Bureau of Land Management Density Management Study

John Cissel, Paul Anderson, Shanti Berryman, Sam Chan, Deanna Olson, Klaus Puettmann

The Bureau of Land Management (BLM), Pacific Northwest Research Station (PNW), U.S. Geological Survey (USGS), and Oregon State University (OSU) established the Density Management Study (DMS) in 1994 to develop and test options for young stand management to meet Northwest Forest Plan objectives in western Oregon. The DMS demonstrates and evaluates alternative approaches to managing 40- to 70-year-old forest stands on low-elevation sites in western Oregon to create and maintain late-successional forest characteristics.

Scientific and management objectives of the DMS include the following:

- evaluate effects of alternative forest density management treatments on important late-successional habitat attributes (large trees; standing and down dead wood; understory trees, shrubs, and herbs; vertical distribution of tree canopy; and spatial distribution of trees, shrubs, herbs, and dead wood)
- determine treatment effects on selected plant and animal taxa (amphibians, arthropods, mollusks, nonvascular plants, and fungi)
- assess the combined effects of density management and alternative riparian buffer widths on aquatic and riparian resources
- use DMS sites to develop operational approaches to implementation of new prescriptions and improve methods for effectiveness monitoring of plant and animal taxa
- use DMS sites to share results of on-the-ground practices and study findings with land managers, regulatory agencies, and policy-makers
- use results from DMS to conduct a long-term adaptive management process where management implications and policy changes are regularly evaluated and changed as needed

Methods

Study Treatments

The DMS consists of three sets of treatments: initial thinning, rethinning, and riparian buffer widths (see http://www.fsl.orst.edu/cfer/pdfs/DMS.pdf for more details).

The initial thinning treatments were installed in 40- to 60-year-old stands that had never been commercially thinned. Four stand treatments of 30–60 acres each (1 acre = 0.405 ha) were established at each of seven study sites: 1) unthinned control, 2) high density retention (120 trees per acre [TPA]), 3) moderate density retention (80 TPA), and 4) variable density retention (40–120 TPA). Small (0.25 to 1 acre) leave islands were included in all treatments except the control, and small patch cuts (0.25 to 1 acre in size) were included in the moderate and variable density treatments.

Alternative riparian buffer treatments were nested within the moderate density retention treatment at each of the seven initial thinning study sites. Alternative riparian buffer width treatments included 1) streamside retention (one tree canopy width, or 20–25 ft [1 ft = 0.305 m], 2) variable width (follows topographic and vegetative breaks, approximately 70 ft), 3) one full tree height (approximately 220 ft), and 4) two full tree heights (approximately 440 ft). Physical limitations at each site usually prevented installation of all four treat-

ments, and the two-tree-height treatment fit the ground on only two sites.

The rethinning treatments were installed in four 60- to 70-year-old stands that had been previously commercial thinned. Each study stand was split into two parts: one, an untreated control, and the other, a rethinning (30–60 TPA). The rethinning treatment was intended to represent a potential future option for a second entry thinning 15–25 years after an initial thinning.

Location

Study sites were selected on BLM lands to be broadly representative of mesic, low-elevation forests in western Oregon. Sites are located in both the Coast Range and the Cascade Range (Figure 1).

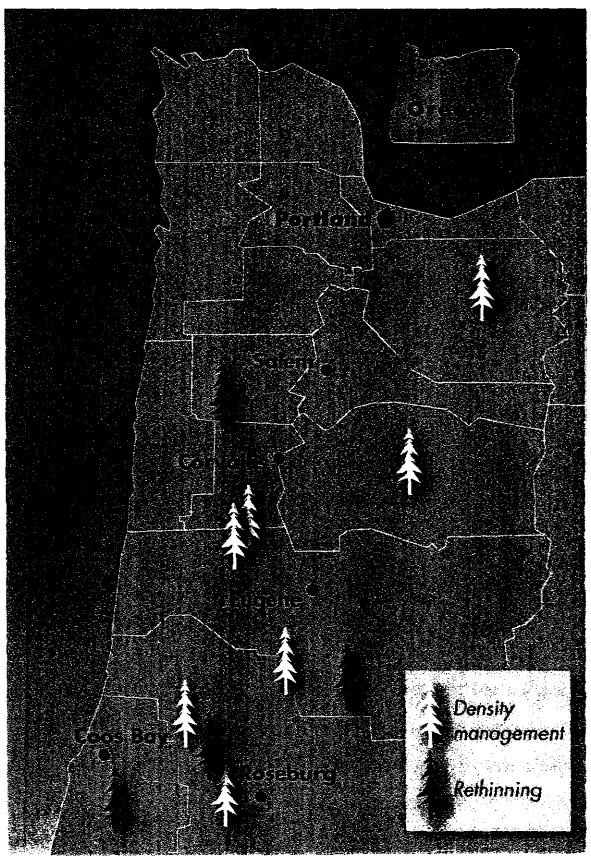

Figure 1. Location of the Density Management Study sites.

Component Studies

Several component studies are currently underway addressing DMS objectives. Measurement, remeasurement, data management, and analysis were ongoing for each of these components in 2004.

Vegetation

Randomly allocated plots are scattered across all treatment areas to characterize treatment implementation and whole-treatment vegetation response. These plots also provide information about the influence of overstory conditions on understory vegetation diversity and development. Transects across patch-cut boundaries are being used to measure patch dynamics as affected by patch size and neighborhood. A full suite of overstory and understory tree, shrub, herb, and dead wood variables are being monitored. Klaus Puettmann (OSU) is the lead investigator for this component.

Microclimate and microhabitat

Microclimate and microhabitat gradients due to density management practices and alternative riparian buffer widths are being monitored at seven DMS sites along transects oriented perpendicular to streams and extending from stream center to approximately 240 ft past the end of the riparian buffer. Available light, air and soil temperature, streambed temperature, relative humidity, vegetation, and overstory trees are measured at points distributed along these transects. Paul Anderson (PNW) and Samuel Chan (OSU) are the lead investigators for this component.

Aquatic vertebrates

DMS sites are being used to assess potentially unique aquatic resources in managed headwaters and evaluate the effects of thinning in riparian reserves. Pre- and post-treatment surveys along streams with alternative riparian buffer widths and moderate retention thinning measure fish and amphibian abundances and their habitats. Terrestrial salamanders and mollusks are being monitored on two sites. Deanna Olson (PNW) is the lead investigator for this component.

Arthropods

Aquatic and terrestrial arthropods add significantly to the beauty and biodiversity of forest and stream ecosystems, are significant links in many food chains, and are important regulators of nutrient cycling processes. The biodiversity and biomass responses of aquatic and terrestrial arthropods to thinning and to alternative riparian buffer widths are being evaluated on three DMS sites using data collected with pitfall and emergence traps. Andrew Moldenke (OSU) leads this component.

Leave Islands

Retention of leave islands during forest harvest operations has emerged as an important strategy to maintain plant and animal diversity. The objective of this component is to evaluate the relative effectiveness of leave islands in providing refugia for low mobility species including vascular plants, amphibians, mollusks, and arthropods. Species abundance and diversity in leave islands of different sizes are being compared to thinned areas and to unthinned controls. Stephanie Wessell (OSU), working under the direction of Deanna Olson and Richard Schmitz (OSU), is leading this component of the study.

2004 Highlights

Overall study accomplishments

- Organized and hosted the first DMS findings workshop (165 participants, mostly BLM); PowerPoint presentations with initial results are available online (http://ocid.nacse.org/nbii/density/)
- Hosted eight DMS field tours, including two for national symposia (ESA and IUFRO)
- Developed DMS poster and brochure
- Developed GIS database template and metadata and created GIS databases for seven DMS sites
- Developed proposal for new study treatments to be implemented in 2009–2011
- Completed site histories for all 11 sites
- Developed draft DMS establishment report and study plan
- Manuscript describing the DMS and riparian buffer study published (Chan et al. 2004, Variable density management in Riparian Reserves: lessons learned from an operational study in managed forests of western Oregon, USA. *Forest Snow and Landscape Research* 78: 151–172)
- Book chapter describing the initial findings of the effects of thinning on aboveground fungi published (Norvell and Exeter 2004, Ectomycorrhizal epigeous basidiomycete diversity in Oregon Coast Range *Pseudotsuga menziesii* forests preliminary observations *in* C.L. Cripps, editor. Fungi in Forest Ecosystems: Systematics, Diversity, and Ecology. The New York Botanical Garden Press. Bronx, NY.)
- Manuscript describing the effectiveness of leave islands for low-mobility species submitted

Vegetation

- Developed the vegetation database with associated metadata
- Documented DMS vegetation sampling protocol for BLM plots
- Analyzed the response of overstory and understory vegetation to the thinning treatments 5 years post harvest at three sites (Keel Mountain, Bottomline, OM Hubbard)
- Field survey of overstory and understory vegetation and coarse woody debris at 77 new plots at North Soup
- Remeasurement field survey of understory vegetation at 256 BLM monitoring plots at seven sites (Keel Mountain, OM Hubbard, Bottomline, North Soup, Sand Creek, Little Wolf, and Blue Retro)
- Remeasurement field survey of overstory trees at 93 BLM monitoring plots at three sites (North Soup, Blue Retro, Little Wolf)

- Installation and vegetation survey of 22 permanent gradient transects in gaps (0.25 and 1 acre) at four sites (Keel Mountain, Bottomline, North Soup, OM Hubbard)
- Poster displaying study methods and initial results developed

Microclimate and microhabitat

- Field survey of stand density, basal area, and mean tree diameter; data collection at 283 plots over five sites (Green Peak, Keel Mountain, OM Hubbard, North Soup, Bottomline)
- Analyses of microclimate data for six sites (those listed above plus Callahan Creek)
- Development and submission of Interim Report on the microclimate component of the DMS-Riparian Buffer Study (http://ocid.nacse.org/nbii/density/)
- Analysis of relationships between measures of overstory structure (density, basal area, relative density) and canopy light transmittance
- Poster displaying study methods and initial results developed

Aquatic vertebrates

- Field surveys of stream habitats and vertebrates were conducted in spring and summer at three sites (BLM sites: Perkins Creek, Green Peak; Forest Service site: Schooner Creek)
- Site monumenting and metadata documentation completed for most sites
- Data entry and quality control completed for pre-treatment data and years 1 and 2 post-treatment data
- Analyses of years 1 and 2 post-treatment vertebrate data completed in comparison to pre-treatment conditions
- Analyses of years 1 and 2 post-treatment habitat data initiated in comparison to pre-treatment conditions, including instream substrate, flow conditions, and down wood
- Report to site coordinators submitted, including detailed maps of stream reaches included in the study and species inventories derived from pre- and post-treatment sampling
- Poster displaying study methods and initial results developed

Arthropods

- Field data for terrestrial arthropods collected in patch openings, thinned and unthinned areas, and three riparian buffer widths on three DMS sites (27 plots per site)
- Field data for aquatic arthropods collected for three riparian buffer widths on three DMS sites (15 sample points per site)
- Sorting, identification, data management, and analysis completed for the terrestrial arthropods and in progress for the aquatic arthropods

Leave islands

- Arthropod and vascular plant species identification completed for all sites
- Arthropod and vascular plant functional groups determined
- Analyses completed of comparisons among five treatment types (unthinned forest, thinned forest (80 TPA), and circular leave islands of 0.25 acre, 0.5 acre, and 1 acre) of arthropod, mollusk, amphibian, and vascular plant abundance
- Multivariate analyses of community organization and habitats completed
- Initial results presented at the Ecological Society of America annual meeting
- Poster displaying study methods and initial results developed

Preliminary Research Results: Microclimate

Microclimate is an important element of ecosystem function, as it influences biological processes, such as primary production and decomposition, and the physical environment determining habitat suitability for many organisms. Basic knowledge of spatial and temporal variation in microclimate of riparian and adjacent upland forests of western Oregon is lacking. Further, the influence of forest management practices, particularly overstory thinning and riparian buffer delineation, on microclimate conditions of riparian zones is generally unknown. Given that much of the active management on federal lands occurs in headwater forests, it is important that relationships between silvicultural treatments and microclimate be characterized for riparian and adjacent upslope forests.

The microclimate study component included the following objectives: 1) describe microclimate gradients associated with riparian and adjacent upland forests in both thinned and unthinned stands, and 2) evaluate potential differences in microclimate gradients among alternative buffer widths.

For each site and treatment combination, canopy cover, understory light, air and soil temperature, and relative humidity were measured or monitored prior to and following implementation of the commercial thinning treatments. Spatial variation in cover, light, and microclimate was characterized by repeated sampling along transects originating at stream center and extending perpendicular to the channel through the riparian zone and into the adjacent upland forest (Figure 2).

While most transects extended about 200 ft upslope, a few extended in excess of 700 ft, depending on buffer width and topography. Observations of canopy cover and light transmittance were made at 3.3 ft above ground. Air temperature and relative humidity were measured at heights of 0.7 ft (near-ground) and 3.3 ft above ground (understory). Light and microclimate were sampled at six of the seven BLM sites, five in the Coast Range and one in the Cascade Range. Results are reported for observations made during the summer when treatment effects were expected to be most pronounced.

Commercial thinning substantially increased understory light when stand density was decreased to a basal area (BA) less than 120 ft^2, or in other terms, below a relative density (RD) of 30. At higher residual densities, light transmittance values were very similar to those of unthinned stands, being about 10% of light in the open (Figure 3). Increased thinning intensity to a moderate level of 80 TPA (BA of ca. 100 ft^2 or RD 20) resulted in average light levels of 25% of open conditions. The heaviest thinning, to 40 TPA (BA of ca. 60 ft^2 or RD 15), resulted in light levels averaging about 30% of that in the open, only a 5% increase for a doubling of thinning intensity over the 80 TPA treatment. Light conditions within 1-acre patch openings averaged about 57% of open conditions as a result of light interception by the surrounding trees. With respect to riparian buffers, increased light transmittance resulting from thinning adjacent stands was generally limited to 60 ft from the buffer-upland forest edge.

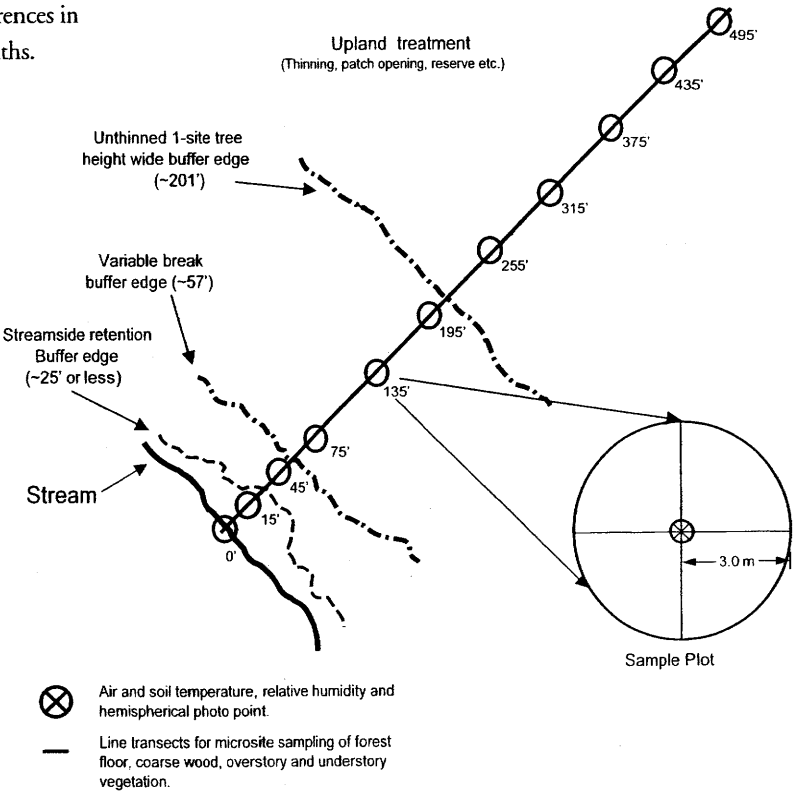

Figure 2. Transect and sub-plot layout for microclimate and microsite sampling in the riparian buffer component of the Density Management Studies.

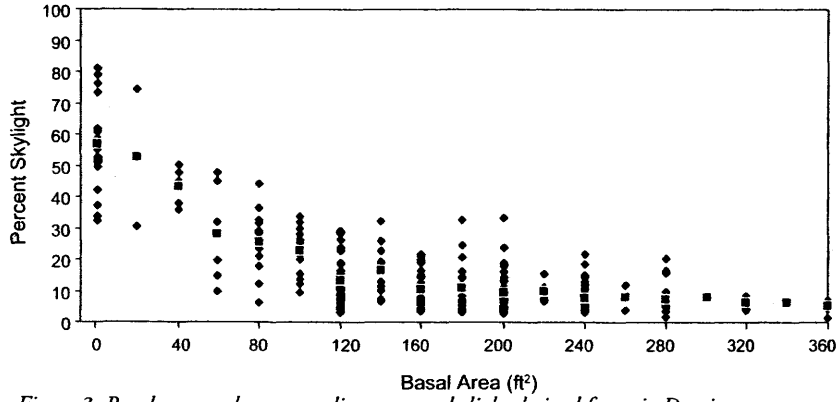

Figure 3. Basal area and corresponding percent skylight derived from six Density Management Study sites during summer conditions. Scatter points represent individual plot values while squares represent means.

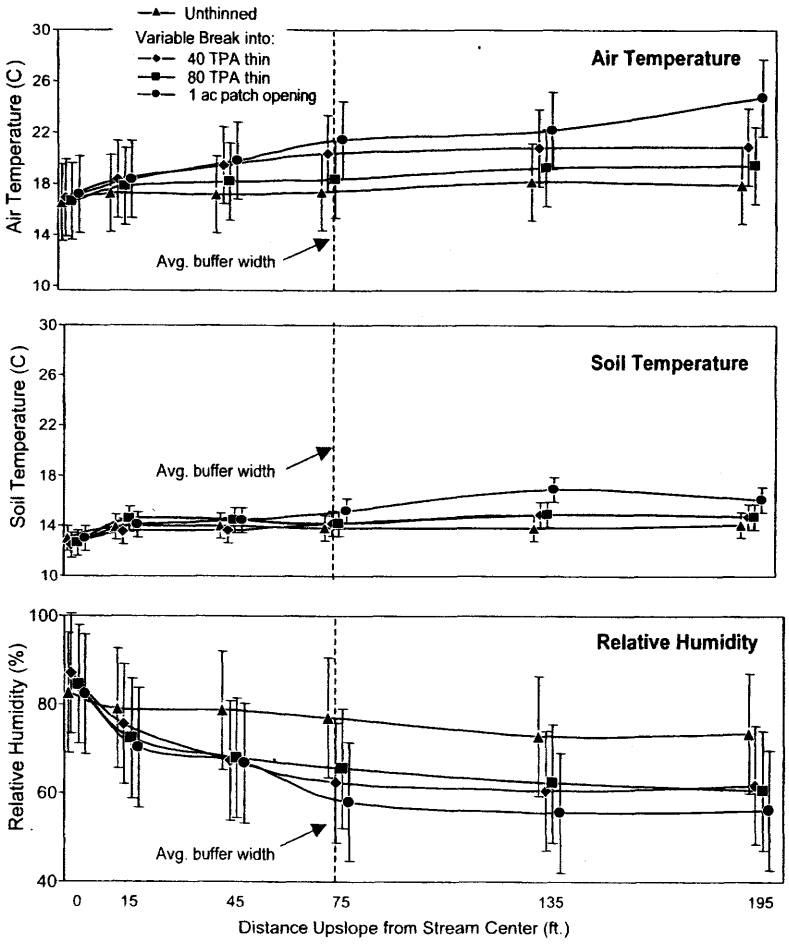

Figure 4. Spatial variation in microclimate at 4 pm; variable break (approximately 73 ft) buffers into 80 TPA thinned stand, 40 TPA thinned stand, and 1-acre patch opening; and an unthinned stand.

Microclimate gradients at 4 pm, the warmest and driest part of the day, indicated a significant influence of the stream extending about 75 ft outward from stream center. The strongest influence of the stream on microclimate, as indicated by steepness in temperature and relative humidity gradients, occurred within 15 ft of the stream (Figure 4). Microclimates differed significantly among upslope treatment areas during the peak stress period at 4 pm. Patch openings tended to be warmer and drier than thinned stands, which in turn were warmer and drier than unthinned stands. Among stands thinned to various densities, however, microclimates on average were not significantly different. There was considerable overlap in observed temperatures and humidities between thinned and unthinned stands, suggesting that these stands provide a wide-range of microclimates. Microclimate differences associated with buffer width or density management were not evident between 6 pm and 6 am.

At the stream we were unable to detect significant effects of either buffer width or upland density management on streambed water temperature or air temperature and relative humidity within the first 15 ft of the stream center.

Study Timeline

Thinning treatments were implemented on the 11 study sites between 1997 and 2002. Permanent vegetation plots were established in each stand soon thereafter. Remeasurement of permanent plots is scheduled to occur periodically on a 5-year cycle. Each component study follows a similar timeline. Major analyses and reports are expected on a 5-year cycle. A second round of treatments is proposed to begin in 2009.

For more information on the current status of these studies, please contact John Cissel, DMS Coordinator (jcissel@or.blm.gov, 541-683-6410).

THE COOPERATIVE FOREST ECOSYSTEM RESEARCH PROGRAM

Annual Report 2004

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Gretchen Bracher, Graphic Artist
Nancy Creel, CFER Administrative Assistant

December 2004
Corvallis, OR

December

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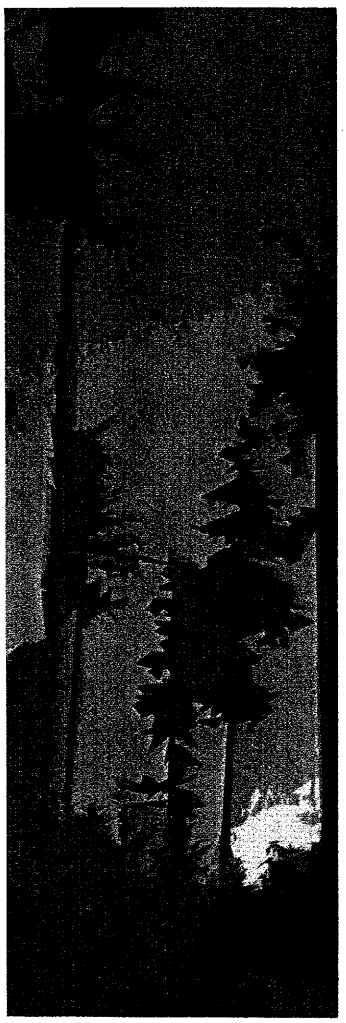

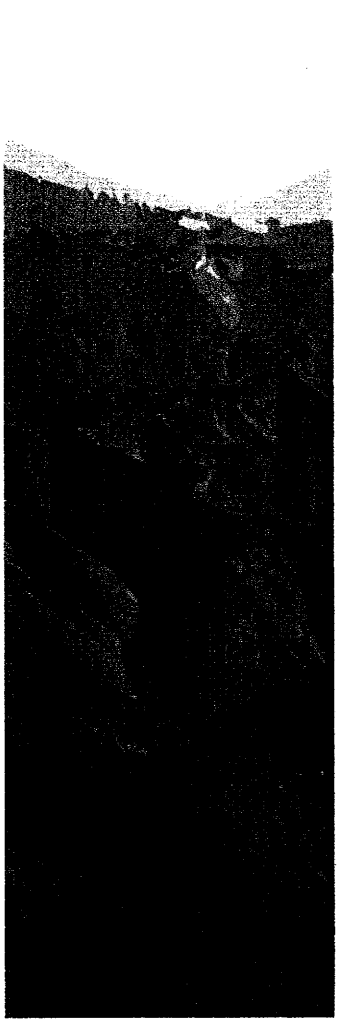
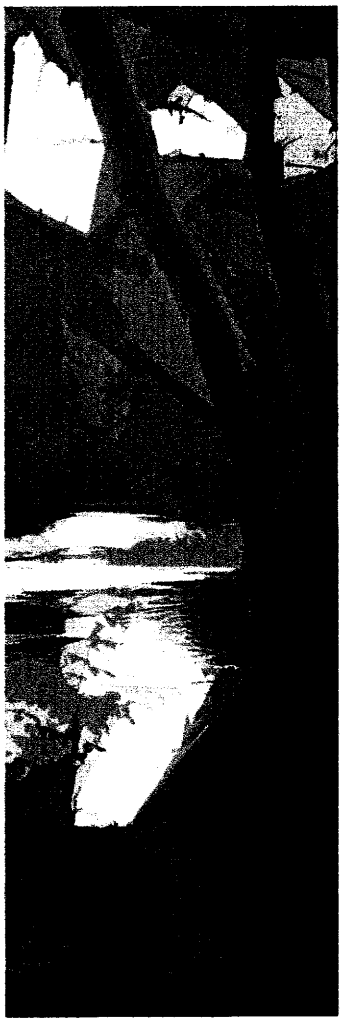

2004 Annual Report

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