RECENT TRENDS IN PHOSPHATE MINE RECLAMATION IN THE UNITED STATES[1]

by

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Abstract. Phosphate mining has occurred in several regions of the United States, including portions of Florida, North Carolina, Tennessee, Idaho, Montana, Utah, Wyoming, and California. About 85 percent of the combined total U.S. phosphate production comes from Florida and North Carolina, while the western states account for 10 percent, and Tennessee produces 5 percent. Phosphate rock is mined under different physical and ecological conditions in each of these states and this leads to differences in reclamation requirements and expectations. Also, the political climate associated with phosphate mining is highly variable from state to state and this has been reflected in reclamation regulations. Florida has the most rigorous environmental standards and reclamation regulations of any of the states mentioned, with North Carolina, western states, and Tennessee, respectively, having less rigorous restrictions and fewer reclamation regulations. Reclamation regulations and changes in resulting reclamation were documented on a state-by-state basis over the 5-year period, 1983-88. In Florida, revisions of the reclamation regulations over this interval have resulted in changes in emphasis from an early focus on re-establishing wetlands to a more recent emphasis on redeveloping drainage patterns and upon reclaiming to upland forests. Reclamation changes in other states have been more subtle, with subsequent land use and economic considerations often dictating requirements for reclamation.

Additional Key Words: Phosphate mining, reclamation, regulations, trends

Introduction

Phosphate mining in the United States is typically accomplished using surface strip mining techniques and, in some states, this has resulted in major alterations of drainage patterns, landscape features and vegetative communities. Phosphate reclamation regulations have evolved in nearly every state with this mining activity and the implementation of these regulations often being controversial as various regulatory agencies, phosphate industry, environmental groups, and other concerned groups have sought to provide input into the process. As these various groups have tried to clarify, further regulate, or negotiate various provisions of reclamation regulations, confusion over interpretation and enforcement of specific reclamation provisions sometimes has resulted in both backlogs and delayed implementation schedules for mandatory reclamation. For example, in Florida where about 76 percent of the nation's phosphate is mined (Stowasser 1986), reclamation has been required since 1975 on all

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lands altered by phosphate mining. However, of the 32,500 hectares of land in Florida disturbed by this mining since 1975, only 40 percent has been reclaimed (Florida Department of Natural Resources 1989).

Phosphate reclamation regulations are presumed to represent the currently negotiated state-of-the-art for each state, despite the fact that they are concurrently being modified and evolving in some states. By examining the similarities and differences between states and regions involved in phosphate mining, it is possible to develop some generalizations regarding the relative sophistication of reclamation procedures and environmental concerns. This paper is an attempt to compare and contrast phosphate mining regulations and reclamation nationwide and to explore recent trends associated with these topics. Emphasis will be placed upon the ability of reclamation programs to replace natural contours and drainage patterns, vegetation, and ecosystem function.

Methods

Interviews with phosphate mine operators and regulatory agency officials were personally conducted in the fall of 1983 at nearly all locations of mine reclamation activity in the United States. Also, during this process, representative mines were visited and reclamation sites were photographed in two districts of Florida and in appropriate regions of Idaho, North Carolina, and Tennessee. Slightly more than 5 years later (early in 1989), copies of the most recent phosphate reclamation regulations were obtained from the appropriate agencies in each of these states and were qualitatively compared with the 1983 reclamation regulations. Any major changes were noted in these reclamation regulations over the 5-year interval particularly as they affect reclamation back to natural ecosystems in each state.

Results

Reclamation of lands disturbed by phosphate mining has been required since the early to mid-1970's in most states discussed in this paper. Land reclamation involves a variety of technologies and regulations that illustrate the complexity of economical, ecological and political forces involved in the decision-making process. The magnitude of disturbance and size of mining operations in each of the states are strong determinants of the types of reclamation that are appropriate and the degree of associated environmental concern. Florida dominates phosphate mining activities in the U. S. with a total of over 70,000 hectares disturbed since mining began in the state. In Maury County, Tennessee, approximately 5,000 hectares have been mined for phosphate; this land area is over twice as large as the 2,000 ha of land mined for phosphate in Idaho and western Wyoming. In coastal North Carolina, one mining company has disturbed about 1500 ha of land so far, but the phosphate reserves in the Pungo River formation of this state are thought to exceed 140,000 additional hectares (Schaller and Sutton 1978). Phosphate mining in California has been restricted to about 100 hectares disturbed several years ago but this area has not yet been reclaimed (H. Record 1983 pers. comm.).

Florida.

The dominance of Florida in the magnitude of disturbance and production of phosphate in the United States will be reflected in this paper due to the readily available sources of information and research on this topic. The magnitude of phosphate mining in Florida and the high level of public concern has resulted in substantial involvement by agencies and organizations in the permitting and review process, including at least four at the federal level, nine at the state level and numerous local organizations (Marion 1986). Florida has by far the most sophisticated phosphate reclamation technology, environmental concerns and reclamation options of any state in the country. State agencies, particularly the Department of Natural Resources and the Department of Environmental Regulation, are the primary governmental entities reviewing reclamation applications, implementation, and completion in Florida.

Early reclamation regulations relating to natural ecosystems dealt with water quality standards, slopes and sizes of wetlands and other water bodies, and minimal requirements and timing for re-establishing ground cover on reclaimed sites. The traditional reclamation in Florida has been mostly to pastures, with some citrus groves or other agricultural croplands and many "land and lakes" wetlands where rounded peninsulas are interspersed and form the meandering shorelines of reclaimed lakes. More recent revisions of the reclamation regulations in Florida involve more detailed

physical and biological descriptions of the property. This includes consideration of original drainage patterns and detailed design of wetlands to include both deep and shallow areas, protection of endangered flora and fauna, planting of at least 10 percent of upland sites in native trees and shrubs, and provision of a greenbelt of indigenous trees and shrubs around wetlands. In most cases, these revisions of the reclamation regulations in Florida represent improvements in the reclamation process to provide for natural ecosystem functions. A publication by King et al. (1985) was instrumental in providing on-site reclamation guidelines to the industry that provided numerous illustrations of innovative ways to reclaim and connect wetland and upland sites. As reported in another paper (Marion and King 1988), the early reclamation in Florida emphasized restoration of wetlands, but more recent emphasis has been on providing more indigenous upland forests. The importance of upland forests has appeared in provisions of the reclamation regulations and on the landscape as this reclamation is implemented.

North Carolina.

Phosphate mine reclamation has been required in North Carolina since the enactment of the Mining Law of 1971, a law that required acre-for-acre reclamation within two years after the completion of active mining. This law has been amended at least twice since then (1981 and 1987) to include minor additions and changes in bonding (D. Stewart 1989 pers. comm.). Mining operations and reclamation in North Carolina are overseen by a Mining Commission that serves as a first line of decision-making to resolve any differences between the phosphate industry and regulatory agencies. The phosphate mine reclamation regulations appear to be broad and relatively flexible in this state -- they do not require reclamation back to pre-mining conditions, but generally do require that the land is put back in a "useful" condition. A major purpose of the Mining Act of 1971 was "to provide that the usefulness, productivity, and scenic values of all lands and waters involved in mining within the State will receive the greatest practical degree of protection and restoration." In many respects, the most stringent environmental regulations affecting phosphate mining in North Carolina are promulgated by federal agencies such as the U. S. Army Corps of Engineers and the U. S. Fish and Wildlife Service. The former agency's standards protecting coastal wetlands are probably the most stringent of any of the regulations affecting mining in this state. In 1988, a major violation of air and water quality standards resulted in a $ 5 million fine against the company mining phosphate in North Carolina; this violation and increasing public pressure is causing this company to respond more positively to environmental regulations.

In many ways, phosphate mining operations in North Carolina appear to be similar to operations in Florida. Mining in both of these states is accomplished by open pit strip mining as the underlying matrix containing phosphatic clay is brought to the surface from various depths (10-15 m in Florida, 25-30 m in North Carolina). Because phosphatic clays are extracted from nearly twice the depth in North Carolina as in Florida, initial phases of strip mining in North Carolina normally involve flooding the area and using hydraulic dredges to remove the upper third of the soil prior to draining and excavation of the mine with electric draglines. At least three major "waste" by-products result from phosphate mining operations in both states; these include (1) overburden soils, (2) sand tailings, and (3) phosphatic clay "slimes". The reclamation and revegetation of these materials was discussed in some detail by Farmer and Blue (1978).

In both North Carolina and Florida, a high proportion (60-70 percent) of the landscape in and near the mine becomes phosphatic clay settling ponds. These settling ponds result when an area of unreclaimed overburden spoil piles and mine cuts is surrounded by a dike and inundated with "waste" clay slurry left after the removal of phosphate particles from the saturated clay matrix. This procedure of disposal of "waste clays" in these diked impoundments typically delays reclamation of these mined areas for long periods of time (e.g. 10-15 years). In North Carolina, well over half of the total area mined has been inundated with settling ponds since mining resulting in there being little reclamation to adequately evaluate (D. Stewart 1989 pers. comm.). Thus, in North Carolina and Florida, the need for disposal sites for large volumes of waste clays in suspension has both created vast areas of new wetlands on the landscape and delayed initiation of reclamation for several years. Phosphate settling ponds are extremely attractive habitats for a number of wildlife species groups, especially waterfowl and

wading birds. The values associated with these ponds as habitats for birds have been previously assessed and are thought to be both beneficial and detrimental for wildlife species (Marion 1989).

In general, environmental regulations associated with phosphate mining in North Carolina have not developed either to the extent or sophistication of those in Florida. Recent evidence suggests that public pressure on the industry in North Carolina is beginning to cause some changes and regulations will likely further evolve, but this is occurring slowly.

Tennessee.

Tennessee has been requiring reclamation of phosphate lands since enactment of the Mineral Surface Mining Law of 1972 and the amendments in 1980. A relatively modest performance bond is necessary to be filed with the state of Tennessee in order to legally mine for phosphate. Unlike several other areas where phosphate mining exists (e.g. Florida, Idaho, and North Carolina) and where the ultimate land use after reclamation is only vaguely known, the intended land use after mining for phosphate in Tennessee is clearly known and is usually agricultural pasturelands or grain fields. The mining in this state is generally small-scale, shallow (3-4 m) strip mining using relatively small equipment and causing, at most, only a temporary disruption of the surface. Prior to mining, the landowner generally specifies the vegetation to be used in post-mining reclamation that typically is pasture grass (e.g. fescue, sweetclover, Sudangrass, orchardgrass) or agricultural crops (e.g. corn, oats, soybeans, barley, and alfalfa).

Phosphate mining in this state is extremely localized and normally goes from a pasture back to a pasture within a matter of weeks or months, depending mostly on the time of year and weather conditions. Because agriculture is the existing and likely future land use in the area, landowners have minimal incentives to plant either pine trees (which grow poorly in south-central Tennessee) or hardwoods (slow growth and often poor investment) on their lands following mining. Development of or enhancing wildlife habitat values on the landscape following mining are essentially being overlooked on upland sites. A major landform resulting from the phosphate mining operation is the establishment of large, deep slurry ponds; these are being retained as open water areas with abundant fish populations and some use by waterfowl. As in Florida, long-term maintenance of these ponds as wetlands or lakes will depend upon having an adequate supply of water (currently coming from mining operations). Some mining operations have closed recently in Tennessee, leaving the future uses and potential recreational benefits of these areas in jeopardy.

Western States.

Phosphate mining in the western states is considerably different from mining in the southeastern states and it is therefore difficult to make valid, direct comparisons. Although most mining is being conducted in southeastern Idaho, phosphate mining also has occurred in portions of California, Montana, Utah and Wyoming. In Idaho, phosphate mining began in 1909 at the Waterloo Mine and is expected to continue in the area for several more decades. About 35 percent of the phosphate reserves in the United States are in southeastern Idaho and much of this is close enough to the surface to be strip mined (Evans 1984). Phosphate is mined from sedimentary rock layers that have been severely faulted and uplifted by crustal movements. Phosphate mining is accomplished by strip-mining of selected layers containing ore in mountainous terrain; large, rocky, relatively unstable waste dumps are the focus of reclamation efforts.

Since many of the lands mined for phosphate are owned by the U.S. Forest Service, this agency has taken the lead in establishing stability and revegetation stipulations. The stated policy of the Caribou National Forest (20,000 acres currently leased for phosphate mining) regarding mined land reclamation is: "The short term reclamation objective is the immediate reduction and prevention of erosion, by stabilizing the soil with adaptable plant species. The long term goal is to return the land to an end use similar to that which existed prior to mining at a level of productivity equal to or better than that previously realized. The reclamation plan which accompanies each mining plan will incorporate a long term revegetation plan." Attempts at reclamation in Idaho began in 1958 and has evolved since then; recently, detailed reclamation guidelines were outlined in an R-4 Reclamation Field Guide (Albrechtsen and

Farmer undated). The "waste" materials that remain after phosphate mining in the Idaho foothills are limestones, cherts, medium waste shales, mined out areas and catchment basins. Limestones and cherts are usually large, rocky materials that are buried during the reclamation process.

Reclamation technology includes procedures to meet, but not to exceed, the U.S. Forest Service's stipulations on slopes (3:1 or flatter) and on revegetation (67 percent cover over 90 percent of the area within 3 years after completion of mining). Heavy equipment has typically been used to recontour waste shale dumps wherever they existed following mining and these sites are typically harrowed, fertilized and seeded with a rangeland drill or by broadcast seeding. To reduce erosion and to meet the revegetation requirements, the normal strategy has been to plant grasses and forbs (Richardson and Farmer 1983) while experimenting with re-establishment of shrubs and trees (which takes several years). Strong, local pressures exist to open up recently reclaimed and revegetated lands to grazing (Francis 1984) and to maintaining these lands as grazeable pastures, rather than allowing them to naturally return to forested lands. Control and supervision are necessary to restrict early and over-grazing of recently revegetated sites. Although phosphate mining was controversial from an environmental perspective in the mid-1970's, these operations appear to be less so now and the reclamation stipulations in Idaho have been relatively well-established for several years.

Conclusions

Phosphate reclamation regulations appear to be relatively stable in Idaho, just as they were in North Carolina and Tennessee. In Florida, where reclamation regulations have shown the most growth and sophistication, these regulations continue to evolve and be revised to "fine-tune" reclamation on the landscape. In general, this study confirmed several trends --primarily that the magnitude of mining disturbance in each state or region directly affects the sophistication of environmental concerns, reclamation regulations, and revegetation combinations. The extent of local disturbance was found to be minimal in Tennessee, intermediate in Idaho and North Carolina, and extensive in Florida. The reclamation technology employed in most states has been selected based upon extent of disturbance, previous company experience, and economic considerations.

Revegetation of phosphate mines has generally involved establishing a grass cover within time limitations and budgetary considerations. Most states have developed experimentation/demonstration of other revegetation options (e.g. various shrubs and trees), but the incentives to explore and/or widely implement these options over broad areas have been lacking. Generally, phosphate lands are reclaimed for eventual use as pastures or other agricultural lands. Reclamation in Florida involves considerably more experimentation and demonstration (e.g. crop, shrub and tree planting) than most other states involved in phosphate mining. Reclamation of at least a portion (25-30 percent) of disturbed landscapes back to natural ecosystems that have natural functions and intrinsic values for fish and wildlife resources (as described by Marion and King 1988) remains a worthy goal and challenge.

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