Skov & Landskab

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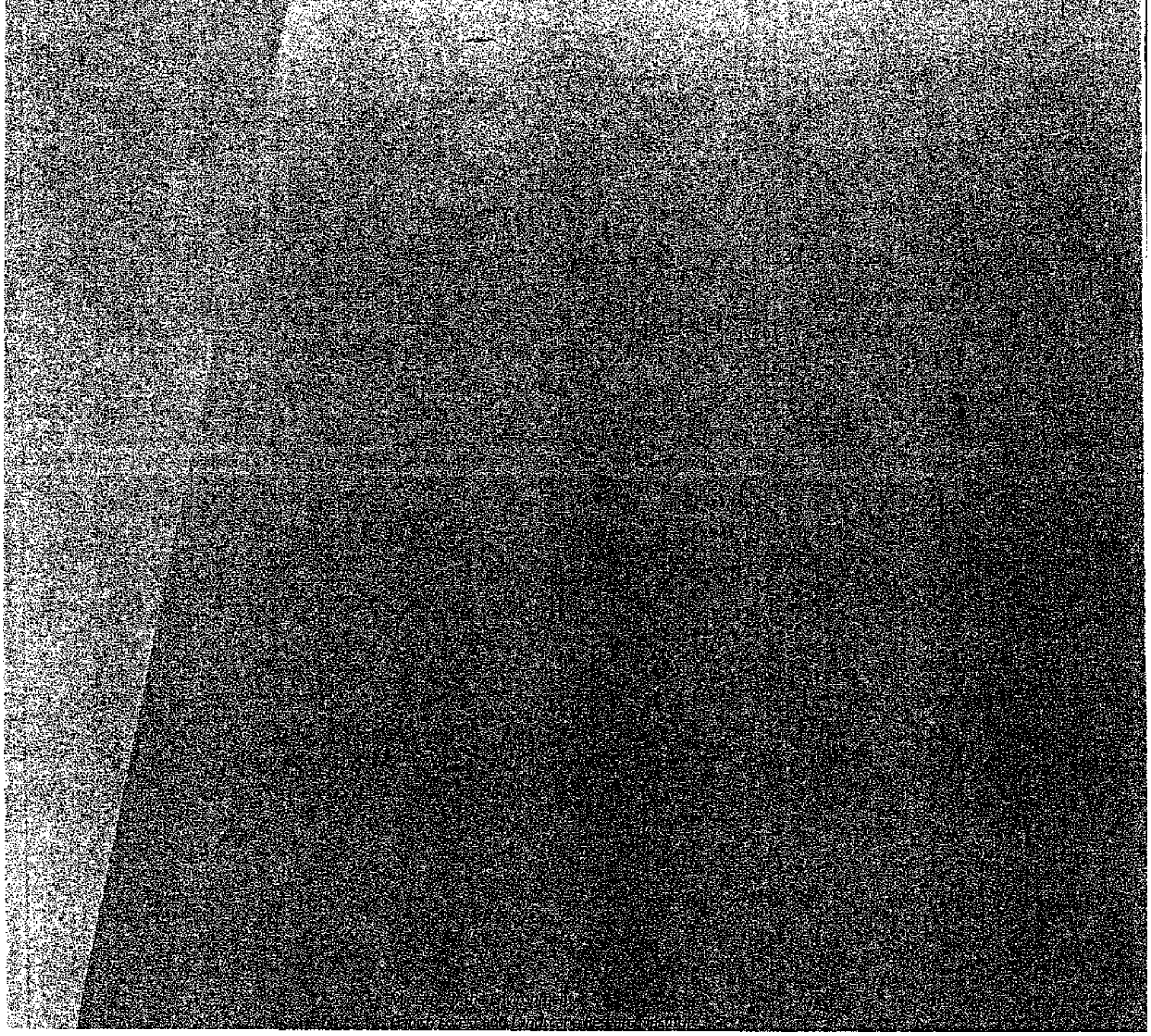
# Proceedings of the IUFRO Conference on Restoration of Boreal and Temperate Forests

## Documenting Forest Restoration Knowledge and Practices in Boreal and Temperate Ecosystems

Compiled by: Emile S. Gardiner and Lynne J. Breland



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Ministry of the Environment
Danish Forest and Landscape Research Institute

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# Preface

Forestry research and management has undergone profound change in many countries over the last decade. Following the United Nations Conference on Environment and Development in Rio de Janeiro, 1992, national commitments to sustainable forest ecosystems have transformed the way professionals and the public view forest management On the 10th annivesary of the Rio Conference, researchers and managers came together in Vejle, Denmark to identify general approaches, appreciate regional differences, and explore common challenges for restoring forest ecosystems.

The objective of this conference was to document forest restoration knowledge and practice in boreal and temperate ecosystems. Under the auspices of the International Union of Forestry Research Organizations (IUFRO), the conference was organized by the Working Parties on Restoration of Boreal and Temperate Forests (WP 1.17.02) and Temperate Forest Regeneration (WP 1.05.08). The Danish Forest and Landscape Research Institute, the United States Department of Agriculture Forest Service, and the Southern Swedish Forest Research Centre graciously provided sponsorship.

Viewing forest restoration broadly, the organizers emphasized summarizing the entire range of restoration activities at regional and local scales. Invited presentations set the tone by documenting and comparing restoration in specific regions of the temperate and boreal zones. Volunteer oral and poster presentations by speakers from 20 countries established the broad scope of the conference to include (1) Techniques for restoration and rehabilitation of forests (including afforestation, vegetation conversions, natural and artificial regeneration techniques); (2) Effects at stand and landscape levels of forest restoration, especially on biodiversity, wildlife, aquatic systems, and on land-use; (3) Understanding processes and changes in process levels during forest restoration; and (4) Economic and political impacts of forest restoration, including landowner participation, impacts on local communities, and the role of government in restoration programs.

# Restoration Effects on Biogeochemistry and Aquatic Systems

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Over the past several years, there has been an acceleration of restoration efforts to mitigate or enhance key components of watershed ecosystems that regulate biogeochemical cycling and associated aquatic components. Biogeochemical processes are complex because they operate at a variety of spatial and temporal scales (e.g., near instantaneous soil chemical reactions vs. bedrock weathering). Large-scale assessments of the integrity of these fine scale processes would be a daunting task; however, our knowledge of ecosystem processes at larger scales (e.g., stands, watersheds, basins) suggests emergent (and measurable) properties that integrate these finer scale processes. For example, nutrient budgets are key indicators of watershed health, and have proven useful for evaluating response and recovery to a variety of disturbances and management activities (Swank and Vose 1997, Swank et al. 2001). Since water moves nutrients through the system, hydrologic, aquatic, and biogeochemical processes are tightly linked. Nutrient budget components serve as a focal point for identifying ecosystem nutrient pools or processes requiring restoration to enhance biogiochemical processes and aquatic systems.

Restoration of biogeochemical processes and aquatic systems is inherently scale dependent. Restoration in small areas (i.e., a 50 ha watershed) may not translate into measurable changes in biogeochemistry or aquatic conditions at larger scales (i.e., >1000 ha), since current condition is the incremental, summed, or interactive effects of the impact of restoration added to other past or present impacts (Gosselink et al. 1990). The interrelationship between biogeochemical processes, and aquatic systems of upland tributaries to higher order streams with a variety ecosystem conditions (e.g., mixed ownership, mixed condition) must be understood in a cumulative effects context to develop appropriate restoration strategies. Most importantly, a conceptual and analytical framework must be developed to assess thresholds of response and recovery at a variety of spatial and temporal scales. This conceptual and analytical framework has important implications for restoration, providing a tool for prioritizing the location and intensity of restoration efforts and a framework for measuring success.

The resistance and resilience model of ecosystem response to disturbance is one potential conceptual framework for evaluating restoration success for enhancing biogeochemical cycles and aquatic systems (Waide 1988, Vose 2000). The model can be used as a conceptual construct for evaluating spatial and temporal aspects of current ecosystem condition, desired ecosystem condition, and systems response (Figure 1). For example, the historical and contemporary disturbance legacy of an ecosystem (or watersheds) determines it degree of departure from desired conditions, influences the rate of attainment of desired ecosystem conditions, and influences the magnitude of response to the restoration treatment A practical example is stream [$NO_3$], which increases in response to upland and riparian disturbances (Swank and Vose 1997) and produces an "initial condition". The desired condition is established in consideration of aquatic system response, water quality standards for human health, and the range of natural variability and sets the target for evaluation of restoration success. Restoration practices to reduce stream [$NO_3$], such as enhanced vegetation uptake, maintenance or enhancement of riparian buffers and wetlands, or altered land use patterns are evaluated in the context of rate of return and maintenance of desired conditions. While the resistance-resilience model provides the conceptual framework, analytical tools — modeling, GIS, and remote sensing — are required to quantify spatial and temporal responses.

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