was examined in three silvicultural treatments (group-selection cuts, 2-story regeneration harvests, clearcuts with retained trees) in 30 Douglas-fir stands in the Oregon Coast Range. Snags were either clustered or scattered. Eight bird species nested in created snags. Eleven species used snags and live-topped conifers for nesting or foraging. Nesting, species richness, and species diversity were higher in open-canopy stands (2-story and clearcut treatments) than in closed-canopy, group-selection stands. Snag distribution did not affect nesting levels. In created snags, most active nests were in the top 25% of the bole, cavity entrances typically faced northeast, and dead branches did not alter nesting use. Topped conifers that were still alive were rarely used for nesting or foraging. The number of cavities/created snag/silvicultural treatment increased 3.3- to 6-fold in the 6 years since the last survey, and four additional species were nesting, three of which were secondary cavity nesters. Total cavities per snag averaged 5.1 for created snags, 4.3 for natural snags >12 years old, and 2.5 for natural snags <12 years old. Natural new snag recruitment resulting from residual green tree mortality was highest in 2-story stands and lowest in clearcuts. Snags created by topping lasted a long time and were readily used by birds. They therefore should be considered an option for improving avian habitat in managed forests.

Wang, Y, M Castellano, and J Trappe. 2005. *Melanogaster utriculatus* sp. nov. from Japan. *Mycotaxon* 93: 315–317.

For fungal taxonomists. This new truffle species is unique in being the only one in the genus with spores having an outer utricle, or skin. It is known only from the Japanese island of Honshu.

Williams, M, PA Schwarz, BE Law, J Irvine, and MR Kurpius. 2005. An improved analysis of forest carbon dynamics using data assimilation. *Global Change Biology* 11(1): 89–105.

For ecologists, plant physiologists, and others interested in carbon dynamics. Landscape carbon (C) dynamics can be quantified either by measuring changes in C stock over time or by directly measuring C flux. Carbon budgets have also been generated with process-based models. All these approaches, however, have drawbacks. Data assimilation techniques combine stock and flux observation with a dynamic model. This study shows how this approach can improve estimates and understanding of ecosystem C exchanges. The demonstration incorporated data on eddy flux and soil CO₂ efflux, lateral collection, stem surveys, root and soil cores, and leaf area index. The assimilation process reduced the uncertainties occurring when data or model alone is used and produced statistically unbiased estimates of forecast net ecosystem C exchange. The importance of time series length is explained and additional roles of data assimilation techniques are discussed.

Withrow-Robinson, BA, and DE Hibbs. 2005. Testing an ecologically based classification tool on fruit-based agroforestry in northern Thailand. *Agroforestry Systems* 65: 123–135.

For agroforesters and forest managers. Highland farmers in Thailand have been expanding fruit cropping and agroforestry, in particular fruit-based agroforestry. In order to introduce more objectivity and rigor to classifying and relating different highland garden systems to each other, the authors adopted a multivariate approach similar to that used by ecologists to reveal relationships between communities, using data on crop species composition, species abundance, perennial-crop age groups, and other physical and ecological fac-

tors. The gardens were clustered into different types with hierarchical cluster analysis. Classifications and analysis gradients were interpreted with the help of nonmetric multidimensional scaling analysis, which showed overall crop diversity, herbaceous food crops, size, and market potential of the fruit planting to be important classifying factors. Because the 82 gardens studied varied considerably in their characteristics, yet overlapped greatly, the classification resulting from this analysis did not distinguish garden types and elucidate their relationships as clearly as had been hoped.

Wurtz, T, A Wita, N Weber, and D Pilz. 2005. *Harvesting Morels after Wildfire in Alaska.* Research Note PNW-RN-546, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forest managers, policymakers, mycologists, and mushroom harvesters. This research note reports on morel mushrooms that fruit following large wildfires in interior Alaska. It discusses Alaska's boreal forest environment, describes what is known about the ecology of morels that fruit after fire, and reports levels of morel productivity for three recently burned areas. It also describes the results of a series of in-depth interviews on the commercial harvest of morels in the Pacific Northwest, western Canada, and Alaska. Information includes current harvest levels, development of an Alaskan morel industry, and potential implications for resource management and business development.

Yang, Z, WB Cohen, and ME Harmon. 2005. Modeling early forest succession following clear-cutting in western Oregon. *Canadian Journal of Forest Research* 35: 1889–1900.

For silviculturists, forest planners, and ecologists. Forest processes such as carbon storage, nutrient cycling, and

biodiversity are affected by conifer development after stand-replacing disturbance. Canopy cover change of shrubs, hardwoods, and conifers from 1959 to 1997 was examined by photo-interpretation of historic aerial photographs of 94 stands in the Western Cascades Province and 59 stands from the Coast Range Province and modeling with a Chapman-Richards growth function. Rates and densities of conifer regeneration differed distinctly among sites. The study regions also differed in both trajectories and rates of early forest succession, with establishment of regeneration taking longer to establish and developing more slowly than in the Coast Range Province.

Yano, Y, K Lajtha, P Sollins, and BA Caldwell. 2005. Chemistry and dynamics of dissolved organic matter in a temperate coniferous forest on Andic soils: Effects of litter quality *Ecosystems* 8: 286–300.

For soil scientists and ecologists. Although the chemical properties of dissolved organic matter (DOM) are assumed to control its retention in soils, information linking litter quality and

DOM chemistry and retention is lacking. This study investigated the effects of litter quality and inputs on solution chemistry and DOM quality and removal in the field in a temperate coniferous forest. Solution chemistry was greatly influenced by litter type and degree of decomposition. Root litter appeared to be most responsible for production of dissolved organic nitrogen. The O-horizon leachate was similar in chemical composition under all field treatments (normal litter inputs, doubled needle, and doubled wood) and most resembled laboratory extracts of well-decomposed litter. Concentration of DOM in water deep in the mineral soil was low regardless of litter input or its concentration in water entering the mineral soil. The results suggest that DOM was retained in the soil primarily by abiotic sorption.

Yi, HB, and A Moldenke. 2005. Response of ground-dwelling arthropods to different thinning intensities in young Douglas-fir forests of Western Oregon. *Environmental Entomology* 34: 1071–1080.

For forest entomologists, ecologists, and environmental scientists. Abundance, diversity, and community structure of

ground-dwelling arthropods were assessed 5 years after thinning in 40- to 60-year-old stands under three thinning intensities (light thin, light thin with gaps, and heavy thin) and unthinned controls. Arthropods were collected with pitfall traps in June (warm, wet season) and August (hot, dry season). The heavy and light/gap treatments had higher arthropod abundance and diversity in both seasons and were preferred by ants, spiders, camel-cricket, and millipedes. The abundance of carabids, the third most abundant group, was highest at the unthinned control during the wet season, but not during the dry. The authors hypothesize that thinning increased habitat heterogeneity, thereby indirectly increasing species richness and abundance of ground dwellers. Both seasonality and thinning were highly significant factors; these variables were correlated with litter moisture. Some dominant groups of ground-dwelling arthropods may be sensitive indicators of environmental change.

Additional Program Areas: Forest Regeneration, Integrated Protection of Forests and Watersheds

Integrated Protection of Forests and Watersheds

Akay, A, K Boston, and J Sessions. 2005. The evolution of computer-aided road design systems. *International Journal of Forest Engineering* 16(2): 73–79.

For forest engineers. Route selection is time-consuming and requires evaluation of alternative alignments while taking many criteria into account. Computer-aided analysis has been applied to road design for over five decades. This paper traces the development of computer-aided road design methods and describes some of the unsolved problems in forest road design.

Additional Program Area: Forest Ecology, Culture, and Productivity

Anderson, JK, SM Wondzell, MN Gooseff, and R Haggerty. 2005. Patterns in stream longitudinal profiles and implications for hyporheic exchange flow at the HJ Andrews Experimental Forest, Oregon, USA. *Hydrological Processes* 19: 2931–2949.

For hydrologists. This paper identifies the characteristics of stream channel morphology that vary throughout stream networks and influence patterns of hyporheic exchange flow in mountain streams. Examining longitudinal profiles of streams according to channel unit spacing and the concavity of the water surface led to three key findings. First, channel unit spacing is closely correlated to the spacing between zones of upwelling and downwelling in the beds of mountain streams. Second, vertical hydraulic gradients (VHGs) increase with rising water surface concavity. Third, channel unit spacing and water surface concavity can be used to predict how patterns in hyporheic exchange vary among headwater and mid-order streams. Average hyporheic flow path lengths appear to increase and the potential for hy-

porheic exchange flow in stream reaches appears to decrease from headwater to mid-order mountain streams.

Aruga, K, J Sessions, and AE Akay. 2005. Application of an airborne laser scanner to forest road design with accurate earthwork volumes. *Journal of Forest Research* 10: 113–123.

For forest engineers. This paper describes the potential for earthwork measurements for road design using elevation data provided by laser. In order to help reduce or eliminate road surveying involved in designing forest roads, the authors devised a forest road design program. The program was based on a high-resolution digital elevation model (DEM) from a light detection and ranging (LIDAR) system. This program model was applied to a high-resolution DEM from the LIDAR of Capitol Forest in Washington State, USA. The usefulness of the tool increases with increases in the accuracy of a high-resolution DEM from LIDAR.

Aruga, K, J Sessions, and AE Akay. 2005. Heuristic planning techniques applied to forest road profiles. *Journal of Forest Research* 10: 83–92.

For forest engineers. This paper describes techniques for optimizing forest road profiles and compares an optimized design to a manually developed design. A manually designed forest road profile (345.7 m long with an average gradient of 14.1%) was compared with two heuristic techniques for design: Genetic algorithm (GA) and Tabu search (TS). Both heuristic techniques gave profiles with best costs less than those of the manual design. The cost found by GA was nearly the same as the global optimum solution; TS usually found a

good solution in less time than GA. Increasing the number of control points reduced construction costs but might decrease driving safety and comfort. Although it was not possible to search all alternatives, the results indicated that both GA and TS found good solutions in a reasonable time.

Asana, Y, T Uchida, and J McDonnell. 2005. Searching for a post-variable source area concept of rainfall-runoff response in headwater. *Japanese Society of Hydrology and Water Resources* 18(4): 459–468. (In Japanese, with English abstract).

For hydrologists. For some 70 years, hydrologists have been trying to discover where water goes when it rains. The variable source area theory (VSA), an alternative to infiltration excess theory, has been the basis of many rainfall runoff models. Recent studies of natural hillslopes in the Pacific Rim have found that VSA is inadequate to explain behaviors discovered by modern techniques. The authors summarize advances in hillslope hydrology over the past 40 years, examine the applicability of VSA assumptions used in current rainfall-runoff models, and discuss recent challenges in introducing qualitative field information to such models. Finally, they present directions for future research in developing a post-variable source area concept.

Bateman, D, R Gresswell, and C Torgersen. 2005. Evaluating single-pass catch as a tool for identifying spatial pattern in fish distribution. *Journal of Freshwater Ecology* 20: 335–345.

For fish biologists and freshwater ecologists. Spatially continuous sampling of stream fishes is rarely done at a wa-

tershed scale in mid-size catchments, partly because doing so is expensive and partly because the importance of spatial context has not been recognized. In this study, patterns of abundance, sampling effort, and length-frequency distributions of coastal cutthroat trout (*Oncorhynchus clarki clarki*) obtained by single-pass electrofishing without blocknets were compared with those obtained with a more precise multiple-pass removal electrofishing method in two 500–1000 ha watersheds. Population estimates obtained by the two methods were strongly positively correlated. There were no significant trends in capture probabilities at the watershed scale. Single-pass electrofishing appeared to provide enough precision to detect spatial patterns of abundance at the scale of mid-sized watersheds. The technique may also be useful in providing context for investigating fish-habitat relationships at multiple scales.

Beschta, RL, and WJ Ripple. 2005. Rapid assessment of riparian cottonwood recruitment: Middle Fork John Day River, Northeastern Oregon. *Ecological Restoration* 23: 150–156.

For restoration scientists and plant ecologists. Information about ecological status or functioning of riparian areas is increasingly needed, especially with respect to discovering the effects of streamside management practice on riparian and aquatic habitats. The authors conducted a vegetation assessment along the middle fork of the John Day River. They selected black cottonwood (*Populus trichocarpa*) as the primary species because of its overstory dominance in many areas, ease of visual identification, and importance in ecological functions of many riparian systems in the western United States. They developed a rapid visual methodology for enumerating black cottonwood, categorized by height class, along a 65-km reach of river and used that methodology to evaluate the recruitment status

of black cottonwood along the reach. Tall saplings and pole-sized trees were observed on only 8% and 5%, respectively, of sites accessible to both domestic and wild ungulates but on 60% and 80%, respectively, of refugia sites. This was so in spite of frequent peak flows, which are associated with widespread establishment of cottonwood seedlings. The authors propose that low cottonwood recruitment resulted from ungulate browsing pressure.

Additional Program Area: Forest Ecology, Culture, and Productivity

Burns, D, T Vitvar, J McDonnell, J Hassett, J Duncan, and C Kendall. 2005. Effect of suburban development on runoff generation in the Croton River basin, New York, USA. *Journal of Hydrology* 311: 266–281.

For hydrologists. Three headwater catchments representing a range of suburban development (high density residential, medium density residential, and undeveloped) were studied to assess the changes in storm runoff and groundwater recharge that development can bring about. The effects of impervious area, septic leach-field effluent, and a riparian wetland were examined. The results indicated that the human influence was not enough to greatly affect the groundwater recharge and discharge properties that determine catchment residence time. Although development increased the speed of storm runoff into streams, remnant landscape features and human alterations such as deep groundwater supply and septic systems can alter the effects of development on storm runoff and groundwater recharge.

Buttle, J, and J McDonnell. 2005. Isotope tracers in catchment hydrology in the humid tropics, pp. 770–789 in *Forest, Water, and People in the Humid Tropics*, M Bonell and L Bruijnzeel, eds. Cambridge University Press, Cambridge.

For hydrologists. Abstract not available

Divine, C, and JJ McDonnell. 2005. The future of applied tracers in hydrogeology. *Hydrogeology Journal* 13: 255–258.

For hydrologists. Tracing techniques have proven to be very useful in hydrogeology. Applied tracers (intentionally introduced unnatural constituents) in particular allow control and characterization of the application, which allows transport parameters and subsurface to be quantified at a level superior to those allowed by standard physical methods. In the past decade, many new uses of applied tracers have been developed for hydrogeologic studies. Although tracer approaches present many challenges and limitations, they appear to offer a very useful tool for future work in hydrogeology. The authors discuss specific techniques that are likely to become routinely applied and new methods that may be extremely useful in the future. The power of the technique should increase as tracer test design and optimization and data interpretation improve further.

Doescher, P, JD McIver, H Barrett, M Brunson, S Bunting, J Chambers, C D'Antonio, S Karl, S Knick, R Miller, M Pellant, F Pierson, D Pyke, K Rollins, B Roundy, G Schupp, R Tausch, D Turner, and M Wisdom. 2005. A regional experiment to evaluate effects of fire and fire surrogate treatments in the sagebrush biome. *Northwestern Naturalist* 86(2): 91.

For wildlife biologists and restoration ecologists. During the past 150 years, the fire regime in the Great Basin has changed markedly. The authors describe their planned comprehensive 5-year study of fire and fire surrogate treatments in restoring sagebrush steppe communities in the region. The study, in its early phases when the article was written, will determine conditions under which sagebrush communities can recover on their own after treatment, conditions that will require active

restoration, and the abiotic and biotic thresholds that determine sustainability of sagebrush communities. The information obtained will help managers in restoring ecological communities and understanding the ecological, hydrological, economic, and sociological tradeoffs involved in management alternatives.

Fitzgerald, S, DA Maguire, and R Singleton. 2005. Simulating structural development and fire resistance of second-growth ponderosa pine stands for two contrasting stand treatments, pp. 191–198 in *Balancing Ecosystem Values: Innovative Experiments for Sustainable Forestry: Proceedings of a Conference, August 19–20, 2004, Portland, Oregon*, CE Peterson and DA Maguire, eds. General Technical Report PNW-GTR-635, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For silviculturists and forestland managers. Heavy logging of old-growth ponderosa pine forest in central Oregon 80 years ago, followed by natural regeneration, produced dense, even-aged stands that now are increasingly susceptible to insects, disease, and fire. The authors simulated the effects of two silvicultural alternatives on fire resistance of second-growth, even-aged stands of ponderosa pine: heavy low thinning, leaving the “best” dominant and codominant trees at relatively low stand densities, and single-tree selection, removing trees evenly across all diameter classes. They found that thinning method can significantly affect stand structural attributes, thereby affecting resistance to wildfire. Fire resistance increased under the heavy low thinning treatment but decreased in the single-tree selection treatment.

Additional Program Area: Forest Ecology, Culture, and Productivity

Ganio, LM, CE Torgersen, and RE Gresswell. 2005. A geostatistical approach

for describing spatial pattern in stream networks. *Frontiers in Ecology and the Environment* 3: 138–144.

For landscape ecologists, hydrologists, fish biologists, and geostatisticians. Stream ecologists are faced with many questions about spatial structure in a network as they try to work out how the structure of stream networks affects physical and biological functioning of streams. The authors suggest using exploratory variogram analysis as an initial step and describe how they adapted commercially available software and GIS to generate an empirical variogram and fit variogram models. They demonstrate their method by constructing an empirical variogram to describe spatial patterns in abundance of trout in headwater stream networks.

Gooseff, MN, JK Anderson, SM Wondzell, J Lanier, and R Haggerty. 2005. A modeling study of hyporheic exchange pattern and the sequence, size, and spacing of stream bedforms in mountain stream networks, Oregon, USA. *Hydrological Processes* 19: 2915–2929.

For hydrologists. Slope breaks in longitudinal profile of streams control exchange flow at the channel scale. Building on a previous field study that suggested that spacing between zones of upwelling and downwelling can be predicted from channel unit spacing in stream longitudinal profiles, the authors simulated hyporheic exchange along the longitudinal axis of stream flow in 2nd, 3rd, and 4th-order mountain stream reaches. Exchange was simulated in two sets of idealized stream reaches and one set of observed. The simulations suggested that upwelling and downwelling lengths and step spacing in idealized streams increase with increase in stream order. Overall, their results suggest that channel unit spacing, size, and sequence all are important factors in hyporheic exchange patterns. Although flow nets were much more complex in surveyed

than in idealized stream reaches, trends were similar.

Greslebin, AG, EM Hansen, LM Winton, and M Rajchenberg. 2005. *Phytophthora* species from declining *Austrocedrus chilensis* forests in Patagonia, Argentina. *Mycologia* 97: 218–228.

For mycologists and plant pathologists. Seventeen declining and three healthy stands of *Austrocedrus chilensis*, together with 11 associated streams, were surveyed to determine the *Phytophthora* species present. Species were identified both morphologically and by ITS rDNA sequences. Five species were identified. *Phytophthora syringae* was most common, isolated from soil, streams, or both at nine declining sites and one healthy site. Two undescribed taxa were identified from streams at one declining site each. *Phytophthora cambivora* was isolated from soil at one declining site, and *P. ponapodydes* was isolated from streams at five declining sites. The authors describe each species and discuss their possible relationship with “mal de ciprés”.

Hansen, EM, JL Parke, and W Sutton. 2005. Susceptibility of Oregon forest trees and shrubs to *Phytophthora ramorum*: A comparison of artificial inoculation and natural infection. *Plant Disease* 89: 63–70.

For forest pathology research and extension specialists. *Phytophthora ramorum* causes several diseases in woody plants, including sudden oak death, shoot dieback, and leaf blight. The authors compared symptoms resulting from natural and artificial infection in 49 western trees and shrubs, 80% of which proved at least somewhat susceptible. Whole plant dip most nearly approximated the full range of symptoms observed in the field. Detached-leaf dip provided a rapid assay for susceptibility to leaf blight; these assays were affected by leaf age and inoculum dose. Other techniques were effective

for certain hosts. Pacific rhododendron, salmonberry, cascara, and poison oak were confirmed as hosts. This study provides experimental demonstration of the susceptibility of many forest tree and shrub species to this important pathogen.

Keim, RF, AE Skaugset, and M Weiler. 2005. Temporal persistence of spatial patterns in throughfall. *Journal of Hydrology* 314: 263–274.

For hydrologists. Spatial and temporal variability in throughfall were measured under three forest stands in the Pacific Northwest. The relationships between tree crown size and correlation length of the throughfall pattern discovered in this study require further study. Although spatial patterns were quantifiable and the same from storm to storm, they could not be predicted from tree locations. Time stability plots of throughfall allowed comparison of temporal persistence of spatial throughfall variability among stands. The authors conclude that variograms and time stability plots, in combination, are flexible tools to quantify variability of throughfall in space and time, whether variability is strong or weak, temporally persistent or random. Variograms and plots can provide a basis for models of throughfall used in models in infiltration, soil process, and watershed hydrology.

Kelsey, RG, PE Hennon, M Huso, and JJ Karchesy. 2005. Changes in heartwood chemistry of dead yellow-cedar trees that remain standing for 80 years or more in Southeast Alaska. *Journal of Chemical Ecology* 31: 2653–2670.

For chemical ecologists and forestland managers. Yellow-cedar, *Chamaecyparis nootkatensis* (D. Don) Spach, which grows in southeast Alaska, is socially, ecologically, and economically valuable. Yellow-cedar forests near bogs or other sites with poor drainage have been declining for over a century. Because

of the natural durability and strength of the heartwood, snags of dead trees can persist for up to a century. Snags can be logistically difficult and expensive to salvage commercially and have largely been used for firewood. Salvage for more valuable uses would be financially feasible if wood properties of snags were comparable with those of live trees. The authors compared the heartwood characteristics of five age classes of yellow-cedar snags with those of live trees and evaluated the influence of geographic location on heartwood chemistry. Changes in the extractives measured, relative to live trees, began to appear in Class 3 snags averaging 26 years since death. Changes in compound concentrations in snag heartwood were associated with major physical changes associated with deterioration. The heartwood of the oldest trees (averaging 81 years since death) had the lowest concentrations of extractives, which is reflected in their greater susceptibility to decay. Geographic location was not a significant factor in heartwood chemistry.

Lambrecht-McDowell, SC, and SR Radosевич. 2005. Population demographics and trade-offs to reproduction of an invasive and noninvasive species of *Rubus*. *Biological Invasions* 7: 281–295.

For plant ecologists and conservation and restoration biologists. In order to determine whether invasive and noninvasive plant species differ in tradeoffs between growth and reproduction and whether such tradeoffs are related to population demographics, the authors compared demographics for congeneric plant species in populations of varying density. One species (*Rubus discolor*) is invasive and the other (*R. ursinus*) is noninvasive. *Rubus ursinus* displayed trade-offs between both sexual and vegetative reproduction and future growth, whereas *R. discolor* did not. In both species, population growth rates were high in low-density populations but low

or zero in high-density populations. The low growth in high-density populations was due primarily to increased mortality of clonal sprouts in *R. ursinus* and decreased sprout production in *R. discolor*. Clonal growth was more important than sexual reproduction for population growth in both species. Elasticity analysis indicated that *R. discolor* in stable populations could have enhanced ability to disperse to new sites through increased reliance on sexual reproduction. *Rubus discolor* could be controlled by reducing clonal production and reducing seed production.

Additional Program Area: Forest Ecology, Culture, and Productivity

Mainwaring, DB, DA Maguire, A Kanaskie, and J Brandt. 2005. Growth responses to commercial thinning in Douglas-fir stands with varying severity of Swiss needle cast in Oregon, USA. *Canadian Journal of Forest Research* 35: 2394–2402.

For forest pathologists and silviculturists. In response to concerns about how stands of Douglas-fir respond to thinning after infection with Swiss needle cast (SNC), a retrospective study was established in previously infected stands that had been commercially thinned 4 to 10 years previously. As SNC severity increased, past volume and basal area growth decreased. Although thinning reduced stand level growth, individual tree growth increased in stands with lower residual density. Trees responded positively to thinning at all infection levels, but response with less as severity of SNC increased.

McDonnell, JJ. 2005. Discussion of "Simple Estimation of Prevalence of Hortonian Flow in New York City Watersheds" by Walter et al. *Journal of Hydrologic Engineering ASCE* 10: 168–169.

For hydrologists. The author points out that water quality models are strongly

conditioned by internal processes. He acknowledges the contribution of the paper by Walter et al. in that it challenges engineers and hydrologists to think about Horton infiltration theory and exposes the limitations of standard approaches and models influenced by the theory. His concern, however, is that some practitioners will conclude that rapid runoff in the New York City watersheds is generated only by saturation overland flow. He argues that lateral subsurface storm flow may be more problematic for water quality and quantity and calls for integrated assessment of spatial scales, land uses, and process domains.

McGuire, KJ, JJ McDonnell, M Weiler, C Kendall, BL McGlynn, JM Welker, and J Seibert. 2005. The role of topography on catchment-scale water residence time. *Water Resources Research* 41(5): W05002.

For hydrologists. The residence time of water is a basic indicator of its catchment hydrology, providing information concerning its storage, flow pathways, and source. The authors studied topographic controls on residence time for seven catchments (0.085–62.4 km²) with diverse geological and geomorphical conditions in the western Cascade Mountains of Oregon, hypothesizing that residence time is related to the size of the basin. Topography, rather than basin area, appeared to control catchment-scale transport. This study provides a basis for future research describing scale-invariant transport across climatic and geological conditions in which the first-order control on residence time is defined by the internal form and structure of the basin.

Murphy, G, and M Wing. 2005. Road sediment yields from dispersed versus clustered forest harvesting activity: a case study. *International Journal of Forest Engineering* 16: 65–72.

For forest road designers and harvest site planners. Fine sediments in streams

can reduce aquatic habitat adversely by reducing the number, depth, and volume of pools. When sediment levels are consistently elevated, fish growth may decrease and mortality may increase. Although all streams have natural sediment inputs, road construction, failure, and use in forested watersheds can be a significant sediment source. In this study, road sediments reaching streams over 20 years were modeled under a “clustered” scenario, in which all harvesting took place in one half of a 4900-ha forest, and a dispersed scenario, in which the same level of harvesting was spread over the full forest. Total road sediment yields were 36% lower in the clustered scenario than in the dispersed.

Additional Program Area: Forest Ecology, Culture, and Productivity

Newton, M, and EC Cole. 2005. Linkage between riparian buffer features and regeneration, benthic communities, and water temperature in headwater streams, western Oregon, pp. 81–101 in *Productivity of Western Forests: a Forest Products Focus*, CA Harrington and SH Schoenholtz, eds. USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For riparian ecologists and forest-land managers. Seven 2nd or 3rd order streams were either patch clearcut with no buffers or given one-sided narrow buffers divided by uncut reaches. Intensive regeneration experiments involving three tree species and two stock types of Douglas-fir were set up on four streams; experiments on the other three evaluated how harvest pattern affects water temperature. Size of seedlings strongly influenced their competitive ability. In both unbuffered clearcuts and those buffered on the south side only, aquatic insect communities approximately doubled in abundance. Some genera increased markedly, enhancing the food resource

for salmonids. Stream temperatures increased when all cover was removed. Warming and cooling trends were not definitive on the streams with regeneration experiments; in the clearcuts with narrow buffer screens on the south side only, warming was not observed in uncut areas 300 m downstream of cut areas.

O’Driscoll, M, D DeWalle, K McGuire, and W Gburek. 2005. Seasonal ¹⁸O variations and groundwater recharge for three landscape types in central Pennsylvania, USA. *Journal of Hydrology* 303: 108–124.

For hydrologists. Seasonal dynamics of groundwater recharge were analyzed in three catchments in central Pennsylvania, representing three common landscape types. Variation in ¹⁸O in precipitation, soil water, snowmelt, spring flow, and stream baseflow were analyzed in biweekly samples collected over 1 year. Precipitation, soil water, and baseflow data indicated that recharge on all sites occurred only during brief periods in spring, fall, and winter, rather than year-round. Precipitation, soil water, and stream baseflow data showed an altitude effect. Soils effectively damped the seasonal variation of precipitation isotopic composition at depths of 1.62–2.85 m, with the greatest damping occurring in the shallow soil layers. The signal may be completely damped before reaching the stream in landscapes with thick soils. Residence times for subsurface water seemed to be much longer than the annual seasonal ¹⁸O cycles in precipitation. Predictive models to determine isotopic damping depth could help increase understanding of the variability of recharge and attenuation of contaminants on the landscape scale.

Perkins, TE, and MV Wilson. 2005. The impacts of *Phalaris arundinacea* (reed canarygrass) invasion on wetland plant richness in the Oregon Coast

Range, USA depend on beavers. *Biological Conservation* 124: 291–295.

For ecologists, conservationists, and restoration biologists. The relationship between reed canarygrass (*Phalaris arundinacea*), an invasive species, and species richness was examined in beaver impoundments, unimpounded areas, and areas upstream from debris jams. Three sites of each type were chosen in each of four basins. There was a strong inverse relationship between *Phalaris* and species richness at dam sites, but no relationship at debris jams or unimpounded sites. *Phalaris* flourishes in areas of beaver impoundment and therefore, because of the prevalence of beaver wetlands in the region, threatens landscape heterogeneity and ecosystem function.

Additional Program Areas: Forest Ecology, Culture, and Productivity

Rizzo, D, M Garbelotto, and EM Hansen. 2005. *Phytophthora ramorum*: Integrative research and management of an emerging pathogen in California and Oregon forests. *Annual Review of Phytopathology* 43: 309–335.

For plant pathologists. *Phytophthora ramorum*, which causes sudden oak death, has a host range of more than 40 genera in Europe and North America. These genera include trees commonly found in forests, as well as species sold by horticultural nurseries. This review concentrates on research and management of the pathogen in California and Oregon forests. Topics covered include levels and complexity of management, the affected forest types, recent advances in pathogen characterization, the biology of *P. ramorum* in forests, determination of impacts of the pathogens on forest ecology, and management actions and necessary components of a management program in the region.

Ross, D, G Daterman, and AS Munson. 2005. Spruce beetle (Coleoptera:

Scolytidae) response to traps baited with selected semiochemicals in Utah. *Western North American Naturalist* 65(1): 123–126.

For entomologists and forest resource managers. Racemic 1-methyl-2-cyclohexen-1-ol (MCOL) significantly increased the catch of spruce beetles, *Dendroctonus rufipennis* (Kirby), in multiple-funnel traps baited with frontalin and alpha-pinene. Traps baited with frontalin and MCOL caught significantly more beetles than traps baited with frontalin and alpha-pinene. These results indicate that trap lures for spruce beetle in the Southern Rocky Mountains should contain frontalin and MCOL with or without alpha-pinene.

Shaw, DC, J Chen, E Freeman, and D Braun. 2005. Spatial and population characteristics of dwarf mistletoe infected trees in an old-growth Douglas-fir/western hemlock forest. *Canadian Journal of Forest Research* 35: 990–1001.

For forest pathologists, silviculturists, and ecologists. Western hemlock dwarf mistletoe (*Arceuthobium tsugense*), a hemiparasite of several conifers in the Pacific Northwest, causes deformation and brooming of woody structures; decreases wood production, water use efficiency, and photosynthetic capacity; and increases cull in heavily infected trees. On the other hand, recent research has shown positive effects of dwarf mistletoe on stand biodiversity and wildlife habitat. The authors quantified dwarf mistletoe infections on all trees in an old-growth forest in the Cascade Mountains of southwest Washington, compared the structural features of infected hemlocks in the context of the forest community, identified the spatial distribution of infections, and explored the possible mechanisms for mistletoe dispersion across the stand. Some level of infection was found in 33% of the area; noble fir (*Abies procera*) had the highest rate of infection (29%). On

average, infected trees were larger than uninfected, which enhances the probability of spreading of the mistletoe. The infection centers were actively spreading at their margins.

Temel, F, GR Johnson, and WT Adams. 2005. Early genetic testing of coastal Douglas-fir for Swiss needle cast tolerance. *Canadian Journal of Forest Research* 35: 521–529.

For forest geneticists. Seedlings from 55 families of Douglas-fir from western Oregon were tested for tolerance to Swiss needle cast. After natural field inoculation of the seedlings with the pathogen at two test sites, they were scored visually for needle and foliage color and retention at age 2 and at ages 10 and 12. In the laboratory, seedlings were examined to determine the proportion of needle stomata occluded with pseudothecia and the amount of pathogen DNA in needles. Families differed significantly at both ages for all factors but amount of fungal DNA, indicating that genetic variation in symptoms results primarily from differences in tolerance to the disease, rather than in resistance to infection. Estimated individual-tree heritabilities for SNC symptom traits were low to moderate at both ages, and moderately to strongly genetically correlated within each age-class. Laboratory measurements did not increase efficiency of early selection. Family selection for SNC tolerance at the seedling stage can be very effective in increasing tolerance in older trees.

Additional Program Areas: Forest Regeneration; Forest Ecology, Culture, and Productivity

Tromp van Meerveld, I, and JJ McDonnell. 2005. Comment to "Spatial correlation of soil moisture in small catchments and its relationship to dominant spatial hydrological processes", *Journal of Hydrology* 286: 113–134. *Journal of Hydrology* 303(1–4): 307–312.

For hydrologists. The authors present concerns about a previously published paper and related work by other scientists, specifically about conclusions that indices of mapped soil moisture in the upper decimeters of the soil profile represent causally, topographically driven lateral subsurface flow. They present a counter-argument and data indicating that soil moisture is of little direct importance in the generation of lateral subsurface flow.

Uchida, T, I Tromp-van Meerveld, and JJ McDonnell. 2005. The role of lateral pipe flow in hillslope runoff response: an intercomparison of non-linear hillslope response. *Journal of Hydrology* 311: 117–133.

For hydrologists. Although many studies have described the importance of lateral pipe flow in generating runoff on wet, steep slopes, most have been done in isolation and focused on pipe flow responses to slope characteristics at a single site. The first order controls on pipe flow responses therefore are still not well understood. In this study, pipe flow response to storm rainfall was compared at four sites, one in the United States (Panola, in Georgia) and three in Japan (Toinotani, near Kyoto; Jankei, on Hokkaido; and Hakyuchi, near Tokyo). The objective was to identify commonality among the sites, which differed substantially in topography,

climate, soil type and soil matrix hydraulic conductivity. Four common pipe flow responses to rainfall were found. A decision tree was developed from these results to determine the general conditions required for significant pipe flow. The results of this comparative study agreed well with those of studies of individual slope pipe flow.

Warren, J, FC Meinzer, JR Brooks, and JC Domec. 2005. Vertical stratification of soil water storage and release dynamics in Pacific Northwest conifer forests. *Agricultural and Forest Meteorology* 130: 39–58.

For hydrologists and meteorologists. When there is little rain during the growing season, plants must rely on water stored in the plants or in the soil. The authors characterized vertical variation in the seasonal release of stored soil moisture in xeric forests of old-growth ponderosa pine and in mesic young and old-growth Douglas-fir forests. Soil volumetric water content measured at a particular soil water potential increased with soil depth and depended strongly on soil texture. Soil texture and bulk density accounted for 60–90% of the variation in the soil water retention curves. Even though 40% to 60% of fine roots were located in the upper 20 cm of soil, this zone accounted for only 20% of total water depletion from the upper 2 m at peak

water uptake. The strong dependence of daily water uptake from the entire 2-m profile indicates that fine roots in the upper soil may be important regulators of water uptake through hydraulic effects on stomatal conductance.

Weiler, M, J McDonnell, I Tromp van Meerveld, and T Uchida. 2005. Subsurface stormflow, pp. 1719–1732 in *Encyclopedia of Hydrological Sciences*, M Anderson and J McDonnell, eds. Wiley, New York.

For hydrologists. Subsurface stormflow, which occurs when water moves laterally down a slope through soil or rock, occurs in most upland terrains. In addition to contributing to the volume of flow in streams, it transports labile nutrients and other chemicals into surface waters. It may also be responsible for landslide initiation. The authors present a historical development of ideas about subsurface stormflow, beginning with the work of Engler in 1919. They then discuss homogenous matrix flow and preferential flow, the principal flow regimes of subsurface stormflow. Finally, they treat current research in subsurface flow processes, including initiation of subsurface flow, topographic control on lateral subsurface flow, subsurface flow in soil pipes and macropores, and thresholds and nonlinearities, and suggest areas for future research.

Evaluation of Forest Uses, Practices, and Policies

Abrams, J, E Kelly, B Shindler, and J Wilson. 2005. Value orientation and forest management: The forest health debate. *Environmental Management* 36: 495–505.

For forest managers, silviculturists, and social scientists. The authors surveyed Washington and Oregon residents concerning the management of forest health. They recognized a lack of research in this area, pointing out that most current studies on the subject have concentrated on the polar opinions of either the forest industry or environmentalists. Survey results from the study showed that active management was generally accepted, regardless of a respondent's economic or environmental priorities. The study found disagreement, however, when specific circumstances of forest management and forest conditions were at issue, and environmental or economic orientation was related to perceptions of threats to forest health.

Acuña, MA, CD Palma, A Weintraub, DL Martell, and W-B Cui. 2005. Integrated timber harvest and fire management planning, pp. 167–173 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium, October 7–9, 2003*, Stevenson, Washington, M Bevers and TM Barrett, eds. General Technical Report PNW-GTR-656, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For harvest planners and fire risk managers. Although harvest planners often consider potential fire losses, and timber production plans can influence fire management, timber harvest planning and fire management planning usually are carried out largely independently. The procedure applied in this work

considers an integrated fire and forest management planning methodology that accounts for and exploits interactions among road construction, timber harvesting, and silvicultural activities that can influence forest flammability. The methodology uses a fire-spread model, a network model that identifies crucial stands that can influence the spread of fires across a landscape, and a spatially explicit timber harvest scheduling model. The model and its application to a forest management unit in the boreal forest region of Canada are described, and areas for future research are outlined.

Adams, D, J Mills, R Alig, and R Haynes. 2005. SOFRA and RPA: Two views of the future of southern timber supply. *Southern Journal of Applied Forestry* 29: 123–134.

For foresters and analysts. This report compares results from two major studies of US South timber supply potential and comments on why and how differences arise in the projections. The studies, one by Southern Forest Resource Assessment (SOFRA) and the other by the Fifth Resources Planning Act Timber Assessment (RPA), used different models and methods to obtain their conclusions. The authors conclude that five assumptions about five major points underlie the discrepancies in conclusions: (1) shifts in land area from forest to urban and from agriculture to forest; (2) the correlation between pine plantations to expected timber prices; (3) the way in which southern timber demand can meet the prices; (4) the definition of timber harvest, and (5) the timing of the yield.

Additional Program Area: Forest Ecology, Culture, and Productivity

Adams, DM, and GS Latta. 2005. Costs and regional impacts of restoration thinning programs on the national forests in eastern Oregon. *Canadian Journal of Forest Research* 35: 1319–1330.

For silviculturists, forestland managers, and economists. Many factors affect the feasibility and desirability of thinning programs in restoring forest health to densely stocked stands with high fuel loads. The authors describe a dynamic spatial equilibrium model and use it to examine the effect of several restoration scenarios on the market and on forest health. The thinning programs examined varied in their impacts on private harvest timing, numbers of mills, and the regional timber market. The analysis found that private forestland owners would be consistent losers under the scenarios examined, whereas mills would benefit. Overall, net agency receipts from sales probably would not be enough to cover the costs to thin all areas needing treatment.

Adams, DM, and GS Latta. 2005. Timber harvest potential from private lands in the Pacific Northwest: Biological, investment, and policy issues, pp. 4–12 in *Understanding Key Issues of Sustainable Wood Production in the Pacific Northwest*, RL Deal and SM White, eds. USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forest economists and policymakers. The goal of this study was to develop a broad assessment of future Pacific Northwest (PNW) timber harvest potential. On the basis of conclusions gathered from four half-state studies, as well as information from the fifth Resources Planning Act Timber Assess-

ment, the researchers concluded that the PNW should be able to maintain or exceed recent historical harvest levels over the next 50 or more years. Implications and assumptions based on this prediction are discussed in detail.

Additional Program Area: Forest Ecology, Culture, and Productivity

Akay, A, and J Sessions. 2005. Applying the decision support system, TRACER, to forest road design. *Western Journal of Applied Forestry* 20: 184–191.

For forest engineers. The authors describe the methodology used in the three-dimensional forest-road-alignment model software TRACER. The model is designed to optimize vertical road alignments, taking into account construction, maintenance, and transportation costs. Two optimization techniques are integrated in the model: a linear programming for earthwork allocation and a heuristic approach for vertical alignment selection. A GIS-based road erosion/delivery model is used to estimate the average sediment delivered to a stream from the road section.

Alig, R. 2005. Methods for projecting large-scale area changes for U.S. land uses and land covers: the past and the future, pp. 15–26 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium October 7–9, 2003*, Stevenson, Washington, M Bevers and TM Barrett, eds. General Technical Report PNW-GTR-656, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For land-planners and policymakers. This review synthesizes research related to renewable resource assessments over the 25 years since area projection modeling systems became a state-of-the-art approach to assessment of regional, national, and even global resources. Projections of area changes affect analyses of many natural resource components, including wildlife habitat,

timber supply, global climate change, water, and recreation. These models recognize that different socioeconomic factors drive key land base changes, such as afforestation and deforestation. The author discusses three types of empirical land use models in detail—econometric, mathematical programming, and simulation—and how land use models are linked to other models in resource assessments. He presents a detailed proposal for next-generation models that will help meet significant challenges in resource assessment.

Alig, RJ. 2005. Land use changes that impact sustainable forestry, pp. 28–35 in *Understanding Key Issues of Sustainable Wood Production in the Pacific Northwest*, RL Deal and SM White, eds. General Technical Report PNW-GTR-626, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forest economists, land use planners, and policymakers. The above-average population growth expected in the Pacific Northwest in the next 5 decades likely will increase land use pressures, affecting sustainability in agriculture and forestry, residential communities, biodiversity, and other goods and services. Research on potential development scenarios and their impacts on forest land can help in evaluating and anticipating effects of population growth and associated land-use changes on forest productivity, both regionally and nationally.

Additional Program Area: Forest Ecology, Culture, and Productivity

Alig, RJ, DJ Lewis, and JJ Swenson. 2005. Is forest fragmentation driven by the spatial configuration of land quality? *Forest Ecology and Management* 217: 266–274.

For forest ecologists, planners, and land managers. Attributes of land quality act as economic drivers of forest frag-

mentation at the landscape level. When attributes of the spatial configuration of land quality were included as independent variables in models of forest fragmentation, land quality fragmentation appeared to be a significant determinant of forest fragmentation. This was true both for a model having a fragmentation index comprising three fragmentation metrics (percent nonforest, percent edge, and interspersion) and for separate models for each metric. The fit of the regression in the models was increased more when the dependent variable represented spatial pattern, rather than aggregate land use. When variables capturing spatial configuration of soil quality were included, the fit of all specifications was improved and the bias of other parameter estimates were affected.

Additional Program Area: Forest Ecology, Culture, and Productivity

Anderson, RC, D Fell, RL Smith, EN Hansen, and S Gomon. 2005. Current consumer behavior research in forest products. *Forest Products Journal* 55(1): 21–27.

For wood products marketers and manufacturers. This paper examines consumer behavior research with respect to forest products. New challenges have arisen as the trend towards sophistication in collecting consumer data rises. Recent research at Forintek Canada Corporation, Oregon State University, and Virginia Tech indicates that sampling errors with respect to mail surveys should be monitored carefully. This report also points out the challenges related to consumer behavior research when performed in collaboration with large retailers.

Anderson, RC, D Laband, E Hansen, and C Knowles. 2005. Price premiums in the mist. *Forest Products Journal* 55(6): 19–22.

For economists and wood products marketers and manufacturers. This

study was set up to clarify the effects of "ecolabeling" finished products and resulting price premiums on consumer behavior. Identical pencils were displayed in side-by-side containers in two university bookstores; the containers were labeled with hangtags, one designating an ecolabel and the other not. Consumers were not influenced by a 20% price premium, but bought non-ecolabeled pencils preferentially when the premium was 100%. (The 100% premium was tested at only one of the bookstores because the manager of the other thought customers would consider the high price to be indicative of higher prices throughout the store).

Ballard, H, D Pilz, ET Jones, and C Getz. 2005. *Training Curriculum for Scientists and Managers: Broadening Participation in Biological Monitoring*. Institute for Culture and Ecology, Portland OR. Available at (<http://www.ifcae.org/projects/ncssf3/>).

For scientists and managers who wish to learn how to institute participatory monitoring programs. Although participatory monitoring is becoming more widespread, it is unexplored territory for many forest managers and scientists. This curriculum is designed to be a companion training guide for "Broadening participation in Biological Monitoring: Guidelines for Scientists and Managers" (Pilz and others 2005). This curriculum will provide government and non-government trainers with a tool for introducing participatory biological monitoring and use of the guidelines to managers and scientists during a one-day workshop. In addition to learning how to use the guidelines, the curriculum will help forest managers and scientists explore the reasons for a participatory approach to monitoring and the logistics of implementing such a project. Training sessions also provide an opportunity to network with nearby colleagues that have similar interests.

Bettinger, P, and M Lennette. 2005. *Extreme policies modeled within the landscape management policy simulator (LAMPS)*, pp. 291–298 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium, October 7–9, 2005*, Stevenson, Washington, M Bevers and TM Barrett, eds. General Technical Report PNW-GTR-656, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forestland managers and policy-makers. The Coast Range analysis area covered by the CLAMS project contains about 2.8 million ha in a patchwork of ownerships. The Landscape Management Policy Simulator (LAMPS), developed within that project to evaluate forest management policies within the Oregon Coast Range, was initially designed to simulate "Base Case" management for federal, state, industrial, and nonindustrial private owners. The "extreme policies" modeled were minimizing maximum clearcut to 30 acres, setting a minimum harvest age of 80 years, and assuming that entire Coast Range forests are managed by a single landowner group. Assuming a 40-acre minimum clearcut resulted in minor projected reductions in harvest levels and net present value, but an 80-year minimum harvest age resulted in major projected reductions in both harvest levels and net present value. Assuming that the entire Coast Range is managed by industrial or nonindustrial landowners resulted in significant projected increases in both harvest levels and net present value. This is the first such quantification for such a large area and long period.

Bettinger, P, D Graetz, and J Sessions. 2005. *A density-dependent stand-level optimization approach for deriving management prescriptions for interior northwest (USA) landscapes*. *Forest Ecology and Management* 217: 171–186.

For forest managers, silviculturists, and forest landscape modelers and plan-

ners. The authors describe an approach for developing efficient prescriptions including considerations for fire. Over the last decade, management prescriptions for stands in federal forests in the interior northwest come to emphasize ecological, rather than economic, criteria. The authors describe an approach for developing efficient prescriptions, including considerations for fire. The process uses dynamic programming and a region-limited search strategy, penalizes deviation from a preferred range of stand density, and treats operational considerations as constraints. Harvest entries must also meet certain criteria. Records of residual, harvested, and dead trees, available for each decade of the optimal regime, can contribute to forest product or habitat suitability analysis in developing forest policy.

Additional Program Areas: Forest Ecology, Culture, and Productivity; Integrated Protection of Forests and Watersheds

Bettinger, P, M Lennette, K Johnson, and T Spies. 2005. *A hierarchical spatial framework for forest landscape planning*. *Ecological Modelling* 182: 25–48.

For forest landscape modelers and planners. The authors develop a hierarchical spatial framework to facilitate large-scale, long-term planning for forest landscapes. A 560,000-ha area of the Oregon Coast Range is used for example policy analyses. Spatial data available from satellite imagery can be aggregated to management units for which forest management decisions can be simulated. Alternatively, and more realistically, management units can be aggregated into harvest blocks. Management emphases required by multiple, diverse land allocations and management objects can be accommodated in the simulation and implications of management policies in a large-scale forest landscape can be assessed.

Bliss, JC, and C Bailey. 2005. Pulp, paper, and poverty: Forest-based rural development in Alabama, 1950–2000, pp. 138–158 in *Communities and Forests: Where People Meet the Land*, R Lee and D Fields, eds. Oregon State University Press, Corvallis.

For social scientists, planners, and policymakers. In 1965, a new pulp mill was recruited to Wilcox County in Alabama as part of the state's forest-based rural-development strategy. By the 1990's, the region had become a world center of pulp and paper production. Nevertheless, 34% of county residents in 1998 lived in poverty. This chapter explores the role of forests, forestry, and the forest industry in shaping rural communities in Alabama during the last half of the twentieth century. The authors synthesize several research projects addressing the broad economic, ecological, and political context in which timber-dependent rural communities are situated. They argue that policies that benefit the forest products sector are not necessarily beneficial to rural communities and challenge the view that healthy, productive forests inevitably support healthy, prosperous communities.

Boston, K. 2005. A description of a primary forest products supply chain management system, pp. 39–46 in *The Role of Forests for Coming Generations: Philosophy and Technology for Forest Resource Management*, October 17–22, 2004, K Naito, ed. Japanese Society of Forest Planning Press, Utsunomiya, Japan.

For forest harvest planners and market evaluators. The typical forestry supply chain comprises the forest owner (supplier), harvesting contractors, hauling contractors, sawmills, secondary solid wood manufacturers, pulp mills, and paper mills. These elements often have competing objectives. In fact, the forestry supply chain is a combination of demand-and supply-driven supply

chains. The execution of the primary forestry supply chains could be improved significantly to reduce inventory and improve delivery performance, leading to cost reductions. The author proposes a five-component supply chain management system to produce such improvements and discusses the system in detail. The proposed system includes demand management, supply management, planning and scheduling, execution, and knowledge collection and reporting.

Bradshaw, G, A Schore, J Brown, J Poole, and C Moss. 2005. Elephant breakdown. *Nature* 433: 807.

For large animal biologists and ecologists and animal behaviorists. Parental attachment and support and relationships with extended family are seen to be crucial to the development of young elephants. Young male elephants who witness stressful or traumatic events early in life are more likely to exhibit post-traumatic stress disorders as adults than those that grow up in a normal elephant society. In order to quell the antisocial and hyperaggressive behavior of young male elephants, they must be allowed to develop in normal elephant society without separation from older generations. Young females also need social support and protection from traumatic experience and habitat loss. New conservation strategies for elephants need to promote normal social patterns.

Calkin, D, K Gebert, J Jones, and R Neilson. 2005. Forest Service large fire area burned and suppression expenditure trends, 1970–2002. *Journal of Forestry* 103: 179–183.

For fire ecologists, planners, and economists. This study examines data on emergency wildland fire suppression expenditures, number of fires, and acres burned in order to develop statistical models to estimate areas burned using drought indices for the USDA Forest Service from 1970 through 2002. Although

only a few fires are large, they account for most of the area burned. The results indicate that expenditures for fire suppression are closely related to the area burned, which is largely a function of weather patterns. Fuel accumulation and development in the wildland-urban interface also contribute to difficulties in fire suppression. The authors conclude that successful strategies to contain fire suppression costs will require careful analysis in order to avoid increasing fire damage and costs.

Additional Program Area: Forest Ecology, Culture, and Productivity

Carey, P, and GE Murphy. 2005. Mechanised versus manual log-making in two Chilean *Pinus radiata* stands. *New Zealand Journal of Forestry Science* 35(1): 25–34.

For harvest planners and forest engineers. Forest companies in Chile have been introducing highly mechanized harvesting systems to help meet rapidly increasing harvest production from plantation forests of *Pinus radiata*. Mechanized processing can result in significant value losses relative to manual processing under many circumstances. On the other hand, mechanized processing can increase value recovery where complex product specifications make it difficult for a manual operator to optimize log-making. In order to provide information about performance of different harvesting and processing systems in recovering log value, the authors compared results from mechanized, computer-based optimal log-making with theoretical values obtained by an experienced log maker using a chain saw. The study was carried out in two stands of *Pinus radiata* in Chile; the same experienced manual and mechanized operators were used at both sites. The manual log-making system recovered more volume and value at one site, but there was no difference between systems at the other.

Additional Program Area: Forest Ecology, Culture, and Productivity

Cho, S-H, H Wu, and R Alig. 2005. Land development under regulation: Comparison between the east and west sides of the Cascade Range in Oregon, Washington, and California. *Review of Urban and Regional Development Studies* 17: 1–16.

For forest land-use planners and policy makers. Rapid conversion of farm and forest land to urban uses has increased public interest in land use planning. Few studies have addressed local land use regulations and policies. The authors compare land development and regulation on the east and west sides of the Cascade Range in Washington, Oregon, and northwestern California; the two sides differ dramatically with respect to socioeconomic factors and physical landscapes. They present a model of land-use conversion decisions, which showed that land development was more responsive to economic changes on the west side, and the west side was more involved in land-use planning and regulation. Development was more attracted to urban areas and better land on the west side. On both sides, forestland development substituted for farmland development, and agricultural zoning was the most effective regulation in management of development and farmland loss. Although forest zoning reduced forestland losses, development then shifted to farmland. Risks were important factors in development decisions on both sides.

Collins, A, R Rosenberger, and J Fletcher. 2005. The economic value of stream restoration. *Water Resources Research* 41:W2017: n.a.

For restoration scientists and economists. Acidification of streams from acid rain and acid mine drainage is a major problem in the Appalachian region of the United States. Restoration of affected streams presents many problems,

including justifying stream restoration within a cost-benefit analysis, prioritizing restoration projects, demonstrating economic importance of preserving quality of undegraded streams, and devising a cost-efficient method of data collection for economic valuations. Because little is known about the total valuation of stream restoration, the authors designed and tested a combination mail and Internet survey and used it together with personal contact surveys to determine the economic value of restoring a creek in West Virginia. The economic values of full restoration were ranked aquatic life > scenic quality ≈ swimming. The per-household welfare improvement estimates for full restoration of all three attributes ranged between \$12 and \$16/month, with anglers having the largest gain and nonanglers the lowest. The benefit from full restoration of the creek to the entire watershed population was estimated to be about \$1.9 million annually.

Additional Program Area: Integrated Protection of Forests and Watersheds

Conradie, IP, WD Greene, JF Cox, and GE Murphy. 2005. Applying the thinking process of the theory of constraints: An exploratory research methodology to evaluate the lack of use of cut-to-length harvesting systems in the Southeastern United States. *Journal of Forest Products Business Research* 2: n.a.

For forest products marketers. This study had two objectives: (1) to describe and illustrate the use of a logic-based set of tools to address a situation where a product has failed to be adopted; (2) to analyze reasons for the lack of use of cut-to-length (CTL) harvesting systems in the southeastern United States. The objectives were addressed by applying two components of the Thinking Process Theory of Constraints—the Current Reality Tree (a problem identification methodology) and the Future Reality Tree (a problem solution

methodology) to the lack of CTL use in the Southeast. The authors first review the literature, discussing the conflict between qualitative and quantitative research paradigms, giving an overview of the history and use of the Theory of Constraints in qualitative research, and providing an international and local perspective on CTL adoption. They identified 16 reasons why CTL has not been widely adopted in the southeast, used the Current Reality Tree to identify the core problem (complexity of the equipment), and constructed a potential solution with the Future Reality Tree. They conclude that the Thinking Process methodology is useful for analyzing problems with small population and sample sizes.

Gordon, SN, KN Johnson, KM Reynolds, P Crist, and N Brown. 2005. Decision-support systems for forest biodiversity: a review, pp. 3–6 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium, October 7–9, 2003, Stevenson, Washington, M Bevers and TM Barrett, eds., USDA Forest Service, Pacific Northwest Research Station, Portland OR.*

For forestland managers, decision makers, and decision support system users, designers, and funders. Decision support systems (DSS) are computer applications that help managers deal with complex problems. This review of DSS focuses on two questions: What DSS exist that can help managers address forest diversity issues, and how well do these DSS cover the range of issues related to forest biodiversity. Thirty of 114 available systems met the specified criteria and were reviewed; only 5 of the 30 appeared to have integrated capabilities for both forest and biodiversity modeling. Few DSS model both coarse- and fine-scale species indicators. Models that evaluate the influences of fire and biological threats on forest ecosystem generally do not deal with related biodiversity effects, and

only one system integrated the influence of climate change. Very few DSS appear to be designed to address the value-based, political nature of decisions relating to forest biodiversity.

Additional Program Area: Forest Ecology, Culture, and Productivity

Graetz, D, and P Bettinger. 2005. Determining thinning regimes to reach stand density targets for any-aged stand management in the Blue Mountains of Eastern Oregon, pp. 255–264 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium, October 7–9, 2003, Stevenson, Washington, M Bevers and TM Barrett, eds. General Technical Report PNW-GTR-656, USDA Forest Service, Pacific Northwest Research Station, Portland OR.*

For forestland managers. Stand-level optimization methods have been appearing since the 1960's to help manage individual stands as well as possible. The stand-level optimization procedure described in this paper was developed to facilitate development of management prescriptions addressing ecological or biological goals for forests in Eastern Oregon. Stand-level goals first must be defined by basic tree-level data; the procedure then minimizes deviations of stand conditions from these goals over 100 years. The SLOMO program, which has an embedded distance-independent, single-tree growth model, executes and solves the stand-level optimization problem. Constraints can be imposed or removed and surrogate shadow prices determined under those constraints. Capabilities of the procedure are demonstrated with an example from the upper Grand Ronde watershed.

Additional Program Area: Forest Ecology, Culture, and Productivity

Gray, AN, CF Veneklas, and RD Rhoads. 2005. *Timber Resource Statistics for Nonnational Forest Land in Western*

Washington, 2001. Resource Bulletin PNW-RB-246, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forestland managers and planners. Timber resource statistics are summarized for an inventory of the 19 counties in western Washington. The 2000 inventory sampled all public and private lands not administered by the National Forests or reserved from management for wood products. The organizations managing parks and other reserves provided information for their area. Estimates of land area, timber volume, growth, mortality, and harvest are tabulated.

Hansen, E. 2005. Innovation & NPD in the Oregon and Alaska forest products sectors, pp. 32–36 in *Proceedings, Linking Healthy Forests and Communities: Successful Strategies and Future Directions, October 19–21, Anchorage, Alaska, D Nichols, ed. General Technical Report PNW-GTR-631, USDA Forest Service, Pacific Northwest Research Station, Portland OR.*

For forest product industry planners and marketers. The forest products industry in the US is increasingly challenged to remain competitive in the face of foreign competition, even though the industry has greatly increased fiber utilization and generally follows a low-cost strategy. Innovation in product, process, or business systems offers a significant area for improving competitiveness. Forest industry firms in Oregon and Alaska (more than 300 in each state) were surveyed about their practices with respect to innovation, especially product innovation. Contrary to initial expectations, there were no differences in innovation. In both states, the responding firms emphasized product and process innovation more than business systems innovation. Even though the firms in both states did not consider themselves innovative, they undertook many innovative activities that are not recognized

or quantified. Increased emphasis on business systems innovation likely will be needed to maintain competitiveness in the future.

Hansen, E, and H Juslin. 2005. Marketing of forest products in a changing world. *New Zealand Journal of Forestry Science* 35: 190–204.

For forest products marketers. Changes in the business environment over time have led to changes in marketing philosophies in the forest sector and elsewhere. Orientation in marketing has moved from production to marketing, and the forest products industry is challenged to combine resources and capabilities with customer relationships and value propositions. Marketing in the future will require accentuating social and environmental responsibility, choosing appropriate approaches to marketing problems, and using the best tools available. The authors provide a brief history of marketing thought in the forest industry, explain the basics of strategic marketing, and discuss the parallel between strategic marketing and new business model thinking.

Hovgaard, A, E Hansen, and J Roos. 2005. *Innovation in the Forest Products Industry: an Analysis of Companies in Alaska and Oregon. General Technical Report PNW-GTR-629, Pacific Northwest Research Station, USDA Forest Service, Portland OR.*

For wood products manufacturers and marketers. Research on innovation in forest products is lacking. This study set out to understand the process and definition of innovation in the industry, identify constraints in innovation and resources that would improve innovation of forest products companies, compare the innovation environments in Alaska and Oregon, and provide a benchmark study. Innovation proved to be a combination of semiformal development, trial and error, intuition, and luck. Constraints on innovation included

government regulation, shipping and labor costs, lack of cash flow, raw material supply and characteristics, and marketing expertise. Although somewhat similar, the innovation environments in Alaska and Oregon differed in the marketing tactics and techniques used to obtain market information, the type of innovation projects emphasized, and the processes used to develop innovation. None of the companies interviewed could recommend any helpful resources, other than having a chance to exchange ideas and network.

Additional Program Area: Wood Processing and Product Performance

Howe, GT, B Shindler, B Cashore, E Hansen, D Lach, and W Armstrong. 2005. Public influences on plantation forestry. *Journal of Forestry* 103: 90–94.

For silviculturists, forest planners, and social scientists. As with other resource policies, plantation forestry must meet three criteria if it is to fulfill its potential to supply humanity's needs for wood: biological possibility, economic feasibility, and social acceptability. While least studied, the last criterion is perhaps most critical to the adoption of new approaches to forest management. Focusing on the Pacific Northwest (PNW) of the United States, but drawing heavily from experiences in other countries, the authors discuss public acceptance of plantation forestry in order to provide an understanding of structure and dynamics of public judgments to managers involved with plantation forestry. They point out the ever-increasing complexity of factors underlying public judgments in the PNW and the intuitive nature of most decisions. They suggest that careful attention to social acceptability and forging accords that promote the goals of both environmentalists and forest industries might minimize conflicts over plantation forestry.

Additional Program Area: Forest Ecology, Culture, and Productivity

Isham, J, M Woolcock, L Pritchett, and G Busby. 2005. The varieties of resource experience: Natural resource export structures and the political economy of economic growth. *The World Bank Economic Review* 19(2): 141–174.

For economists and political and social scientists. In the 1970s and early 1980s, commodities underwent a boom and bust period, which was followed in many oil-, mineral- and plantation-based economies by a considerable slowing of growth. This article discusses how such economies are susceptible to heightened economic and social divisions and weakened institutional capacity that diminish their capacity to respond to shocks. Such countries, which rely on resources extracted from a narrow geographic base, do poorly across an array of governance indicators. Countries with diffuse natural resource exports, in contrast, do not show the same strong governance effects and are capable of more robust growth recovery.

Johnson, RL, B Shelby, M Brunson, and J Leahy. 2005. Socioeconomic responses to silvicultural alternatives, pp. 88–103 in *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*, CC Maguire and CL Chambers, eds. Research Contribution 46, Forest Research Laboratory, Oregon State University, Corvallis.

For economists and social scientists. The Peavy replications in the College of Forestry Integrated Research Project (CFIRP) are situated in a popular recreation area in the McDonald-Dunn Forest, north of the city of Corvallis, Oregon. The program therefore presented an opportunity to study socioeconomic aspects of alternative silvicultural treatments in a near-urban setting. Three projects are discussed in this chapter: a public perceptions study, a study of adjacent landowners, and a recreation

study. All three studies showed that the constituencies surveyed are highly sensitive to impacts of silvicultural treatments. Treatments other than clearcutting and sites with the least evidence of human manipulations were more favorably appraised. Landscape-level considerations proved important.

Kellogg, LD, and GV Milota. 2005. Harvest and economics research, pp. 45–51 in *College of Forestry Integrated Research Project: Ecological and Socioeconomic Responses to Alternative Silvicultural Treatment*, CC Maguire and CL Chambers, eds. Research Contribution 46, Forest Research Laboratory, Oregon State University, Corvallis.

For harvest planners and economists. This study compared cost differences between clearcutting and alternative silvicultural treatments on the Peavy (three treatments) and Dunn (five treatments) replications in the College of Forestry Integrated Research Project (CFIRP). Site, stand, and logging conditions were either similar or normalized and data were collected by identical methods for each sample. Ground skidding and cable logging were studied on the Peavy site; only cable logging was studied on the Dunn site. Logging planning and field layout requirements and log production and harvesting costs for the various treatments and systems are described.

Kim, S-O, and B Shelby. 2005. Developing standards for trail conditions using image capture technology. *Leisure Sciences* 27(3): 279–295.

For recreational planners and designers. The authors conducted a trail impact survey of 281 hikers, using three survey techniques: asking respondents to rate the acceptability of bare soil area for a series of photographs (OPEM), having respondents select a photograph from a series of 10 that represented the largest acceptable ratio of bare soil area (SPEM-1), and asking respondents

to chose a number on a scale relating to the largest acceptable proportion of bare soil area after viewing three photographs (SPEM-2). The respondents found the SPEM-1 to be easiest; SPEM-2 was least preferred.

Kim, YH, and P Bettinger. 2005. Spatial optimization of fuel management activities, pp. 205–214 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium, October 7–9, 2003, Stevenson, Washington, M Bevers and TM Barrett, eds. General Technical Report PNW-GTR-656, USDA Forest Service, Pacific Northwest Research Station, Portland OR.*

For forestland managers and fuel management planners. The overall study of which this paper is a part examines the effects of spatial and temporal placement of fuel management activities on wildfire behavior. The preliminary work presented in this paper has to do with scheduling fuel management treatments to achieve desired timber harvest and landscape patterns. Dispersed, clumped, random, and regular landscape patterns of management activities were modeled. The forest planning scheduling processes described give solutions that place activities in a pattern on the landscape and achieve commodity production goals. The scheduling methodology developed should enhance understanding of how spatial variation in management activities can affect wildfire behavior and management goals.

Additional Program Area: Forest Ecology, Culture, and Productivity

Kiser, J, D Solmie, and L Kellogg. 2005. Efficiencies of traditional and digital measurement technologies for forest operations. *Western Journal of Applied Forestry* 20: 138–143.

For forest managers and harvest planners. Few trials have quantified the benefits of higher-precision technolo-

gies in an operational setting. Three surveying techniques were used to measure unit boundaries for 16 units: (1) a string box, manual compass, and clinometer; (2) a laser, digital compass, and digital data collector; and a (3) global positioning system (GPS). A benchmark method was established with a total station. The total station technique was most expensive but most effective. Method (2) had higher initial equipment costs but was more effective than Method (1); Method (1) also required considerably more time to complete a traverse. Strengths and weaknesses of each method should be considered in choosing the most appropriate for specific land management objectives.

Kline, JD, and RJ Alig. 2005. Forestland development and private forestry with examples from Oregon (USA). *Forest Policy and Economics* 7: 709–720.

For economists, land planners, and policymakers. As human populations increase, some forestlands will inevitably be developed. The landscape changes that result may influence timber production in the long term and affect wildlife habitat and other aspects of forestland that are valued by society. Management and policy strategies that balance the many societal needs for land benefit from being able to anticipate effects of forestland development. The authors review previous research on forestland development in western Oregon, including projections of future development and effects of conversion on private forest management and investment. Using data and models from the previous research, they project the implications for private forestry in the region for the next 50 years.

Latta, G, and D Adams. 2005. Analysis of an extensive thinning program on Eastern Oregon national forests by using a dynamic spatial equilibrium

market model with endogenous industry capacity, pp. 341–350 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium, October 7–9, 2003, Stevenson, Washington, M Bevers and TM Barrett, eds. General Technical Report PNW-GTR-656, USDA Forest Service, Pacific Northwest Research Station, Portland OR.*

For forest planners, managers, and policymakers. The forest products industry in eastern Oregon is in decline. Harvests from national forests have been nearly eliminated; even on the basis of private timber resources, further reductions seem likely. At the same time, wide-scale thinning programs have been proposed to lessen overstocking and accompanying problems with forest health and fire. The authors used a dynamic spatial equilibrium model of the eastern Oregon log market to examine the impacts of such programs on potential harvest, price, and mill capacity. According to the simulations, 63% of the treatable area and 91% of the board foot volume in thinning areas could be removed over 20 years without incurring stumpage charges or hazard removal costs. These volumes, however, would replace declining private harvests only in the first decade. The projected long-term drop in regional cut would not be reduced. Reductions in mill numbers would be postponed until after 2030.

LeMay, V, and H Temesgen. 2005. Comparison of nearest neighbor methods for estimating basal area and stems per hectare using aerial auxiliary variables. *Forest Science* 51: 109–119.

For forest biometricians and silviculturists. Aerial data, which are commonly available for forested lands, can be used to input variables obtained from ground information. Variable-space nearest-neighbor methods for imputing ground-measured stems per ha and basal area per ha were compared by simulation for

complex stands of southeastern British Columbia. Aerial photographs were interpreted to obtain species composition and other characteristics for every stand. The simulations included three distance metrics, three intensities of stands with full information, two sets of aerial variables, and three averaging methods. Increasing the number of stands with full information from 20% to 50% increased accuracy, but a further increase to 80% resulted in no further increase. The most similar neighbor measure gave good results in imputing stems per ha and basal area per ha, particularly when there was a mixture of correlations between the auxiliary (aerial) and the ground variables.

LeMay, V, and H Temesgen. 2005. Connecting inventory information sources for landscape level analyses. *Journal of Forest Biometry, Modeling and Information Sciences* 1: 37–49.

For forest managers, modelers, and planners. Forests cover some 50% of the land area of Canada, with 94% of those lands being public. Management is primarily a provincial responsibility. The forests are quite variable in terms of productivity and forest type, and much of the forested area is accessible only by air. Information about the forests is therefore largely derived from remote sensing, with ground data being quite limited. Because of the limited data, most resource managers take the simplest approach of projecting stand yield from aggregated yield tables. Others use spatial mapping from data obtained by aerial photography or remotely sensed media. Linkages among spatial maps, data, and forecast models are critical, but often difficult to achieve. The authors illustrate the challenges in making and evaluating these connections, using a 5,000-ha area in British Columbia as an example.

Additional Program Area: Forest Ecology, Culture, and Productivity

Mahapatra, AK, HJ Albers, and EJZ Robinson. 2005. The Impact of NTFP Sales on Rural Households' Cash Income in India's Dry Deciduous Forest. *Environmental Management* 35: 258–265.

For economists, policymakers, and others interested in rural development. Nontimber forest products can contribute significantly to the economy of rural regions and the well-being of their inhabitants. This study examined the contribution of nontimber forest products to cash income and the rural economy in two areas of India. Such contributions varied across ecological settings, seasons, income level, and caste.

Marshall, D, and E Turnblom. 2005. Wood productivity of Pacific Northwest Douglas-fir: Estimates from growth-and-yield models. *Journal of Forestry* 103: 71–72.

For silviculturists and growth-and-yield modelers. The authors review historical aspects of research on regeneration and growth-and-yield models. They then compare yields obtained by three models for a well-stocked natural stand or plantation at age 45. The models differed in their projections because of differences in data sets, modeling, and assumptions, but all of them demonstrate the increased potential wood production gained from management of coastal Douglas-fir stands. Continued increases in productivity are expected with further advances in silvicultural practices.

Additional Program Area: Forest Ecology, Culture, and Productivity

Marshall, H, and K Boston. 2005. The potential of ArcLogistics 3 route for solving forestry transportation problems, pp. 351–355 in *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium, October 7–9, Stevenson, Washington*, M Bevers and TM Barrett, eds. PNW-GTR-656, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forest road engineers and transportation managers. Log transportation is a major component of the forest supply chain and is the largest cost for many forest companies world-wide. Although improved transportation planning offers many potential gains, very few logistic planning systems are available to the forest industry. The industry has long used geographical information systems (GIS) to improve other areas of operations, but has been slow to use GIS in planning and managing transportation systems. Management of transportation systems will need to intensify as the industry moves more towards customer-driven supply chain management systems. The authors review the suitability of the ArcLogistics software for solving modern problems in routing and scheduling log trucks. They conclude that ArcLogistics probably is not suitable for day-to-day scheduling by large companies, but it may be cost-effective for small to medium companies in evaluating the effects of transport and inventory policies.

Moeur, M, T Spies, M Hemstrom, J Martin, J Alegria, J Browning, J Cissel, W Cohen, T Demeo, S Healey, and R Warbington. 2005. *Northwest Forest Plan—The First 10 Years (1994–2003): Status and Trend of Late-successional and Old-growth Forest*. General Technical Report PNW-GTR-646, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forestland managers, planners, and policymakers. The status and trend of late-successional and old-growth forest managed by federal agencies under the Northwest Forest Plan were monitored between 1994 and 2003. The amount of older forest was estimated and mapped at the start of the Plan and followed with satellite imagery, remotely sensed change detection, and statistical analysis of inventory plot information. The data indicated that the annual net rate of increase of older forest was

about 1.9% and outpaced losses from all sources. Loss from wildfire may be of concern to managers in the future. Older maps often were not accurate, especially for the eastern Cascades. Remote sensing was very accurate for assessing losses of older forests to clearcutting and stand-replacing wildfire, but was not so useful for detecting less severe disturbance. Estimates made from plot data were unbiased, accurate, and precise, but not of sufficient resolution to allow for spatial analysis or identify causes of change. In the future, the plot-based and mapped data sets will be tied together more closely.

Montgomery, CA. 2005. A proposal for evaluating alternative approaches to implementing sustainable forestry practices in western Oregon, pp. 47–53 in *Understanding Key Issues of Sustainable Wood Production in the Pacific Northwest*, RL Deal and SM White, eds. General Technical Report PNW-GTR-626, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forest planners and economists. Two previous studies are described that examined cost-effective strategies to increase private forest area with structure associated with old-growth conifer forest. One study searched for suitable land management practices that met old-growth structural criteria, using a heuristic optimization algorithm. The second, based on a timber-supply model, searched for ways to meet regional targets for private forest area meeting old-growth structural criteria within a given time. Both approaches sought to minimize impact on value of timber production. The author proposes to extend those studies to include alternative approaches for management to increase older forest structure on private land. The timber-supply model would be used to simulated approaches, based on regulations and on incentive, and to evaluate those approaches on

the basis of forest conditions at the end of the analysis period and effect on timber harvest value.

Murphy, GE. 2005. Determining sample size for harvesting cost estimation. *New Zealand Journal of Forestry Science* 35: 166–169.

For harvest planners and forest operations managers. Information from time studies provides the basis for estimating harvesting production rates and costs. If sampling design is not efficient, however, time studies can be more costly than other procedures and acceptable levels of precision may not be attained. The author describes a simple method to determine sample size for harvesting cost estimates and provides a sample calculation.

Additional Program Area: Forest Ecology, Culture, and Productivity

Murphy, GE, WRJ Sutton, D Hill, C Chambers, D Creel, C Binkley, and D New. 2005. Economics of intensively managed forest plantations in the Pacific Northwest. *Journal of Forestry* 103: 78–82.

For economists, silviculturists, and forestland managers. Although demand for wood is increasing, more forest land is converted to other uses every year and wood supply from public lands has decreased dramatically. Increasing wood supply from nonfederal land, and especially from intensively managed forest plantations (IMFPs), is one possible way to compensate for decreased supply from federal lands. Because forestry is very capital intensive, investors are going to be needed to finance IMFPs. This article examines the roles of IMPFs in an investor's portfolio, the drivers affecting silvicultural strategy, and the effects of intensive management on timberland value. They point out that IMFP practices may not benefit or meet the full set of management objectives of small owners or public

owners. Nevertheless, IMFP practices must be adopted in the region overall if landowners are to compete effectively in global markets.

Nalle, DJ, JL Arthur, and CA Montgomery. 2005. Economic impacts of adjacency and green-up constraints on timber production at a landscape scale. *Journal of Forest Economics* 10(4): 189–205.

For forest economists and forestland managers. At least 40 nongovernmental organizations (NGOs) world-wide set certification standards to promote sustainable forest management. Although these NGOs differ in many respects, there is often some overlap in their philosophy, specificity, managerial approach, and geographical applicability. This study estimated impacts on timber harvest and the opportunity cost from applying different hypothetical standards with respect to adjacency and green-up (a temporal extension of adjacency) to an entire landscape, two standards common to many certifying bodies. The opportunity cost of restrictions associated with implementation of n^{th} -order adjacency and green-up constraints was 0.25–66% of the unconstrained value. Greenup requirements of 40 and 100 years were estimated to have the same opportunity costs, regardless of adjacency requirements. Such information could be useful to policymakers adjusting certification standards while trying to protect multiple nontimber forest uses and ecological and social services.

Pilz, D, H Ballard, and E Jones. 2005. *Broadening participation in biological monitoring: guidelines for scientists and managers.* Institute for Culture and Ecology, Portland OR. Available at www.ifcae.org/projects/nccsf3/.

For scientists and managers who wish to include other individuals and groups in monitoring programs. The purpose of these guidelines is to provide forest

managers and scientists with practical guidelines for how to organize public or stakeholder participation in monitoring activities. The focus was on biological diversity monitoring, but the guidelines and curriculum also will be widely applicable to other forms of biological resource monitoring. "Participants" are defined broadly to include individual volunteers, community groups, organizations, associations, clubs, interest groups, businesses, nontimber forest product harvesters, and any other interested stakeholders, regardless of affiliation. Likewise "participation" includes the spectrum of involvement from volunteer field personnel through advisors to full collaboration and joint ownership of a monitoring project.

Radosevich, SR, BA Endress, and CG Parks. 2005. Defining a regional approach for invasive plant research and management, pp. 141–165 in *Invasive Plants: Ecological and Agricultural Aspects*, Inderjit, ed. Birkhäuser Verlag AG, Basel, Switzerland.

For ecologists and conservation and restoration biologists. A regional approach to invasive plant research and management requires three elements: (1) an understanding of the steps for plant invasions to occur; (2) consideration of relevant biological and geographic scales; and (3) interaction with natural resource managers. The authors discuss these elements and develop an example research framework, using the invasive plant *Potentilla recta* in the Blue Mountains Ecoregion of North America.

Additional Program Area: Forest Ecology, Culture, and Productivity

Reuter, RJ. 2005. Learning ecological restoration at a distance (Oregon). *Ecological Restoration* 23: 290–291.

For educators. This article summarizes the course objectives for FOR 445, a unique distance education course that requires students to develop a restora-

tion plan for a degraded ecosystem. It includes an example of a student project.

Rosenberger, R, and D English. 2005. Impacts of wilderness on local economic development, pp. 181–204 in *The Multiple Values of Wilderness*, H Cordell, J Bergstrom, and J Bowker, eds. Venture Publishing, State College PA.

For social scientists and economists. Wilderness designation limits human use of land in favor of preserving natural systems and their functions. The effect of federally designated wilderness on the well-being of local economies has been perceived both negatively and positively. Wilderness designation is criticized for locking up natural resources that could be used by local industries while providing free recreation to a small number of backcountry users who could go elsewhere. Wilderness advocates, on the other hand, argue that wilderness supplies amenities that draw people and service-sector jobs, fueling economic growth. The authors discuss economic impacts of visitor spending, trends in rural areas with wilderness, indications of a wilderness-related advantage, and wilderness and "amenity migration" (movement of people to areas where there are significant natural amenities). They conclude that wilderness protection may have positive, negative, or neutral effects on any individual area, depending mostly on the current structure of the community and how that structure is trending. Counties with wilderness seem to have an advantage over other nonmetropolitan counties, but identifying causal links is difficult because so many factors can affect economic growth in rural areas. Wilderness did not seem to affect employment trends.

Rosenberger, RS, AR Collins, and JB Svetlik. 2005. Private provision of a public good: Willingness to pay for privately stocked trout. *Society and Natural Resources* 18: 74–87.

For fish and wildlife managers and natural resource economists. When government does not supply a public good, private organizations may step in to provide what the public wants. In the case examined in this study, a local nongovernmental organization stocked fish on a restored public waterway in West Virginia. Anglers generally supported the program and were willing to pay approximately \$29 annually for the stocking. Support was strongest among those who felt catching many fish and being able to keep them is important and who were dissatisfied with fishing quality in the previous season. Willingness to pay decreased as distance from the site increased, although knowledge about the program lessened the decrease. These findings could be useful in promoting the stocking program.

Shelby, B, JR Thompson, M Brunson, and R Johnson. 2005. A decade of recreation ratings for six silviculture treatments in Western Oregon. *Journal of Environmental Management* 75: 239–246.

For recreational planners and silviculturists. As the use of managed forests for recreation and other uses increases, silvicultural prescriptions may have to be tailored to accommodate those multiple uses while maintaining the value of forests as sources of wood products. In this study, camping and hiking quality were assessed for unharvested old-growth and five stands logged under different silvicultural prescriptions (clearcut, thinning, snag retention, two-story, and patch cut). Sites were assessed within 2 years after harvest and through the next 10 years. The old-growth site was rated highest for both hiking and camping quality throughout the time of the study. Ratings of both hiking and camping quality improved over the course of the study in all other treatments except patch cut, where it increased and then declined. Camping quality was consistently lower than hiking quality.

Additional Program Area: Forest Ecology, Culture, and Productivity

Shindler, B, J Hino, and R Gordon. 2005. **Digital video in the classroom: Communication skills for future resource professionals.** *Journal of Forestry* 103(1): 41–46.

For natural resource and communications teachers. Improving public understanding of forest management activities through outreach programs tailored to the format and audience is critical to acceptance and implementation of those activities. In this article, the authors describe the usefulness and accessibility of video presentations as a communications method. As an example, they describe an undergraduate course offered by the College of Forestry at Oregon State University that integrates video production skills with training in teamwork and group dynamics, meeting management, public relations, interpretation and public outreach, and citizen engagement. They also describe ways in which natural resource professionals outside the university can learn and use video production in their work.

Stankey, GH, RN Clark, and BT Bormann. 2005. **Adaptive Management of Natural Resources: Theory, Concepts, and Management Institutions.** General Technical Report PNW-GTR-654, USDA Forest Service, Pacific Northwest Research Station, Portland OR.

For forest managers. The authors review the literature from many fields on the theories, concepts, and frameworks underlying adaptive management, including social learning, risk and uncertainty, and institutional analysis. They identify opportunities in and barriers to adaptive management and describe steps necessary to the implementation of adaptive management.

Stein, S, R McRoberts, R Alig, M Nelson, D Theobald, M Eley, M Dechter, and M Carr. 2005. **Forests on the Edge: Hous-**

ing Development on America's Private Forests. General Technical Report PNW-GTR-636, USDA Forest Service Pacific Northwest Research Station, Portland OR.

For forest managers and land-use planners. The conversion of private forests to developed uses has implications for the condition and management of these forests, their associated watersheds, and their contributions to timber, wildlife, and water resources. This first report of the Forests on the Edge project describes housing density projections on private forests across the conterminous United States. Fourth-level watersheds containing private forests projected to have higher housing density by 2030 were identified by geographic information systems (GIS). The resulting projections indicate that >11% of private forest likely will have dramatically increased housing development during that period, impacting ecological, economic, and social services. The trend will be most pronounced in the East. Local jurisdictions and states can attempt to prevent or reduce conversion of the most valuable private forest lands in order to maintain their resiliency and productivity.

Størdal, S, and DM Adams. 2005. **Testing for variation in the western Oregon softwood log price structure.** *Canadian Journal of Forest Research* 35: 713–723.

For forest economists. Prices for different grades of logs have been converging in western Oregon, with prices eroding for higher quality logs. This development has caused concern among timber owners and may induce them to move away from longer rotations. The authors present and test a model that allows identification of some of the sources of change in log price structure. Higher quality lumber grades became more important for 3Saw logs during the sample period, whereas lower quality lumber grades and chips became

more important for 2Saw. Consequently, the log grade prices moved closer together. Historical time patterns had little impact on the simulated relationship of 2Saw and 3Saw prices, suggesting that factors shifting the coefficients in the models may have been the primary drivers of price convergence.

Swenson, JJ, RH Waring, WH Fan, and N Coops. 2005. **Predicting site index with a physiologically based growth model across Oregon, USA.** *Canadian Journal of Forest Research* 35: 1697–1707.

For silviculturists, growth modelers, and forestland managers. The authors set out to create a benchmark estimate of spatial variability of potential forest productivity across Oregon, using state-wide soil maps and averaged climatic data. Model predictions of maximum periodic annual increment (MAI), a measure of potential productivity, of Douglas-fir were converted to equivalent site indices and compared with site index measurements on >5000 federal forest inventory plots on public and private lands in Oregon. The mapping tool 3-PG was used to generate MAI, which was mapped at a 1-km² resolution. The model predicted 100-year site index reasonably well, given methodological constraints. The differences between modeled and field measure site index were found; the points within ± 6 m error were relatively evenly distributed across the state. Improving accuracy of this method will probably require refinements in data quality, methods, location of field plots, and model functions and species parameters. Especially after such refinements, maps generated by this method could provide an important component of regional land-use planning and management and a basis for setting limits on carbon sequestration.

Additional Program Area: Forest Ecology, Culture, and Productivity

Theobald, DM, T Spies, J Kline, B Maxwell, NT Hobbs, and VH Dale. 2005. Ecological support for rural land-use planning. *Ecological Applications* 15: 1906–1914.

For ecologists, land planners, and social scientists. Urban and exurban development and conversion of natural areas to intensive agriculture and forestry threaten biotic resources. The ecological consequences of land-use changes are rarely considered in rural land-use decision making. Improving access to scientific information could help decision makers to perceive potential consequences of rural land-use change and avoid unintended ecological effects. The authors suggest ways in which ecological science can be more effectively applied to support land-use planning and policymaking in rural areas. They specify four primary challenges in improving rural land-use planning that require attention from ecologists. First, the spatial and temporal scales in which ecological processes occur are not consonant with those of land-use planning. Second, research is needed to determine how, if, and when ecological information influences rural land-use. Third, a comprehensive land-use framework is needed to place ecological studies within a broader landscape context. Finally, ecologists must develop environmental indicators that directly inform land-use planning.

Thomas, J, E Hansen, and AM Brackley. 2005. An assessment of educational needs in the Alaskan forest products industry. *Forest Products Journal* 55(9): 19–23.

For forest industry educators and forest products manufacturers. The forest industry in Alaska is rebuilding after a period of dramatic shrinkage resulting from globalization, consolidation, and governmental forest and environmental policies. The Sitka Forest Product

Program at the University of Alaska undertook to study the educational needs of the industry and the preferred methods for delivering training to employees. Over 500 forest products firms were surveyed, 25% of which responded. Ten of the top 12 educational topics were related to marketing and business. Demand was low for courses in technical processing areas. Firms preferred to train existing personnel in obtaining skilled personnel, followed by hiring high school graduates with technical training, then high school graduates with business training. In spite of great differences in the industries of the states, educational needs in Alaska were very similar to those established in similar studies in Virginia and Oregon.

Turner, DP. 2005. Thinking at the global scale. *Global Ecology & Biogeography* 14: 505–508.

For ecologists and biogeographers. Two versions of the noosphere—a sphere of thought emerging from the biosphere over the course of human evolution—have been conceptualized in the 20th century. Both assume that the relationship between collective human thought and the biosphere would be benevolent if based on a scientific epistemology. One version considers the noosphere as separate from the biosphere, whereas the other considers it a new form of the biosphere. The influence of humanity on ecosystems and biogeochemical cycles is still growing, but the ability of humanity to self-regulated has not been confirmed. The noosphere concept acknowledges that human brain functioning is subjective and that humans have a propensity to think and work collaboratively, both traits that are necessary if a structured coupling of humanity and the biosphere that will preserve the processes sustaining the ecosphere is to be achieved.

Additional Program Area: Forest Ecology, Culture, and Productivity

Wagner, E, and E Hansen. 2005. Innovation in large versus small companies: insights from the U.S. wood products industry. *Management Decision* 43: 837–850.

For wood products marketers and manufacturers. The authors examined how firm size affects company innovation in the wood products industry. Forty-three top executives of wood products companies of different sizes in the United States and Chile were interviewed about innovation and corporate strategy in their firms. They conclude that in this industry firm size affects innovation type. Large companies were more successful in process innovations because of their large capital. Small companies, however, caught up when product and business system innovations were considered and therefore should probably concentrate on these types of innovations.

Wing, MG, A Eklund, and LD Kellogg. 2005. Consumer-grade global positioning system (GPS) accuracy and reliability. *Journal of Forestry* 103: 169–173.

For foresters, especially forest engineers. Canopy cover, topography, and other factors that interfere with satellite signals can interfere with the use of global positioning systems (GPS) in forestry. The authors tested the accuracy and reliability of six consumer-grade GPS receivers on measurement courses representing three settings pertinent to forestry applications: open sky, young forest, and closed canopy. Measurement accuracy and reliability varied greatly among the receivers. The measured performance of the models and tips for optimizing performance are presented and discussed in detail.

Wood Processing and Product Performance

Acuña, M, and GE Murphy. 2005. Optimal bucking of Douglas-fir taking into consideration external properties and wood density. *New Zealand Journal of Forestry Science* 35: 139–152.

For harvest planners and logging managers. The increasing mechanization of forest harvesting in the past few decades has led to new opportunities, including the ability to sort logs for niche markets and optimally control bucking at harvest to suit the needs of such markets. Current markets are beginning to add new wood properties, such as density and stiffness, to their traditional requirements. Although markets are not yet paying higher prices for higher density logs, such logs are clearly preferred. The objective of this study was to determine the effect of density specification of volume by log type, total volume, and revenue. The authors developed a new optimal bucking procedure for Douglas-fir that takes basic wood density into account. They examined four hypothetical market scenarios that covered a range of density specifications and price incentives. The results indicated that, while optimal bucking algorithms could easily include density, doing so would likely change the distribution of logs and the merchantable volume of each log type. This has implications for log handling and might reduce total value recovered by the forest owners unless premium prices were paid for desired properties. Limitations of the study and topics for future research are discussed.

Additional Program Areas: Forest Ecology, Culture, and Productivity; Evaluation of Forest Uses, Practices, and Policies

Bulleit, WM, W-C Pang, and DV Rosowsky. 2005. Modeling wood walls subjected

to combined transverse and axial loads. *Journal of Structural Engineering* 131: 781–793.

For structural engineers, modelers, and architects. The system behavior of conventional stud walls is not well understood. Models that can be used to analyze their behavior and reliability are therefore needed. This report describes a structural analysis model for wood walls under transverse wind loads combined with either axial tension from wind uplift or axial compression from snow and live load suitable for reliability studies. The results of the Monte Carlo simulation used in this study show that the model is accurate and simple enough to be used in reliability analyses.

Chowdhury, MJA, and PE Humphrey. 2005. A sealed pressing system and its use to explore the ammonia plasticization of natural fiber mats. *Wood and Fiber Science* 37: 42–50.

For wood products scientists and manufacturers. The pressing processes used in the manufacture of wood-based composites greatly influence the internal structure and the properties of the end products. The authors describe a digitally controlled, sealed pressing system that allows manipulation of the thermodynamic and chemical environments and applied stress so that largely stress-relaxed microstructures may be in place before adhesion begins. They also examined the use of gaseous ammonia as a softening agent for natural fiber and particle composite materials. Ammonia was found to be an effective, rapidly acting softener and may provide a useful alternative to heat- and moisture-induced softening, allowing optimal sequencing of rheological and adhesion mechanisms.

Freitag, C, and JJ Morrell. 2005. Development of threshold values for boron and fluoride in non-soil contact applications. *Forest Products Journal* 55(4): 97–101.

For wood preservationists. Applications of different amounts of boron and fluoride to Douglas-fir sapwood and heartwood in nonsoil contact exposures were examined. The purpose of this study was to examine the thresholds of boron and fluoride against three decay fungi: *Postia placenta*, *Gloeophyllum trabeum*, and *Trametes versicolor*. The exceptional protection provided to the heartwood by even small amounts of chemical made it difficult to determine accurate thresholds. In sapwood, thresholds for the brown-rot fungi were far lower than those previously found: 0.40–0.44 kg/m³ for boron and 0.33 kg/m³ for fluoride. Thresholds could not be determined for *T. versicolor* because weight losses were too low.

Gartner, BL, JM Robbins, and M Newton. 2005. Effects of pruning on wood density and tracheid length in young Douglas-fir. *Wood and Fiber Science* 37: 304–313.

For wood anatomists, wood products manufacturers, silviculturists, and others concerned with wood quality. The effects of pruning on the transition from juvenile to mature wood and associated wood properties were examined 10 years after trees were pruned to either 3.4 m or 5.5 m. Trees were 13, 16, or 18 years old when pruned. Pruning had little effect overall on growth ring width, density, or tracheid length; those effects that were observed would be expected if pruning accelerated the juvenile-to-mature wood transition. Pruning, especially early in rotation,

provides the larger benefits of shortening healing time and allowing a longer period of clear wood production.

Additional Program Area: Forest Ecology, Culture, and Productivity

Geng, Y, K Li, and J Simonsen. 2005. A combination of poly(diphenylmethane diisocyanate) and stearic anhydride as a novel compatibilizer for wood-polyethylene composites. *Journal of Adhesion Science and Technology* 19: 987–1001.

For wood composites manufacturers and researchers. The authors studied a new compatibilizer system, a combination of poly(diphenylmethane diisocyanate)(PMDI) and stearic anhydride, to improve adhesion between wood and polyethylene (PE). Wood-PE composites made of wood flour treated with PMDI had higher modulus of rupture (MOR) and modulus of elasticity (MOE). These values were increased even more when stearic anhydride was combined with the PMDI, exceeding the MOR and MOE obtained with the commercially used compatibilizer system maleic anhydride grafted polyethylene (MAPE). The moisture content of the wood flour affected compatibilization in both systems. Composites with the new system were more water-resistant than those made with MAPE.

Geng, Y, K Li, and J Simonsen. 2005. A commercially viable compatibilizer system for wood-polyethylene composites. *Journal of Adhesion Science & Technology* 19: 1363–1373.

For adhesive chemists, wood products manufacturers. Wood-plastic composites (WPCs) have many advantages over either wood or plastic, but a compatibilizer is required in their manufacture in order to obtain acceptable interfacial adhesion. The authors describe a commercially viable compatibilizer system containing poly(diphenylmethane diisocyanate) (PMDI) and stearic acid

for improving the interfacial adhesion between wood and polyethylene (PE). Treating PE with PMDI before mixing with wood increased both the modulus of rupture (MOR) and the modulus of elasticity (MOE) of the resulting composites. Adding stearic acid at certain dosages further increased MOR. The test system was more effective in increasing both the MOR and MOE of the resulting composites than maleic anhydride-grafted polyethylene (MAPE), a commonly used commercial compatibilizer. Composites made with the PMDI–stearic acid system were statistically more water-resistant than those made with MAPE.

Grotta, AT, BL Gartner, SR Radosevich, and M Huso. 2005. Influence of red alder competition on cambial phenology and latewood formation in Douglas-fir. *IAWA Journal* 26: 309–324.

For wood anatomists, wood products manufacturers, silviculturists, and others interested in wood quality. Competition may influence wood formation and wood quality. Plots were set up at similar densities but with different proportions of Douglas-fir and red alder, different planting dates for the red alder, and one of two planting densities. In most trees, cambial activity began in May and ended in late August or early September. Transition to latewood occurred on average on July 6; early transition was associated with higher basal area in red alder. Percent latewood depended on date of transition to latewood production but was not affected by treatment. The period of radial growth in Douglas-fir was shorter in the treatment with the highest red alder basal area than in pure stands of Douglas-fir but did not seem to be affected in treatments with lower red alder basal areas. Diameter also affected the duration of radial growth, which was shorter in smaller-diameter trees.

Additional Program Area: Forest Ecology, Culture, and Productivity

Grotta, AT, RJ Leichti, BL Gartner, and GR Johnson. 2005. Effect of growth ring orientation and placement of earlywood and latewood on MOE and MOR of very small clear Douglas-fir beams. *Wood and Fiber Science* 37: 207–212.

For wood anatomists, structural engineers, and wood products manufacturers. Standard sizes for ASTM bending tests are not always suitable for characterizing smaller sections of wood, and their specification that the sample be loaded on the longitudinal-tangential surface could affect values of modulus of elasticity (MOE) and modulus of rupture (MOR) in small specimens. The authors examined the effects of growth ring orientation and the location of latewood and earlywood on bending properties of 10- x 10- x 150-mm Douglas-fir specimens. Ring orientation did not affect MOE. Loading specimens on the radial surface resulted in an MOR about 5% higher than when loading was on the tangential surface. Variations in MOR and MOE were lower when loads were applied to the longitudinal-radial, rather than the longitudinal-tangential, surface. Loading on the longitudinal-tangential surfaces showed an effect of wood type (earlywood or latewood) on both MOE and MOR when it was the compression surface. Tracking wood type of the top and bottom surfaces could reduce variance in measurements of MOE and MOR.

Gupta, R. 2005. System behaviour of wood truss assemblies. *Progress in Structural and Engineering Materials* 7: 183–193.

For structural engineers and wood products manufacturers. There is a great deal of literature on single trusses and joints, but the system behavior of truss assemblies is less well studied. The author reviews previous research on system behavior of sheathed truss assemblies, including full-scale testing, computer modeling, and design. He then discusses a new systems-based

approach to the one usually used for including system effects in assembly design, a three-dimensional structural analysis program that can be used to analyze and design complex whole-truss assemblies and include system effects directly.

Gupta, R, and V Gopu. 2005. Wood engineering education—Trends and challenges, pp. n.a. in *Structures 2005: Metropolis and Beyond, Proceedings of the 2005 Structures Congress and the 2005 Forensic Engineering Symposium, April 20–24, 2005, New York City, New York. SEI/ASCE, Reston VA.*

For structural engineers. The authors present an overview of factors affecting education in wood engineering and design in the United States and outline actions needed to ensure that wood engineering continues to be included in engineering programs.

Gupta, R, and TS Miller. 2005. Stress distribution in structural composite lumber under torsion. *Forest Products Journal* 55: 51–56.

For structural engineers and wood products manufacturers. Finite element analysis was used to determine stress distribution in full-size structural composite lumber (SCL) under torsion and the results were compared with experimental results. The finite-element analysis found the behavior of SCL to be more orthotropic than that of solid-sawn lumber, indicating that shear strength of SCL should be determined by using orthotropic torsion theory. The shear strength based on the FEA matched experimental results within 2%.

Gupta, R, and T Siller. 2005. Shear strength of structural composite lumber using torsion tests. *Journal of Testing and Evaluation* 33(2): 110–117.

For wood and wood-composite researchers and structural engineers. The shear strength of 85 full-size rectangular specimens of laminated strand

lumber (LSL), laminated veneer lumber (LVL), and parallel strand lumber (PSL) was determined by torsion tests. Site and manner of failure differed among the lumber types. LSL failed in a brittle manner along the strand (LT Plane). LVL and PSL failed in a ductile manner across the veneer/strand (LR plane). The different failure modes observed were due to the differences in the shear moduli in two longitudinal planes. The results of this study indicate that the torsion test, the only known test method that imposes a state of pure shear stress in the specimens, can be recommended as a standard method for determining the pure shear strength of full-size SCL.

Gupta, R, and TS Siller. 2005. A comparison of the shear strength of structural composite lumber using torsion and shear block tests. *Forest Products Journal* 55(12): 29–34.

For structural engineers. The shear block test for shear strength of structural composite lumber uses small specimens. Several studies have shown that shear strength determined in bending tests of full-sized specimens may not be the true shear strength of the material. The authors compared the shear strength of structural composite lumber determined with a shear block test to the torsion-based shear strength obtained in their earlier study. Shear strength based on torsion was 12–39% lower than that obtained in the shear block test. The authors concluded that the shear block test is not an appropriate way to determine shear strength of structural composite lumber.

Gupta, R, TS Miller, and MR Kittel. 2005. Small-scale modeling of metal-plate-connected wood truss joints. *Journal of Testing and Evaluation* 33(3): 139–149.

For structural engineers. The authors used similitude theory to develop 1/3-scale models of full size (prototype)

metal-plate-connected wood truss joints and a complete truss. The model showed greater variation in stiffness than the prototype, but their average properties were similar. The 1/3-scale tension splice joints had an average design stiffness within 1% of the prototype and a 7% lower ultimate load. Model heel joints had stiffness within 22% and strength within 17% of the prototypes. The authors conclude that it may be feasible to use small-scale models and similitude theory to model behavior of full-size truss connections.

Hong, Y, L Muszynski, and R Lopez-Anido. 2005. Modeling and calibration of a laminating press prototype for fiber-reinforced polymer-glulam billets. *Journal of Testing and Evaluation* 33(6): 395–305.

For wood products manufacturers and researchers. Manufacture of wood and fiber-reinforced polymer (FRP) composite laminated billets for use in delamination and shear block tests involves clamping the laminate at a specific level of uniformly distributed pressure for as long as is needed for the resin to cure. The authors designed a mechanical clamping device that would allow control over the stress applied and maintain required pressure for up to 24 hours. Procedures to calibrate the device to adjust flow of resin pressed out of the gluelines and the nonlinear time-dependent behavior of the laminate and to determine clamping pressure loss over 24 hours are also described.

Hood, JP, FA Kamke, and J Fuller. 2005. Permeability of oriented strandboard mats. *Forest Products Journal* 55(12): 194–199.

For wood products manufacturers and users of wood composites. The manufacture of wood-based composites such as oriented strand board (OSB) involves the consolidation of wood flake mats in a hot press. Permeability of the material is affected by flake thickness and align-

ment and by changes in mat density as it is compacted. The authors designed an apparatus that allowed cold pressing of mats to desired densities and permitted measurement of permeability through the mat thickness. They also devised an apparatus that allowed measurement of permeability in the plane of the mat. Permeability decreased with increasing compaction ratio, both through the mat thickness and in its plane, and decreased with decreasing flake size. An empirical equation was developed to predict permeability from flake thickness and compaction ratio. The research gives manufacturers a better understanding of how to manage gas pressure during hot pressing in order to optimize heat transfer and gas venting.

Jain, VK, R Davidson, and D Rosowsky. 2005. Modeling changes in hurricane risk over time. *Natural Hazards Review* 6(2): 88–96.

For structural engineers, emergency planners, and those involved in hurricane risk management. Regional hurricane loss estimation models require correct description of building inventory in the area. If the dynamics of the built environment are not incorporated, loss estimation models may not estimate losses correctly. The new methodology presented in this paper integrates models of wind hazard and changes in building inventory, vulnerability, and economics to simulate changes in expected annual hurricane losses over time. In addition to describing the methodology and its component models, the authors review the literature on hurricane loss estimation and dynamics of risk and illustrate the methodology with a case study.

Jennings, JD, A Zink-Sharp, FA Kamke, and CE Frazier. 2005. Properties of compression densified wood. Part I: bond performance. *Journal of Adhesion Science & Technology* 19: 1249–1261.

For adhesive and wood products manufacturers. Treating wood with high temperature, moisture and compression can result in a product stronger than natural wood. Until recent refinements in the densification process, however, compressed densified wood was unstable in moist conditions. Development of products using compressed densified wood is now feasible but limited by lack of information on bonding of such wood. This study compared bond performance of untreated, hygrothermally treated, and hygrothermally compressed densified wood of yellow-poplar (*Liriodendron tulipifera*). Phenol-formaldehyde film (PF) and polymeric diphenylmethane diisocyanate (pMDI) were the adhesives used. Bond performance was evaluated by opening mode double cantilever beam fracture testing and cyclic boiling. Fracture toughness of hygrothermal specimens did not differ from that of controls when bonded with pMDI but was significantly higher when bonded with PF film. Densified samples, in contrast, showed significantly higher fracture toughness than controls when bonded with pMDI, but did not differ when bonded with PF film. Accelerated aging by cyclic boiling significantly reduced fracture toughness only in the hygrothermally treated samples, with either adhesive. Fracture toughness increased significantly in densified samples bonded with pMDI increased significantly after accelerated aging.

Johnson, GR, AT Grotta, BL Gartner, and G Downes. 2005. Impact of the foliar pathogen Swiss needle cast on wood quality of Douglas-fir. *Canadian Journal of Forest Research* 35: 331–339.

For forest pathologists, silviculturists, and those interested in wood quality. Although many stands of Douglas-fir near the coast of Oregon and Washington are heavily affected by Swiss needle cast, the effects of this disease on wood quality have rarely been studied. Several characteristics affecting wood quality

were examined in 20- to 28-year-old trees from 15 stands affected by Swiss needle cast in various levels of severity. Modulus of elasticity, wood density, and latewood proportion were higher and sapwood moisture content was lower in trees from heavily infected stands than in trees from healthier stands. These properties were also correlated with breast-height age, but age alone was not sufficient to explain the increases. The wood properties examined were generally more strongly correlated with ring width than with needle retention. The increased stiffness in trees from diseased stands appeared to result from increased latewood proportion.

Additional Program Area: Integrated Protection of Forests and Watersheds

Kang, SM, JJ Morrell, J Simonsen, and S Lebow. 2005. Creosote movement from treated wood immersed in fresh water. *Forest Products Journal* 55(12): 42–46.

For wood preservationists. Creosote has been used as a wood preservative since the 1830s. The polycyclic aromatic hydrocarbons (PAHs) that make up nearly 80% of creosote may be toxic to aquatic organisms. Lack of data on how fast creosote and its PAHs migrate into water upon initial exposure has limited the development of accurate models to predict environmental effects of contamination by PAHs. The authors examined the effect of flow rates on creosote migration from freshly treated wood exposed to water. The seven low-molecular-weight PAHs detectable with the analytical methods used decreased sharply after initial exposure and were undetectable within a week. High-molecular-weight PAHs apparently did not leach into the water at detectable levels. Although more research is needed on creosote leaching, the data obtained in this study will support the development of predictive models.

Kasal, B, and RJ Leichti. 2005. State of the art in multi-axial phenomenological failure criteria for wood members. *Progress in Structural Engineering and Materials* 7: 3–13.

For engineers and wood materials scientists. Loads on wood structural members frequently produce multiaxial stress. The authors review the literature on the subject of failure theories as used in wood engineering. The effects of stochastic and deterministic considerations on failure surfaces are included.

Kent, SM, and RJ Leichti. 2005. An assessment of common test methods to evaluate the mechanical properties of structural end-jointed lumber. *Forest Products Journal* 55(3): 32–39.

For structural engineers and wood products scientists. Structural end-jointed lumber, used in glued laminate timber and I-joists, increasingly is being substituted for traditional dimensional lumber. This study assessed four test methods used for qualification and quality control of structural end-jointed lumber and determined relationships between failure stresses and characteristics of the different methods. Test methods affected failure mode, but no test method proved to be superior. A method to convert mean strength and variance between test methods was developed and demonstrated.

Kent, SM, RJ Leichti, DV Rosowsky, and JJ Morrell. 2005. Effects of decay on the cyclic properties of nailed connections. *Journal of Materials in Civil Engineering* 17: 579–585.

For structural engineers and wood preservationists. Nailed connections between oriented strand board sheathing and Douglas-fir framing members were exposed for increasing intervals to the brown rot fungus *Postia placenta*. Maximum loads, slips at maximum loads, yield loads, initial stiffnesses, and cumulative energy dissipation were

then characterized under fully reversed cyclic loading. Specific gravity of parts of the sheathing and framing members from the samples was also determined. The best descriptive variable for the mechanical properties was the specific gravity of the sheathing. The connection property affected most by decay damage was cumulative energy dissipation.

Lebeda, DJ, R Gupta, DV Rosowsky, and JD Dolan. 2005. Effect of hold-down misplacement on strength and stiffness of wood shear walls. *Practice Periodical on Structural Design and Construction* 10(2): 79–87.

For structural engineers and designers. Earthquake damage to wood-frame damage in recent years has been attributed in part to lack of quality control. This study was designed to determine how misplaced hold-downs affect monotonic and cyclic behavior of wood shear walls in three configurations: wall with hold-downs at the ends, walls with one misplaced hold-down to the first interior stud; and walls with misplaced hold-downs and nailing applied to the stud attached to misplaced hold-downs. Strength of samples with misplaced hold-downs was 42% lower under monotonic loading and 35% lower under cyclic loading than in samples with hold-downs at the ends. Denser nail spacing increased strength of walls with misplaced hold-downs.

Leichti, R, JJ Morrell, and D Rosowsky. 2005. Effect of decay on wall system behavior. *Wood Design Focus* 15(1): 3–7.

For structural engineers. As wood frame structures age and are exposed to hazards, their condition changes, so the current condition of a structure cannot be assessed on the basis of the properties of new materials and fasteners. Nevertheless, only data on new engineering properties are available for assessment of shear wall performance. This study quantified the effect of (1)

high moisture and (2) high moisture and fungal decay in the sill plate nail system on the performance of cripple walls. Wetting alone appeared to affect shear wall performance as seriously as a wet and decayed condition. Nails withdrew from the sill plate in dry walls but tore through the sheathing in wet walls. The sill plate/sheathing connection was critical to cripple wall behavior with respect to maximum and failure loads and initial stiffness. New computations showed that many connections in critical locations must be compromised before shear wall performance decreases significantly.

Leichti, RJ, M Meisenzahl, and D Parry. 2005. Structural timbers from retired Douglas-fir utility poles. *Forest Products Journal* 55(3): 61–65.

For wood products manufacturers and recyclers. Reclaimed Douglas-fir utility poles were subsampled and the subsamples were graded visually as posts and timbers. Bending strength and modulus of elasticity were assessed by destructive testing. At the same time, small clear specimens from a different sample of poles were tested at a limited level. Both sets of tests showed that posts and timbers with heart center can meet published design values for No. 1, even after service. Visual inspection was effective for selecting poles that will produce timbers meeting the visual grade requirement for structural products.

Li, K, and X Geng. 2005. Formaldehyde-free wood adhesives from decayed wood. *Macromolecular Rapid Communications* 26: 529–532.

For wood products scientists and manufacturers. Formaldehyde-containing resins used as adhesives in wood composites have environmental and health-related drawbacks. Marine adhesive protein (MAP), secreted by mussels, is a strong, water-resistant, formaldehyde-free adhesive, but is not readily available. Study of MAP led to the hypothesis that

a nonproteinaceous polymer rich in catechol moieties and amino groups could provide adhesive properties similar to those of MAP. The authors used sodium borohydride to reduce soluble decayed wood (SDW) from wood decayed by brown rot fungi, mixed the treated SDW with polyethylenimine under various conditions, and bonded maple veneers with the resulting mixture. Treatment of SDW with sodium borohydride increased both shear strength and water resistance of the resulting wood composites greatly. Treatment time significantly affected adhesive properties. Cure chemistry and adhesive mechanisms of the adhesive require further research, but this system has considerable promise as a formaldehyde-free adhesive for wood composites.

Liu, Y, CC Brunner, JE Reeb, WF Reiter, Jr, and JW Funck. 2005. The durability of serpentine-end-matched joints during veneer slicing. *Forest Products Journal* 55(7/8): 63–68.

For moulding and millwork manufacturers and structural engineers. The clear material supply for moulding and millwork can be increased by edge- and end-gluing small clear pieces into suitable sizes. Overlaying the pieces with veneer makes them appear to be one solid part. In this study, 18 veneer flitches from ponderosa pine were crosscut into paired samples, each of which was crosscut and machined with serpentine-end-matched joints. In each pair, the amplitude of the joint was equal to the width of the joint in one sample and two-thirds of the width in the other. The joints were glued, cured, and sliced to three veneer thicknesses. Of the 468 veneers produced, bonds failed during manufacturing in only 14. Stress testing showed no differences among veneer thickness or failure modes or between joint designs. Partial failure occurred in 65% of the 207 veneers analyzed; failure involved about one-third of the joint and could occur anywhere along the glueline except the joint apex.

Lopez-Anido, R, L Muszynski, D Gardner, B Goodell, and B Herzog. 2005. Performance-based material evaluation of fiber-reinforced polymer-wood interfaces in reinforced glulam members. *Journal of Testing and Evaluation* 33(6): 385–394.

For wood products manufacturers and researchers. Fiber-reinforced polymer (FRP) composite systems are used to reinforce wood and glued-laminated timber (glulam) structural members in a variety of structural applications. This usually has been done either by wet lay-up of fabric reinforcement or by adhesive bonding of prefabricated sheets to wood members. A new application process, which uses resin infusion, has recently been developed. In all cases, a high-quality durable bond must be developed between dissimilar materials. This study had three objectives: (1) to determine if the test methods now used in the United States to assess durability of wood-wood bonds for exterior use can be adopted to test FRP composite reinforcement; (2) to investigate possible modifications of these procedures to accommodate specifics of the adhesive bonds in hybrid FRP-wood assemblies; (3) to propose a unified approach to interpreting FRP-wood interface test results, focusing on development of acceptance criteria. The authors discuss the test methods currently used and their possible modification, including issues relevant to FRP-wood adhesive bonding. They selected four commercially available FRP composite systems to validate the material qualification protocol that represented a broad spectrum of fiber reinforcement, matrix, adhesives, and fabrication. Their experimental results validating the proposed methodology are described. They identify relevant issues that require further investigation.

Milota, MR, CD West, and ID Hartley. 2005. Gate-to-gate life-cycle inventory of softwood lumber production. *Wood and Fiber Science* 37(Special CORRIM Report): 47–57.

Wood and Fiber Science 37(Special CORRIM Report): 47–57.

For wood products manufacturers A life-cycle inventory was carried out for the production of planed, dry dimension lumber from logs of fir, Douglas-fir, several species of pine, and western hemlock in the western (Oregon and Washington) and southern (Georgia, Alabama, Mississippi, and Louisiana) United States. Data were obtained from surveys of manufacturers. Because much more of the energy used for production in the South comes from wood fuels, CO₂ emissions were greater in the South. In the West, 53% of the log volume leaves the mill as planed, dry dimension lumber; in the South, 41% does so.

Morrell, JJ, CM Freitag, and H Chen. 2005. Sequential treatments with fluoride and copper: Effects of solution concentration and dipping time on treatment. *Forest Products Journal* 55(7/8): 57–62.

For wood preservationists. When pressure treatment for wood preservation is unavailable, double diffusion treatment provides an alternative. Copper and fluoride have been widely used in wood preservation, but the potential for interactions between them has not been previously studied. In this study, oven-dried, defect-free cubes of ponderosa pine were treated with sodium fluoride (2% or 5%), or with sodium fluoride followed by treatment with copper sulfate (2% or 5%). The wood readily sorbed both copper and fluoride but both leached readily from the wood. This leaching could be problematic in terms of environmental contamination. There appeared to be no interaction between copper and fluoride.

Muszyński, L, R Lagana, W Davids, and SM Shaler. 2005. Comments on the experimental methodology for quantitative determination of the hygro-mechanical properties of wood. *Holzforschung* 59: 232–239.

For wood scientists and engineers. The mechano-sorptive effect is an additional deformation that may occur when wood is subjected simultaneously to stress and changes in moisture content below the fiber saturation point. Although realistic modeling of the effect is essential both in structural applications and in wood-drying, and numerous mathematical models and theoretical descriptions have appeared, many features of its basic mechanism remain unclear. Reliable data are difficult to obtain, scattered, and lacking in logical classification. This paper proposes and briefly discusses the basic requirements for adequate experimental methods for comprehensive determination of the mechano-sorptive behavior of wood: the experimental research must focus on the material level properties and elementary load modes; the effect of changing distribution of moisture content within the tested volume must receive proper attention; and the tests must be designed so as to enhance a comprehensive separation of strain components.

Panella, NA, MC Dolan, JJ Karchesy, Y Xiong, J Peralta-Cruz, M Khasawneh, JA Monteneri, and GO Maupin. 2005. Use of novel compounds for pest control: Insecticidal and acaricidal activity of essential oil components from heartwood of Alaska yellow cedar. *Journal of Medical Entomology* 42: 352–358.

For natural products chemists and those interested in insect and mite pest control. The bioactivity of 15 natural products isolated from essential oils from heartwood of Alaska yellow cedar (*Chamaecyparis nootkatensis*) was tested against ticks, fleas, and mosquitoes. Four of the compounds were monoterpenes, five were eremophilane sesquiterpenes, five were derivatives of the eremophilane sesquiterpenes valencene and nootkatone, and one was a non-eremophilane sesquiterpene. Carvacrol was the only monoterpene with

biocidal activity against tick, fleas, and mosquitoes. Nootkatone from Alaska yellow cedar was the most effective of its group against ticks. Mosquitoes were most susceptible to a derivative of valencene. Residual LC₅₀ values for nootkatone were essentially the same four weeks after treatment as they were at the initial treatment. The active compounds were effective at relatively low concentrations and may provide an alternative to synthetic pesticides used to control disease vectors.

Perez-Garcia, J, B Lippke, D Briggs, J Wilson, J Bowyer, and J Meil. 2005. The environmental performance of renewable building materials. *Wood and Fiber Science* 37(Special CORRIM report): 3–17.

For wood products manufacturers, building designers, and structural engineers. In 1976, a study by the National Academy of Science/National Research Council compared the performance of wood products with other similarly used materials with respect to energy use and material utilization. That report did not include many environmental issues that have since become very important and had not been updated or extended until the work undertaken by the Consortium for Research on Renewable Industrial Materials (CORRIM). The authors describe a life-cycle assessment of alternative materials used in residential construction. Their analysis was unique in that it covered the entire life of the material, from extraction through use to final disposal. They first conducted life cycle inventories quantifying the energy, resource use, and emissions associated with a particular product, service or activity involved in constructing, occupying, repairing, and tearing down and disposing of a residence. They then assessed the potential environmental consequences of the energy and resources consumed and the wastes generated. They identify several opportunities for environmental improvements.

Puettmann, ME, and JB Wilson. 2005. Gate-to-gate life-cycle inventory of glued-laminated timbers production. *Wood and Fiber Science* 37(Special CORRIM Issue): 99–113.

For wood products manufacturers. The authors conducted a gate-to-gate life-cycle inventory for the manufacture of softwood glued-laminated (glulam) timbers in the Pacific Northwest (Oregon and Washington) and the Southeast (Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, and Texas). This is the first LCI on production of glulam timbers from two specific regions of the United States. Data on raw material requirements, energy used, and emissions were obtained by surveying manufacturers. Wood drying and adhesive manufacture were major environmental factors, and wood drying dominated the energy consumption in both regions. Data reported on emissions varied by manufacturer and glulam process (cold-cure or radio frequency), as well as by fuel source. Wood fuel accounted for nearly 50% of cumulative energy consumption.

Puettmann, ME, and JB Wilson. 2005. Life-cycle analysis of wood products: cradle-to-gate LCI of residential wood building materials. *Wood and Fiber Science* 37(Special CORRIM Issue): 18–29.

For wood products manufacturers, building designers, construction planners, and environmental scientists. Although the manufacture of wood products used in residential construction has certain environmental impacts, those associated with the manufacture of alternative materials may be even more severe. Life-cycle assessment (LCA) provides an objective analysis of the environmental impacts associated with a product, process, or activity. The LCA described in this report involved a life-cycle inventory for major wood building materials manufactured in the Pacific Northwest and the Southeast

of the United States, the first LCI for the United States with a cradle-to-gate scope. When forest regeneration and harvesting, wood product and resin production, and transportation were considered, one-third of the energy consumed in the manufacture of wood products came from renewable resources and the rest from fossil-based, nonrenewable sources. When the manufacturing life cycle stage alone was considered, the renewable resource component increased to 50–78%. Manufacturing (with resin considered as part of the process) consumed the most energy over all the products; extraction of logs and transport of raw materials had the least environmental impact.

Ren, DK, and KC Li. 2005. Development of wet strength additives from wheat gluten. *Holzforschung* 59: 598–603.

For paper chemists and manufacturers. Glyoxal-polyacrylamide resins, the temporary wet strength resins most commonly used in the manufacture of paper, are made from nonrenewable petrochemicals and complicate paper recycling. The paper describes a procedure to convert gliadin, a key component of naturally abundant and renewable wheat gluten, into an effective temporary wet strength resin. At 1 wt%, the resulting resin was comparable to the glyoxal-polyacrylamide resins in conferring both dry and wet strength to treated paper.

Rogers, J, and J Simonsen. 2005. Interfacial shear strength of wood-plastic composites: a new pullout method using wooden dowels. *Journal of Adhesion Science & Technology* 19: 975–985.

For wood composites manufacturers and researchers. Wood-plastic composites incorporating high-density polyethylene and polypropylene as the plastics, pine and oak as the wood, and maleic-anhydride-grafted polyethylene and polypropylene as compatibilizer, were

examined for the relationship of interfacial shear strength (IFSS) to modulus of rupture. IFSS and MOR were strongly correlated in a limited composition region. Composites made of polypropylene and oak did not show good correlation between MOR and IFSS. Compatibilizer systems with liquid components did not seem to be appropriate for this test method.

Rosowsky, D, DS Gromala, and P Line. 2005. Reliability-based code calibration for design of wood members using load and resistance factor design. *Journal of Structural Engineering* 131: 338–344.

For structural engineers and wood products manufacturers. The load and resistance factor design format for engineered wood construction has much of its basis on the 1993 ASCE 7 load standard. Since development of that standard, load factors in the standard have changed, there is more information about load distribution, and assumptions about resistance statistics have changed. The authors present the basis for reference resistance statistics used in reliability-based code calibration studies, summarize reference statistics for wood product mechanical properties, and examine the range of first-order second moment reliability indices computed by using load statistics and the reference resistance statistics. They found that regional variations in load statistics are the most significant influence on the range of computed reliability indices. Differences in indices among engineered wood products were not considered to be significant.

Schneider, PF, JJ Morrell, and KL Levien. 2005. Internal pressure development during supercritical fluid impregnation of wood. *Wood and Fiber Science* 37: 413–423.

For wood products manufacturers and wood preservationists. Supercritical fluid impregnation allows complete bio-

cide impregnation of a variety of wood-based materials, many of which are otherwise notoriously difficult to treat. The pressure response of wood to supercritical fluid impregnation, however, is largely unknown, especially in larger specimens. The authors assessed internal pressure development and compared grain orientation, sample size, and pressing and venting rates during supercritical carbon dioxide treatment. Four species were tested: ponderosa pine, Douglas-fir, white fir, and Pacific silver fir. Pressure response was lower in less permeable species. Some Pacific silver fir and white fir samples collapsed because of differences between surface and internal pressure. Wood damage can be avoided by changing rates of pressure application and release so as to control pressure differentials.

Scott, RJ, RJ Leichti, and TH Miller. 2005. An experimental investigation of foundation anchorage details and base shear capacity for log buildings. *Forest Products Journal* 55(4): 38–45.

For structural engineers and those interested in log building construction. In log structures, thru-rods or lag screws provide load path continuity. The pathways resisting lateral forces in log structure foundations were evaluated, with focus on the roles of friction, anchor bolts, and thru-rods in providing resistance to seismic shear. The test specimens represented two common construction details for sill log-foundation anchorage: the sill log either sat on the floor diaphragm or contacted the sillplate directly. Both details included anchor bolts and thru-rods. The specimens were loaded vertically to simulate wall and roof dead load and then moved horizontally, first with a static, then with a fully reversed cyclic quasi-static test. The hysteretic diagrams indicated that friction between the sill log and its support dissipated energy. Foundation details differed with respect to initial and ultimate yield modes.

Measured capacities of both connection details exceeded those required for Uniform Building Code seismic zone 4.

Scott, RJ, RJ Leichti, and TH Miller. 2005. Finite-element modeling of log wall lateral force resistance. *Forest Products Journal* 55(9): 48–54.

For structural engineers and those interested in log building construction. Finite-element models for a representative log shear wall and a sill log foundation were developed on the basis of tests of such assemblies. Connection behaviors, friction, and slip between logs were included in the models. Wall performance was affected by thru-rod tension and hole size, tributary roof dead load, and foundation details. The greatest effect on overall displacement resulted from increasing wall aspect ratio. Window openings did not affect wall performance adversely, nor did door openings, with the exception of a negative effect on initial stiffness.

Sessions, J, K Boston, R Hill, and R Stewart. 2005. Log sorting location decisions under uncertainty. *Forest Products Journal* 55(12): 53–57.

For forest engineers and forest operations personnel. Sorting logs at a central sort yard increases costs over sorting at the landing but allows more accurate assignment of logs to the highest destination. This study provides a methodology to assist in deciding where to sort logs, including the cost of missorting. The model and its assumptions are described and illustrated with an case study. For the case study, costs were lower for sorting at the landing, but each situation must be considered individually with respect to log distribution and landing-related costs.

van de Lindt, JW, and DV Rosowsky. 2005. Strength-based reliability of wood shearwalls subject to wind load. *Journal of Structural Engineering* 131: 359–363.

For structural engineers and wood products manufacturers. Wood shearwalls provide most of the lateral resistance to wind and earthquake loading in light-frame wood construction. This note describes a procedure to evaluate the reliability of wood shearwalls designed according to AF&PA/ASCE16. Wood shearwalls built with 8d common nails were subjected to the 50-year design wind load, and ultimate capacity (strength) and statistical distribution of deformation at ultimate capacity were determined. Reliability indices ranged from 3 to 3.5; percent drift, neglecting uplift, ranged from 1.6% to 2%.

van de Lindt, JW, JN Huart, and DV Rosowsky. 2005. Strength-based seismic reliability of wood shear walls designed according to AF&PA/ASCE 16. *Journal of Structural Engineering* 131: 1307–1312.

For structural engineers and wood products manufacturers. Most homes in the United States are constructed with light-frame wood construction. A system of wood shear walls, composed of dimension lumber and either plywood or oriented strand board sheathing, provides resistance to lateral loads such as those produced by wind or earthquakes. This study examined the strength-based reliability of wood shear walls designed to the AF&PA/ASCE-16 standard, which had not previously been determined. Twelve different wood shear walls were subjected to earthquake loading considered characteristic of seismic hazard in Los Angeles. Reliability indices were calculated and were close overall to those expected under the test conditions. The authors point out that they should be considered lower bounds.

Wang, W, and JJ Morrell. 2005. Effects of moisture and temperature cycling on material properties of a wood/plastic composite. *Forest Products Journal* 55(10): 81–83.

For wood products manufacturers

and structural engineers. Wood/plastic composites (WPCs) are being used increasingly as decking material, where they undergo repeated wetting and drying. Although their rate of moisture uptake appears to be much slower than that of wood, laboratory tests of small samples have indicated that modulus of elasticity (MOE) and modulus of rupture (MOR) drop significantly as they sorb moisture. This study examined the potential effects of moisture and temperature cycling on material properties on larger samples. Samples were put through 0–4 cycles of wetting, drying, and reconditioning. Even after the fourth cycle, moisture levels were still very low. Increased cycling led to a trend to increased moisture uptake and a tendency to lose weight. Moisture cycling affected neither MOR nor MOE negatively, nor did inclusion of a freezing period in the cycle.

Wilson, JB. 2005. Documenting the environmental performance of wood building materials. *Wood and Fiber Science* 37(Special CORRIM Report): 1.

For wood products manufacturers, building designers, and structural engineers. This editorial introduces a special issue of *Wood and Fiber Science* devoted to the findings of the Consortium for Research on Renewable Industrial Materials (CORRIM). The author describes the history, structure, and aims of CORRIM and explains the meanings of life-cycle inventory (LCI) and life-cycle assessment (LCA).

Wilson, JB, and ER Dancer. 2005. Gate-to-gate life-cycle inventory of I-joist production. *Wood and Fiber Science* 37(Special CORRIM Report): 85–98.

For wood products manufacturers. Composite wood I-joists can be used to replace structural lumber in joist systems. Manufacturers of I-joists in the Pacific Northwest (Oregon and Washington) and the Southeast (Alabama, Arkansas, Florida, Georgia, Louisiana,

Mississippi, and Texas) were surveyed about the materials, fuels, electricity, coproducts, and emissions associated with the manufacture of softwood plywood. From these data, the authors constructed a gate-to-gate life-cycle inventory (LCI) for I-joists. They provide the details in this paper. The energy use for the manufacture of the I-joist itself was found to be relatively low, compared with the energy used in manufacturing its components. Carbon flow is also discussed. This LCI can be combined with others covering different stages of I-joist production to generate a cradle-to-gate product LCI. It can also be used in life-cycle analysis of assemblies and structures using I-joists and to provide a benchmark for assessment of process performance.

Wilson, JB, and ER Dancer. 2005. Gate-to-gate life-cycle inventory of laminated veneer lumber production. *Wood and Fiber Science* 37(Special CORRIM Report): 114–127.

For wood products manufacturers. Laminated veneer lumber (LVL) is made

from sheets of wood veneer laminated with the grain oriented in the same direction and hot presses. A gate-to-gate life-cycle inventory of LVL manufacturing, from arrival of logs through production of the LVL, was carried out. The inventory was based on surveys of manufacturers in the Pacific Northwest (Washington and Oregon) and the Southeast regions of the USA (Alabama, Georgia, Louisiana, Mississippi, Florida, Arkansas, and Texas). Emissions resulting from production of the LVL itself were small relative to those involved in the production of the input products, such as resin, dry veneer, parallel laminated veneer (PLV), and energy sources. Natural gas and electricity were the primary fuel sources for production of the LVL, although wood fuel was dominant in production of dry veneer and PLV. This LCI could be added to those for logs and the transportation of PLV, veneer, wood fuel and resin to obtain a cradle-to-gate LCI. The data also provide a useful benchmark for assessing process performance and for carrying out life-cycle assessments of structural assemblies and building shells.

Wilson, JB, and ET Sakimoto. 2005. Gate-to-gate life-cycle inventory of softwood plywood production. *Wood and Fiber Science* 37(Special CORRIM Report): 58–73.

For wood products manufacturers. Softwood plywood is used extensively in commercial and residential construction in the United States. Plywood manufacturers in the Pacific Northwest and the Southeast of the United States were surveyed about the materials, fuels, electricity, coproducts, and emissions associated with the manufacture of softwood plywood. From these data, the authors constructed a gate-to-gate life-cycle inventory for this material. They provide the details in this paper. Wood fuel provided most of the energy used in plywood manufacture. Carbon flow is also discussed. This LCI can be combined with others covering different stages of plywood production to generate a cradle-to-gate product LCI. It can also be used in life-cycle analysis of assemblies and structures incorporating plywood. ■