ECOLOGICAL CONSIDERATIONS IN RECLAIMING SURFACE MINED LANDS

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ABSTRACT

The opportunities for, and ecological problems of, reclaiming surfaced-mined land are reviewed. It is suggested that existing methods permit the achievement of ecologically viable goals, although further research would be beneficial. However, an ecologically improved condition will only rarely reproduce the original condition and acceptance of this philosophy will entail compromise by both ecologists and mine operators.

CAN ECOSYSTEMS RECOVER FROM MAJOR PERTURBATIONS?

There is much geological evidence that indicates natural systems have a capability of recovering from major perturbations, including large areas of the world that have been glaciated more than once, wiping out vegetation and animals. In addition, various areas of the world, such as the central plains of the United States, were once covered by water. Organisms, plant and animal, have reoccupied all of these areas. On a smaller scale, forest fires, slumping of land, and other natural disturbances have either totally or seriously depopulated various surface areas which often, but not invariably, are recolonized. Even land never previously colonized, such as emerging volcanic islands, eventually become populated by both plants and animals. It is worth noting that ecological recovery: (a) is not inevitably to the pre-perturbation condition, (b) might require hundreds or even thousands of years, (c) may not be as useful to the organisms originally dependent upon it as it was during the pre-perturbation condition, although for other species conditions might be superior to those which formerly existed, (d) often produces young immature ecosystems less aesthetically pleasing than mature ones.

Although the human race has engaged in various types of surface mining for quite a substantial period of time, only recently has the development of vast earth-moving machines made large-scale ecological perturbations possible in surface mining. There is undoubtedly a scale effect in which the time and type of recovery is influenced by the size of the disturbed area and the degree of disturbance. Unfortunately, the amount of ecological disruption caused by various types of man-made perturbations, including surface mining, is difficult to predict precisely because little ecological evidence was gathered before and after major disturbances of this type and few biologists are investigating the recovery process. This is a consequence of a number of factors including the widespread belief that conquering nature was progress. This has only recently been replaced by a perception of the need to protect natural systems from irreparable harm. Another reason for the paucity of information is that most ecologists preferred to study natural systems as uninfluenced as possible by human beings, so that the ecological relationships could be determined in their 'purest' form. One need only go through the ecological journals and compare the number of pristine areas studied with the number of disturbed areas (such as garbage dumps) to see how little attention was given to man-made disturbances until recently. As a consequence of the paucity of information on the recovery process following man-made disturbances, one must use information from a variety of studies rather than having the luxury of confining examination of the evidence to that from surface mining alone.

Some of the most interesting related evidence is the recovery of ecosystems following extensive logging. Because the larger species involved were inventoried for commercial reasons, the abundance of various species and their customary sizes is recorded, and records may even exist for some of the smaller species associated with the large trees. Even when such evidence is not available, one can make a fairly good estimate of the total ecological association of species by examining similar areas that were not disturbed by logging. A further advantage is that sufficient time has passed since the first major cutting that built the great cities and houses of this country to see ecological evidence of the recovery process. An example is found at the University of Michigan Biological Station, Pellston, Michigan, near the Mackinaw Straits which join Lakes Michigan and Huron. The area was very heavily logged in the early 1900's. It contained, at that time, a seemingly endless, almost unbroken stand of massive trees with considerable patchiness caused by soil differences. A fragment of one of the trees has been kept by one of the lumbar yards in Pellston, Michigan, and its size relative to a human being is quite evident in Figure 1. The logging which occurred around 1911 left a scene of devastation hardly credible at the present time (Fig. 2). The present director of the University of Michigan Biological Station, Dr. David M. Gates, was present as a child at the station and remembers getting covered with soot and ashes from the flash fires that accompanied the logging. He also remembers the rather poor growth that occurred immediately after the logging ceased.

Following the intense logging, the area now occupied by the Station was given to the University of Michigan which first used it for training civil engineers in surveying. As the vegetation became more abundant, interfering with lines of sight and movement, it was devoted virtually entirely to biological research which initially coexisted with the engineering activities. Figure 3 illustrates an early stage of recovery and is characterized by rather low, not particularly impressive, trees, shrubs, grasses, and other vegetation. Figure 4 shows a view of the area of the station taken in 1979. Several points are worth noting. First, except during the period of intense logging, the area was suitable for certain types of biological investigations indicating that the area was not totally devastated. However, most of the academic courses of that era were oriented toward classification of organisms rather than their ecological interactions, and ecology had not then emerged as the thriving discipline it is today. Nonetheless, it was an ideal situation to study plant succession and some of the early investigations on that topic were carried out at the Biological Station. A second important point is that the girth and height of the trees today, many years after the logging, do not even begin to approach that of the trees that once existed. None of the people living today will see forests on this site as impressive as those once here, and it is unlikely even if the ecosystems remained essentially untouched that the generations immediately after this one will do so either. Finally, it is worth noting that for at least 20 years the station has been adequate for ecological research and a variety of other biological

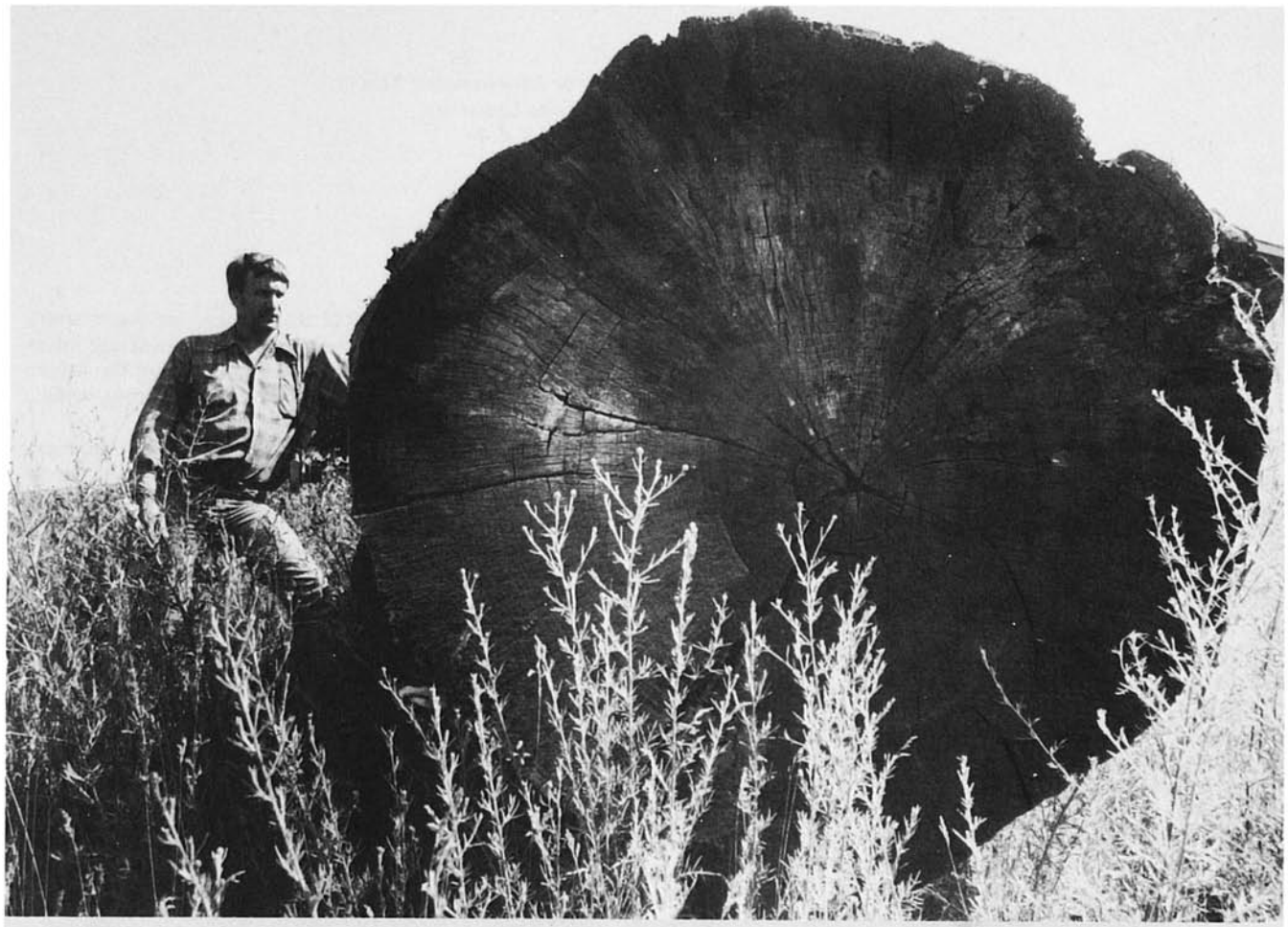

Fig. 3 Partial recovery in the housing area overlooking Douglas Lake (about 1932). (Prints and copy negatives by Gary Williams of Glen Ellyn, Illinois; from UMBS Archives).

investigations. Since there is little evidence of human activity on the nine thousand acres controlled by the Biological Station, students are unlikely to realize when they first arrive that this is an ecosystem recovering from a major man induced perturbation. The few untouched tracts that remain (e.g., Hartwick Pines) provide evidence of the type of ecosystem that once existed here. Even the most development-oriented society needs some untouched, unspoiled natural systems so that it can be determined how far present systems deviate from them and what benefits, both economical and ecological, would be derived from different degrees of rehabilitation.

MANAGEMENT OPTIONS FOR RECLAIMING SURFACE MINED LANDS

These options for management of reclaiming surface mined lands exist:

1. Doing nothing and leaving the land as it was when the mining was completed.
2. Restoring it to its original condition.
3. Reclaiming it to an ecologically improved and more socially acceptable condition.

◀ Fig. 1 A fragment of one of the logs of the logging era; preserved by a lumber yard in Pellston, Michigan. (Photograph by Gary Williams and Jerry Nyckel, Glen Ellyn, Illinois).

◀ Fig. 2 The devastation that occurred about 1911 just before the tract was donated to the University. (Print and copy negative by Gary Williams of Glen Ellyn, Illinois; from UMBS Archives).

Pros and Cons of Option 1: Doing Nothing

Pros

1. Some surface mined land will recover even if no ecological management is associated with the ecological recovery process. There is abundant evidence that at least some types of land will be invaded by species capable of living under the new conditions.
2. It is unjustified to spend money badly needed by society on reclaiming land unless it has some immediate monetary value.
3. Management practices for restoring surface mined land are still in their early developmental stages and it would be more prudent to wait until they are better understood before engaging in them on a large scale.
4. I can do whatever I choose with property that belongs to me.

Cons

1. Most land can be rehabilitated more rapidly if certain management practices are followed.
2. Rehabilitated land is capable of contributing to the economy in various ways and is a source of various renewable resources such as timber, game, and so on, and it makes neither social nor economic sense to abandon a valuable resource by leaving it in an ecologically unsuitable condition.
3. Although rehabilitation practices are not as well understood as they should be, there are a number of proven techniques which are of demonstrable benefit in the rehabilitation process. Following them improves both the rate of rehabilitation and the quality of the resulting ecosystem.
4. The ecological impact of surface mining is not confined to the area mined. Unstable soils increase the suspended solids in

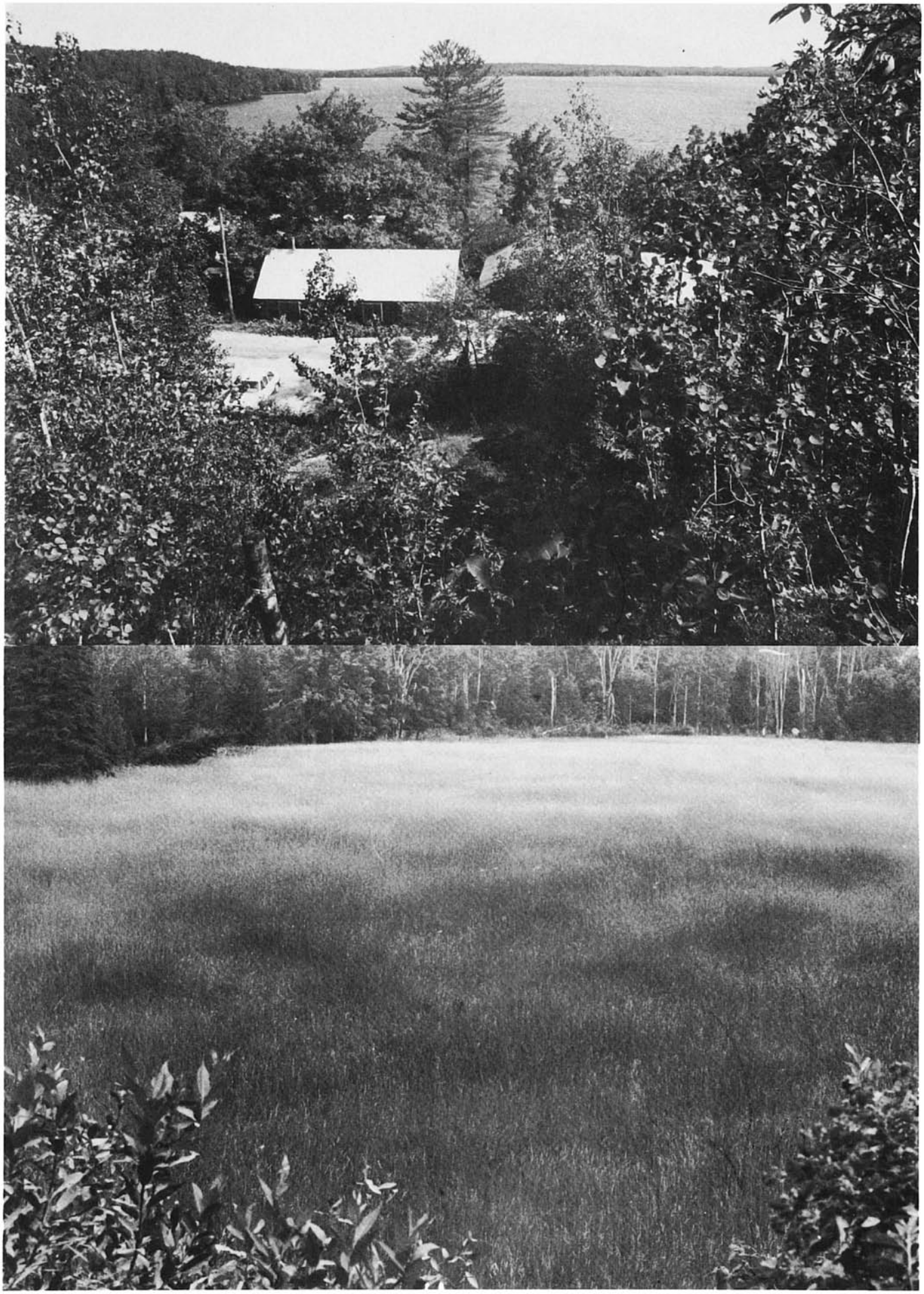

Fig. 6 A more complex combination of grasses and woody vegetation. This might be a natural successional stage following the one in Figure 5 or could be deliberately established. (Photograph by Gary Williams and Jerry Nyckel, Glen Ellyn, Illinois).

streams, decreased moisture retention affects the flow regime of streams so that both quality and quantity functions are impaired and finally damaged ecosystems are unsightly and decrease adjacent land values just as a decaying house decreases the value of other property in the neighborhood.

5. Until the major large scale efforts at rehabilitation are undertaken it is unlikely that the management practices in this area will undergo any major improvement.

6. Since land of all types is becoming scarce it makes no sense to take an ecosystem that could be producing a timber crop or an agricultural crop out of production. Alternatively the reclaimed site could serve some other socially useful function such as recreation.

Pros and Cons of Option 2: Restoring to Original Condition

Pros

1. Restoring to original condition would mean that society has not suffered any long term loss of amenities or of natural resources such as timber or scarce resources such as agricultural land. The ownership of land is not accompanied by the right to damage it in such a way that it imperils neighboring ecosystems and decreases property values in the area.

2. Good stewards will turn over ecosystems to succeeding generations in a comparable or better condition than they were in when received.

3. Large destruction of ecosystems simultaneously destroys rare and endangered species which we have both a moral and legal commitment to protect.

Cons

1. There is no evidence that even with unlimited funds we have sufficient ecological knowledge to restore many kinds of ecosystems to their original condition.

2. Recovery to original condition even when possible may take such long periods of time that it would be impossible to turn over the system fully restored to succeeding generations.

3. An alternative type of ecosystem may be preferable to society than the one now there. For example, there are 100,000 acres of prairie grassland ecosystems on previously surface mined land in the state of West Virginia which was notably deficient in grassland ecosystems before this rehabilitation effort was made. The increased ecological diversity providing somewhat different recreational opportunities to the citizens of the area may be viewed by many as advantageous.

4. Restoration to original condition does not always make good sense ecologically. For example, in areas with precipitous slopes restoration to original slope following surface mining will almost certainly result in less soil stability than would result if the reclamation efforts produced more gradual slopes. Runoff of suspended solids would be greatly reduced on the latter and therefore the streams in the drainage basin would be less affected. Additionally, revegetation will occur more rapidly if the slopes are gentler and therefore more stable.

5. The cost of restoring to original condition is not easily determined and could well require management practices ex-

◀ Fig. 4 A 1979 view from the same location as Figure 3 showing further improvements in vegetative cover. (Photograph by Gary Williams and Jerry Nyckel, Glen Ellyn, Illinois).

◀ Fig. 5 A simple grassland consisting almost entirely of a single species. One of the rehabilitation options. (Photograph by Gary Williams and Jerry Nyckel, Glen Ellyn, Illinois).

tending over a large number of years (in some cases this might extend for generations).

Option 1 clearly seems to be morally, and perhaps economically, indefensible. It is more characteristic of a 'frontier' society than a 'spaceship earth' society. We no longer have land to 'waste' and it is clear that we can benefit socially and economically from reclamation efforts. Option 2 has two major drawbacks. One is the lack of information about the recovery process itself which makes it unlikely that we can carry it out as effectively as we wish if the desired goal is restoration to original condition. In short, we know how to rehabilitate damaged ecosystems to a more socially acceptable and economically viable condition because the number of options is far less diverse than the number of different 'original ecosystems'. A second drawback is that the present society will not enjoy the full benefits of major economic expenditures and despite all the moral justification for such restoration it will be difficult to get political and economic support for activities which involve long range benefits to future generations.

Pros and Cons of Option 3: An Ecologically Improved and More Socially Acceptable Condition

Pros

1. Present management methods are suitable for this goal.
2. The economic costs are more predictable and generally sufficiently low to ensure the feasibility of partial restoration in today's economy.
3. Partial restoration produces immediate or at least short-term benefits that are apparent to those who have paid for the reclamation effort.
4. Surface mined land is more likely to be assured of reclamation if the goals are viewed as more reasonable both technologically and economically.
5. The option of developing alternative ecosystems to the one impaired or destroyed is attractive and even exciting to many members of the population.
6. The citizenry of the area is involved in decision making to a much greater degree than would be the case in options 1 and 2.

Cons

1. Compromise to a partial degree of rehabilitation will encourage more widespread destruction than the requirement of restoring to original condition.
2. It will be difficult to get societal or even professional ecological concensus on the appropriate degree of reclamation on a site-specific basis.
3. There is presently no legislation permitting a compromise of this sort.
4. Determining public opinion on such complex issues is difficult.
5. There are some lands for which prospects for even partial restoration are uncertain. Among these are areas of low rain fall or those with severe climatic conditions such as the Arctic Tundra.

It seems virtually certain that partial restoration to an ecologically improved and more socially acceptable condition is the option that will be most regularly exercised in many countries. Although this may be offensive to many ecologists and environmental activists (and perhaps equally vigorously opposed by developers who feel it is an infringement upon their right to make a profit on their property), it is highly probable that it will be acceptable to the majority of the citizens. There are a number of problems associated with exercising this option. One of the most important is determining the social acceptability of different types of reclamation goals. Reclaimed surface mined land can be used for the following purposes:

1. Recreational (e.g., recreational lakes and ponds, campgrounds, hunting, and even tennis courts, and the like).
2. Agricultural, including grazing, production of various crops, etc.
3. As a building site including housing, community colleges, shopping centers, etc.
4. Land fills for garbage, fly-ash, etc. (this merely postpones the ultimate problem of reclamation and does not resolve it).
5. Production of timber.

DEVELOPING A REGIONAL PLAN

It is clearly impossible for the general public to make sound decisions on a case-by-case basis for a large area. However, one can predict with reasonable accuracy the total amount of land in a state or county that is likely to undergo surface mining. One can also determine with reasonable probability when and where this is likely to occur. Estimates of needs in the various categories listed above as options and where they are likely to occur can be made and one can then determine how compatible the two sets of predictions are. It is quite likely that when these two types of projections are examined in concert, the decision making process will be considerably less difficult than it would appear to be when taken a fragment at a time. This approach also has the advantage of diverting certain types of development activities that are ecologically damaging from areas that are in reasonably good condition to areas that are already disturbed by surface mining. It may well be that in many instances the clearing and grading associated with surface mining will substantially reduce the costs of developmental activities resulting in both ecological and economic benefits. Unfortunately, regional planning is strongly resisted in many parts of the United

Fig. 7 A stand of pines in rows all of the same species and age. (Photograph by Gary Williams and Jerry Nyckel, Glen Ellyn, Illinois).

Fig. 8 A group of mixed species of different ages. (Photograph by Gary Williams and Jerry Nyckel, Glen Ellyn, Illinois).

States and elsewhere in the world. This resistance is not without justification since examples of mismanagement in regional planning are all too common. However, the fact that regional planners sometimes fail, as do other professions, is no reason for abandoning the overall strategy but rather should direct attention toward improving it. Without a comprehensive, well conceived regional plan, it is highly unlikely that the reclamation efforts will be compatible with the societal needs and, therefore, will lack the political and economic support they require.

COMMUNICATING THE AESTHETIC COMPONENT OF RECLAMATION EFFORTS TO THE GENERAL PUBLIC

All reclamation efforts will involve a series of economic and ecological alternatives. The purpose of this section is to create an awareness of the aesthetic problems associated with determining the most socially suitable ecological alternative from an array. Of course, not all options are open for every site. This section is designed to create an awareness of the problem rather than give a definition, explain its extent, or the means to achieve resolution. Each of these ecological conditions: (a) a simple grassland system (Fig. 5); (b) a complex grassland system of grass and shrubs (Fig. 6); (c) a single species of trees of the same age planted in rows (Fig. 7); (d) a complex forest of mixed species of different ages (Fig. 8); requires a different reclamation strategy and associated set of management practices. Communicating these options to the general public may be initially difficult. However, with visual aids and perhaps even visits to appropriate sites for select members of the decision making group, the capability for such judgments can be inculcated in the population as a whole verification of the validity that the choice can be made by frequency of use and other standard measurements.

Even the limited set of options just discussed and illustrated show how vastly different such choices can be. Communicating the full array of options, together with associated costs, to decision makers and the general public is probably the most challenging activity requiring immediate attention. With strong public interest in such activities, it is customary for technologies to develop vigorously.

ESTIMATING COST OF REHABILITATION

The cost of rehabilitation will vary substantially from site to site and will depend on the local climate, the degree of disturbance, and a variety of other factors, including the type of rehabilitation undertaken. It is abundantly clear, however, that the cost of rehabilitation, whatever the climatic conditions or degree of disturbance at the site, will be substantially reduced if rehabilitation plans are made well before the surface mining begins. Such things as careful handling of the top soil with its associated microorganisms, seeds, etc. enormously improves the prospects for a rapid recovery once the rehabilitation activities begin. It will also be beneficial to employ skilled professionals for the rehabilitation task rather than assign this to someone whose primary responsibilities lie elsewhere.

CONCLUDING STATEMENT

One can in a few pages only create an awareness of the opportunities and ecological problems involved in reclaiming surfaced mined areas. This is a field that has not received much attention from either ecologists or those engaged in surface mining until relatively recently. Although more information would be useful, it is clear that effective and economical rehabilitation is possible with presently available techniques if one's goal is an ecologically viable condition rather than restoration to the original state. In order to facilitate the reclamation process, ecologists will have to compromise by accepting reclamation to an ecologically improved condition which only rarely will replicate the original condition. Those engaged in surface mining will have to compromise by accepting sound reclamation and ecological management practices as a necessary component of surface mining. The adversary relationship which exists all too often must be replaced by a working relationship that will ensure that reclaimed surfaced mined land is returned to an ecologically viable condition wherever possible.