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Evaluating Reclamation Success: The Ecological Consideration—Proceedings of a Symposium

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Evaluating Reclamation Success: The Ecological Consideration

Based on a session of invited papers presented at the annual meeting of the American Society for Surface Mining and Reclamation

April 23-26, 1990
Charleston, West Virginia

Jeanne C. Chambers and Gary L. Wade, Editors

This symposium was cosponsored by the USDA Forest Service, American Society for Surface Mining and Reclamation, and Western Regional Coordinating Committee on Revegetation and Stabilization of Deteriorated and Altered Lands.

Abstract

Includes 10 papers from a symposium organized to review what is known about the ecological principles that will govern the ultimate success or failure of all reclamation efforts on drastically disturbed lands. The papers cover four general areas: soil biological properties and nutrient cycling; vegetation dynamics; animal recolonization; and landscape-scale processes.

Most papers were not subjected to editorial review by the publisher, the Northeastern Forest Experiment Station. Statements by contributors from outside the U.S. Department of Agriculture may not necessarily reflect the policies of the Department

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Northeastern Forest Experiment Station
5 Radnor Corporate Center
100 Matsonford Road, Suite 200
P.O. Box 6775
Radnor, Pennsylvania 19087-4585

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Introduction

Natural and anthropogenic forces lead to drastic disturbance of landscapes and ecosystems. In many cases, it is desirable to repair the damage or reclaim the areas involved. Causes of large-scale disturbance to ecosystems include landslides and debris from earth movement, floods, or tsunamis; volcanism; salinization or desertification; drastic releases of pollutants; large earth-disturbing construction projects; and surface and subsurface mining. Of these causes, disturbances due to mining are the most widespread and can be the most difficult to reclaim. However, following all disturbances, natural or anthropomorphic, the development of post-disturbance ecosystems proceeds according to basic ecological principles. In the following collection of papers these principles are discussed in the context of mined-land reclamation, but they also are applicable to other disturbances and recovery.

The reclamation of drastically disturbed lands often results in construction of ecosystems literally from bedrock up. Construction of the new ecosystem begins as soon as soils and geological materials are disturbed and replaced. It is at this point that basic characteristics of the new ecosystem are decided. Some of these characteristics are "set in stone;" others will develop or can be modified with more or less effort later in time.

The miner-reclaimer or reclamationist has the power to affect environmental changes both near and distant in space and in time. Using the energy, machinery, and geological and biological materials at hand (all of which can be considered "resources"), the reclamationist determines the new ecosystem's internal (on-site) characteristics: topography, potential soils, on-site hydrology, environmental and biological diversity, microclimate, soil quality and productivity, potential postmining land uses, and on-site aesthetic relationships. Some internal characteristics will have far ranging external characteristics (off-site effects) such as downstream water quality, stream water flow amounts and timing, products from the land, and landscape unit relationships, both financial and purely aesthetic. Some of these characteristics will have transient effects, but others will be important environmental determinants for thousands of years.

Humankind is now a factor in nearly all environments on the face of our planet. Conversely, nearly all environments have an effect on the human environment. Thus, a reclamation-constructed ecosystem can be viewed as having many homocentric characteristics: products produced for human use, potential human land uses, effects on human environments, and human-viewed aesthetic relationships. This in no way negates the importance of natural processes in structuring ecosystems or of using predisturbance ecosystems as models for reconstructed ecosystems. It merely recognizes the potential influence of humans.

With these things in mind, we must reexamine current methods of evaluating the success of land reclamation efforts. Because ecosystems are being constructed that will function in accordance with ecological rules, the success of reclamation must be evaluated holistically in terms of ecological principles.

Accordingly, we organized this symposium, part of the American Society for Surface Mining and Reclamation 1990 Annual Meeting in Charleston, West Virginia, to review what is known about the ecological principles that will govern the ultimate success or failure of all reclamation efforts on drastically disturbed lands. Because ecosystems are complex, their functional characteristics are governed by many principles. Papers produced from the Symposium "Evaluating Reclamation Success: The Ecological Consideration" were divided into four general areas.

Living organisms and populations have definite functions within the ecosystem. They drive ecosystem processes, promote ecosystem development, and lend it stability. Bacteria and fungi are important in this regard, and their roles in ecosystems are discussed in the section **Soil Biological Properties and Nutrient Cycling.** John Zak, Philip Fresquez, and Suzanne Visser address soil microbial processes and dynamics. Michael Allen and Carl Friese point out the important but often overlooked role of mycorrhizal fungi in disturbed landscapes. John Palmer then links soils, microbial populations, and vegetation together with a discussion of nutrient cycling.

New ecosystems develop stability through the process of ecological succession which is manifested most visibly in vegetation establishment and change. This is addressed in the section **Vegetation Dynamics** in which James Young covers the initial stage of plant invasion in a discussion of seeds and seed ecology. Next, Edith Bach Allen covers community-level processes and their effects on succession. Finally, successional similarities and differences among biomes are discussed by Jeanne Chambers, James MacMahon, and Gary Wade.

Animals, both vertebrate and invertebrate, play important roles in ecosystem processes. They pollinate flowers, accelerate nutrient cycles, aerate soils, consume and disseminate plant seeds throughout disturbed and recovering ecosystems, and influence ecosystem development and successional trajectories. In **Animal Recolonization,** Robert Parmenter and James MacMahon discuss animal roles in ecosystems and how these can be evaluated in constructed ecosystems. They also discuss ecosystem properties that enable the establishment of integrated and functioning animal populations.

Ultimately, the new ecosystems on reclaimed land must be integrated with the larger landscape surrounding them. This is the scale at which the external effects of constructed ecosystems become important. In the section **Landscape-**

Scale Processes, Paul Tueller reviews the place of reclaimed lands as part of the surrounding landscape, and Howard Halverson and Roy Sidle look at mining as one land use influencing the cumulative effects of all land uses in a watershed.

The term "reclamation" as commonly used actually encompasses three somewhat different goals of ecosystem construction. These were defined in 1974 by the National Academy of Sciences as follows:

- *Reclamation*: An attempt to create an ecosystem similar to the original or predisturbance ecosystem. It can include introduced species that respond similarly to the native species which they replace.
- *Rehabilitation*: Producing an alternative ecosystem, one that falls within the existing land uses of the area but replaces a native ecosystem with a pasture, park, etc.
- *Restoration*: Re-creation of conditions which are identical before and after disturbance.

Regardless of the goal, restoration, rehabilitation, or the more narrowly defined reclamation, it is understood that the goal includes a stable ecosystem. It also is assumed that characteristics of the reclaimed ecosystem are consistent with surrounding environments and land uses. In the papers that follow, "land reclamation" is used in the broader, more commonly used sense and can include any of the three goals mentioned above.

We the editors and authors hope that this proceedings will focus the attention of land reclamationists, regulators, ecologists, and land managers on the importance of ecological principles and how they relate to the art and technology of land reclamation, ecosystem construction, and progressive development of ecosystems.

Gary L. Wade
Botanist
USDA Forest Service
Northeastern Forest Experiment Station

Jeanne C. Chambers
Ecologist
USDA Forest Service
Intermountain Forest and Range Experiment Station