COAL SURFACE MINING RECLAMATION AND FISH AND WILDLIFE RELATIONSHIPS IN THE EASTERN UNITED STATES

VOLUME I

Fish and Wildlife Service
U.S. Department of the Interior
The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems.

Projects have been initiated in the following areas: coal extraction and conversion; power plants; mineral development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; environmental contaminants; National Wetland Inventory; habitat classification and evaluation; inventory and data management systems; and information management.

The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for development of information and technology by contracting with States, universities, consulting firms, and others; Regional Teams, which provide local expertise and are an important link between the National Teams and the problems at the operating level; and staff at certain Fish and Wildlife Service research facilities, who conduct inhouse research studies.
July 6, 1981

Dear Colleague:

The Eastern Energy and Land Use Team (EELUT) is pleased to provide you with a two volume set of a general reference manual: "Coal Surface Mining and Fish and Wildlife Relationships in the Eastern United States" Volume 1 "Past Findings, the Surface Mining Law of 1977 (P. L. 95-87), Future Planning and Management Considerations, and Information Sources" FWS/OBS 80/24, and Volume 2 "Opportunities and Approaches for Fish and Wildlife Planning and Management in Coal Surface Mining, Reclamation, and Post-Mining Land Use" FWS/OBS-80/25. This product has been over two years in preparation by the author, Dr. Dan Leedy, Urban Wildlife Research Center, Columbia, Maryland.

Volume 1 contains abundant information on the past effects of coal surface mining on fish and wildlife populations. Sources of information for planning and assistance for reclamation activities are provided. Volume 2 provides the reader with special fish and wildlife management insights. In addition, Bob Hines, FWS Artist, depicts representative case examples for developing good fish and wildlife habitat for area, contour and mountaintop removal mining practices.

We are interested in your evaluation of this document and suggestions for future EELUT products.

Sincerely,

[Signature]

Edgar A. Pash
Team Leader, EELUT
COAL SURFACE MINING RECLAMATION AND FISH AND WILDLIFE RELATIONSHIPS IN THE EASTERN UNITED STATES

Volume I

PAST FINDINGS, THE SURFACE MINING LAW OF 1977 (P.L. 95-87), PLANNING AND MANAGEMENT CONSIDERATIONS, AND INFORMATION SOURCES

By

Daniel L. Leedy, Research Director
Urban Wildlife Research Center, Inc.
10921 Trotting Ridge Way
Columbia, Maryland 21044

William T. Mason, Jr., and
Charles T. Cushwa, Project Officers
Eastern Energy and Land Use Team
U.S. Fish and Wildlife Service
Rt. 3, Box 44
Kearneysville, WV 25430
Contract No. 14-16-0009-78-060

Library
U.S. Fish & Wildlife Service
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PREFACE

The Eastern Energy and Land Use Team, Office of Biological Services of the U.S. Fish and Wildlife Service's Habitat Preservation Program, initiated the development of a primary reference manual on fish and wildlife and surface mining reclamation in the eastern United States in late 1977. This two-volume manual, produced by the Urban Wildlife Research Center, is intended as a general reference manual for biologists, lawyers, administrators, planners and others relating to the subject.

Volume I emphasizes historical aspects of the relationships between coal surface mining and fish and wildlife in the East. The volume gives a brief overview of Public Law 95-87, "The Surface Mining Control and Reclamation Act of 1977", and refers to sources of information and assistance applicable to development of effective fish and wildlife programs.

This Volume contains 181 references plus other information sources identified in the text, an index, and 11 appendices. Part I provides general information on the extent and nature of surface mining in the East, amount of reclamation that has been accomplished, postmining land use alternatives, and environmental effects of surface mining in the past. The report covers much of the information available on fish and wildlife responses to habitat alterations caused by mining and reclamation. Information is presented concerning the capabilities to support fish and wildlife of mine spoils and land forms resulting from mining.

Part 2, Volume I, introduces the reader to P.L. 95-87 and its related Rules and Regulations. It outlines some of the major purposes of the Act referring to fish and wildlife and summarizes roles of agencies responsible for administering and implementing the Act. The relevance of some other Federal environmental laws, and assistance that can be rendered by other agencies in carrying out fish and wildlife conservation programs on surface-mined lands are discussed.

Part 3 details sources of information and assistance for developing data needed for preparing applications for mining permit-reclamation plans and for managing fish and wildlife on surface-mined areas.

Volume II, "Opportunities and Approaches for Fish and Wildlife Planning and Management in Coal Surface Mining, Reclamation and Postmining Land Use", is a primer on, and provides case examples of, reclamation for fish and wildlife. Recommendations are described on ways to enhance and benefit fish and wildlife populations before, during, and after mining. Volume II suggests approaches for fish and wildlife reclamation in the major coal bearing regions of the eastern United States.

The reader should be aware that certain parts of this manual contain information on the "Surface Mining Control and Reclamation Act of 1977" and its Regulations that may be subject to significant revision. A Court Order in August 1980 remanded certain Sections of the Regulations for review by the U.S. Department of the Interior. A ruling concerning the outcome of the review process is expected in late 1981. An Addendum to this manual will be distributed when final revisions to the Regulations are received.
EXECUTIVE SUMMARY*

This two-volume work summarizes, evaluates, and interprets much of the information developed during the past 40 years on coal surface mining reclamation and fish and wildlife relationships in the eastern United States. It provides an overview of the "Surface Mining Control and Reclamation Act of 1977" (P.L. 95-87) with particular reference to its implications for fish and wildlife planning and management in the future. It identifies sources of technical and financial assistance and suggests opportunities and approaches that can be helpful in fish and wildlife conservation and management in surface mining and reclamation. Where feasible, a distinction is preserved among: (1) areas to be mined; (2) areas being mined, or very recently mined; and (3) areas which have been mined, sometimes years ago. Throughout the publication a clear theme identifies the need for cooperation among technical specialists working in interacting, though distinct, fields, such as biology, engineering, law, and planning.

Volume I

Past Findings, the Surface Mining Law of 1977 (P.L. 95-87), Planning and Management Considerations, and Information Sources.

This volume, containing references, is composed of three major parts, a references cited section of over 180 entries, a subject matter index, and 11 appendices, in addition to the front end material. It is intended as an information source book for use, primarily, of fish and wildlife administrators, biologists, and consultants concerned with planning and management for fish and wildlife on surface mined areas. However, other concerned individuals such as planners, landowners, coal mine operators, government officials, lawyers, and members of professional societies and private conservation groups will be able to use this volume whether or not they have had biological training. For the busy reader, there is a summary at the beginning of each part of the report.

Part 1 provides background information on the extent and nature of surface coal mining areas in the East, briefly discusses land uses alternatives for surface-mined areas, describes environmental effects of mining, and presents a comprehensive review of known fish and wildlife responses to habitat alterations caused by mining and reclamation activities in the past. Appraisals are included of the rather limited management efforts made specifically for fish and wildlife enhancement to date.

It is recognized that surface coal mining is essential to meet national coal needs. As of January, 1965, land in the United States disturbed by surface mining for coal totaled over 1.3 million acres, about half of which had been contour-mined and half mined by area stripping. As practiced prior to enactment of State and Federal protective laws, contour mining, especially, resulted in slides and severe erosion on the steep outslopes which affected streams and other fish and wildlife habitat components. Highwalls as tall as 100 feet were left in some areas. Recently, with modern equipment, "mountaintop removal" and "head-of-hollow fills" have become acceptable means of coal extraction and waste disposal in parts of Appalachia. Where area stripping was practiced, as in parts of Illinois, drainage was mostly internal and the land form left was composed of spoil ridges and valleys, the latter often containing impoundments.

Though less than one percent of the total eastern land areas has been subjected to surface mining, environmental impacts have been apparent locally in terms of: visual effects; the torn-up and denuded landscape accompanying mining; air pollution, including dust, noise and air blast; removal of vegetation; change in land surface and drainage patterns; soil erosion and sedimentation; and water pollution. Much of the land was not reclaimed except through natural processes. As of July 1, 1977, the U.S. Soil Conservation Service estimated that about 1.7 million acres of land disturbed by coal mining in the United States needed reclamation. Of this acreage, approximately 82 percent was located in the 10 States of major concern in this report — Alabama, Illinois, Indiana, Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.

An analysis of factors which may limit the land use of surface-mined areas (Table 3) suggests that there are fewer limitations for fish and wildlife habitat than for woodland-forestry, agriculture, pasture, recreation, residential, or industrial uses. This means that costs of reclamation for fish and wildlife may be considerably less than for other uses. Also, land reclaimed for other purposes may provide fish and wildlife habitat concurrently.

*See Preface note
Environmental effects of surface mining on fish and wildlife habitat are described and responses of fish and wildlife to changed habitat conditions are documented by regions on the basis of numerous published reports. From the information provided, fish and wildlife biologists can gain predictive insight as to what is likely to happen with fish and wildlife populations when an area is mined and reclaimed in certain ways. Though removing vegetation, overburden, and coal from a site eliminates wildlife temporarily and blasting may interfere with the nesting of nearby ground-nesting birds during mining, wildlife repopulates the area as it is revegetated through natural plant invasion and succession or through plantings made by man. Acid mine drainage and fine particle sediments stemming from mined areas may eliminate or result in changes in the populations of aquatic organisms of affected streams and other water bodies for years after mining.

On the other hand, surface mining often has resulted in changes in land forms such as the creation of cliff-like habitat in the form of highwalls, or impoundments, which add habitat diversity. The ridges and valleys left by area strip mining in flat Illinois prairie lands, when covered with woody vegetation, and the creation of new grassland habitat in forested areas of Appalachia by reclamation after mountaintop removal are other examples of increased habitat diversity favorable to certain kinds of wildlife.

Without management, many old, abandoned mined areas have become productive of fish and wildlife as the disturbed surfaces became revegetated and the impoundments less acidic. Enough fish and wildlife work has been done on surface mined areas, however, to show that there can be increased production through management. Thus, through cover management and installation of food plots, populations of bobwhite on mined areas in southern Illinois were increased to levels two and one-half times those on surrounding agricultural areas. On a West Virginia mined site the planting of autumn olive provided food for ruffed grouse and controlled burning increased the availability of insects for bobwhite chicks. Liming and fertilizing have increased fish production in strip mine ponds as has stocking of ponds with fish on a scientific basis.

Part 2 of Volume I deals with P.L. 95-87 as related to fish and wildlife planning and management. Major features of the law are described including provisions for funding and the environmental standards required for surface mining and reclamation. Enactment of this law is viewed as the beginning of a new era of surface mining and control in which there are new opportunities and challenges for fish and wildlife planning and management. Essentially all of the standards for environmental protection set forth are relevant to fish and wildlife. The report emphasizes that the extent to which fish and wildlife resources are protected and enhanced through implementation of the law will depend, in large part, upon the participation of fish and wildlife biologists and the interested public in the preparation of mining permits and state reclamation plans.

Reference is made to the best technology currently available required for minimizing disturbances and adverse impacts of mining and reclamation activities on fish and wildlife. Possible ways of minimizing such disturbances and of enhancing fish and wildlife are mentioned. These include designation of certain tracts, e.g., unique or fragile biological communities providing critical habitat for threatened or endangered species, as unsuitable for mining, and creating or retaining for fish and wildlife purposes, impoundments in the reclamation of mined areas. Precautions to preserve water quality and protect surrounding lands are emphasized.

The roles and responsibilities of the Office of Surface Mining Reclamation and Enforcement in the U.S. Department of the Interior, the Soil Conservation Service in the U.S. Department of Agriculture, the states, the coal mine operators and landowners, and the public in administering and implementing the program authorized by P.L. 95-87 are outlined. In addition, technical and financial assistance available from other federal and state agencies, universities, private industry, scientific societies and conservation organizations is discussed. In this discussion many pertinent references are provided and the names and addresses of key contacts are listed in appendices to the report. Likewise, many other federal environmental laws and Executive Orders relevant to surface mining and fish and wildlife conservation are identified.

Part 3 of Volume I focuses on approaches to, and sources of information for, planning and management of fish and wildlife on surface mined areas. The information presented, including many references to publications providing details on various methodologies, should be valuable both for preparing mining permit-reclamation plans and for managing fish and wildlife resources. Topics treated include: (1) desirability of participation by biologists in collecting data and formulating reclamation plans; (2) early formation of a continuing relationship of biologists with other professionals; (3) concern of landowners and coal operators with postmining land uses; and (4) viability of reclamation for fish and wildlife as an alternative use of the land.

For non-biologists, fish and wildlife requirements — food, water, cover, and a place to live — and wildlife management approaches — habitat management, regulations protecting resources and governing harvests, predator control, stocking, and so forth — are described in relation to surface mined areas.

The main emphasis in Part 3, however, is on needs and sources of information for planning and management. Addressed specifically in this connection are: (1) fish and wildlife inventories; (2) analyses and handling of soil, overburden, and spoil; (3) soil erosion control; (4) pollution control; (5) water data and water management; (6)
land use data; (7) vegetation and its management; (8) preferences of people and socioeconomic impacts of mining and reclamation; and (9) fish and wildlife management. A sketch is provided at the end of Part 3 illustrating management measures that can be applied on surface mined areas for fish and wildlife enhancement.

Volume II

Opportunities and Approaches for Fish and Wildlife Planning and Management in Coal Surface Mining Reclamation and Postmining Land Use.

This volume is intended, primarily, for the use of technicians, consultants, planners, landowners, and coal mine operators in preparing mining permit-reclamation plans and in managing fish and wildlife on surface mined lands. Though numerous publications are mentioned within the text, no separate references cited section is included in this volume. Readers desiring more detailed information on some of the topics mentioned, e.g., acid mine pollution and handling of spoil materials, may wish to refer to Volume I or to references cited in that document.

Volume II contains five parts and five appendices. The first appendix is a work sheet used in determining priority and main benefits of projects conducted under the Rural Abandoned Mines Program (RAMP) administered by the Soil Conservation Service. The other four appendices include lists and characteristics of plants recommended for habitat development on surfaced mined lands, sources of planting stock and seed of the recommended plants, suppliers of planting stock and seed, and lists of contacts for state assistance in obtaining fish for stocking of impoundments. The volume identifies opportunities for fish and wildlife planning and management in connection with different methods of surface mining and reclamation. It is illustrated to show technicians, landowners, and others what wildlife areas look like at different stages of development.

The introduction to Volume II points out that environmental impacts of surface mining in the past have led to the enactment of many state and federal laws to govern mining and require reclamation of surface mined lands. Many old, abandoned mine sites have become productive of fish and wildlife without deliberate management for fish and wildlife; however, in the relatively few areas managed scientifically for fish and wildlife, results have been encouraging. Management has included wildlife food and cover plantings and—in the case of ponds in surface mined areas—maintaining suitable pH levels, fertilizing, stocking, and regulating numbers and species of fish in the pond fish populations. With the ever increasing intensity and scale of agricultural operations and various types of development, lands surface-mined for coal are becoming increasingly important as habitat, or potential habitat, for fish and wildlife. As indicated previously, some of these areas already produce fish and wildlife; others can be made more productive. Some areas can be reclaimed for the primary purpose of providing fish and wildlife in such a way as to meet the requirements of P.L. 95-87 at less cost than reclamation for other purposes. Other areas reclaimed for agriculture, forestry, or other purposes can be managed, both to achieve the primary postmining land use, and to enhance fish and wildlife. Such enhancement can be accomplished by including provisions in the mining permit-reclamation plans and management programs to satisfy the requirements of fish and wildlife, i.e., food, cover, water, and living space.

Part I briefly reviews fish and wildlife-surface mining relationships and points out that although many wildlife species, like agricultural crops, tend to fare better on fertile soils than on infertile soils, wildlife habitat can include large boulders and steep, rocky slopes not suitable for row crop agriculture or for many other uses. Few forms of wildlife are to be found on barren areas recently surface-mined and unreclaimed, but when the areas are revegetated or have vegetation close by, some wildlife almost certainly will use the areas regardless of the postmining use. The kinds of animals—particularly mammals, birds, fish, amphibians, and reptiles—commonly found on abandoned or reclaimed surface mine sites are identified. The importance of “edges” to wildlife is explained and the desirability of including areas adjacent to the mined site in planning and management is emphasized because the living requirements of many species that invade surface mined sites from adjacent areas, but fish usually are introduced into isolated ponds by man where they can survive only if conditions are favorable.

This publication focuses on the eastern United States, rather than nation-wide, but there are regional differences within the area as reflected in the pH of strip mine ponds, in topography, in soils, in vegetation and so forth. These differences must be considered in planning and management. Biologists and planners must be alert, also, to the stricter regulation of surface mining and reclamation imposed by P.L. 95-87 and to the possibility of variances from some of the requirements to benefit fish and wildlife, if fish and wildlife habitat is a preferred postmining land use.
Part 2 deals with special considerations for fish and wildlife in applying for surface mining permits and in reclamation planning under P.L. 95-87. Important additional references are given in this connection. Much of this part of the publication is devoted to checklists useful to biologists, technicians, and planners concerned with fish and wildlife planning and management as related to surface mining, reclamation, and postmining use of lands surface-mined for coal. The steps suggested, based in part on requirements of the Act, apply to different situations including: (1) all lands in which fish and wildlife values are considered in planning; (2) areas to be mined; (3) those areas being mined, or mined only recently; and (4) areas mined long ago and abandoned.

These steps are intended to assure that attention is given to provisions of P.L. 95-87 for environmental protection and to promote fish and wildlife enhancement, whether fish and wildlife habitat is the major postmining use or a secondary use. A checklist is provided for each of the situations or categories mentioned above and, where pertinent, attention is called in the later checklists to suggestions made previously.

The suggestions deal with such items as collecting, organizing, and analyzing the data needed for planning; mapping; determining the presence of endangered or threatened species and unique biological communities on areas prior to mining; taking steps to preserve such species or communities; preserving undisturbed, as much as possible, the original vegetation on an area; choosing land use alternatives and harmonizing fish and wildlife values with the postmining land use selected; routing and construction of roads; creating of impoundments; planning for revegetation to benefit wildlife; handling of topsoil and spoil; identifying sources of pollution; and considering ways of diversifying the habitat, e.g., planting shrubs in old fields or areas with primarily herbaceous cover, and developing travel lanes and woods or field borders.

Part 3 focuses on the management of particular habitat components for fish and wildlife in relation to surface mining and reclamation. It suggests ways of benefiting fish and wildlife in conjunction with the erosion and pollution control, soil and water management, and revegetation of mined areas required by P.L. 95-87.

Management of mine soil and spoil is reviewed briefly and the reader is referred to Volume I for more details. It is pointed out that some variation from the original landform can be beneficial for fish and wildlife and that a good case can be made for creation of permanent impoundments or perhaps exceptions to other requirements of the Act. There is a possibility of saving time and money if impoundments having the desired proportions can be created when excavating the coal and regrading the spoil surface. Quick revegetation limits soil erosion, sedimentation, and often acid mine water pollution.

In connection with water management, every effort should be made to protect existing waters from acid mine drainage and sedimentation. Use of buffer strips of vegetation is described and the value of overhanging vegetation in shading the water and providing insect habitat is discussed. Permanent impoundments provide both habitat for fish and constant water for terrestrial wildlife, and may produce recreational fishing or marketable fish. Information is provided on characteristics of ponds for fish and for other wildlife and a reference dealing with pond construction is cited. The condition of streams and ponds on or near surface-mined sites should be determined so productive ones can be maintained, while nonproductive ones can be improved. New impoundments should be designed according to their proposed use. Water level control devices, especially on larger impoundments, permit accommodating needs of both fish and wildlife. Deliberate formation of islands in new surface mine lakes increase edge and otherwise improves wildlife habitat. Existing ponds may be improved and suggestions are given on how to do this. For fish production in streams it is important that erosion, sedimentation, and acid mine drainage be controlled. Stream channelization is prohibited by P.L. 95-87. Suggestions are made for rehabilitating streams channelized in previous mining. Advice on stream habitat improvement is available from the U.S. Forest Service, (USFS), Fish and Wildlife Service, SCS or state biologists.

Vegetation management is the primary means of managing wildlife. Revegetating a mined area requires considering soil, water, and other environmental factors, as well as the proposed postmining land use of the area. The primary focus in this section is on management of vegetation in a manner that benefits wildlife in addition to its erosion and pollution control, timber and crop production, and aesthetic values. The value of vegetation for wildlife can be increased by edges and diversity of plant species and vegetative growth forms. In general, large plots of uniform plant growth do not favor wildlife. This is why openings in large forested areas are desirable. Diversity of cover can be attained by plantings and by other means which are described. Appendix B of Volume II lists plants valuable to wildlife and recommended for wildlife habitat development on surface-mined land. Suppliers of planting stock and seed are listed in Appendix C.

The process of plant succession is described and methods of establishing and maintaining successional stages desired for certain types of wildlife are presented. Cutting, controlled burning and grazing, disking, selective use of herbicides, and water level manipulation are tools that can be used in vegetation control. Control of water levels is apt to be more successful than planting in establishing aquatic plants.

One part of this section deals with vegetation management for selected areas or purposes. Treated are: (1) streamside vegetation in relation both to fish and wildlife and erosion control; (2) roadside plantings; (3) wildlife
travel lanes; and (4) field and woods borders. Suggestions on ways of establishing and managing vegetation in these categories are provided and plant species are recommended.

Part 4 deals primarily with fish and wildlife management measures not directly related to soil, water, and living vegetation. It is pointed out that except in the case of coldwater ponds where the owner wishes to provide fishing through frequent stocking and rearing of trout to catchable size, in which feeding of commercially available pellets is necessary, most artificial feeding for wildlife on surface-mined areas is unjustified. Feeding can, however, attract wildlife to areas used for recreation and wildlife viewing. Similarly, predator control probably cannot be justified except under special situations, such as benefitting preferred species. The best predator control is establishing and maintaining effective nesting and escape cover. Because of their difficult terrain, strip-mined areas may serve as wildlife refuges whether or not they are so designated, but their management as refuges may preserve valuable habitat.

More applicable to surface-mined areas are regulations governing the taking of fish and wildlife; the installation of nesting, resting, and cover devices which are described in some detail; stocking, particularly of fish, in a scientific manner; fencing of ponds to prevent damage by livestock; liming and fertilizing ponds to improve water quality; fish population control; and providing cover and spawning beds for fish. Another integral part of planning and management which is discussed, is the evaluation of management measures to determine their effectiveness and to provide a basis for any updating or revisions necessary in the management plans.

Part 5 provides illustrated examples of fish and wildlife management measures suggested earlier in the text which can be applied on different types of surface mined areas in the eastern United States. Each example is illustrated by three sketches depicting the area before mining, during mining, and following mining and reclamation. The first example, based in part upon an aerial photograph taken by the senior author southeast of St. Louis, shows how an area in flat, fertile terrain which has been strip mined can be improved for fish and wildlife and recreational use. The second example depicts a situation which might be found in east Tennessee or elsewhere in Appalachia in which a forested area has been mined by the contour method. The third example illustrates the type of habitat alteration and fish and wildlife management practices that might be applied to an area involving mountaintop removal and head-of-hollow fill. Legends accompanying each example explain the management measures taken to enhance fish and wildlife. Readers are advised to refer to the explanations previously provided regarding travel lines, field border plantings and so forth.
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Land disturbed by surface mining is planted to trees and grass after coal is removed from this section of the Fidelity Mine of The United Electric Coal Companies near Du Quoin, Ill. Soon it will bear a profitable growth of timber like land in background which was reclaimed several years earlier. Waterfilled mine pit provides recreation area.

(Photograph, National Coal Association)
PART 1
Background Information on Past Surface Mining and Fish and Wildlife Relationships and Management Efforts

Summary of Part 1

This section reviews the literature on surface mining for coal and reclamation of surface-mined lands as related to fish and wildlife resources in the eastern United States. This review excludes much of the literature on reforestation problems and techniques to be treated in Volume II of this report. It provides background information on the extent of surface mining for coal and reclamation of mined sites and responses of fish and wildlife to alterations in the habitat prior to implementation of “The Surface Mining Control and Reclamation Act of 1977” (P.L. 95-87).

Readers desiring more detail should refer to the text and to the references cited. Probably the best single source of information is “Proceedings of a Symposium — Surface Mining and Fish/Wildlife Needs in the Eastern United States” (Samuel et al. 1978). Some findings and conclusions of past research and experience are summarized below:

Need for and Extent of Surface Mining for Coal

1. Surface mining for coal is vital to the nation’s energy needs.
2. Less than one percent of the total eastern land area is affected.
3. Environmental impacts of coal surface mining have required enacting federal and state laws to protect the environment and restore the land to productive use.
4. The 1965 estimate of lands in the United States disturbed by surface coal mining was over 1.3 million acres and in 1977 the estimate of disturbed lands had risen to nearly 1.7 million acres, an increase of 30% in 12 years. One third of the total coal-mined lands in 1965 was probably reclaimed by natural forces or by man’s efforts.

Pre-1977 Fish and Wildlife Resources and Management Approaches

1. Wildlife was, and to some extent is, present on essentially all previously surface-mined land; wildlife exists on land to be mined; and wildlife is a valuable, bona fide component of the natural environment.
2. Managing surface-mined areas to satisfy the requirements of fish and wildlife — food, water, cover, and a place to live — has been relatively limited.
3. Some vegetation plantings provide food and cover for wildlife.
4. The acidity of some surface mine ponds is sufficiently neutralized by natural buffering capacity to support good fish populations, but many ponds remain acidic and pose a threat of off-site toxic discharges to streams, lakes, and groundwater.
5. Some impoundments have been stocked with fish although desired species composition and ratios between forage fish and game fish have been difficult to maintain.

Effects of Surface Mining on Fish and Wildlife Habitat

1. Removal of vegetation, overburden, and coal from a site eliminates wildlife temporarily but, as the site becomes revegetated through natural means or reclamation, wildlife again can inhabit the site.
2. In past contour mining, when the overburden was stacked on the outer edge of the contour bench or pushed downslope, it was subject to accelerated erosion and massive landslides which sometimes covered trees and blocked stream channels.
3. Sediment yields from coal surface-mined areas can be as much as 1,000 times those of undisturbed forest. Silt reduces light transmittance and photosynthesis, raises the water temperature, and adsorbs organic materials. The larger sediment particles can cover spawning areas and smother aquatic life.
4. Spoil banks may contain pyritic or sulfuric materials, resulting in acid mine drainage (AMD).
5. A study in the early 1960s revealed that over 5,000 miles of streams in the East had been deleteriously affected by acid mine water pollution, much of the acid coming from deep mines. Subsequently, in some of the streams, water quality has improved in part because of better pollution control.
6. AMD affects streams by reducing pH, increasing the load of dissolved solids, decreasing alkalinity, and introducing floc and toxic substances such as heavy metals.
7. Surface mining, resulting in parallel spoil ridges, often creates impoundments in the valleys and last cuts with varying quality of water; and where contour mining is done, impoundments often are created in the cut next to the highwall. Impoundments also may be created by coal haulage roads which block the natural drainage channels of small streams, or in shallow depressions in the spoil.

8. Impoundments add to surface water. Overflow of water from acidic ponds contributes to stream pollution. Over time, strip mine ponds tend to become less acidic and more suited to fish production.

9. In relatively flat agricultural areas, such as parts of Illinois, the ridge and valley topography and subsequent impoundments created by area mining add to the diversity of habitat for fish and wildlife. Woody plants sometimes become established on upgraded area mines after several years.

10. In hilly forested areas largely devoid of grassland cover, such as parts of northern West Virginia, new grassland habitat is created when previously wooded areas are mined and reclaimed as pasture, adding to habitat diversity for wildlife.

11. In mountainous regions of Appalachia where surface mining involves removing whole mountaintops, what were formerly wooded mountaintops may become leveled plateaus. If mountaintops are isolated by highwalls, access may be limited; however, with removal of the whole mountaintop the highwall is eliminated.

12. Highwalls provide cliff-like habitat for such species of wildlife as cliff-nesting raptors, but unless properly guarded can pose a threat to human safety.

Responses of Fish and Wildlife to Surface Mining and Reclamation

1. Birds nesting on the ground near active surface mines may be adversely affected by dust and debris blown by blasting. In forested areas, some canopy-dwelling birds apparently are tolerant of this type of disturbance, but there is a decline generally in bird and presumably other wildlife populations.

2. Plants and animals invading an area following mining usually are those found in the vicinity of the disturbed area. A species of fish extirpated from a stretch of polluted stream may be unable to repopulate or invade that section later if prevented from moving upstream by a waterfall or dam. Similarly, deer may be restricted from an area if it is cut off by highwalls.

3. Mammals commonly invading surface mined sites include: deer mice, especially during early stages of plant succession; white-footed mice, particularly in later stages with woody cover; cottontail rabbits; field mice or voles; shrews; moles in areas with moist soil; woodchucks; opossums; raccoons; squirrels; foxes; and bats. Except for occasional forays into strip-mined areas, tree squirrels are restricted largely to older areas with trees large enough to contain cavities for dens and to produce mast. Deer frequent many areas. Muskrats, mink and beaver may be found in areas with impoundments or streams.

4. Birds are able to use essentially all components of surface mined habitat from water to spoil bank or reclaimed surface to highwall and isolated mountain-top. Waterfowl, herons, and shorebirds use the water areas; cliff swallows and other cliff-nesting species use the highwalls; and game and passerine birds use other components of the surface-mined habitat. These include the ruffed grouse, bobwhite quail, mourning dove, field sparrow, indigo bunting, cardinal, rufous-sided towhee, American goldfinch, yellow-breasted chat, yellow-billed cuckoo, and various warblers. In the newly created grasslands of northern West Virginia, a relatively few species such as the horned lark, eastern meadowlark, red-winged blackbird, and various sparrows are found in place of the 40 to 50 species of breeding birds that used the woodland prior to mining and reclamation.

5. Studies in Illinois and Ohio have revealed that a majority of the species of amphibians occupying areas adjacent to areas that were mined have been able to invade the newly created environment within a few years. In Illinois these species were found most abundantly in or adjacent to shallow ponds containing aquatic vegetation rather than in deep ponds with steep banks and a scarcity of vegetation.

6. In streams affected by AMD, the total abundance and species diversity of fish and benthic invertebrate populations are reduced even 10 to 20 years after mining as a result of stream pollution and sedimentation.

7. Among the species of fish often stocked in strip mine lakes are green sunfish, bluegills, bullheads, largemouth bass, white crappie, black crappie, redbreast sunfish, and redear sunfish. Various species of trout, channel catfish, and chain pickerel have been stocked in some lakes.

Implications for Planning and Management for Fish and Wildlife

1. Though relatively little attention has been given to the deliberate management of surface-mined areas for fish and wildlife, management opportunities exist.

2. Many old, abandoned mined areas, particularly where the overburden contains calcareous materials or the sulfuriotic materials were buried, have developed, without management, into productive fish and wildlife areas and support more wildlife than surrounding lands.
3. Many vertebrates on surface-mined lands, however, range onto adjacent areas where they satisfy a part of their requirements for food, water, or cover. Hence, in planning for their management it is important that the whole area be considered as to how to make adjacent habitat accessible and useful. Such habitat, undisturbed by mining, constitutes the primary source of recruitment for wildlife on reclaimed areas.

4. Before surface mining regulation, spoil banks were often acidic and unfavorable for plant growth. Therefore, consideration should be given to site preparation and soil amendments before attempting to establish plants for wildlife in such areas.

5. Good success has been achieved in limited management attempts for fish and wildlife on surface mined areas. Management measures, such as controlled revegetation, applied to strip-mined land in southern Illinois increased bobwhite populations to levels two and one-half times those on unmanaged farms in that part of the state.

6. Experimental controlled burning on mined sites in West Virginia showed promise as a means of maintaining the open herbaceous vegetative cover useful to bobwhite and of removing litter that obstructed bobwhite chicks from obtaining insects needed during their first few weeks of life.

7. Autumn olive planted on a bench of a contour mine in West Virginia improved conditions for ruffed grouse, which used the ripe berries as food.

8. Studies in Virginia and Tennessee showed that wildlife-oriented reclamation techniques would facilitate the recovery of bird species diversity on mined sites. With a mixture of planted herbs and shrubs, coupled with natural succession of vegetation, recovery of bird species diversity and composition similar to mature forest conditions was attained on narrow-bench contour mines within a 13-15 year time period. A somewhat longer period was reported for mined sites in Alabama.

9. Within a few years after mining, narrow-bench contour mines provide edge-type cover. When trees reach sufficient maturity that ground cover is reduced through shade, the number of bird species declines, but some species are benefited.

10. Tree seedlings interspersed with herbs and shrubs in areas planted where natural invasion of trees is limited may provide for future development of higher vegetational strata and increased avian species diversity.

11. Because of poorer growing conditions on many spoils areas, plant succession is slower than on undisturbed areas. Once the desired vegetative stage is reached, less effort is needed to maintain that stage.

12. Strip mine ponds with steep banks and highwalls are protected from wind and subsequent aeration. In addition, they may be exposed to extreme changes in water temperature. Consequently, measures for their management may be more costly than normally could be justified for sustaining a sport fishery alone. Water quality improves with stabilization of the spoil banks. Periodic applications of lime and fertilizers have proven to be a means of increasing fish and fish food production in strip mine ponds, at least temporarily.

13. In developing impoundments deliberately, raising the water level sufficiently high to cover any exposed coal seams or other acid-producing materials curtails or eliminates the oxidation of these materials to sulfuric acid and may create a littoral zone of shallow water along some of the shore, thus improving conditions for fish and other aquatic life.

14. Constructing multipurpose ponds and lakes in a strip-mined area in southeastern Illinois resulted in use of the area within three years by three species of ducks and the giant Canada goose.

15. Although chemical analyses of water samples provide useful information for planning, these analyses should be supplemented by analyses of natural biological monitors living in the systems.

16. With present knowledge of species requirements and current methodologies, detailed study of the vegetation structure may have predictive value in determining which species will inhabit a site but may not be able to determine why the species are or are not there.

17. Knowledge gained from studies and observations made in the past, whether concerned with harmful or beneficial effects of surface mining on fish and wildlife, or with unsuccessful or successful management attempts to reclaim and manage surface-mined areas in a manner beneficial to these resources, should be helpful in developing more effective future programs.
Introduction

Supplying the energy needed to maintain the Nation's economy is a top priority requirement. Coal has been, and will continue to be, a main source of supply for many years. With the equipment now available, about half of the annual coal production comes from surface mines. Mining, hauling, processing, and using the coal have damaging effects on the environment. As a result, state and federal laws have been passed to regulate surface mining and to protect the environment. In this report we are concerned with fish and wildlife as part of the environment and as a valuable renewable resource on mined lands in the eastern United States.

Most of the land disturbed by surface mining for coal can be reclaimed for productive uses such as woodland, pasture, forage and other agricultural crops. Mined land also can be used for recreation and as industrial and residential sites. The possibilities for rehabilitation of mined land depend upon how it is treated during and after extraction of the coal. Physical reclamation, including adequate compaction of the spoils, is particularly important in preventing subsidence, collapse of structures, and flooding.

Because wildlife species are so varied, it can be assumed that wildlife of some kind was present on essentially all of the land mined in the past, is present on land to be mined, and will utilize areas reclaimed in the future. The species diversity and numbers of individuals present on reclaimed areas depend on many factors which will be discussed in this report. It is emphasized, however, that with planning and management, wildlife can be enhanced not only on mined areas reclaimed primarily for wildlife, but also on areas reclaimed for woodland, agriculture, and recreation, and even for industrial and residential use.

Elimination of vegetation, removal of the overburden, including the topsoil in which many organisms live or burrow, extraction of the coal, and other activities involved in mining may practically eliminate wildlife from the mine site temporarily. Wildlife will reinvade the area, however, and the habitat may have been altered or diversified to such an extent, e.g., by the presence of a pond not there before, that additional species can be supported.

Some surface-mined sites left untreated, have, over the years, developed into productive wildlife areas through natural invasion and succession of plants and amelioration of the acidity in ponds created as a result of mining. However, through such measures as seeding the mined sites to establish herbaceous cover, planting shrubs and trees, controlling erosion, eliminating acid water drainage, and raising the pH of acid ponds, wildlife invasion into the sites can be accelerated and larger populations of fish and wildlife can be attained. These resources add to the value and multiple use of reclaimed areas. It should be noted that not all areas surface-mined for coal are acidic in nature; some of them are alkaline or have good buffering capacity. Management will vary accordingly.

Part 1 of this volume summarizes information on the following topics:

- Extent and nature of surface coal mining areas and coal mining methods in the eastern United States;
- Land use alternatives for surface mined areas;
- Environmental effects of surface mining on fish and wildlife habitat prior to implementation of P.L. 95-87; and
- Responses of fish and wildlife to habitat alterations resulting from surface mining and/or reclamation and post fish and wildlife management efforts.

Responses of fish and wildlife to habitat alterations are summarized by coal mining regions and states. This background information should be useful to planners, managers, and researchers in assessing the capabilities of various types of surface-mined sites and surrounding areas for fish and wildlife production and should aid in developing plans and management programs for the implementation of P.L. 95-87. This law will be discussed in Part 2 of this reference manual.

Extent and Nature of Surface Coal Mining Areas in the East

Land in the United States disturbed by surface mining for coal—anthracite, bituminous and lignite—as of January 1, 1965, totaled 1,302,000 acres. Of this total, 665,000 acres had been disturbed by contour mining and 637,000 acres by area stripping. Contour stripping involves digging around a hillside in steep or mountainous country. It creates a shelf or bench
### Table 1. Land (acres) in Selected States Disturbed by Coal Mining and in Need of Reclamation as of July 1, 1977a

<table>
<thead>
<tr>
<th>State</th>
<th>Reclamation not required by any lawb</th>
<th>Reclamation required by law</th>
<th>Total in need of reclamation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>72,292</td>
<td>34,807</td>
<td>107,099</td>
</tr>
<tr>
<td>Illinois</td>
<td>118,711</td>
<td>40,899</td>
<td>159,610</td>
</tr>
<tr>
<td>Indiana</td>
<td>25,882</td>
<td>74,581</td>
<td>100,463</td>
</tr>
<tr>
<td>Kentuckey</td>
<td>101,637</td>
<td>154,218</td>
<td>255,855</td>
</tr>
<tr>
<td>Maryland</td>
<td>6,412</td>
<td>5,703</td>
<td>12,115</td>
</tr>
<tr>
<td>Ohio</td>
<td>196,709</td>
<td>77,050</td>
<td>273,759</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>240,000</td>
<td>60,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Tennessee</td>
<td>29,583</td>
<td>3,127</td>
<td>32,710</td>
</tr>
<tr>
<td>Virginia</td>
<td>23,724</td>
<td>8,222</td>
<td>31,946</td>
</tr>
<tr>
<td>W. Virginia</td>
<td>84,868</td>
<td>7,658</td>
<td>92,526</td>
</tr>
<tr>
<td>TOTAL</td>
<td>899,818</td>
<td>466,265</td>
<td>1,366,083</td>
</tr>
</tbody>
</table>

aBased upon information excerpted from Table 1, pp. 3-4 (USDA-SCS 1979).

bThe survey was completed prior to enactment of P.L. 95-87 or other laws requiring reclamation of acreages listed in this column.

bordered on the inside by a “highwall” that may be as much as 100 feet tall and on the outside by a rim and a steep outslope covered by loose spoil material. Recently, in mountainous country, as in parts of the Appalachians, “mountaintop removal” and “head-of-hollow fills” have become accepted means of coal extraction and waste disposal (Grim and Hill 1974). Contour stripping is generally a short-lived operation on a given site. Area stripping, usually done in relatively flat or rolling terrain, involves digging a series of parallel trenches and placing the spoil in the cut previously made. The last cut made leaves an open trench. The rest of the mined area resembles the ridges of a washboard. Area stripping operations are generally long-lived (U.S. Department of Agriculture 1973).

As of July 1, 1977, the Soil Conservation Service (USDA SCS 1979) indicated that 1,667,168 acres of land disturbed by coal mining in the United States needed reclamation in comparison with 2,155,151 acres disturbed by surface mining for sand and gravel and other minerals. Thus, it appears that coal mining accounted for 43.6 percent of the disturbed mining land in need of reclamation as of 1977 compared with the 41 percent estimated in 1965 (U.S. Department of Interior 1967). In addition, the 1977 survey showed that 1,898,203 acres that had been disturbed by all surface mining in the United States did not require reclamation, i.e., 33.2 percent of the disturbed land had been reclaimed by natural seeding or through the efforts of landowners.

Of the coal mining disturbed lands in need of reclamation in 1977, 1,366,083 acres or approximately 82 percent were located in the ten states of major concern in this report (Table 1).

To gain a better perspective of how acreage used for mining compares with other land uses nationally, information compiled by Paone et al. (1974) may be helpful. They reported 3.7 million acres used for mining during the period 1930-71 compared with 3.3 million for airports and 3.2 million for railroads. Land in agriculture, including grazed and ungrazed forest land, constituted 1,808 million of the 2,271.3 million acres total for the United States.

The same authorities provided information shown in Table 2 on the amount of land used for the mining of bituminous coal, presumably including deep as well as surface mining.

### Table 2. Land (acres) Used for Mining Bituminous Coal in Selected States, 1931-71a

<table>
<thead>
<tr>
<th>State</th>
<th>Bituminous Coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>34,900</td>
</tr>
<tr>
<td>Illinois</td>
<td>234,000</td>
</tr>
<tr>
<td>Indiana</td>
<td>130,000</td>
</tr>
<tr>
<td>Kentuckey</td>
<td>210,000</td>
</tr>
<tr>
<td>Maryland</td>
<td>4,610</td>
</tr>
<tr>
<td>Ohio</td>
<td>207,000</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>247,000</td>
</tr>
<tr>
<td>Tennessee</td>
<td>17,900</td>
</tr>
<tr>
<td>Virginia</td>
<td>34,800</td>
</tr>
<tr>
<td>West Virginia</td>
<td>196,000</td>
</tr>
</tbody>
</table>

aBased upon Paone et al. (1974)
As of 1965, based on data from the Soil Conservation Service and certain states, USDI (1967) concluded that probably only one-third of the total acreage disturbed by surface mining had been adequately reclaimed by natural forces or by man’s effort. With enactment of more laws, a much higher percentage of mined land currently is being reclaimed including some of the “abandoned” areas. (See Part 2 of this report.)

According to the USDA (1973) about 91 percent of the surface-mined land in the United States is in private ownership (mining industries, 52 percent; farm, 23 percent and other 16 percent) while 9 percent is in public ownership (federal, 5 percent; and state 4 percent). It is obvious, therefore, that the private sector will be much involved in the implementation of P.L. 95-87.

Before settlement by the white man, most of the eastern United States was covered by forest. In the northern sections of the coal mining area in Illinois, there were prairies. With settlement in that area, most of the prairie land was plowed. Elsewhere, in Appalachia, much of the land was cleared for farming. By the time surface mining was done on a large scale, some of the land had reverted to forest land; some of it was in the old-field stage of plant succession; and some of it was still being farmed. On the basis of land capability, some should never have been farmed.

Topography varies from flat prairie in Illinois to mountains in parts of Appalachia. At the higher elevations and in the northern parts of the coal mining region, climatic conditions differ from areas at lower elevations and in southern Appalachia. The pH and soil fertility also differ in different areas. All of these factors bear on the best use to which reclaimed surface-mined areas can be put, as do the demands and needs of people.

**Land Use Alternatives For Strip Mined Areas**

Postmining uses of reclaimed areas of fish and wildlife alone, and in conjunction with other uses, are discussed in a companion report pertaining to opportunities for fish and wildlife management under P.L. 95-87. However, Table 3 suggests the wide diversity of conditions of surface-mined areas under which wildlife occurs.

<table>
<thead>
<tr>
<th>Reclamation alternative</th>
<th>Slope</th>
<th>Soil reaction (pH)</th>
<th>Soil composition</th>
<th>Water</th>
<th>Access conditions</th>
<th>Mine size</th>
<th>Adjacent land use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than 10%</td>
<td>10% to 25%</td>
<td>More than 25%</td>
<td>Alkaline and calcareous (pH more than 8)</td>
<td>Neutral (pH 6-8)</td>
<td>Acidic (pH less than 6)</td>
<td>1-5% stones and boulders</td>
</tr>
<tr>
<td>Fish and wildlife habitat</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Woodland/forestry</td>
<td>.</td>
<td>.</td>
<td>.</td>
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<td>.</td>
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<tr>
<td>Agriculture</td>
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<td>.</td>
<td>.</td>
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<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Pasture</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Recreation</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
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<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Residential</td>
<td>.</td>
<td>.</td>
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<td>.</td>
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<td>.</td>
</tr>
<tr>
<td>Industrial</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
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</tr>
</tbody>
</table>

: Suitable  
L = Limitations  
X = Unsuitable  
* = Fences needed

**Note:** Wildlife may be limited or scarce in extremely acidic or alkaline sites but some forms usually occur in such areas. Some agronomists suggest that slopes as great as 30 percent can be used for pasture and recreation and that soils with 15-20 percent stones and boulders probably ought to be considered unsuitable for agriculture.
A survey conducted by the USDA (1973) provides information on potential uses of surface-mined areas. Data for several states in the area of our concern are presented in Table 4. It would seem that the great difference in the potential use of sites for wildlife habitat between Pennsylvania and West Virginia reflects the use of different criteria or reporting systems.

Table 4. Potential (percent) Multiple and Alternative Uses of Surface Mined Areas in Several States

<table>
<thead>
<tr>
<th>State</th>
<th>Crop land</th>
<th>Pasture land</th>
<th>Range land</th>
<th>Wood land</th>
<th>Wildlife habitat</th>
<th>Ponds and reservoirs</th>
<th>Farm &amp; forest recreation</th>
<th>Residential, institutional, industrial</th>
<th>Other unidentified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illinois</td>
<td>15.2</td>
<td>49.6</td>
<td>0.9</td>
<td>27.3</td>
<td>31.8</td>
<td>9.0</td>
<td>28.9</td>
<td>7.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Indiana</td>
<td>2.4</td>
<td>15.9</td>
<td>(b)</td>
<td>55.9</td>
<td>49.2</td>
<td>12.7</td>
<td>47.5</td>
<td>12.9</td>
<td>6.0</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>10.0</td>
<td>20.0</td>
<td>(b)</td>
<td>80.0</td>
<td>92.0</td>
<td>2.0</td>
<td>12.0</td>
<td>13.0</td>
<td>5.0</td>
</tr>
<tr>
<td>W. Virginia</td>
<td>9.0</td>
<td>5.0</td>
<td>(b)</td>
<td>75.9</td>
<td>10.0</td>
<td>0.1</td>
<td>34.0</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

a The percentages exceed 100 for individual states because more than one potential use may apply to some areas.

b Less than 0.1 percent.

A survey made in 1966 by the USDA of 693 surface mine sites, including 180 coal mine sites, showed many of them to be small and widely scattered. "Nearly 80 percent of the sites were in forest, farm, or grassland or reverting to forest at the time of the survey. These same uses were being made of land adjacent to 86 percent of the sites. Less than 2 percent of the acreage had been set aside solely as outdoor recreation or wildlife areas; usually these are compatible with other uses of the land" (USDA 1973).

A resume of the use of nearly 200,000 acres of surface-mined land in Illinois was provided by Klimstra et al. (1977). These data indicated that in the period 1866-1962, prior to enactment of surface mining and reclamation laws in that state, land categorized for recreation as the postmining use constituted 24.1 percent of the surface-mined area. During the period 1975-1979, following enactment and amendment of a law with stringent reclamation requirements, the percentage of land in the recreation category was reduced to 5.3 percent. Streeter et al. (1979) summarized their views of postmining land uses as follows: "Energy mining, although not affecting every state or province equally, will have major regional effects on land uses. The post-mining land uses and the increase of public pressures on wildlife resources will be the primary impacting agents. By taking an active, positive role in governmental and industrial decision processes, wildlife managers can be effective by identifying lands suitable for mining, by establishing protective stipulations and mitigation requirements, and by promoting preferred wildlife related postmining land uses. These actions will maximize benefits to wildlife resources as positive approaches to the problems related to energy mining."

One alternative mode of reclamation for wildlife is, after careful analysis of the existing situation, to undertake no further reclamation. This applies where an abandoned site has developed naturally into a productive wildlife area, is not causing any pollution or hazards to man's safety or health, is not displeasing aesthetically, is compatible with land uses on adjacent areas, and where wildlife is desired by the landowner-operator. To remove the cover and grade such an area would cause renewed erosion and pollution, eliminate wildlife temporarily from the immediate site, and require revegetation of the area. Furthermore, reclamation requires considerable time and money which may not be available in the near future under P.L. 95-87 for reclaiming such areas (particularly if there are extensive higher priority areas requiring reclamation) (See Part 2). Also, if the site is in a flat area, has been left ungraded, and is now covered with woody vegetation, the rough topography and related ponds created by mining provide more diversity than if it were graded to a flat and relatively smooth surface and farmed. Some of the environmental effects of surface mining are treated in the next section.
Environmental Effect of Surface Mining on Fish and Wildlife Habitat in the Past

General and Historical

Among the environmental impacts of surface mining are: visual effects, the torn-up and denuded landscape accompanying mining; air pollution, including dust, noise and air blast; removal of vegetation; change in land surface and drainage patterns; soil erosion; and water pollution.

Land utilized by the mining industry from 1930 through 1971 amounted to only 0.16 percent of the land area in the United States (Paone et al. 1974). However, 80 percent of the use of land for mining is for surface mine operations, including disposal of overburden waste. During this 42-year period, reclamation of excavated areas and overburden disposal sites accounted for 95 percent of the 1.46 million acres reclaimed.

In the early days of surface mining in the United States, relatively little attention was given to environmental impacts and the need for reclaiming mined areas. Effects on the environment became so apparent locally, however, that there was public demand for action to prevent unnecessary damage to mined and adjacent lands. Accordingly, strip mine legislation was enacted, first by West Virginia in 1939, followed by Indiana (1941), Illinois (1943), Pennsylvania (1945), Ohio (1947), Kentucky (1954), Maryland (1955), Virginia (1966), and Tennessee (1967) (Paone et al. 1974). With a growing public appreciation of the need to protect the environment and enactment of P.L. 95-87, new state laws or revisions of existing laws are appearing in coal mining states; in fact, the states are required to develop and submit their regulatory programs under P.L. 95-87 to the Office of Surface Mining, U.S. Department of the Interior.

Removal of Vegetation

Removal of vegetation by cutting and bulldozing preparatory to mining has a direct effect on terrestrial wildlife in that plants provide food and cover including, for many species, nesting materials and/or a site in which to nest, den, roost, perch, or breed. This is true whether the vegetation on the mine site is forest, agricultural crops, or old fields. When brush and trees from the mine site are left in piles, they still provide some wildlife cover.

Blasting

The noise of blasting could disrupt the nesting of birds under some circumstances. Studies by Allaire (1978a) indicate that ground nesting birds such as the ovenbird, Kentucky warbler, worm-eating warbler, and black-and-white warbler may be adversely affected by the dust and debris blown over areas adjacent to a mine. On the other hand, birds such as the hooded warbler, eastern wood pewee, red-eyed vireo, scarlet tanager, and cerulean warbler appear to be extremely tolerant to nearby blasting.

Removal of Overburden and Coal

In the early days of surface mining, valuable topsoil often was covered with a heterogeneous mixture of rocks and finer materials, and thus became unavailable for use in reclamation. In fact, many of the mined areas were not reclaimed except by natural processes which on some sites operated very slowly to ameliorate deleterious effects of mining such as acid mine water pollution and erosion. Where pyritic materials were left on the surface of the spoil bank exposed to rain and air, acid pollution continued for a long period of time. Conditions generally were unfavorable for the establishment of vegetation.

About one-half of the surface-mined coal acreage has been mined by the contour method in which the overburden is pushed down-slope where it is subject to massive slides which may cover trees and block stream channels (USDI 1967). By 1967, about 1,700 miles of outslope were affected by slides and 20,000 miles of highwalls had been created. In some instances, these highwalls can be a barrier to the movement of wildlife; however, they provide new habitat for cliff-nesting birds.

Conventional area strip mining is practiced in parts of Illinois and in other areas where the topography is more level. Massive landslides in such areas are not a problem and numerous strip mine ponds are created in the valleys and final cuts. In those parts of Appalachia where area strip mining is practiced, it usually is of a modified type (Hutchins 1978).

The spoils in the eastern United States vary considerably in their composition and capability for supporting plant growth. Many spoils are almost completely infertile and require application of nutrients for plant growth. The spoils also may contain metals in a low pH environment which facilitates uptake of these elements by plants in toxic quantities (Armiger et al. 1976). Spoils in some areas of Appalachia have an extremely low pH (2.4-3.0) and may contain large quantities of Fe, Mn, Cu, Al, and SO₄ along with small amounts of needed plant nutrients, N, P, K, Mg, and Ca (Skelly and Loy 1978). Some surface-mined sites are alkaline in nature. Organic matter is practically nonexistent in poorly vegetated spoils with consequent reduction in water-holding capacities and soil microbial activities which are important to plant growth.
Effects on Water

Surface mining results in the formation of many impoundments ranging in size from a quarter of an acre or less to 20 acres or more. Most of these ponds or lakes are found in the valleys between the ridges of spoil in area strip mining or in the final cut next to the highwall in area or contour mining. Others may be created by haul roads which block the natural drainage from the mined site. Some of these ponds may be infertile and too acid initially to be productive of fish life, but some are alkaline. The water chemistry reflects the nature of the watershed from which the drainage and ground waters come. Also, many of the ponds have steep banks and little shallow water and gravel for fish spawning and are protected by highwalls and spoil banks so there is little wave action to promote aeration. When the watershed is composed of near neutral or slightly acidic spoil, fish food organisms and fish may survive and reproduce. Ohio and Illinois have more fishable waters than they would have had without surface mining.

Acid mine drainage affects both impoundments and streams where the drainage occurs and considerable distances downstream, depending upon the amount of discharge and volume of stream flow. Concentrations of acid may cause direct mortality, reduce the rate of fish growth, or prevent reproduction of desirable sport fishes (Boccardy and Spaulding 1968). Although much of the acid mine damage may have resulted from deep mining for coal, a study in the early 1960s revealed that over 5,000 miles of streams and nearly 14,000 acres of impoundments had been deleteriously affected by acid mine water pollution in Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia (Kinney 1964). Acid mine water drainage may result in the precipitation of iron hydroxide or “yellow boy” which coats stream bottoms and destroys habitat for some forms of aquatic life. Terrestrial wildlife unwilling to drink acid mine water may be absent near badly polluted areas.

Drainage from area mines is mostly internal; however, with contour stripping in mountainous areas, erosion and sedimentation can be greatly accelerated. Offsite research conducted in Kentucky indicated that sediment yields from strip-mined areas can be as much as 1,000 times that of undisturbed forest (USDI 1967). Silt and sediments reduce light transmittance and photosynthesis, raise the temperature, and adsorb organic materials. The larger particles can cover spawning areas and smother aquatic life (Boccardy and Spaulding 1968).

Fish and Wildlife Responses to Habitat Alterations

General and Historical

This subsection summarizes observations on fish and wildlife responses to the new environment of surface-mined areas. These include: (1) areas where little, if any, reclamation had occurred except through natural processes; (2) areas where revegetation had been accomplished by seeding and planting; and (3) areas on which some fish and wildlife management measures had been applied. Details of these studies cannot be presented here, but they can be obtained from the references cited. Findings from these studies and past observations are helpful in defining the limitations for occupancy by different species of fish and wildlife of various types of surface-mined areas and in predicting what species are likely to occur in different stages of mined-area reclamation. The successes and failures of past fish and wildlife management efforts are helpful, also, in developing management measures for inclusion in the application for the mining permit and reclamation plan required by P.L. 95-87.

Responses of Fish and Wildlife to Habitat Alterations Because of Surface Mining, Reclamation, and Past Management

Mid-continent

ILLINOIS. One of the first biologists to call attention to the potentials of surface-mined coal lands for fish and wildlife production was Yeager (1940). He pointed out that on areas in the black prairie region of Illinois that had been mined 15 to 30 years or more before, recovery of vegetation—primarily through natural invasion and succession—was such that populations of rabbits, bobwhite, and pheasants probably were greater than on adjacent farm land. Among other game and fur species occurring on Illinois surface-mined areas were shorebirds, waterfowl, muskrats, minks, opossums, weasels, skunks, foxes, and raccoons. In addition, there were heavy populations of meadow mice or voles on areas having herbaceous cover; woodchucks; a variety of passerine birds; herons on the older water areas; and fish, including largemouth black bass, crappies, bluegills, and bullheads. In a later paper Yeager (1942) added white-footed mice, jumping mice, eastern chipmunks, flying squirrels, and tree squirrels to his list; the last species occurred in some of the cavities of soft maples in areas mined 60 years previously.
Opportunities for fish and wildlife management on surface-mined areas and some of the limitations for such management were discussed in a perceptive article by Klimestone (1959). The Wildlife Research Laboratory headed by Dr. W.D. Klimestone at Southern Illinois University, Carbondale, has made extensive studies of fish and wildlife on surface-mined areas in southern Illinois where, on some sites, the spoil pH is lower than that in the prairie region.

In Perry County, on land that had been strip mined from 6 to 24 years before, Verts (1957) found that the prairie deer mouse, the predominant form of *Peromyscus* on the most recent stripplings, decreased in dominance with increased age of the spoils, and the woodmouse became the only species of *Peromyscus* taken in areas mined before 1936. In another publication Verts (1959) reported finding evidence of 26 species of mammals. Among those species found on areas at least partially covered with woody vegetation were the short-tailed shrew, eastern pipistrelle, red bat, chipmunk, gray squirrel, fox squirrel, flying squirrel, white-footed mouse, long-tailed weasel, and white-tailed deer. He found prairie voles in areas supporting heavy growths of grasses, and house mice and eastern moles in areas with moist soil. Beavers were found in some of the ponds.

In Vermillion County in east-central Illinois, Yeager (1942) reported heavy populations of muskrats on some 10- to 60-year-old ponds. Cattail stands in water two or three feet deep in some Vermillion County ponds permitted muskrats to build houses for denning. These houses were protected from wave and wind action by the irregular shape of water areas and the high spoil banks. In southern Illinois, Arata (1959) found that muskrat habitat was limited largely to a belt around the edge of the pond and that ponds 6-8 years old possessed essentially the same flora as ponds 20-25 years old. Verts (1959) noted that much rock and shale in banks of deep ponds would render it difficult for muskrats to tunnel for bank-denning.

On the 1792-acre study tract in Perry County, Illinois, observations on plots that had been mined from 6 to 24 years previously revealed 44 species of breeding birds (Brewer 1958). More species and more breeding pairs were seen per hour on land that had been stripped 14-17 years before. The most numerous species, in order of decreasing abundance, were field sparrow, indigo bunting, mourning dove, cardinal, red-winged blackbird, rufous-sided towhee, American goldfinch, yellow-breasted chat and yellow-billed cuckoo. Nearly all of these species may be classified as forest-edge birds in that they tend to occur where there is an interspersion of trees and/or shrubs in areas covered with herbaceous plants. Brewer (1958) stated that belted kingfishers were present where there were fairly extensive bodies of water with steep banks; red-winged blackbirds were associated with growth of cattail; and killdeers nested only on the packed gob roads that had been used by mining trucks. Brewer surmised that future successional changes in the bird population, involving replacement of field and forest edge birds with forest species, would probably depend on the development of a closed canopy.

Karr (1968) studied bird populations following strip mining on four successional stages in east-central Illinois. These stages were designated as bare ground (mined about 1963, i.e., 4-5 years prior to the study); early shrub (mined in 1954); late shrub (mined between 1920-25); and bottomland forest (mined between 1900 and 1910). The study correlated changes in bird populations with redevelopment of vegetation following strip mining. The rate of revegetation was affected by the manner in which the area was mined, the amount of reclamation work done after mining, and the time since mining. Bird species diversity increased from one successional stage to another “and was linearly correlated with foliage-height diversity and the logarithm of percent vegetation cover.” Karr (1968) found that the bird species diversity and populations were greater on strip-mined areas than on unstripped areas with similar vegetation due, he hypothesized, to the presence of water on strip-mined areas and, to a lesser extent, to the ridge and valley topography characteristic of these areas.

Responses of bobwhite to management practices applied on 920 acres of strip-mined land in southern Illinois were reported by Vohs and Birkenholz (1962). Roads were constructed to provide access; 12.1 miles of spoil crests were graded; 0.9 mile of spoil valley was graded and widened; and selected areas of spoil banks were leveled on plots of 0.25 to 1.5 acres for “edge” and to provide places to establish plant species of benefit to quail. Korean lespedeza was broadcast seeded on spoil banks lacking in cover and on roadsides, leveled areas, and nonmined lands; sericea and bicolor lespedeza were planted on spoils, roadsides, and in prepared food plots; food plots containing combinations of Korean lespedeza, German millet, sorghum, soybeans, corn, and buckwheat were established on unmined areas and in spoil banks on leveled areas; and row crops were planted most years on the interior and perimeter areas that were not mined. Spoil banks were created from 1932 through 1941 and, in 1942 and 1943, about half the area was planted to trees including plantations of shortleaf and jack pine and deciduous species—black locust, osage-orange, catalpa, silver maple and various oaks. Invading trees included cottonwood, sycamore, willow, red elm, box elder, and persimmon. Herbaceous species included white and yellow sweet clover, goldenrod, wood aster, and cheat. Interspersed with these shrubs were clumps of sumac, poison ivy, and blackberry.

Observations showed an increase of bobwhite quail from 46 prior to management in 1954 to 279 in 1959-
60, or about 1 bird per 2.3 acres (excluding the pine and hardwood plantations which except for parts of the locust plantings were not used by quail). This population was about two and one-half times the quail populations on unmanaged farm lands in southern Illinois. The quail did not include in their ranges areas of extensive leveling of spoils or isolated leveled plots where no food-producing plants were provided. Vohs and Birkenholz (1962) recommended that plantation-type plantings exceeding five acres not be made on spoil banks which are managed for wildlife. They suggested that management efforts on older stripped lands might be more profitably directed toward retarding succession on naturally revegetated areas and establishing food-producing plots. They found that establishment of quail covey ranges could be correlated with the development of food plots on the spoil banks, especially where Korean lespedeza had been planted, and that much of the food consumed by the quail was from these food plots.

In 1975, Peabody Coal Company reclaimed 219 hectares (ha) (about 719 acres) of surface-mined land on the flood plain of the Saline River in southeastern Illinois. About 33 percent of the area was converted into small multipurpose ponds and lakes. According to Sandusky (1978), three species of ducks used the area in 1977. Blue-winged teal preferred the smaller ponds, while mallards preferred the larger ponds and used shore vegetation for escape cover. A brood of wood ducks hatched in a nesting box placed on a post in a large pond. The giant Canada goose, once thought to be extinct, was reported to be using the reclaimed area in 1978.

A study by Myers and Klimstra (1963) on land stripped for coal in southern Illinois 19-29 years previously showed that a majority of the species of amphibians and reptiles occupying adjacent areas had been able to invade the new environment. They were most abundant in or adjacent to ponds caused by surface or subsurface water filling low places between spoils, rather than in those caused by inundation of old haul roads and final box cuts which tended to have steep banks and a scarcity of shallows and aquatic vegetation.

Mine effluents affect both strip mine lakes and the streams that receive their drainage. Parsons (1956, 1968) worked in central Missouri where he found that the two major sources which contribute to both the continuous and the periodic pollution of streams are: (1) the accumulated sulfuric salts on the spoil piles; and (2) the strip mine lakes. He indicated that the initiation, maintenance, extent, and intensity of an excessive acid flow and the rate of recovery of the stream are a function of the amount, intensity, and distribution of rainfall and, to some extent, of the time interval between rains. Oxidation of iron sulfide occurs on spoil piles, and strip mine lakes act as holding areas of oxidized sulfuric materials. In continuously polluted areas, the zooplankton and benthic population species are comparatively few compared to the total number of individuals. Parsons felt that although a biological community can serve as an indicator of water quality, a single species cannot. Effects of acid effluents upon the abiotic environment included precipitation of the normal silt load, destruction of the bicarbonate buffer system, increase in the titratable acidity and hydrogen-ion concentration, introduction of various metal ions, and reduction of the oxygen concentration downstream. He stated that control of excessive acid flows depends upon maintaining such a relationship between the watershed and lake volume that the normal ratio of rainfall to evaporation will limit the volume of accumulated water, thus preventing acid-water overflow. He suggested that control of such overflow may be attained by the construction and maintenance of earthen dams in strategic areas adjacent to strip mine lakes.

Information on the characteristics of strip mine lakes in the Interior Coal Province in Missouri was also provided by Campbell et al. (1965) and Campbell and Lind (1969). Strip mine lakes are frequently highly acid at first. The rate of recovery from acid pollution is variable and, in the presence of waste coal piles, recovery may be delayed for 45 years. The initial acid stage is characterized by low pH, high potential acidity, absence of carbonate, and large concentrations of dissolved minerals which produce high conductivity measures. These conditions become less pronounced as sulfuric acid pollution ameliorates and, in the alkaline stage, the lakes appear comparable to those in early eutrophic stages in natural lakes.

In strip-mine ponds in Jackson County, Illinois, Lewis and Nickum (1964) found that thermal stratification was evident by the last of April and continued until the third week of September with the thermocline established between 10 and 20 feet of depth. The pH of the water five feet below the surface varied from 7.3 to 8.3. These authors did not consider strip mine ponds to constitute an important potential as waters to be managed for fishing because of limited access and physical features which rendered it difficult to use conventional pond-management techniques. They suggested, however, that some of the ponds might supply water needed for fish hatchery and fish-rearing units. It also should be pointed out that on various developed recreation sites in Illinois limitations on pond management have been corrected or overcome.

Klimstra et al. (1963) stated that in Perry County, Illinois, most of the suitable ponds in strip mined areas contained green sunfish and bullheads; largemouth bass and sunfish showed good growth and reproduction; and some of the ponds were stocked with trout.
and channel catfish that did not reproduce. Other stockings included smallmouth bass, pike, and hybrid sunfish. Introduction of beaver on one area resulted in a harvestable population in three years.

**INDIANA.** Less information is available on the responses of fish and wildlife species to surface mining for coal in Indiana and western Kentucky. However, environmental conditions in those mined areas are comparable to those in parts of east-central and southern Illinois, and it is assumed that responses have been similar.

Sly (1976) investigated small mammals on three areas in Vigo County, western Indiana, which had been strip mined for coal 5, 12, and 28 years previously. The most recently mined area had been seeded with lespedezas and fescue and had good ground cover with relatively few invading weedy plants. The 12-year-old area, not seeded by man, had cover consisting primarily of goldenrod, white sweet clover, and purple-top, and some trees—pines, elms, black locust, cottonwood, and black walnut—as a result of planting. The oldest area had woody cover so well established that from the air it could not be observed to be strip-mined land. Only the meadow vole, house mouse, and least shrew were taken in the first area; the prairie vole and the short-tailed shrew were collected in all areas, but in comparatively low numbers. The white-footed mouse and the deer mouse were the most abundant mammals present. The deer mouse occurred in the youngest and intermediate areas, and the white-footed mouse was found in the intermediate and oldest areas. There was a significant positive association between white-footed mice and thick patches of white sweet clover even when most of the ground was bare.

Sly found deer mice in the most open areas, often in plots with higher pH values and high amounts of coarse material in the spoil. White-footed mice were more abundant in areas of woody cover on spoil with low pH values and small amounts of coarse material. He pointed out that age alone is not an accurate standard in measuring the amount of succession which has occurred because an area with relatively normal soil might have considerably more vegetation on it than an area which had been stripped much earlier but had poor soil.

Burner (1973) reported that there were approximately 10,000 acres of strip mine lake waters in southwest Indiana with a similar area in Ohio and Illinois, of which only a relatively small amount was being used for managed fishing. He stated that a good quality sport fishery can be developed in strip mine lakes, and that in the Midwest less than 10 percent of these waters have a pH of 6.0. Burner believed that although pits with favorable pH should be placed into fish management programs first, acid pits could be considered if there were sufficient demand for fishing areas and if the source of acid could be located and properly treated, e.g., by applying lime to provide fishing at a reasonable cost.

The Office of Fishery Assistance, USD1. Fish and Wildlife Service, is doing research on fish management at its Central States Fishery Station, Princeton, Indiana. This includes investigating the effects of fertilization on strip mine lakes in southern Indiana.

**WESTERN KENTUCKY.** Rosso and Walcott (1977) and Russell (1978) have reported on the development of conditions favorable for fish and wildlife on the Peabody Coal Company's 95-acre Ken Mine site in Ohio County, western Kentucky. Conception and implementation of the plans for managing this site were done cooperatively by the Kentucky State Bureau of Land Resources, Department of Fish and Wildlife Resources, Western Kentucky Reclamation Association, and the Peabody Coal Company. This area contains a shallow spoil lake utilized by waterfowl, wading birds, and shorebirds. The lake has been stocked with fish. Bobwhite quail and rabbits, formerly common residents of the upland sites that were improved through food plots and border plantings, are less common currently (1979), possibly due to deterioration of the vegetation on the old spoil—a continuing problem on some sites.

**Appalachia**

**OHIO.** Surface mining of coal in Ohio is done in rolling and hilly topography intermediate between the relatively level prairie lands mined in parts of Illinois and the mountainous parts of some of the Appalachian states. In Ohio much of the research on strip mining in relation to wildlife has been accomplished by Riley (1954, 1957, 1960, 1963, 1972, 1973, 1974, and 1976) and by Bookhout et al. (1968), Lindsay and Bookhout (1978), Lindsay et al. (1978), and DeCapita and Bookhout (1975). Work by Riley and by Bookhout and his group has considerable application to predicting fish and wildlife occurrence or productivity in area-striped regions.

Riley has traced recovery of areas mined in 1918 on the unglaciated Allegheny Plateau of southeastern Ohio and has made personal observations on ecosystem development since 1946. Over approximately 60 years the recovery has been such that the area now supports a fairly diverse vegetative cover and numerous mammals, birds, reptiles, and amphibians. Water quality in a study pond has improved. It now supports largemouth bass, bluegills, redear sunfish, and chain pickerel. Plantings by man helped speed the recovery. Riley (1957) concluded from a survey of strip-mined lands in 27 Ohio counties in 1947-51 and 1954-55 that black locust was superior—apparently even though it is susceptible to the locust borer—to all other hardwood species in the establishment of
suitable wildlife habitat partly because of its adaptability to various sites, its value in site preparation and modification and the early invasion of native species. Conifers were most valuable when used in a clump planting or narrow strip. Bicolor and sericea lespedeza were adaptable to various sites, and Korean lespedeza did well when seeded in soil having a high percentage of calcareous materials. Cottontail rabbit populations were found to be higher on reclaimed coal stripland than on abandoned farmland, cropland, and forest land. Populations of woodchuck, ruffed grouse, and bobwhite were comparable to those on adjacent land.

Bookhout et al. (1968) reported on the biota of a 4,400-acre tract of strip-mined land in Perry County, Ohio. This contained 3,695 acres of terrestrial habitat and 139 ponds. *Peromyscus* (especially the white-footed mouse), cottontail rabbit, and short-tailed shrew were the most numerous small mammals. *Peromyscus* and possibly the woodchuck were more abundant on strip-mined portions of the area than on the unmined portion, but the opossum and most of the common forest species were more abundant on unmined areas. Ten species of waterfowl were observed to use the area during migration and 59 percent of the bird species known to breed in the county were observed on the area. Faunal diversity and pH were higher on the undisturbed tracts.

Seven years later there had been a loss of dominant black locust and improved growth of other plants (DeCapita and Bookhout 1975). Trapping of mammals showed the same three species to be most abundant on the area, but that there had been increases in the populations of several species. The authors pointed out that the woodchuck, common on strip-mined land, may be valuable as a provider of ground dens particularly in the absence of large trees, logs or stumps on such areas. On this area the strip mine spoil texture is usually loamy and the pH, sometimes lower than 3.8, seldom exceeds 5.5.

Chemical analyses of plants from this study area and another site in Harrison County, Ohio, indicated that the plants contained normal nutrient levels (Lindsay et al., 1978) and could generally be expected to contain low levels of lead and mercury (Lindsay and Bookhout 1978). The investigators pointed out, however, that the complex question of whether or not a given area is suitable for wildlife habitation is not resolved by an assay of the chemical constituents of plants growing in the area. It also involves the species composition of the plant community and the palatability to animals of species present (Lindsay et al., 1978). After 18 to 30 years, some unvegetated spoil banks are evidence that adverse chemical and physical conditions have prevented or retarded plant recolonization.

Of 139 ponds on the Perry County study area, 31 were semipermanent. Of the permanent ponds, 86 had a pH of 2.8 to 4.0, 11 had a pH of 4.0 to 5.5, and 11 had a pH of more than 5.5. A pH of 5.5 is generally considered minimal for good fish production. The presence of large amounts of dissolved solids in suspension (1000 mg/l) indicated that the runoff waters were still leaching large amounts of salts from the watershed. Studies showed that dissolved oxygen in all of the study lakes remained near saturation at all depths throughout the year; mixing of the waters was minimal due to protection by highwalls from wind action; thermal stratification existed in the summer months; organic material was lacking; and erosion on the steep slopes exposed more oxidized pyrite, causing continued acid production. In the more acidic ponds, rotifers were the dominant zooplankton and chironomids were the most abundant benthic animals. Broad-leaved cattail was the most common emergent aquatic plant and occurred around the edges of even the more acidic ponds (Bookhout et al. 1968).

Looking to the future, the investigators believe that even after reclamation, these strip mine ponds will not support large fish populations. Populations of fish-food organisms, they believe, will be confined to a reduced littoral zone created by steep banks which will also shelter the ponds from wind action and limit mixing of the water. Nutrients in the runoff waters are expected to be quite limited for several years and limited food supply and lack of nutrients will necessitate intensive management if the ponds are utilized to their maximum potential. Conventional management will be difficult since equipment must be packed into most of the area. It should be pointed out, also, that submerged aquatic plants—scarce in all these ponds—which are of greatest value as waterfowl food, grow best in waters with a summer pH range of 7.0 to 9.2. The low carbonate alkalinity and high salinity and turbidity characteristic of many of the ponds are detrimental to production of waterfowl food plants.

**Pennsylvania.** Work by Brenner (1973, 1978) and Brenner et al. (1975) dominates the studies of fish and wildlife on strip-mined areas in the bituminous-coal region of Pennsylvania; however, neither fisheries nor wildlife of Pennsylvania anthracite mines have received much attention. This state, in northern Appalachia, has areas surface-mined for coal which are similar to other parts of the region. The length of the growing season for plants is somewhat less and the winter temperatures lower than in southern Appalachia. These factors have a bearing on the types of plants that can be used successfully in revegetating mined areas. As reported for Illinois, Indiana, and Ohio, white-footed mice were found to be common on spoils in central Pennsylvania. They were sufficiently abundant, in fact, that they were a cause of failure for three attempts to establish red oak in that area because of their feeding on the acorns that had been seeded and
covered with a sawdust mulch (Bramble and Sharp 1949). Farther north, in the central Adirondack Mountains, New York, Kirkland (1976) found only the woodland deer mouse to be abundant on poorly vegetated granitic mine wastes resulting from open pit mining for titanium and iron ores.

Vegetative associations in relation to wildlife usage have been surveyed on 82 strip-mined areas in Pennsylvania by Brenner (1978). He found four basic types of vegetation on the mined areas: coniferous, usually on areas mined over 20 years earlier; deciduous, resulting primarily from natural invasion of such species as quaking aspen, red maple, and black cherry; mixed coniferous and deciduous, characterized by a mixture of the two previous associations with the addition of black locust; and grasslands, characterized by a variety of grasses (including switch grass, blue grass, and fescue), legumes, (such as birdsfoot trefoil, sweet clover, and red clover), and herbaceous species (including goldenrod and wild strawberry).

With respect to ground cover, Brenner (1978) reported that the meadow vole, common shrew, short-tailed shrew, and cottontail rabbit populations were significantly correlated with the total biomass and vegetation height, but only the meadow vole populations were significantly correlated with forage density. The size of deer mouse and eastern chipmunk populations were significantly correlated only with vegetation height. Cover provided by alfalfa, red clover, sweet clover, Queen Anne's lace, ragweed, and dandelion seemed to be well populated with small mammals.

These strip-mined areas had abundant white-tailed deer which indicated a food preference for red maple, red-osier dogwood, hawthorn, and apple while avoiding bristly locust and hybrid poplar.

In an earlier paper Brenner (1973) reported finding 48 species of birds representing 10 orders on strip mines in Mercer County, northwest Pennsylvania. These included many passerine species, wading birds, shorebirds, woodpeckers, hawks, belted kingfisher, three species of waterfowl, ringneck pheasant, ruffed grouse, wild turkey, American coot, woodcock, and mourning dove.

Of 138 strip mine ponds he examined, Brenner (1975) believed 30 might have some potential for further waterfowl development. He found that the ponds supported approximately 9 species of fish with the bluegill and pumpkinseed sunfishes and the largemouth bass having the widest distribution.

In a third paper, Brenner et al. (1975) suggested that in planning the reclamation of surface-mined areas for wildlife, it is beneficial to intersperse deciduous trees and shrubs with conifers as well as allowing for open grassland that is seeded for both grasses and legumes, especially alfalfa and red clover.

Interesting research results are available on acid mine drainage (AMD) effects on Pennsylvania streams. Following up on experimental studies, Herricks and Cairns (1974) made a two-year study of Indian Creek, Fayette County, which received one major and several minor AMD discharges in its upstream region. Recovery from these discharges resulted from additions of unpolluted tributary waters which provided sources of recolonizing organisms and maintained good water quality through both chemical reaction and dilution. The authors found that recovery occurred within 10 miles of initial AMD discharges.

These same investigators found that lime added to Little Scrubgrass Creek in Venango County, Pennsylvania, neutralized the acid and restored water quality immediately downstream, but recovery of bottom fauna communities did not occur until the confluence with healthy tributaries, the source of recolonizing organisms. As a byproduct of the AMD neutralization, hydroxide floe precipitation occurred, which sometimes created secondary stress on the organisms.

Herricks and Cairns (1974, p. 103) stated, “the primary effects of acid mine drainage on the water quality of a receiving stream are: reducing pH; increasing dissolved solids load; decreasing alkalinity with a corresponding increased acidity; and introducing high toxic heavy metals. Several secondary effects also occur. A residual toxicity may be produced by the precipitation of various heavy metals, floc accumulations may build up in the areas of the stream where the acid mine drainage is neutralized, and localized reduction in stream dissolved oxygen may occur if incompletely oxidized acid mine drainage is discharged in the stream. In general, water quality is reduced and severe damage to the biological system may occur if acid mine drainage is discharged into a stream.” They pointed out that AMD comes from both surface and subsurface sources. They found that during low stream discharge periods, AMD intensity was high, and there was little dilution of the mine drainage.

In the production of coal by strip mining, the leading producers in steeply sloping areas (25 degrees) are Virginia, Kentucky, West Virginia, and Tennessee (Hutchins 1978). In such areas the contour method of strip mining has been used with the spoils placed down-slope from the mined site and a highwall left on the inside. Unless properly handled, the outslopes can become seriously eroded with consequent problems of sedimentation and pollution. Sometimes the entire mountaintop is removed. Elsewhere, however, large areas of these states are currently being graded, following mining, and seeded to mixtures of grass and legumes.

WEST VIRGINIA. Very steep highwalls can obstruct the movement of deer, as pointed out earlier. Knotts (1975) found, however, that deer can cross
relatively steep highwalls, especially if the ground surface near the top contains little rock.

Moore and Larson (1970) reported observing approximately five beaver occupying bank dens behind a single large beaver dam on a small tributary of Bingamon Creek near Wyatt, Harrison County, West Virginia. Although Bingamon Creek itself was free of mine pollution above the tributary, the tributary received a relatively constant flow of acid water from a six-inch pipe draining a deep coal mine. Water chemistry studies (January 5-December 20, 1966) for the acid mine drainage in which the active beaver colony was located showed the annual mean pH to be 3.84. In this instance, because clean water was available in the immediate vicinity, the authors concluded the presence of acid mine drainage was not a limiting factor in the selection of the site by the beaver. This beaver dam and two superficial dams located downstream from the main dam were covered with yellow, iron hydroxide deposits and the authors reported that the beaver fur also appeared to be yellowed by the same material.

Surface mine operations have caused drastic changes in avian habitats and bird populations in West Virginia (Whitmore and Hall 1978). Since 1972, 43,225 hectares (106,766 acres) of new grassland have been created in the northern part of the state through reclamation of strip-mined areas. What was once a hardwood forest supporting 40-50 breeding passerine bird species has become a sparse grassland supporting one to eight species. Among the species of passerine birds that have benefited from the change in habitat are: the horned lark, now found on heavily grazed hilltops, recently reclaimed mines, or bare spots on older mined areas; the eastern meadowlark, found on the more open areas including reclaimed surface mines; the red-winged blackbird, common on the more mesic areas of reclaimed surface mines and often associated with large patches of birdsfoot trefoil; the savannah sparrow, found where the percentage of ground cover is higher than for all the species above; the grasshopper sparrow, the most abundant species on the reclaimed surface mines, found especially in areas of tall grass; the vesper sparrow, found in open sections of grassland with low ground cover; and the bobolink, sighted on one surface mine in Preston County. Seventy-four percent of the land area of West Virginia is forested, and new areas of grassland produced by surface mine reclamation represent an important, if temporary, addition to the habitat of the state (Whitmore and Hall 1978).

In another paper, Whitmore (1979) considered changes in the vegetation structure of three reclaimed surface-mined areas in northern West Virginia and their effects on grasshopper sparrow population densities. He included in the study, however, observations on other species of sparrows, the horned lark, eastern meadowlark, and red-winged blackbird. Rough correlations were made of bird density and presence with such vegetational variables as mean effective height of vegetation; litter depth; and percentages of forb cover, litter cover, bare ground, and grass cover. The oldest area from date of reclamation (1970) he described as typical of many older mines in that the acid from the spoils had worked to the surface and begun to kill the vegetation which had resulted from seeding the mined area. On this site, between 1976 and 1978 (three breeding seasons), the breeding pairs of birds increased four-fold, while on the other two mined areas, the breeding pairs decreased to about one-third of their 1976 densities. The eastern meadowlark was an exception in that it increased as vegetation density increased and bare areas decreased.

Whitmore (1979) suggested that these variations in populations were due to changes in the amount of open areas on the sites. Optimum values of habitat variables were developed on the basis of these studies. The author concluded that grassland birds select a certain habitat patch out of the spectrum of available types, and that when the number or availability of such patches decreases, so does the number of birds. He stated that the choice of the patches for these species appears to be directed by overall density of ground cover and that there must be enough open or bare ground to allow the birds freedom to move about but enough cover to provide adequate nesting sites. Apparently, for grasshopper sparrows, territories must have at least 24 percent bare ground. Whitmore concluded that detailed study of the vegetation structure may have predictive value in determining which species will inhabit a site, but it cannot determine why the species is or is not there.

In southern West Virginia, the use of highwalls and adjacent mine benches in areas that had been mined from 3 to 23 years previously was surveyed for bird use by Crawford et al. (1978) and compared with bird populations on nearby unmined areas. The indigo bunting was the most common species on mined areas and was found more abundant on recently mined sites that had been revegetated with herbaceous and shrubby species than on older mines that supported tree growth. Field sparrows were the next most abundant birds, again prevalent on newer mines, and rufous-sided towhees were common on the newer mines. On sites mined less than 14 years previously, golden-winged warblers and goldfinches were relatively common; and yellow-breasted chats, yellowthroats, phoebes, and prairie warblers were found only on mined areas less than 14 years old.

Crawford et al. (1978) found red-eyed vireos to be common on mined areas of all ages, and on unmined areas, while dark-eyed juncos, black-capped chickadees, black-throated green warblers and veerys were
commonly found on older mined sites as well as unmined areas. Species found only on unmined areas included the acadian flycatcher, blackburnian warbler, bobwhite, broad-wing hawk, loggerhead shrike, magnolia warbler, pine warbler, prothonotary warbler, rose-breasted grosbeak, and winter wren.

The greatest number of bird species was found on unmined areas and on areas mined eight years before; the greatest number of birds was found on areas mined nine years before. As the amount of tree cover increased in the relatively open, recently mined sites, they gradually lost their value for species of open habitats or edge vegetation; however, they did not appear to accrue equal value to species that require mature forest habitats. These investigators concluded that high populations of birds that do not depend on tree cover are possible in early successional stages following contour strip mining. However, they believe that shrub cover with herbaceous cover is important to support large populations and suggest that seeding of grasses on benches and spoil banks should be supplemented with shrub plantings to obtain larger populations of birds.

Older strip-mined areas which have become revegetated through natural invasion of plants or through a combination of natural succession and plantings often provide good habitat for ruffed grouse. Kimmel and Samuel (1978) describe such an area in Monongalia County, West Virginia, in which the mine benches had been planted with black locust and autumn olive after mining and the areas above the highwalls were covered with species typical of a second growth hardwood forest with some openings and a light to moderate understory. Volunteer species such as black birch, clones of big-tooth aspen, goldenrod, and panic grass are common on the benches where the vegetation is fairly open and is characteristic of an early successional stage. The mixture of cover on the benches and above the highwall satisfies the requirements for ruffed grouse which are abundant on the area. The authors note that the benches of a mine like this remain in an early successional type structure for a longer period of time than an area with its soil horizons undisturbed. They point out that this May's Run area, mined and reclaimed 20 years ago, has vegetation similar to a 5- to 10-year successional stage.

Early stages of plant succession, if foods are available in sufficient amount and shrubby cover is present, also provide favorable habitat for bobwhite. Brown and Samuel (1978) reported that in northern West Virginia, controlled burning on two mined sites and a control plot showed promise as a means of maintaining the open herbaceous vegetative structure useful to the bobwhite. Burning removed the litter that obstructed quail chicks in their feeding on insects, a primary part of their diet during the first four weeks after hatching, and kept the trefoil, and other vegetation upon which the insects fed, to a height more within reach of the chicks.

Jernejcic (1978) reported on studies of water quality and fisheries of the Tygart subdivision of the Monongahela River basin in West Virginia. Apparently as a result of acid mine water drainage—much of it from deep mines, but part of it from surface mines—only remnant numbers of game fish, mainly acid-tolerant bullheads, remained in Tygart Lake in the late 1950s. Since 1960, however, the number of active deep mines has decreased markedly, and, with an increase in regulatory personnel in conjunction with more stringent laws, pH values have increased above 6. Gill netting in Tygart Lake in October 1972 produced 15 species. Jernejcic stated that circumstantially it appears that surface mining conducted under the 1971 Act caused an improvement in water quality of receiving streams.

EASTERN KENTUCKY. Effects of surface mining on fish and wildlife and the responses of these resources in eastern Kentucky are similar to those documented for southern West Virginia. Deer use older spoil banks that are in the more advanced states of revegetation and furnish suitable browse. Bobwhite occur on some of the areas, probably most abundantly some 8 to 12 years after mining. Foxes are common. Large dense pine plantations do not provide good habitat for most wildlife species and are lacking in understory food and cover plants (Kays 1967).

The effects of an active contour strip mining operation in eastern Kentucky on birds in adjacent forestland were observed by Allaire (1978a). Data collected in 1975 before mining, during mining in 1976-1977, and when mining was nearly complete in 1978 showed that the density and diversity of birds along a 100-meter-wide strip of forest adjacent to the active pit decreased during mining and began recovering when mining ceased. The temporary decline of the singing male population was 39 percent during mining. In other papers Allaire (1974, 1978b) drew attention to the potential grassland habitat for birds resulting from the reclamation of areas that had been mined by mountaintop removal.

Turner (1958) compared standing fish populations of a portion of Goose Creek near Manchester, Kentucky, that had been polluted with acid mine drainage in 1957, with another portion of the stream above the source of pollution. By electroshocking operations to collect fish 20 days after pollution occurred, he found that the weight of fish in the unpolluted water was nearly 12 times as great as that in the polluted area. Using estimated creel values for fish at that time, he calculated that the minimum economic loss of fish in 16.3 miles of the polluted stream on April 23, 1957, was $13,325.

Branson and Batch (1972) reported on the deleterious effects of acid mine drainage and siltation
from surface mining on fish populations of two small streams in east-central Kentucky. They found, after 17 months of a proposed five-year study, that the fish were affected by acid mine drainage. At that time, the authors were not optimistic about the fisheries of those streams in the future.

MARYLAND. Unreclaimed strip mine ponds in most of Northern Appalachia are generally poor fish habitat due to the long-lasting damaging effects of mining and type of overburden. Such ponds do offer some fish management possibilities, however, and are used by waterfowl, reptiles, and amphibians and, if not extremely acidic, as watering areas for wildlife. Davis (1971) reported on results of an 11-month study of Little Meadow Lake in Garrett County in western Maryland. This lake was created by building a dam at the outlet of an area mined in 1966. Some grading was done to provide access to the shoreline and facilitate revegetation. Raising the water level above the exposed coal seams probably curtailed or eliminated the oxidation of sulfuric materials and improved conditions for fish. Applications of lime were made to ensure that the pH of the water remained at 6 or above. Maximum temperature at the surface was 70°F and the bottom temperature was 53°F. Dissolved oxygen above 15 feet exceeded 7 ppm all year.

This lake was stocked from 1967-69 with channel catfish, pumpkinseed, bluegill, largemouth bass, white crappie, black crappie, rainbow trout, brown trout, brook trout, and tiger trout (Salvelinus fontinalis x Salmo trutta). The pond owner reported that a satisfactory trout fishery was being maintained by stocking. Bluegills, pumpkinseeds, brown bullheads, and golden shiners were reproducing. The latter two species were not stocked by the owner.

The Youghiogheny River, with its tributaries in Pennsylvania, Maryland, and West Virginia, was heavily polluted in the 1950s with acid mine drainage, municipal sewage, industrial effluents, and agricultural runoff in addition to siltation. Since then, with better pollution control, the basin has partially recovered. In a recent study, 52 species of fish in 10 families were collected and identified from the river (Stauffer et al. 1978).

VIRGINIA. Observations in 12 study areas on abandoned contour strip mines in southwestern Virginia confirmed the importance of ground cover and diversity of vegetation to breeding birds. The study areas represented different vegetative conditions on sites that had been mined from 11 to more than 30 years previously and ranged from mostly bare ground to young forest. There was a strong association between the number of breeding birds and the cover of vegetation up to one meter high, and, generally, with the development of higher canopy layers up to the point where closing caused a reduction in the understory vegetation. In areas with little understory vegetation, the number of breeding birds was less (Chapman et al. 1978). The implications of this study for management of birds, in view of the importance of a well-developed ground layer of vegetation, are to plant herbs and shrubs in areas with poorly developed ground vegetation. Planting of tree seedlings interspersed within the herbs and other cover to provide for the future development of higher vegetational strata, it is believed, will add to species diversity.

In Virginia, the Penn Virginia Corporation made available a mined area known as the Hagy for development as a "no-fee" public hunting area. This area was developed under a cooperative agreement among that corporation, the Virginia Commission of Game and Inland Fisheries, the Virginia Division of Mines Land Reclamation, and TVA. In describing this cooperative venture, Fowler and Perry (1973) point out that the reclamation of such contour strip mines for the benefit of wildlife involves consideration of the mined site and adjacent forest as an "ecological whole" since only a small portion of the daily home range of many wild animals is provided by a contour strip mine. On the Hagy area, many of the trees were of pole size and the primary habitat deficiency was thought to be marginal mast production; 70 percent of the ground cover on the orphaned spoil had been achieved by natural plant invasion since 1956. Such species as pokeweed, wild millet, grape, and greenbrier were good food and cover plants but were not present in sufficient numbers. Also, winter cover and sheltered travel lanes across the bench were lacking. Cottontail rabbits were the primary game species, although ruffed grouse made use of the toe of the outcrop. This situation, as described for the Hagy area, apparently is fairly typical of orphaned contour strip-mined sites in Appalachia.

Peltz and Maughan (1978) collected water and fish samples for analysis from five ponds on abandoned contour strip-mined areas in Wise County, Virginia, in 1976-77. The ponds, typical of those in the area, were steep-sided pits located on the bench against the highwall with little or no littoral area. All had fish presumably introduced by fishermen. Water samples showed low fertility and pH levels within the range considered necessary for good fish production. Total hardness, sulfates, and total solids in the water were all relatively high. Eleven fish species were collected in total from five ponds, and the mean estimated standing crops were extremely low—59.6 lbs/surface acre. Fertility and the composition of the fish species within the ponds appeared to be the principal factors limiting fish production. Species present included creek chub, stoneroller, northern hogsucker—all native to small streams in this area—and bluegill, redbreast sunfish, redear sunfish, largemouth bass, rock bass, black crappie, and brown bullhead. The authors believed the
ponds had fishery potential with proper management.

Headwater streams in southwestern Virginia were studied to determine the sustained impact of contour surface mining on populations of fish and bottom-dwelling organisms (Matter et al. 1978). Sulfate, total hardness, and silt indices were higher in streams draining abandoned mines than in control streams, and the total abundance and taxonomic richness of fish and benthic invertebrate populations were reduced, even 10 to 20 years after abandonment. The investigators found that these reductions bore some relation to the degree of sedimentation—particularly fine particle sedimentation presumably associated with mining and the construction, use, and abandonment of haul roads—but not to pH. The study also revealed that acid from other sources could completely mask the effects of sedimentation originating from surface mines in the watershed.

TENNESSEE. Bird populations on three contour mines that had been subjected to different types and different degrees of reclamation located in mixed mesophytic forest on the mountainous eastern edge of the Cumberland Plateau of Tennessee were studied by Curtis et al. (1978). Here, intensive wildlife oriented reclamation techniques included judicious placement of wildlife food and cover plants, such as autumn olive and crabapples, among the pines and hardwoods. This created a multi-layered vegetation structure and accelerated bird recovery and successional patterns on mined areas. Apparently, on older narrow-bench contour mines, where various rapid-growing hardwood, pine, and shrub seedlings are used, the recovery of avian species diversity and composition similar to mature forest conditions may be attained within a 13-15 year period. Exposed ledges on rock highwalls were found to be used as nesting sites by eastern phoebes and rough-winged swallows.

Vaughan et al. (1978) analyzed the time course of recovery for diatom, fish, and insect communities in streams polluted by runoff from contour strip mines in east Tennessee. Sampling was done in 24 streams in areas where mining had ceased 23 years previously or less including areas in which there was current mining. They found that, for insects, the total population size, species diversity, and total number of taxa dropped to a minimum within three to four years of initial mine activity but slowly returned to predisturbance values over a period in excess of 20 years. The effects on species diversity of fish were similar, but only those fish populations in streams where upstream migration was possible could recover. In those streams capable of maintaining any fish in the immediate postmining period, the creek chub, a top-water feeder, comprised most of the population, whereas bottom-feeding species, such as the darters, were eliminated. Diatom communities did not completely recover, but species diversity did increase over time.

Vaughan et al. (1978) concluded that contour mining for coal, as has been practiced in the New River drainage basin, profoundly affects population size, species richness, and equitability of the different groups of organisms they studied, but that streams can return to a “healthy,” if not the original, condition over a period of perhaps 20 years. Even after 20 years, species composition of aquatic insects differs from prepollution conditions and, apparently, those species most susceptible to siltation suffer the greatest attrition. Thus, particularly in the case of alkaline drainage systems, the impact of mining could be reduced if it were possible to prevent the entry of so much particulate material and silt into the streams.

Another study of the New River in Tennessee (Winger 1978) revealed that, on the basis of chemical analyses alone, only a few of the sampling stations appeared to be stressed; however, when biological information was considered, nearly all of the stations showed some degree of stress resulting from acid mine drainage and sedimentation. The investigator pointed out that determining the ability of water to sustain natural populations of aquatic organisms cannot be based solely on circumstantial evidence provided by water chemical analysis, but should also include analysis of the natural biological monitors that reside in the system.

ALABAMA. At this southern end of Appalachia, Terrel and French (1976) studied wintering bird populations in three major coal fields in 1973-74. Each of the three study units consisted of a 5-, 15-, and 25-year-old abandoned mine site (with no reclamation) and two or three adjacent unmined plots of second-growth forest, mostly oak-hickory-pine. They found that the density of birds—particularly field sparrows, dark-eyed juncos and mourning doves—was highest on plots on sites mined five years previously, but the species diversity was lowest on these plots. The total numbers of species observed were 16 on the 5-year-old plots, 31 on the 15-year-old plots, 32 on the 25-year-old plots, and 38 on the unmined forest areas used for comparison. The studies indicated that nearly normal species composition in relation to second growth forests of the area would be reached 25 to 35 years after stripping occurred; however, there was great variability between mined sites of the same age class. In contrast to the mourning dove, which occurred mostly on the 5-year-old sites, the bobwhite was found most frequently in the 15-year-old mined areas. Neither species was well represented in the older seral stages.

Using some of the same study areas on the Sunlight Mines in Walker County, Alabama, Winterringer (1978) followed bobwhite movements by means of radiotelemetry. During the summer, 39.1 percent of the land in the ranges of the male bobwhite was unmined land and quail activities were often centered on the unmined, usually forested, land tracts. Also,
slightly more than one-third of the land used as fall and winter range was unmined. This emphasizes the importance of maintaining, undisturbed, land not stripped in mining operations.

Waterfowl use of strip mine ponds in Alabama was studied by Smith (1978). He stated that wood ducks use older-aged ponds with extensive shoreline vegetation and overhead cover for nesting and brood rearing, and that the more secluded ponds also may be used as molting sites. Apparently, even excessively acidic ponds can be useful to wood ducks if the shoreline vegetation provides enough invertebrates as food to enable the young to reach the flight stage at which time they can disperse to surrounding ponds which support more vegetation. He pointed out that diving ducks, such as ringnecks, use any age ponds as resting areas during migration and may winter on ponds which have a suitable food source. Beavers, he stated, are beneficial in that they provide loafing sites for ducks and habitat for invertebrates when they fell trees into the water. Such trees also contribute organic matter to the relatively sterile ponds.

Among possible management measures suggested by Smith (1978) are: (1) during reclamation of the surface mined site, construction of impoundments with gently sloping margins, a minimum of 1.5 hectares in surface area, and a maximum depth of approximately 3.5 meters because shallow water is more productive of waterfowl food; (2) planting and establishment of submergent and emergent plants for waterfowl food and cover soon after reclamation grading is completed; and (3) erection of wood duck nesting boxes soon after reclamation efforts are completed.

Note to the reader

Part 1 is primarily a review of the literature dealing with surface mining and reclamation-wildlife relationships in the eastern United States prior to implementation of P.L. 95-87. Part 2, which follows, provides an introduction to this law and suggests some of the implications of the law for fish and wildlife management in the future.
Newly surface-mined area "returned to contour" at demonstration site in Eastern Tennessee.

(Photo, T.M. Franklin)
PART 2

Public Law 95-87* as Related to
Fish and Wildlife Planning and Management:
The Law, Its Administration, and Suggested
Sources of Information For Its Implementation

Summary of Part 2

P.L. 95-87, the Surface Mining Control and
Reclamation Act of 1977, is identified and described
briefly with particular regard to environmental
standards required for surface mining and reclamation
and to provisions of primary relevance to the
protection, conservation, and management of fish and
wildlife resources and habitats. Enactment of this law
is viewed as beginning a new era of surface mining and
control. It presents new opportunities and challenges
for fish and wildlife planning and management. The
extent to which fish and wildlife resources are
protected or enhanced through implementation of the
Act will depend in large part upon the participation of
fish and wildlife biologists and the interested public in
the preparation of mining permits and state
reclamation plans. Topics in Part 2 are treated under
the following headings:

Introduction

1. This cites the Act and the related Rules and
Regulations as published in the Federal Register. It
points out that in addition to sources of information
and assistance mentioned in the text in relation to
administering and implementing the Act, other
sources are provided in the References Cited section
and in designated appendices.

New Opportunities and Challenges for Fish
and Wildlife Planning and Management

1. P.L. 95-87 is described briefly as to purposes and
provisions for funding.
2. Essentially all of the standards for environmental
protection that must be met in future surface mining
for coal and reclamation of mined sites are relevant to
fish and wildlife.
3. Reference is made to the use of the best
technology currently available (BTCA) required to
minimize the disturbances and adverse impacts of
mining and reclamation activities on fish and wildlife
and on related environmental values and for achieving
enhancement of such resources where practicable.
4. Possible exceptions to the requirements of the
Act for the enhancement of fish and wildlife resources,
e.g., by impoundments on reclaimed areas or by
designation of certain tracts as unsuitable for mining,
are mentioned.

Implementation of P.L. 95-87 and Relevance
of Other Environmental Laws

1. Roles of Federal agencies in administering P.L.
95-87, excerpted from the Act, are briefly described:
(a) The USDI Office of Surface Mining
Reclamation and Enforcement.
(b) The USDA Soil Conservation Service with
respect to administering and implementing
the Rural Abandoned Mine Program
(RAMP).
2. Roles and functions of the states in implementing
P.L. 95-87 are discussed.
3. Roles and functions of coal mine operators and
land owners are discussed.
4. The role of the public is noted in the
development, revision, and enforcement of regulations,
standards, reclamation plans, and programs established
under the Act by the Secretary of the Interior or any
state.
5. Possible sources of assistance or information that
can be provided in implementing the Act are
summarized. In the U.S. Department of the Interior
these include the Office of Biological Services, the
Bureau of Land Management, the Bureau of Mines,
and the Geological Survey; in the U.S. Department of
Agriculture they include the Soil Conservation
Service, the Agricultural Research Service, the Forest
Service, and the Agriculture Stabilization and
Conservation Service.
6. Other Federal laws and agency involvements
relevant to surface mining for coal and the reclamation
of surface-mined lands are discussed. In particular, the
U.S. Environmental Protection Agency and the U.S.
Army Corps of Engineers are involved, in addition to
the U.S. Departments of the Interior and Agriculture.

*See Preface note
Introduction

This part of the report is intended to acquaint the reader with some of the requirements of P.L. 95-87—The Surface Mining Control and Reclamation Act of 1977—and other laws with respect to planning and management and to outline the roles of agencies, the mining industry, landowners, and the public in implementing P.L. 95-87. Suggestions also are given on the types of technical information and assistance other agencies and organizations can provide.

Some of the provisions of the law have not been tested in court and many of the state specifications are yet to be developed. Also, because more comprehensive analyses and interpretations are being prepared for publication, this review is brief. For more details, readers are advised to consult with agencies charged with implementing the Surface Mining Control and Reclamation Act of 1977 or refer to the Act itself (30 USC 1201) and the related Rules and Regulations. The latter were published in the Federal Register as follows: Rural Abandoned Mine Program—Final Rules and Regulations, 43(189):44747-447576, September 28, 1978; Abandoned Mine Land Reclamation Program—Final Rules, 43(201):49931-49952, October 25, 1978; Surface Coal Mining and Reclamation Operation (Book 2)—Permanent Regulatory Program, 44(50):14901-15309, March 13, 1978; and Book 3—Permanent Regulatory Program, 44(50):15311-15463, March 13, 1978. Other sources of information and assistance are provided in the text of Section II of this report, in the References Cited, and in the Appendices.

In addition, readers may wish to refer to the “Final Regulatory Analysis” of the Permanent Regulatory Program of the Surface Mining Control and Reclamation Act of 1977. Published by the Office of Surface Mining Reclamation and Enforcement, U.S. Department of the Interior, as OSM-RA-1, March 1979, this analysis is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Stock No. 024-020-00001-1). It summarizes impacts on the coal industry and the economy of major alternatives considered in developing the regulatory program as required by Section 501 of P.L. 95-87. The analyses reported in the Regulatory Analysis were used in decision making to help balance environmental, technical, and economic considerations subject to applicable legal constraints.

New Opportunities and Challenges for Fish and Wildlife Planning and Management: P.L. 95-87

P.L. 95-87: An Overview in Relation to Fish and Wildlife

With enactment of P.L. 95-87, a new era of surface mining control and reclamation began. This Act provides for cooperation between the Secretary of the Interior and the states with respect to the regulation of surface coal mining operations and the acquisition and reclamation of abandoned mines. It contains provisions intended to assure that such mining operations are so conducted to protect the environment and are not conducted where reclamation as required by the law is not feasible. Also, the Act deals in part with underground mining operations, particularly as related to surface effects, and it provides for a study of reclamation standards for surface mining and reclamation for minerals other than coal.

Funds for reclamation of abandoned mines will come from coal operators—eventually the consumers—who will pay 35 cents per ton of surface-mined coal and 15 cents per ton of underground-mined coal. The reclamation fees will yield an estimated $140-$160 million per year which will be deposited in an Abandoned Mine Reclamation Fund to be administered by the Secretary of the Interior.

Half of these funds will go directly to the state or Indian reservation from which the fees were paid, provided there is an approved abandoned mine reclamation program; the other half of the funds may be spent in any State either directly by the Secretary of the Interior or by making additional grants for reclamation, including up to 20 percent which may go to the Soil Conservation Service to be cost-shared with landowners for reclaiming abandoned mine lands. The Act authorizes annual appropriations by the Congress for allotments to approved state mineral resources research institutes and for administration of the program by the Secretary of the Interior.

The Act provides for establishing minimum Federal standards for active surface and underground mining for coal and for reclamation operations which will permit the mining of coal essential to the Nation’s energy requirements, protect the environment, and assure agricultural productivity. Measures for environ-
mental protection are incorporated in the state and federal mining permits and reclamation plans for individual mining operations. Compliance with the standards will be ensured by the federal or state governments through on-site inspections and various strong enforcement sanctions.

The environmental protection standards that must be met in future surface mining of coal and reclamation of mined sites are specified in Section 515 of the Act. Essentially all of these are relevant to fish and wildlife. Generally they are expected to improve conditions for fish and wildlife, particularly from the standpoints of reduced erosion and sedimentation, reduced acid mine drainage, and the restoration of the land to a condition capable of supporting vegetation and either the uses which it was capable of supporting prior to any mining, or perhaps higher or better uses.

The standards generally are expected to reduce erosion and sedimentation, limit acid mine drainage, permit the restored land to support either uses identical to those it had before any mining, or better or higher uses. An important provision in Section 701.5 of the Permanent Regulatory Program (Rules and Regulations) defines "best technology currently available" in terms of accomplishments rather than means for achieving them. Section 816.97 (a) of the Permanent Regulatory Program states: "Any person conducting surface mining activities shall, to the extent possible using the best technology currently available, minimize disturbances and adverse impacts of the activities on fish, wildlife, and related environmental values, and achieve enhancement of such resources where practicable." Several specific requirements designed to protect or enhance fish and wildlife are listed in this section. Paragraph 10 of this section states, for example, "Where cropland is to be the alternative postmining land use on lands diverted from a fish and wildlife premining land use and where appropriate for wildlife and crop management practices, (the miner shall) intersperse the fields with trees, hedges, or fence rows throughout the harvested area to break up large blocks of monoculture and to diversify habitat types for birds and other animals. Wetlands shall be preserved or created rather than drained or otherwise permanently abolished...."

In Section 701.5 of the Permanent Regulatory Program (Rules and Regulations), BTCA, best technology currently available, is defined in part as "equipment, devices, systems, methods or techniques which will (a) prevent, to the extent possible, additional contributions of suspended solids to stream flow or runoff outside the permit area, but in no event result in contributions of suspended solids in excess of requirements set by applicable State or Federal laws; and (b) minimize to the extent possible, disturbances and adverse impacts on fish, wildlife, and related environmental values, and achieve enhancement of these resources where practicable...." The latter objective (b) is repeated in Section 810.2 (e) of the Permanent Regulatory Program dealing with general provisions for performance standards.

One of the reclamation requirements of the Act, however, is to restore the spoils to approximate the original contour of the land with all highwalls, spoil piles, and depressions eliminated (unless small depressions are needed in order to retain moisture to assist revegetation or as otherwise authorized). Provisions are made for certain exceptions, such as mountaintop removal, where restoration to the approximate original land contour is impossible or undesirable. Possibly a case can be made for retaining for fish and wildlife some depressions or impoundments if they serve also to minimize erosion, conserve soil moisture, or promote vegetation. Likewise, if fish and wildlife is selected as a high priority postmining use, it might be feasible to explore possibilities under Section 515 (c) of the Act of getting approval for exception to restoration of the original contour.

As of November 1979 the Office of Surface Mining had proposed changes that would provide for variances from the requirement to return land to its approximate original contour (AOC) and permit more flexible alternatives to coal operators in promoting environmentally sound reclamation. The proposed changes would allow for variance from AOC to improve watershed control of lands within the permit area and on adjacent lands, and allow the land to be used for an industrial, commercial, residential, or public use, including recreation facilities.

Section 515 (b) 8 permits creation, if authorized in the approved mining and reclamation plan and permit, of permanent impoundments of water on mining sites as part of reclamation activities when it is adequately demonstrated that: the size of the impoundment is adequate for its intended purposes; the impoundment dam will be designed so as to achieve necessary stability with an adequate margin of safety compatible with that of structures constructed under Public Law 83-566; the quality of impounded water will be suitable on a permanent basis for its intended use, and discharges from the impoundment will not degrade the water quality below water quality standards established pursuant to applicable Federal and state law in the receiving stream; the level of water will be reasonably stable; final grading will provide adequate safety and access for proposed water users; and such water impoundments will not result in the diminution of quality or quantity of water utilized by adjacent or surrounding landowners for agricultural, industrial, recreation, or domestic uses.

Under Title IV of the Act, dealing with abandoned mine reclamation, provisions in Section 407 (c) permit the Secretary or the state, pursuant to an approved state program, to acquire any land, by purchase,
donation, or condemnation, which is adversely affected by past mining practices if the Secretary determines that acquisition of such land is necessary to successful reclamation and that the acquired land, after restoration, reclamation, abatement, control, or prevention of the adverse effects of the past coal mining practices, will serve recreation and historic purposes or provide open space benefits, and so forth.

As provided for in Section 522 of P.L. 95-87, certain areas of a state may be designated as unsuitable for surface mining. These include fragile or historic lands in which such mining could result in significant damage to important historic, cultural, scientific, and aesthetic values of natural systems. Except for Federal lands, the state, upon getting its Program approved by the Office of Surface Mining, will have the responsibility for designating lands as unsuitable for surface mining. Some of these areas may have special value to wildlife, such as habitats of endangered species. Each state is required to develop a data base and inventory of these lands, and OSM is currently developing a national inventory system working with the Oak Ridge National Laboratory.

The priorities listed in the Act for expenditure of monies from the Abandoned Mine Reclamation Fund are in the following order:

1. the protection of public health, safety, general welfare, and property from extreme danger of adverse effects of coal mining practices;
2. the protection of public health, safety, and general welfare from adverse effects of coal mining practices;
3. the restoration of land and water resources and the environment previously degraded by adverse effects of coal mining practices, including measures for the conservation and development of soil, water (excluding channelization), woodland, fish and wildlife, recreation resources, and agricultural productivity;
4. research and demonstration projects relating to the development of surface mining reclamation and water quality control program methods and techniques;
5. the protection, repair, replacement, construction, or enhancement of public facilities such as utilities, roads, recreation, and conservation facilities adversely affected by coal mining practices; and
6. the development of publicly owned land adversely affected by coal mining practices including land acquired as provided in Title 4 for recreation and historic purposes, conservation, and reclamation purposes and open space benefits.

The general location of abandoned coal mined lands in the United States is shown in Appendix A.

Thus, funds are authorized for reclamation of mined lands for wildlife and for other types of land use which have value for fish and wildlife. Likewise, the various provisions in the Act which are intended to provide environmental protection in coal exploration and mining have an important bearing on fish and wildlife habitat.

The extent to which fish and wildlife resources are protected or enhanced through implementation of P.L. 95-87 and other Federal environmental acts and state laws which relate to surface mining and reclamation will depend in part upon the participation of fish and wildlife biologists and the interested public in the development of mining and reclamation permits and State reclamation plans.

Implementation of P.L. 95-87 and Relevance of Other Environmental Laws: Responsibilities and Sources of Assistance

This section summarizes the roles of state and Federal agencies, coal landowners, and the public in implementing the Act. It further lists types of assistance that can be provided by other agencies and organizations.

Federal Agencies

Office of Surface Mining
Reclamation and Enforcement

P.L. 95-87 established the Office of Surface Mining Reclamation and Enforcement (OSM) in the U.S. Department of the Interior to administer the programs required by the Act. Among the many functions of OSM are the following:

1. to administer the state grant-in-aid program for the development of state programs for surface mining and reclamation operations provided for in Title V of the Act;
2. to administer the programs for the purchase and reclamation of abandoned and unreclaimed mined lands pursuant to Title IV of the Act;
3. to assist the states in the development of state programs for surface coal mining and reclamation operations which meet the requirements of the Act, and at the same time, reflect local requirements and local environmental and agricultural conditions; and
4. to assist the states in developing objective scientific criteria and appropriate procedures and institutions for determining those areas of a state to be designated unsuitable for all or certain types of surface coal mining pursuant to Section 552 of the Act.

Excerpted in this manner from the Act, these roles appear to be simple and clear-cut but in reality are complex. Development of the final rules for the Abandoned Mine Land Reclamation Program, the
Permanent Regulatory Program, and the Final Regulatory Analysis mentioned in the Introduction to Part 2, alone, required much effort and consultation. Information on these roles and other activities may be obtained by writing the Office of Surface Mining Reclamation and Enforcement, U.S. Department of the Interior, Washington, DC 20240 or the OSM Regional Offices. (See Appendix B.)

Other Agencies in the U.S. Department of the Interior

The Fish and Wildlife Service in the Department of the Interior can also provide assistance in the implementation of P.L. 95-87. Particularly important elements are the Office of Biological Services (OBS), Office of Endangered Species, Division of Wildlife Ecology Research, Division of Fishery Ecology Research, Office of Fishery Assistance, and the Division of National Fish Hatcheries. Others are the Bureau of Land Management, the Geological Survey, the Bureau of Mines, and the Heritage Conservation and Recreation Service. All of these agencies, offices, or divisions may be contacted at the U.S. Department of the Interior, Washington, DC 20240 and many of them through regional offices.


Copies of these reports are available upon request from EELUT, as are copies of: the proceedings of a workshop on Methods for Assessment and Prediction of Mineral Mining Impacts on Aquatic Communities: a Review and Analysis (Mason 1978): an Annotated Bibliography on the Ecology and Reclamation of Drastically Disturbed Areas (Czapowskiyj 1976), a Guide for Vegetating Surface-Mined Lands for Wildlife in Eastern Kentucky and West Virginia (Raifail and Vogel, 1978), and other relevant materials. In addition, EELUT, in cooperation with the USDA Forest Service and state agencies, has developed a computerized data system for fish and wildlife resources. This system (Mason et al. 1979), currently being used or implemented in Alabama, Pennsylvania and West Virginia, provides wildlife managers with documented ecological information on individual species of wildlife, including: distribution; protection status; association with vegetation or water body type; food habits; cover requirements; key habitat factors; and management practices.

Other Fish and Wildlife Service offices or divisions can provide information on requirements of, and management techniques for, species that may be affected by surface mining for coal, on procedures for dealing with threatened and endangered species and their habitats, on fish management in strip mine ponds, and on the availability of fish for stocking.

The Bureau of Land Management, in connection with P.L. 95-87, is concerned primarily with the leasing of Federally-owned land for coal mining and protection of natural resources, including fish and wildlife, on public lands. Information relevant to management of Federally-owned coal lands and to a planning system for public lands and resources is published in the Federal Register, Part VIII for July 19, 1979, and in Part II for August 7, 1979, respectively.

It may be possible for states with approved programs to receive financial assistance in acquiring land and developing it for public fish and wildlife and recreation use from the Land and Water Fund administered by the Heritage Conservation and Recreation Service. Some demonstration projects have been funded in the past.

The Bureau of Mines can provide information on the technology of mining for coal, on such reclamation methodologies as backfilling strip mined areas (Griffith et al. 1966), on costs of reclamation, and on coal production statistics.

The Geological Survey develops and maintains much information on surface and ground water quality and quantity and can provide topographic and other types of maps and information useful in planning for surface mining and reclamation. Geological Survey Circular 731 (Imhoff et al. 1976) serves as a primer on surface mining and reclamation. It presents information on the status of state programs and laws on this subject. A guide to obtaining environmental data base information from the USGS has been prepared by Clarke et al. (1978).

U.S. Soil Conservation Service

The Soil Conservation Service receives funds transferred to the Secretary of Agriculture from the Abandoned Mine Reclamation Fund for administering and implementing the Rural Abandoned Mine
Program (RAMP) authorized by Section 406 of P.L. 95-87. Through this program it is estimated, on the basis of full annual funding of about $40 million, that some 5,800 acres of abandoned coal mines will be reclaimed yearly. Thus, over the 15-year period for which RAMP is authorized, approximately 87,000 acres of abandoned coal mine lands would be reclaimed, resulting in approximately 35,000 acres of woodland, 26,100 acres of pastureland, 17,200 acres of wildlife land, and 8,700 acres of cropland (USDA 1978a).

RAMP will be administered by the Soil Conservation Service in cooperation with local conservation districts. The SCS is not required under the Act to work with the reclamation of active mines but would render technical assistance, if requested, in the same manner as for rural abandoned mine land. Land user participation in RAMP is voluntary, but through contracts of 5 to 10 years, the program provides for cost-share assistance for installing reclamation and conservation practices on abandoned coal mines. The contracts are to be based on approved reclamation plans prepared by land users with technical assistance from the SCS. The reclamation plans will prescribe vegetation, mechanical, and other measures that will achieve the objectives of RAMP and the land user. Environmental assessments are used in developing the reclamation plan (USDA 1978a).

State Reclamation Committees within RAMP have an important function in developing the reclamation plans. These committees, made up of knowledgeable state, Federal, and private sector personnel, review proposed projects, recommend priority rankings, and make other recommendations to the SCS concerning site-specific reclamation plans.

Depending upon the income-producing potential of the land after reclamation, the Federal cost-share rate for applying land use and conservation treatment may be up to 80 percent for 120 acres or less. This rate may be increased to a level required to obtain participation when the main benefits of reclamation accrue to the public and there is declaration of financial burden. The cost-share rate is reduced proportionately by up to 0.5 percent per acre for acreage in excess of 120 acres up to 320 acres maximum. The SCS Administrator may establish specific rates according to these criteria. Initially, the cost-share rates will range from 25 to 100 percent (USDA 1978a). Although the SCS could conceivably provide 100 percent cost-sharing if fish and wildlife were designated the primary postmining use of a reclaimed area, fish and wildlife may often be considered a secondary use in RAMP. Some district conservationists, however, think that fish and wildlife production is the best use of reclaimed lands and are encouraging landowners to consider this as a primary land use alternative. In any case, it is important to incorporate provisions for fish and wildlife enhancement into plans for reclaiming mined lands for woodland and agriculture.

The reclamation plan developed for a mined area by the land owner in cooperation with the conservation district and the district conservationist or other professionals identifies all reclamation and conservation practices needed to realize the program objective. Other practices that enhance the quality of the environment over and above the essential conservation treatment may be included. For example, provisions for establishment of field border vegetative cover and shrub plantings to improve wildlife habitat, where cropland is the planned use, can be included in the plan. All conservation treatment must meet the standards and specifications in the local SCS technical guide and these, in turn, must meet the minimum requirements of applicable Federal and state laws (USDA 1978a).

In addition to administering RAMP and providing technical assistance with respect to its implementation, the SCS provides technical services, information on soil capabilities, and other information valuable to technicians, landowners, and others working on different parts of the surface mining and reclamation program. In addition to many publications dealing with revegetation and erosion control on surface mined lands, there is a recently revised National Handbook of Conservation Practices (NHCP) available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (USDA 1977b). This handbook establishes official names, definitions, national standards and specifications, or guides to specifications, for the practices commonly used in soil and water conservation programs including water management, pollution abatement, improved fish and wildlife habitat, and improved quality of the environment. Specifications appropriate for each state or field office are to be developed in the detail needed for applying the practices locally. Of particular interest in surface mining and reclamation are the design criteria and specifications related to grading, diversion ditches, dams, and other water control structures.

Another pertinent SCS reference is Agriculture Handbook No. 387, Ponds for Water Supply and Recreation (USDA 1971), which outlines requirements for developing a pond for water supply and provides design criteria and specifications for dams and spillways.

To help meet the diverse needs for plant materials in conservation work, the SCS operates plant materials centers where different plants are tested for potential use for erosion control, wildlife food and cover, and beautification. As a result of cooperative work with other State and Federal agencies, including the Agricultural Research Service (ARS), several new
species or varieties of plants useful for revegetating surface-mined areas have been identified or released for commercial production (MacLauchlan 1975).

Other USDA Agencies

The Agricultural Research Service (ARS) also does research on methods of revegetating surface-mined lands and has published useful material on species suitability for different kinds of spoils and on the kinds and amounts of soil amendments needed for good plant survival and growth on different soils. This subject is dealt with very well in the publication, *Revegetation of Land Disturbed by Strip Mining of Coal in Appalachia* (Armiger et al. 1976).

The U.S. Forest Service has done, and continues to do, much research related to the revegetation of surface-mined areas. In Illinois, Indiana, and Ohio, much of this was done in the past by the former Central States Forest Experiment Station; in the East it was done by the Northeastern Forest Experiment Station, Upper Darby, Pennsylvania. Currently the work unit of the Forest Service’s watershed management research in the East which does research on reclamation of surface-mined areas is located on Center Street, Berea, Kentucky 40403. The mission of this work unit is to develop practical methods of reducing damage to the environment and forest resources during surface mining operations and to rehabilitate mined areas for the production of quality water, timber, wildlife, recreation, range, and aesthetic benefits. Among the problems being researched are overburden and spoil properties, spoil movement and placement, sediment and chemical pollution of streams, revegetation of steep banks and toxic spoils, and wildlife. Much useful information can be obtained by contacting this unit with respect to reclamation of mined areas in Appalachia. A representative publication is that by Vogel (1975) on requirements and use of fertilizer, lime, and mulch for vegetating acid mine spoils.

Under the Cooperative Forestry Assistance Act of 1978 (P.L. 95-313), the Forest Service can cooperate with the SCS and the Agricultural Stabilization and Conservation Service (ASCS). Under such programs, the Forest Service can assist in increasing timber inventories, improving and maintaining fish and wildlife habitat, and providing other forest resources on non-federal forest land. P.L. 95-113 authorizes the Secretary of Agriculture to provide financial, technical, and related assistance to State foresters or equivalent State officials to:

1. develop genetically improved tree seeds;
2. procure, produce, and distribute tree seeds and trees for the purpose of establishing forest, windbreaks, shelterbelts, woodlots, and other plantings;
3. plant tree seeds and trees for the reforestation of non-federal forest lands suitable for the production of timber and other benefits associated with the growing of trees;
4. plan, organize, and implement measures on non-federal forest lands, including, but not limited to, thinning, prescribed burning, and other silvicultural practices designed to increase the quantity and improve the quality of trees and other vegetation, fish and wildlife habitats, and water yielded therefrom;
5. protect or improve soil fertility on non-federal forest lands and the quality, quantity, and timing of water yields; and
6. provide technical information, advice, and related assistance to private forest landowners and managers, vendors, forest operators, wood processors, public agencies and individuals.

Such information and assistance extends to the above operations and the effects of forestry practices on fish and wildlife and their habitats. Landowners wanting forest management assistance can contact their State forester, county agent, Soil Conservation District, or other agricultural agency for help in reaching the nearest service forester.

State foresters furnish landowners with forest tree seedlings at moderate cost. The Federal government cooperates in this work but much of the expense of raising the trees is borne by the state governments. According to the Forest Service’s 1977 *Report—Forest Planting, Seedling and Silvical Treatments in the United States* (USDA Forest Service, 1978), special purpose tree plantings from October 1, 1976-September 30, 1977 included 30,501 acres for surface mine reclamation and 17,935 acres for wildlife purposes.

Application forms and guidance can be secured through the state forester; the county extension agent; the SCS; local private consulting forester; and, for cost-share assistance to plant trees or improve tree stands, through the ASCS office.

U.S. Forest Service regional offices in the Midwest and the East are located as follows:

Forest Service, USDA
Eastern Region
633 West Wisconsin Avenue
Milwaukee, WI 53203

and

Forest Service, USDA
Southern Region
1720 Peachtree Road, NW
Atlanta, GA 30309
The Cooperative State and Private Forest Service Regional offices in the East are located as follows:

Forest Service, USDA
Northeastern Area
370 Reed Road
Broomall, PA 19008

and

Forest Service, USDA
Southeastern Area
1720 Peachtree Road, NW
Atlanta, GA 30309

The names and addresses of USDA Forest Service representatives for mining and reclamation as of October 18, 1978 are given in Appendix D. A list of state agencies in eastern coal-producing states cooperating with the U.S. Forest Service is presented in Appendix E.

The Forestry Incentive Program (FIP) authorized by P.L. 95-313 is intended to encourage private forest lands. Individual forest management plans are developed by the landowner and the Secretary of Agriculture, and the costs of implementing the forestry practices are shared up to 75 percent by the Federal government. Landowners can determine whether their county is participating in FIP by checking with their county Agricultural Stabilization and Conservation Service Office (ASCS), State Forester, or Extension Service Office.

The Agricultural Conservation Program, administered by ASCS with technical assistance from SCS and the Forest Service, provides cost-sharing assistance to farmers for applying practices to their land for soil and water conservation, pollution abatement, and woodland management, including those beneficial to fish and wildlife. A visit to the local ASCS office would enable an owner of strip-mined land to determine whether assistance could be obtained through this program in reclaiming his land. The Washington address is Agricultural Stabilization and Conservation Service, U.S. Department of Agriculture, P.O. Box 2415, Washington, DC 20013.

Other Federal Laws and Agency Involvements

In addition to P.L. 95-87, there are many other Federal laws and executive orders intended to protect the environment and certain resources which have relevance to surface mining and reclamation. Many of them relate to environmental assessment as an integral part of reclamation planning (USDA 1978a). Various Federal agencies are involved in the enforcement of environmental laws.

The Federal Water Pollution Control Act of 1972 as amended (the Clean Water Act of 1978) is very pertinent to surface mining and reclamation. It establishes the overall goal of eliminating the discharge of pollutants into navigable waters of the United States by 1985 and an interim goal of achieving water quality "which provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water" by 1 July 1983. The Corps of Engineers shares responsibility with the Environmental Protection Agency (EPA) for control of pollution in navigable streams and their tributaries and has other responsibilities, chiefly over navigable waters, which makes it variously responsible for streams in coal-mining areas. There are agreements between EPA, the Corps, and several of the states.

This Act provides for various planning processes that must be used by EPA (which administers the Act), the states, and local responsible agencies. Comprehensive water resources management is required by Section 208, which deals with nonpoint-source pollution, including surface and underground mine runoff. Each state or regional authority is required to prepare area-wide plans for control of nonpoint-source pollution. Each plan prepared under this Act must address "mine-related sources of pollution, including new, current, and abandoned surface and underground mine runoff." The plan must also "regulate the location, modification, and construction of any facilities within such area which may result in any discharge in such area." Thus, advance siting approval may be required for any structure which discharges mine water into streams.

The Water Pollution Control Act also requires National Pollutant Discharge Elimination System (NPDES) permits for all point-source pollution. These permits are issued by EPA or by the states with approved NPDES programs. Therefore, prior to undertaking reclamation of abandoned mines, the landowner should obtain all necessary approvals and permits for the discharge of pollutants into navigable waters. The locations of regulatory offices of EPA are shown in Appendix F.


Among those acts, in addition to P.L. 95-87, cited by Stewart et al. (1979) as requiring consideration in determining land suitability or unsuitability criteria on the basis of fish and wildlife habitat are: Anadromous Fish Conservation Act; Bald Eagle Protection Act; Endangered Species Act; Federal Land Policy and
Management Act; Fish and Wildlife Act of 1956; Fish and Wildlife Coordination Act; Migratory Bird Treaty Act; and the Sikes Act. For further information refer to Section 522 of P.L. 95-87 and to the final rules and regulations pursuant to this law.

Regulations as developed by the Council on Environmental Quality for implementing the procedural provisions of the National Environmental Policy Act have been reprinted from the Federal Register (Reprint 43FR 55978-56007, November 29, 1978, 40CFR Parts 1500-1508).

Under Section 7 of the Endangered Species Act of 1973 as amended, Federal agencies are obligated to ensure that any action authorized, funded, or carried out by the agency does not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of habitat of such species considered to be critical after consultation as appropriate with the affected states. Specific guidance on consultation procedures and requirements is provided in 50 CFR Part 402—Rules and Interagency Cooperation.

State Agencies

Those states participating in the program authorized by P.L. 95-87 have a very important role in implementing the Act. Most of the money expected to be made available in accordance with the Act will go to the states and the effectiveness of the program will depend largely upon how well the funds are used. Coal operators pay the fees for reclamation of surface-mined lands, but the costs are passed back to the consumers. Most of the mining is done on private land and the owners have the lead role in determining whether their land is mined and what the postmining use will be, but the public has a concern also. Thus, the state agency for surface mining reclamation and enforcement or its equivalent through which most of the funds are channeled, has challenging responsibilities. Most states have several other agencies or divisions concerned with environmental protection, resources development, land use planning, forestry, agriculture, recreation, and fish and wildlife management which can render assistance in the development of an effective state program. Cooperation with these agencies and the understanding and support of the public in program development should be sought.

Functions of the States in Implementing P.L. 95-87

Among State functions are the following:
1. Designate a state agency or official(s)—State Regulatory Authority—as the principal contact for personnel of the Office of Surface Mining Reclamation and Enforcement. Abandoned Mine Lands Reclamation Program State Officials are listed with their addresses and telephone numbers in Appendix G.
2. Develop procedures and mechanisms for receiving and disbursing federal funds that may be made available.
3. Consult with personnel of OSM and SCS charged with administering the Act, and develop procedures for obtaining advice and assistance from other Federal, state, and local agencies, universities, planning boards, and the public in the development and conduct of the state program.
4. Develop a state program that meets the requirements of the Act and, at the same time, reflects local requirements and local environmental and agricultural conditions (Sec. 503).
5. Develop, in conjunction with OSM, objective scientific criteria and appropriate procedures and institutions for determining those areas of a State to be designated unsuitable for all or certain types of surface coal mining pursuant to Section 522 of the Act.
6. Devise a program for the purchase and reclamation of abandoned and unreclaimed mined areas provided for in Title IV of the Act.
7. Develop, or revise as necessary, state laws for surface mining and reclamation which will meet requirements of P.L. 95-87 and other relevant laws.
8. Monitor coal surface mining and reclamation activities within the state and enforce the laws governing such activities.
9. Submit the state program to OSM for approval.
10. Annually submit applications to OSM for the support of the state program and implementation of specific reclamation projects.
11. Provide annual and other reports, as may be necessary, to the Secretary of the Interior.
12. Establish an approved mineral resources research institute or center at a university which is determined to have an eligible school of mines or equivalent in order to receive annual appropriations for research and other activities described in Section 301 of the Act.

State programs are submitted to the OSM Regional Directors in whose regions the states are located. Section 731.14 of the Permanent Regulatory Program emphasizes that programs must demonstrate the capability of the state for carrying out the provisions of the Act by providing complete descriptions of the program to be implemented, means of enforcement, staffing proposed for implementing the program, plans for communication and consultation with other agencies, lines of authority and jurisdiction, and so forth. Many of these requirements have been summarized along with other pertinent information by Haynes (1979).
In addition to the state regulatory agency directly involved in the implementation of P.L. 95-87, many more state agencies or offices can contribute to the effectiveness of the program. Among these are the State Geological Survey, the State Forestry Department, and the State Fish and Wildlife Department or their equivalents.

Some of the state regulatory agencies for surface mining and reclamation are parts of the State Geological Surveys. In any case, the State Geologist can provide much information concerning the extent of coal deposits in the state, nature of the coal seams, depth, and nature of the overburden. The State Geologists are listed in Appendix H.

The grading of mined areas and the construction of diversion ditches and various water control structures, as well as permanent impoundments, will be an important part of mining and reclamation; hence, the Office of the State Engineer should be able to provide valuable assistance. See the list of State Engineers in Appendix I.

Also of special importance to wildlife are the extent to which mined areas are revegetated and the types of plants to be used. State Departments of Forestry or their equivalents can be helpful in advising on methods of site preparation and on plant species best suited for different kinds of sites. State Foresters who work cooperatively with the USDA's cooperative forestry programs may be able to advise on the availability of planting stock and on potential assistance in reforestation of surface-mined areas from the Forest Service and ASCS. See Appendix J for a list of these State agencies or departments.

The State Fish and Wildlife Department or its equivalent can advise on such matters as habitat requirements of fish and wildlife, preferred food and cover species of plants, areas affording critical habitat for threatened or endangered species, and measures known to be effective in fish and wildlife management. A list of state officials in charge of fish and wildlife management activities in the states of primary concern in the eastern United States is given in Appendix K. Kentucky has prepared a statement on how that State may take advantage of opportunities for fish and wildlife in the reclamation of surface-mined areas under P.L. 95-87; other states may do likewise.

State universities—and often others within a state—have a wealth of information on fish and wildlife and other natural resources and their management. Also, suggestions to these institutions on problems encountered in surface mining and reclamation may lead to studies, the results of which could be very helpful in conducting an effective state program under P.L. 95-87. Support of research, experimentation, and demonstrations with respect to effects of mining on fish and wildlife and planning for and management of these resources is much needed. Also needed are biologists able to contribute to the planning and decision-making processes. Those institutions with approved mineral resources research institutes, especially, are eligible for funding of research projects under the Act which relate to surface mining and reclamation. The state institutions, the Agricultural Experiment Stations, and the Extension Service personnel housed in them can provide much information on forestry, soil capabilities, and revegetation techniques, and can make soil analyses which are needed as a basis for revegetating strip mine spoils.

Coal Mine Operators and Landowners

The mining industry and private landholders own most of the land surface-mined for coal in the East. Some of the larger coal companies own extensive holdings and have personnel who can comply with requirements of P.L. 95-87. Small operators and private landowners who plan to have portions of their land mined in small tracts may wish to hire consultants to prepare the necessary applications for coal mining and reclamation. Help also may be available through small operator assistance programs funded by OSM.

In either case, the landowner must have his application for a permit for active mining and plans for reclamation approved as a part of the state plan submitted by the state regulatory authority. The landowner can draw upon the expertise of the agencies and institutions listed above in preparing this application.

For the reclamation of abandoned mined land, the owner, whether an individual or a company, can apply for cost-sharing assistance to the Soil Conservation Service under RAMP, in which case he will probably contact the local Soil Conservation District or the state regulatory agency if he elects to apply for assistance in reclamation under Section 405 of the Act.

As in the case of preparing a permit application for active mining and reclamation, the owner can obtain much valuable assistance from the Federal and state agencies and institutions listed above. For fish and wildlife enhancement it is best to obtain such advice well before the reclamation plan is submitted in order to have desirable information on such matters as the configurations of impoundments needed for fish vs. waterfowl and shorebirds, and the value of present habitat in comparison with that which may be developed. More information on reclamation planning for fish and wildlife is included in Part 3 of this publication.

Some of the larger coal companies employ biologists on a full-time basis or as consultants and have been active in reclamation programs for fish and wildlife.
The National Mining Association and Bituminous Coal Research, Inc. sponsors symposia and publishes proceedings containing much relevant information. State Reclamation Associations have contributed importantly to reclamation of surface-mined lands and have helped support some research and demonstration projects.

Public

One of the stated purposes of P.L. 95-87 is to “assure that appropriate procedures are provided for the participation of the public in the development, revision, and enforcement of regulations, standards, reclamation plans, or programs established by the Secretary or any State under this Act” (Section 102). A mechanism for public input in developing reclamation plans and programs is available in the local soil conservation district organization composed of private citizens. There are other approaches as well. Public preferences for certain programs, such as acquiring land for reclamation for fish and wildlife and recreation, can be expressed to the state regulatory agency. The earlier in the planning cycle these views can be made known, the more likely they are to be included in the state program.

As stated by Haynes (1979), “The evaluatory responsibilities of the regulatory authority (federal or state) for protection of fish and wildlife and other environmental values are great and should be scrutinized. A concerned public should accept the opportunity and responsibility to review and comment on the mining and reclamation plans and should challenge any statements and proposed decisions which they believe to be detrimental to environmental values. Regardless of whether or not any or all public comments are accepted by the regulatory authority, they must respond publicly to each comment justifying their decisions. Thus, public participation in the review process can be a powerful mechanism for achieving balance in the decision-making process.”

Note to the reader

Part 2 of this source book, the summary of which has been placed at the beginning of the section, is intended to provide an introduction to the Surface Mining Control and Reclamation Act of 1977. Some of the provisions of the Act which relate to fish and wildlife are identified, the roles of agencies and others in administering and implementing the Act are outlined, and types of assistance that can be provided by these and other agencies in carrying out the national program are mentioned.

The next section deals with suggested approaches to, and information sources for, planning and management for fish and wildlife in relation to surface mining for coal and reclamation of surface-mined lands in the eastern United States.
Surface-mined land reclaimed by the U.S. Forest Service in Eastern Kentucky.

(Photo, U.S. Forest Service)
PART 3
Planning and Management:
Approaches and Sources of Information

Summary of Part 3
This part deals with planning and management for fish and wildlife in connection with surface mining for coal and reclamation of surface-mined lands in the eastern United States. Without going into details of methodology, it suggests approaches to planning and management and identifies source materials of potential interest to biologists, planners, consultants, and other professional personnel, as well as to some landowners and coal mine operators.

This information should be particularly useful in preparing applications for mining permit-reclamation plans as required by P.L. 95-87, and for protecting and managing fish and wildlife resources during and following mining operations.

For nonbiologists, fish and wildlife requirements and management approaches are reviewed briefly, with emphasis on vegetation and vegetation management. The main focus, however, is on informational needs and approaches to obtaining the information. Authoritative documents describing methodologies are cited and other sources of assistance and information are suggested.

The following topics are treated in this section.

General
1. It is desirable that fish and wildlife biologists and ecologists aid in collecting biological data and participate in formulating the mining permit-reclamation plans. Applicants for mining-reclamation permits are required to contact the regulatory authority to determine what fish and wildlife resources information is necessary.
2. Biologists should consult early in planning with engineers and operators and with other professionals concerned with mining, reclamation, and postmining uses of the land, developing a continuing cooperative relationship.
3. Although some landowners and coal operators may be concerned primarily with meeting legal requirements so they can mine coal, most also will be interested in postmining uses of the land.
4. Reclamation for fish and wildlife habitat is a viable alternative use of the land under the Act.

Planning Requirements and Processes
1. Landowners and operators, i.e., the applicants, contact the state regulatory agency for application forms and to determine what information is required for surface mining permit reclamation plans.
2. Owners of rural abandoned surface-mined land in need of reclamation can get advice and assistance from the U.S. Soil Conservation Service.
3. The planning process is described and desirable components of a plan for fish and wildlife are identified.
4. Criteria and priorities for reclamation are identified.
5. Some significant publications dealing with types of mining and reclamation and integration with sound land use objectives are discussed.

Wildlife Requirements and Management Approaches
1. Primary requirements for fish and wildlife are food, water, cover, and space in which the wild animals can live and reproduce.
2. The primary approach to fish and wildlife management is to assure that adequate food, cover, water, and space to sustain desired populations are present.
3. Habitat management is the primary means of managing for fish and wildlife.
4. Other approaches or methods include: regulations to protect the resources and govern the harvest of game crops; winter feeding; predator control; and stocking.

Assistance for Environmental Planning and Management in Surface Mining and Reclamation
1. General: Information needs for fish and wildlife planning and management extend far beyond the animals themselves and include data on most aspects of the environment, including man and his works and interests. Some of these data needs are identified and publications describing methods are cited in topics treated below.
2. Fish and Wildlife Inventories: These inventories, which require the services of biologists, may reveal the presence of rare or unique species or potentials of an area for supporting such species in addition to other desirable life forms.
3. Soil, Overburden, and Spoil: The nature of these materials, and methods of analyzing, treating, and handling them are considered, with special reference to establishing vegetation on surface mined areas.
4. **Soil Erosion Control**: Effective soil erosion control is an important means of reducing sedimentation and acid mine water pollution, the two principal causes of aquatic habitat degradation resulting from surface mining for coal. Grading and reshaping of the surface, spoil amendments, and structural devices are discussed in addition to vegetation establishment.

5. **Pollution Control**: Approaches considered include revegetation of mined areas, burying toxic materials, raising the level of water in strip mine ponds to cover seams producing toxic chemicals, use of spoil amendments, sealing of auger holes before backfilling to prevent water egress and infiltration into the waste, and erosion control as mentioned in item 4 above. Attention is called to the need for biologists to point out detrimental effects of erosion and pollution and to encourage effective control.

6. **Water and Water Management**: Need for, and approaches to collecting and analyzing physical and chemical water quality and aquatic biological data are discussed.

7. **Land Use Data**: Types of land use data useful for fish and wildlife planning and management are identified. Land use on areas surrounding the mined site is important because many wildlife species may be able to satisfy only a part of their living requirements on the mined site. Use of maps, aerial photography and remote sensing is discussed. The West Virginia Heritage Trust program is cited as an example of how information on unique areas or species can be brought to the attention of planners and developers or coal mine operators.

8. **Vegetation and Its Management**: On areas relatively undisturbed prior to surface mining, the type of natural vegetation present provides an indication of the vegetation type that will become reestablished on the mined site. Methods for surveying and classifying vegetation, including wetland areas, are noted. A list of bibliographies and selected publications dealing with revegetating surface-mined lands and vegetation management for wildlife is provided.

9. **Preferences of People and Socioeconomic Impacts of Mining and Reclamation**: Planners and managers—including biologists—must be aware of the attitudes and preferences of people and of the socioeconomic impacts of surface mining and reclamation in making their recommendations. Opportunities may exist for acquiring and reclaiming mined areas for fish and wildlife habitat or other recreational use for the public good. Costs and benefits of reclamation are discussed.

10. **Fish and Wildlife Management**: With information collected as required by the Act for mining permit reclamation applications, state plans, and RAMP, and other information of the type suggested in items 1-9 above, fish and wildlife managers should be able to make sound recommendations. Although relatively little attention has been given to such management in the past, opportunities exist for enhancing fish and wildlife, even when the primary purpose of reclamation is for agriculture.
Scope

A mining and reclamation permit must be obtained before engaging in surface mining for coal and reclaiming surface-mined lands. Application requirements and reclamation plan requirements are set forth in Sections 506, 507 and 508 of P.L. 95-87 and in the related Rules and Regulations. A variety of information is collected and presented in the mining permit reclamation plan applications. This includes information on cultural and historic resources, water quality and quantity, hydrology, geology, climate, vegetation, fish and wildlife resources, and land use, including prime farmland considerations. This will provide most of the information needed to develop plans for managing fish and wildlife in connection with surface mining and reclamation.

Biologists and ecologists should contribute to collecting the required fish and wildlife and environmental information and to formulating the mining permit reclamation plan. In accordance with Section 779.20 of the Permanent Regulatory Program, each application for a mining-reclamation permit must include a study of fish and wildlife and their habitat within the proposed mine plan area and the portions of the adjacent areas where effects on such resources may reasonably be expected to occur. The regulatory authority, in consultation with the appropriate state and Federal fish and wildlife management, conservation, or land management agencies having responsibilities for fish and wildlife or their habitats, determines the level of detail and the areas of such studies according to: (1) published data and other information available; (2) site-specific information obtained by the applicant; and (3) written guidance obtained from agencies consulted.

Basic components of the plan include descriptions of: the type and method of coal mining operation that exists or is proposed; the engineering techniques proposed or used; the equipment proposed to be used; how the reclamation is to be achieved; and the proposed postmining use of the land. Timely suggestions by biologists to engineers and operators in the planning, construction, or operation of haul roads and railroads, coal-cleaning and other refuse-producing facilities, and water treatment plants in addition to the clearing of sites, removal of overburden, and reclamation processes, can result in slight changes in procedures with benefit to fish and wildlife. It is important, therefore, that biologists consult early in planning with engineers and operators and develop a cooperative relationship that continues throughout the mining and reclamation activities. Other professionals with whom it is desirable for fish and wildlife biologists to consult and exchange information are soil conservationists, agronomists, hydrologists, economists, meteorologists, and regional and local planners.

Some of the variations of practice in surface mining for coal in the eastern United States have been discussed by Grim and Hill (1974). Approaches to planning for reclamation and development of abandoned mine lands in the Appalachians have been described in a model prepared for the U.S. Department of the Interior, Office of Surface Mining. A case study of surface mining and reclamation for a mine in West Virginia (Bogner and Perry 1977) provides much information useful to planners.

Realistically, the primary objective of many landowners-coal operators initially may be to meet the requirements of P.L. 95-87 so they can get on with the job of surface mining for coal. However, for most, the postmining use of the land will be of importance too, and they must decide what that use will be. Use as fish and wildlife habitat is a viable alternative and fish and wildlife biologists can contribute to the effective implementation of P.L. 95-87 by advising on or describing the use of the “Best Techniques Currently Available” (BTCA) as required by law.

It is beyond the scope of this volume to provide details on methodologies for the planning and management of fish and wildlife on surface-mined lands of widely varying types and in different regions. Other publications are planned or in preparation to provide some of these details. It is appropriate to suggest here, however, some of the needs and approaches to planning and management for fish and wildlife and to provide references and information sources for use of planners, managers, coal mine operators, and land owners in their mining, reclamation, and postmining land use activities and programs. Some information sources have been identified in Part 2 of this document; additional sources will be suggested here in relation to more specific topics.

Planning Requirements and Planning Processes

For determining the requirements for surface mining permit-reclamation plans under P.L. 95-87
and of their respective states, most landowners, including coal companies, will contact the state regulatory agencies. By the fall of 1978, the State of Illinois had developed an “Application for Surface Disturbance Coal Mining Permit (Application Form LR-1)” which is used by both the Illinois Department of Mines and Minerals and the Illinois Environmental Protection Agency in permitting operations. Similar forms reflecting requirements of P.L. 95-87 probably will be used by other states.

For rural unreclaimed or abandoned surface-mined land, the owner may wish to seek assistance in reclamation through RAMP, as discussed earlier. The owner or land user is responsible for developing the reclamation plan, but usually he will do this with assistance from the SCS and the conservation district, or with help from other professionals. An acceptable RAMP reclamation plan must meet current SCS standards as specified in the National Conservation Planning Manual (USDA 1978b), and the plan may be a component of an individual or group conservation plan that covers part or all of an operating unit. An approved plan will include all decisions on land use, management, and conservation practices necessary to treat the affected area adequately. It is suggested that the landowner contact the local SCS office or the county agent for information on how to participate in this program.

The basic stages for planning and implementation of a plan for fish and wildlife management, protection, or enhancement, or for other postmining uses of mined land are: (1) a clear statement of goals and objectives; (2) collection and analyses of data on which to base a plan, often including the preparation of various maps; (3) preparation of the plan, which involves reviews and updating, organizing, and synthesizing available information to solve specific problems or meet specific goals; and (4) implementation of the plan.

A plan for fish and wildlife management, as described by Burger (1975), should:

1. Be feasible, biologically. It should depend on improvements in existing natural resources, i.e., make use of what is there.
2. Aim to increase the basic productivity of the area. It should not create situations that can be maintained only by constant artificial treatments.
3. Make sense economically. It should be capable of being completed in a reasonable length of time and preferably without acquiring additional equipment.
4. Aim, whenever possible, at monitoring and increasing plants and animals already native to the area and at complementing existing terrain, water-courses, etc.
5. Contain numerical priorities, proposed methods of accomplishment, estimated costs, and costs if action is deferred.

The plan should also include prediction of anticipated and planned changes as a result of management founded on a preceding environmental assessment. Biologic surveys—to be described later—describe existing conditions and serve as a basis for predicting changes in living systems in the absence of human intervention. Ideally, however, the reclamation plan should predict habitat conditions that will result in the mined area after extraction of coal both without, and as a consequence of, applying mitigative measures which are proposed before, during, and after the mining operation.

Preparation of the mining permit-reclamation plan application will usually involve, particularly for small operations mentioned earlier, securing the services of consultants to help collect needed data and prepare the application. Much information is contained in the publication, Preparing a Permit: What You Need to Know and Where to Find It (Antommaria 1979). Also, E.E. Herricks et al. (in draft) have prepared for publication by EELUT a guidance document to assist mine landowners with preparation of surface mining-reclamation permits. This document provides a step by step procedure for the applicant and includes data for use in developing site plans for fish and wildlife management with particular relevance to Illinois.

Availability of funds for assistance in the reclamation of rural abandoned lands will be an important factor in plans developed under RAMP. The Soil Conservation Service has developed worksheets for the use of SCS technicians in assigning priorities in working with landowners. For off-site or public benefits, protection of human life and property in situations posing extreme danger is assigned priority 1; protection of public health, safety, and general welfare in situations where there are adverse effects is assigned priority 2; while benefits from conservation measures which result in improved quality of the visible perimeter of mined sites, improved water quality or quantity, and improved fish or wildlife, when such use of the land is the designated primary use, are given priority 3. Onsite (private) benefits resulting from applying conservation measures, including increased potential for production of income, non-income-producing benefits, and other benefits all are assigned priority 3. The U.S. Fish and Wildlife Service, in cooperation with the Office of Surface Mining, is developing criteria and categories for the incorporation of fish and wildlife considerations in the various reclamation priorities established by the Act for projects in the Abandoned Mine Land Reclamation Program. Reclamation of some tracts highly productive of fish, wildlife, and plants and with high environmental values would not produce significant public benefits. On other tracts where fish, wildlife, and plant resources were currently in a low state of productivity, reclamation could lead to a land use with high fish and wildlife values.
Plans for wildlife and fisheries in the rehabilitation of surface-mined areas should be developed in recognition of any intentions of the operators for future mining. In many areas, present mining practice is to strip coal, where doing so is economically advantageous, and to return subsequently for further activity only when economic returns warrant. This may occur, for example: when deep layers of coal are recovered by mountaintop removal, as in the Appalachians, some years after the readily accessible part of a deposit has been removed by contour mining; when coal is stripped from beds previously worked by deep mines; or when a deeper stratum is mined in an area which previously had been area stripped. Although, with advanced technology, the trend is to extract all accessible coal, thus making it unnecessary to return to a reclaimed area and disrupt it further by later stripping operations, the remining of areas still occurs. Because of the slow pace of ecological succession and establishment of vegetation, attempts to establish hardwood forests on such areas subject to remining would be impractical from the standpoint of timber production; however, the brush cover that developed in the interim would be valuable for wildlife and aid in erosion control.

In the development of the reclamation plan, the planned land use and treatments should be compatible with surrounding land uses. This does not necessarily mean the same land use. The severity of problems in need of correction on abandoned mined areas including especially the high priority factors listed above relating to hazards to human life and property, health, safety and the general welfare, should be assessed. If such problems are not severe and the mined sites are not causing continued pollution and sedimentation of streams, a judgment should be made as to the likelihood of the area being remined in the near future because of remaining coal reserves, height of the highwall, current mining equipment available, and the coal price. If remining of the area is imminent and hazards to human life and property and the environment are minor, the cost of reclamation until remining has been concluded, might not be justified. Otherwise, on the basis of the data assembled, analyses of the data, wishes of the landowner concerning post-mining uses of the land, and requirements of the Act, the reclamation planning can proceed.

Wildlife Requirements and Management Approaches

Requirements for Fish and Wildlife

In order to survive, grow and reproduce, wildlife—defined broadly to include nondomesticated mammals, birds, fish, reptiles, amphibians, and lower animals—must have food, water, cover, and space. It is important that all of these requirements can be met within the daily range of the resident species.

Vegetative cover and food

Attention to food chain relationships, when developing reclamation plans for surface mined lands, is important. Biologists will recognize, for example, that through photosynthesis, green plants provide the basic source of energy needed by animals. In water, tiny algae are consumed by plant-eating zooplankton such as the small water fleas or daphnids. In turn, the water fleas may be eaten by small fish, which are eaten by larger carnivorous fish. On land, the insects which feed on legumes on a strip-mined area may be eaten by quail or grouse chicks which are consumed by hawks or red foxes.

In addition to providing food, plants are of primary importance in providing cover needed for protection against predators or inclement weather, and for nesting, loafing, or perching. Cover is needed for fish as well as terrestrial wildlife. Vegetation management as a primary approach to wildlife management will be discussed later.

Water

Water is required for all wildlife, whether it is in the form of available surface water, as is needed for most terrestrial species, or whether most of it is obtained from the foods consumed or dew on vegetation. The need for surface water by terrestrial birds can be exemplified by the obvious use of farm and strip mine ponds by mourning doves.

Water requirements for fish and other aquatic organisms are varied but relate both to the quantity and quality of water. It is difficult to assign specific water quality criteria that must be met to support different kinds of fish. Generally, the temperature of water, as in a pond, should seldom be above 70°F in the summer for cold water species such as trout. Warm water species of fish such as largemouth bass, bluegills and redear sunfish may do well in ponds where temperatures rise to 60°F to 70°F in the spring and remain over 70°F throughout the summer.

According to a report entitled Water Quality Criteria prepared by the National Technical Advisory Committee (1968): The concentration of dissolved materials (excluding dissolved toxicants) for fresh water organisms should not exceed 50 millimoles, the equivalent of 1500 mg/1 NaCl; no highly dissociated materials should be added in quantities sufficient to lower the pH below 6.0 or to raise the pH above 9.0;
and for a diversified warm-water biota, including game fish, dissolved oxygen (DO) concentrations should be above 5 mg/l. For cold-water biota, it is desirable that: DO concentrations be at or near saturation and not below 7 mg/l in spawning areas; "free" carbon dioxide concentration not exceed 25 mg/l; turbidity not exceed 50 Jackson units in warm water lakes nor 10 units in cold-water lakes; and 10 percent of the incident light reach the bottom of any desired photosynthetic zone in which adequate dissolved oxygen concentrations are to be maintained.

Most food for fish is provided by plants and lower forms of aquatic animals. Hence an ample supply of nutrients in the water is required. Spawning areas in the form of gravel beds in shallow water are needed by species like bass and bluegills and some form of cover is beneficial.

**Approaches to Fish and Wildlife Management**

The primary approach to fish and wildlife management is to assure that the food, cover, water, and living space required to sustain populations of desired species are present in adequate quantity and quality. If one of these factors is lacking, thus preventing the occurrence of, or limiting the population of, a desired species, it may be possible to supply the missing component. Thus, if there is insufficient food to maintain a covey of quail on a strip-mined area, establishment of legumes or annual food plots may fulfill the need for food; if the pH of a strip mine lake is too low for fish, application of lime may make the water suitable. The capability of an area for producing wildlife is largely governed by the fertility of the area the same as for wheat and corn production—this, despite the fact that steep infertile slopes often are categorized as wildlife land in land use classifications; hence, the need for soil amendments should not be overlooked in managing surface-mined lands for wildlife.

Because plants are of such importance to wildlife, their establishment on barren strip-mined sites must receive primary attention; generally, the greater the diversity of vegetation present, the greater the diversity of animal species that can be expected to occur. Water in ponds or streams, and varied topography or land forms, as created by surface mines, add to the diversity of the environment.

Other approaches to wildlife management include: (1) regulation to protect the resource and govern the harvest of game crops; (2) winter feeding—not usually recommended for strip-mined areas; (3) predator control—not usually needed; (4) stocking of game and fur species; and (5) water level control. State fish and game regulations apply on strip-mined land for all species except migratory birds, which come under Federal jurisdiction, and those threatened and endangered species protected under the Endangered Species Act of 1973, as amended. Trout fishing can be maintained by periodic stocking in some cold water strip mine ponds; other ponds need to be stocked initially with other species. Water level control in ponds is, again, primarily for the purpose of habitat management.

**Assistance for Environmental Planning and Management in Surface Mining and Reclamation**

**General**

This section presents selected information and identifies sources of information and assistance that can be helpful in planning management of surface-mined areas. It deals primarily with soil, overburden, spoil, erosion and pollution, water, and vegetation—those components or characteristics of surface-mined sites that are directly related to habitat conditions for fish and wildlife. More specific recommendations for fish and wildlife management are included in Volume II of this report.

Basic information is needed for both planning and management. Fundamental kinds include data on geology, topography, climate, soils, and vegetation. Historical, cultural, socioeconomic, and demographic information is required, as well as knowledge about fish and wildlife resources. Objectives of the landowner and public preferences for postmining use of mined lands, in particular, are pertinent to the development of the State Reclamation Plan. Only ecologists and other biologists can provide some of the information needed for planning and management. It is important that fish and wildlife-land use-habitat relationships be understood and considered if opportunities for fish and wildlife enhancement are to be realized.

**Fish and Wildlife Inventories**

Fish and wildlife inventories should be conducted as parts of biotic surveys in planning and management either of areas to be mined or of abandoned mined areas. The diversity of species and population densities of wild animals on an area are good indicators of habitat conditions. Well planned and conducted inventories and searches also may reveal the presence of unique species, whether or not designated threatened or endangered. Moreover, the inventory may reveal habitat conditions potentially suitable for such species. For example, it has been pointed out that
even for so wide-ranging an animal as the eastern cougar, suitable habitat is essential (Jon Ghiselin in litt. August 22, 1979). He believes such habitat exists in the strip-mining country in the central highlands of Pennsylvania inasmuch as perhaps half the records of this species in that state since 1950 are from this area.

Not only is it important to know what species are present—and the nature of the biologic community—on the mined site (or proposed site), but also on the area surrounding the site. Species on the surrounding area are likely to be the ones which invade and repopulate the mined site. It is desirable, also, to relate distribution and abundance of fish and wildlife to the habitat in which the species are found and to note, for planning purposes, what the postmining land use and land cover will be.

The apparent absence of a given species from an area does not necessarily mean that it is not present, or could not be present if habitat changes were made, e.g., by construction of a permanent impoundment where none existed, or planting wildlife food and cover where it was scarce. Fish and wildlife biologists who know the requirements of the desired animals can pretty well assess the suitability of habitats for wildlife by field reconnaissance. In the case of fish, it is necessary to collect some data on water quality and quantity and other factors that will be considered later.

Except under very unusual circumstances, complete counts of animals on a land area are impractical; estimates of population size and trends and amount of habitat are usually based on predictive methods and indices. Davis (1963), Overton (1971), and Lewis (1970) have provided good summaries of problems and approaches in inventoring wildlife populations and Ricker (1975) has dealt with fish inventories and their importance to management. Designs for studies to sample aquatic communities are well described in the proceedings of a workshop sponsored by the Fish and Wildlife Service (Mason 1978).

For the ecological characterization of areas and information on individual species, their requirements, and key habitat factors, the system reported on by Mason et al. (1979) would be helpful. For project planning and environmental impact assessment, the habitat evaluation procedures (HEP) described by Schamberger and Farmer (1978) are relevant, as is the discussion of this subject by Haynes and Klopatk (1979).

Many owners of strip-mined areas, or areas to be mined, who are interested in fish and wildlife enhancement, will seek the services of biologists to conduct fish and wildlife inventories and to advise on the potentials of an area for fish and wildlife management. Information on the possibility of threatened or endangered species being present on an area can best be obtained from the state fish and wildlife agency, local members of professional biological and ecological societies, or from the U.S. Fish and Wildlife Service, Office of Endangered Species. Superficial sampling will not suffice in an area where the presence of endangered species is likely, because such organisms are usually rare and cryptic.

Soil, Overburden, and Spoil: Analyses and Handling

The characteristics and composition of the soil, overburden, and spoil, and how these materials are handled in the surface mining and reclamation process, have an important bearing on the capability of a mined site to support vegetation and, hence, wildlife. Effects on fish are reflected largely through acid minewater pollution, erosion and sedimentation, pH, nutrients, and other aspects of water quality.

Information on topsoil can be obtained through standard sampling and testing methods. State university and agricultural extension personnel may be able to perform soil analyses.

Samples of underlying rock strata can be obtained by core drilling and if a highwall on the same seam exists in an area near a site to be mined, much can be learned by examining the existing highwall. Smith et al. (1976) observed that consistent overburden property relationships within basins and over particular named coal seams provide opportunities for generalizations and extrapolations between sampled sites. These authors, along with Plass (1978) and Sobek et al. (1976), suggest ways of handling the overburden to enhance postmining uses of spoil areas.

Because of the mixture and variability of materials in the spoils, when little care has been given to the removal and placement of the overburden, spoil sampling for pH and other characteristics can be very difficult. The Pennsylvania Department of Environmental Resources (Davis et al. 1965, revised 1971) recommends taking 4 to 10 samples per acre and posting the results on a map along with other properties and conditions of the spoil for planning purposes.

Spoils with a pH of 4 and above can be expected to support certain trees but a pH of 6 or higher is needed for most agricultural crops. Stones and boulders near the surface of the spoil, or steep slopes, may render an area unsuitable for agriculture but not for woodland or wildlife habitat. The aspect or direction of the slope can be a limiting factor in establishing vegetation, i.e., it is usually more difficult to establish vegetation on slopes facing the direction of prevailing winds than it is on other slopes (Davis et al. 1965). Also, dark-colored spoil material on the surface may limit establishment of vegetation because of excessive heat.
Soil Erosion Control

Sedimentation and acid mine water pollution are the two principal causes of aquatic habitat degradation resulting from surface mining of coal. Approaches to control involve both structural and nonstructural means. An application for a reclamation plan involving ponds, impoundments, banks, dams, or embankments is required by section 780.25 of the Permanent Regulatory Program to have been prepared by or under the direction of, and certified by, a qualified registered professional engineer or a professional geologist with assistance from experts in related fields such as land surveying and landscape architecture. Also, permanent and temporary impoundments are to be designed to comply with the requirements of 30 CFR 816.49.

Wischmeier and Smith (1965) have reported on a method for predicting rainfall and erosion losses from cropland east of the Rocky Mountains. Wischmeier et al. (1971) have developed a nomograph representing the numerical relationships of various factors influencing soil erodibility when the values of some of the factors are known. They believe this can be of great value in planning sediment control measures for construction sites and other disturbed sites.

The Pennsylvania Department of Natural Resources published an Erosion and Sedimentation Control Manual for Surface Mines (Biggi 1978) describing practical control procedures.

The West Virginia Department of Natural Resources (1975) in cooperation with the USDA Soil Conservation Service prepared a Drainage Handbook for Surface Mining which provides useful standards, criteria, and guides on how to reduce sediment loads and prevent acid water discharges from contour surface-mined coal lands. This handbook indicates that stability is controlled by bench width, outer slope of the spoil, bench surface drainage, bedrock lithology and stratigraphy, and soil and rock content of the spoil. It suggests that the maximum stable slope is about 66 percent on predominantly sandstone bedrock and about 50 percent on predominantly shale areas. The handbook also points out that the strike and dip (slope) of coal strata must be known in order to formulate an effective drainage plan. Such knowledge permits enhancement of drainage plans by using the dip of coal seams in determining which way to drain the surface mine benches, which natural drainways to use in lowering water from the bench to the valley stream, and where to locate possible sediment ponds before drainageways reach the main stream.

Establishing vegetation on spoils is an effective way to reduce both soil erosion and acid mine drainage. Bramble (1952) points out that successful planting of spoil banks exhibiting loose-sliding material is almost impossible. Slopes of over 70 percent represent poor risks for planting tree seedlings unless exceptional stability exists, as in the case of some shales. He observes that often there is excessive erosion on long gradual slopes of 30 to 40 percent created by grading banks to the original land contour, or on steep short slopes with 70 percent gradient or more on unlevelled banks and steep outslopes. Smith (1973) concludes that if the earth is disturbed and replaced at an angle exceeding 32 degrees from the horizontal, the resulting slope cannot be considered stabilized. Compacting spoil banks composed mainly of sticky plastic clays should be avoided as much as possible. Early experiments conducted by the U.S. Forest Service in the Midwest (Limstrom 1952) showed that survival and growth of trees planted on such graded areas were poorer than those on ungraded areas.

Grading and reshaping the surface can reduce or eliminate the severe erosion and landslides that formerly occurred on steep outslopes of contour mines, but grading of the materials into long smooth slopes can also result in erosion if the slopes are not promptly revegetated. Riley (1973) pointed out the desirability of reshaping the spoils to produce a topography with as much plateau-like surface as possible and with slopes as short as possible. He suggested that the spoil surface should remain in a rough or furrowed condition, rather than as a smooth compacted surface, with the furrows preferably on the contour to increase rainfall retention and absorption. In his experience this has resulted in better survival of planted shrubs and trees. Publications of the USDA (1971, 1977a, 1978c) and of the U.S. Environmental Protection Agency (1976a) discuss and illustrate different means of roughening spoil fill slopes and constructing perimeter diversion structures, diversion dikes, reverse benches or terraces, and concave rather than convex slopes at the bottom of long slopes to reduce erosion from runoff.

In addition to establishing vegetation on or leveling spoil ridges for erosion control, there are several structural methods. These include:

Sediment Ponds

Using sediment ponds is a primary method for sediment control on contour surface mines. These ponds prevent surface runoff and sediments from flowing directly into streams, primary ponds or lakes, and croplands by detaining the water and allowing the silt to settle out. Often, settling of tiny particles, such as those in clay soils which may remain suspended for weeks causing muddy water, can be hastened by adding lime, alum, straw, or organic poly electrolyte to the water. Generally, an effective sediment pond should have a minimum storage capacity of 0.125 acre-
feet per acre (380 m³ per ha) of disturbed area in the watershed. The state regulatory agency may require higher storage volumes. The U.S. Environmental Protection Agency (1976a) suggests constructing sediment basins to achieve a certain percentage removal of the suspended material or to settle out a minimum sized particle. Formulas and detailed specifications are provided in engineering terms.

For some mined sites in mountainous areas it is helpful to have a series of small sediment ponds discharging into one large pond. The multiple-pond method has advantages over the one-pond method in that: (1) passing the water from one sediment pond to the next lengthens detention time and improves the removal of suspended solids; (2) small ponds are easier to maintain than large when cleaning is required; and (3) small ponds are easier to remove if necessary.

**Diversion Ditches**

Severe erosion, caused by surface runoff from contour mine benches onto steep outslopes, is prevented by constructing a diversion ditch slightly uphill from the edge of each bench to divert the water. If sediment threatens to fill the ditch, a strip of dense vegetation established above it will serve as a filter. The outlet of the diversion ditch can be a natural drainway such as a creek, a lined erosion-proof drain, a vegetated area such as a forest, or a sediment pond. If the water is not carrying much sediment, lowering the water from the bench to the valley stream by a natural drainageway probably is preferable.

**Erosion-proof Drains**

The concentration of water in a diversion ditch can result in erosion within the ditch. Natural drainage channels used to carry runoff usually are seeded with perennial grasses. Those species most suitable produce a dense uniform cover near the soil surface, live a long time, withstand variable amounts of sedimentation, and provide protection during all seasons of the year. Jute netting can be used as channel lining to protect the drainage channel from erosion while the vegetation becomes established.

If the volume of water is too large, the diversion ditch too steep, and the velocity of water too great for effective control of erosion by vegetation, manmade drainways can be substituted. Materials commonly used as liners for erosion-proof drains include: concrete, clay tile, plastic, fiber or steel pipe, old tires, and rock. Waterways lined with half-round bituminized fiber pipe have been suggested by the U.S. Environmental Protection Agency (1976a).

**Water Bars**

On abandoned surface-mined areas, old haul roads constitute a sizable percentage of the total land area disturbed. When these roads are causing undesirable alterations in drainage or are resulting in pollution and sedimentation problems, and are no longer needed for access into the area, they should be reclaimed. This may require removal of original culverts, side ditches, and other structures and the installation of "water bars" to force the water to run off the road and to follow its original drainage pattern. The water bars may consist of logs or heavy timbers placed across the road.

**Technical Assistance**

Technical assistance with the designs, standards, criteria, and construction of these structural water and erosion control devices is available from the USSCS and USEPA, and from appropriate state agencies. Among pertinent SCS publications are those listed in the Literature Cited under the USDA (1971, 1977b, 1978c). The USEPA (1976a) has published an informative, well illustrated, two-volume work entitled *Erosion and Sediment Control: Surface Mining in the Eastern U.S.* State regulatory agencies should be consulted on engineering specifications and requirements. Some of them, e.g. the West Virginia Department of Natural Resources (1975), have guides or handbooks on drainage for surface mining.

**Pollution Control**

If the bottom of a stream draining a mined area is orange, the water is probably acid. Some indication of the water's acidity can be obtained with litmus paper or a field pH kit available from the local county extension agent or SCS office. However, pH is not the only factor to be concerned with, and more sophisticated techniques probably will be required to ascertain pollution problems. In addition to chemical analyses, the presence of certain aquatic organisms such as bloodworms and sludgeworms, which are tolerant of acidic water, and the absence of mayflies, caddis fly larvae, and clams intolerant of acidic water, but normally present in unpolluted water in an area, suggest that the water is polluted.

If possible, the sources of the acid water draining into strip mine ponds or streams should be pinpointed. It can enter the receiving body of water from surface runoff after a rain, in seepage out of the spoil or a deep mine, or in ground water.
The U.S. Environmental Protection Agency, Office of Water-Hazardous Materials (1975) has published a report entitled *Criteria for Developing Pollution Abatement Programs for Inactive and Abandoned Mine Sites*, which provides information helpful in selecting measures applicable to individual mine sites. Among these measures are:

**Vegetation Establishment**

Establishing vegetation on the spoil will decrease the surface flow and increase infiltration. The growing plants will use water from the soil and dispose of water by evaporation and transpiration. The combined result will be less acid water reaching ponds or streams.

**Raising the Water Level in Ponds**

Oxidation of pyritic materials in a coal seam at the edge of a strip mine pond which receives acid mine drainage from this source sometimes can be prevented by raising the water level sufficiently to cover the seam and prevent air from reaching it (Davis 1971; Riley 1960).

**Use of Spoil Amendments**

Lime is often used to treat acid mine water and natural limestone or agricultural limestone is used to raise the pH of acidic spoils. The amounts of limestone and commercial fertilizers needed are based upon conditions of the spoil and the use to be made of the land, including types of vegetation to be established and maintained. Nitrogen usually is necessary. It is suggested that landowner-coal operators contact the local county agent, SCS office, or Forest Service representative, in addition to state agencies, for advice and assistance on applying spoil amendments.

Plass (1978) suggests using mulches and soil stabilizers, as necessary, to reduce erosion, add organic matter, and help establish vegetation. Among the materials suggested for possible use are: (1) straw and hay at rates of 1 to 2 tons per acre; (2) chemical or asphalt tack to bind straws together so they can resist movement by wind and water; (3) shredded hardwood bark, wood chips, processed wood fibers, and reprocessed paper products applied from a hydroseeder with seed and fertilizer; and (4) chemical binders such as polyvinyl acetate and vegetable gums.

Sopper and Kardos (1972) have conducted studies in Pennsylvania indicating that application of municipal waste aids revegetation of strip-mined spoil banks. Peterson and Gschwind (1973) report that in Illinois, mine spoils have been improved for revegetation by applying domestic sewage sludge.

Other approaches are the more careful handling of overburden materials, backfilling of mined sites, and grading. Plass (1978) notes that selective removal and replacement of overburden may enable the operator to place a type of material on the surface of the spoils that is suitable for re-establishment of vegetative cover, and to bury large rocks in addition to toxic materials. Despard (1974) also suggests that the coal mining operator may be able to bury acid shale under sandstone and shale having approximately neutral pH, thus avoiding problems of acid minewater drainage. On the other hand, Smith et al. (1976) suggest that more emphasis should be placed on blending materials to form better minesoils rather than on burying materials that are particularly toxic. They believe that subsoil suitability for plant roots, aeration, and available water retention is likely to be improved, rather than harmed, by some coarse fragments in the upper spoil surface.

In a book on the environmental impact of mining and pollution control which includes many helpful illustrations, Down and Stocks (1977) suggest the following steps to attain pollution control in surface mining:

1. Identify in the baseline survey waters which may be polluted during mining.
2. Consider using diversion ditches to keep water out of a surface mine and channel it to a sump for settling and then pumping it out for further treatment.
3. Bury pyritic wastes promptly to avoid oxidation.
4. Maintain a barrier at the low wall to prevent uncontrolled runoff of water.
5. Backfill promptly to reduce the area of disturbed land and hence lessen pollution runoff.
6. Compact the waste or isolate it with clay or other impervious seals.
7. Seal up auger holes before backfilling to prevent water egress and infiltration into the waste.
8. Divert surface waters before they reach the waste and convey them around the area.
9. Install underdrains to ease tip drainage and improve stability, and lessen the residence time in the tip.
10. Regrade to achieve gentle slopes which are neither susceptible to serious erosion, nor ponding of water, but which provide adequate conditions for revegetation.
11. Revegetate the mined land.

Anything that biologists involved in fish and wildlife management can do to encourage adequate control of erosion, sedimentation, and pollution (including dust, noise, and toxic materials) due to surface mining will be of benefit to the fish and wildlife resources. Planning for such control prior to mining in order to initiate action early in the course of reclamation is desirable. For instance, trees and shrubs planted along seeded waterways or diversion ditches could provide diversity and improve conditions for wildlife.
Water Data and Water Management

General

To plan effectively for fish and wildlife management on surface-mined areas, it is necessary to have reliable information on the availability, extent, and quality of water. This information needs to be related to the water requirements of the species or aquatic biological communities desired. By planning, it may be possible to make some adjustments in the mining operations or the reclamation which will permit creation, at less expense, of impoundments with morphometry better suited for fish, if they are the preferred species, or for waterfowl. Thus, banks of impoundments may be graded to lower slopes for waterfowl or shorebird use than if the intended use is for fish. In assessing water conditions it also will be necessary to consider land uses of the watershed and to note sources of current or potential pollution.

Physical Data

Items that should be considered in collecting physical data include: depth of water at different seasons of the year; low flow conditions in streams; information on runoff volume; susceptibility to flooding; slope of pond banks; bottom conditions, i.e., rock, silt, clay, sand, gravel, or boulder; presence of dams that would interfere with repopulation of sections of streams that had been depleted of fish through pollution; in intermittent streams, the presence or absence of deep holes which retain water during dry periods; and the presence of oxbow lakes, waterfalls, riffles, pools, quiet backwaters, and islands which may be important to wood ducks and beavers.

Chemical and Water Quality Data

Water quality measurements include water temperature, turbidity, pH, dissolved oxygen, carbon dioxide, alkalinity, and conductivity or total dissolved solids. Information on nitrates and nitrites, phosphates, trace minerals and heavy metals, sulfates, sediments, detergents, and other pollutants is desirable.

Among the many references dealing with methods for collecting, analyzing, and interpreting data on water quality and aquatic organisms are: the U.S. EPA's Biological Field and Laboratory Methods (Weber 1973), the U.S. Geological Survey's method manual (Slack et al. 1973), Standard Methods for the Analysis of Waters and Wastewaters (American Public Health Association et al. 1971), and Sampling for Water Quality (Curtis 1976).

Criteria for determining acid mine water drainage, as suggested by Herricks and Cairns (1974), are shown in Table 5.

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Reports by the U.S. Environmental Protection Agency (1976b), the National Technical Advisory Committee of USDA (1968), the National Academy of Science/National Academy of Engineering (1973), and McKee and Wolf (1963) provide much information on water quality criteria and water quality requirements of aquatic organisms.

The U.S. EPA (1976b) volume, Quality Criteria for Water, recommends criteria levels for a water quality that will provide for the protection and propagation of fish and other aquatic life and for recreation in and on the water in accordance with the 1983 goals of P.L. 92-500. Much of what is known about the effects of various chemicals, including heavy metals, pesticides and other toxicants, and also effects of temperature and color on aquatic life, is included in this volume.

For fish production in ponds the water should be 5 to 6 feet (1.5 to 2m) deep, with perhaps deeper holes in areas subject to heavy freezing so that water with good dissolved oxygen content remains during the coldest weather; have a pH of 6.0 or higher; and have adequate nutrients. It is important to have adequate shallow water because bottom organisms which contribute significantly to the diet of fishes grow best in shallow water and many fishes spawn there; however, the water at the shoreline should be two feet or more deep to prevent the growth of rooted aquatic plants undesirable in fish ponds. For waterfowl and fur animals, such as muskrats, the growth of such vegetation is desirable. Further consideration is given to aquatic, pond, and streamside vegetation in subsequent paragraphs.

Any size of pond over one-fourth acre is suitable for fish production but larger ponds of up to 20 acres or more provide more opportunities for multiple fish and wildlife production. Information on the capacity of ponds needed to accommodate different peak discharges from a watershed and on details of pond construction for water supply and recreation is given in Agriculture Handbook No. 387 (U.S. Department of Agriculture 1971).
Biological Data

Biological data interpreted with physico-chemical conditions of the water are needed: (1) to assess the impact of the proposed operation; and (2) for reclamation planning, mitigation, and enhancement. As pointed out previously, applicants for mining-reclamation plan permits are required by section 779.20 of the Permanent Regulatory Program to consult with state and federal fish and wildlife agencies and the state regulatory agency to determine the fish and wildlife resources information required. The species to be evaluated and the parameters to be measured depend upon a number of factors including: (1) availability of existing information applicable to the proposed site or area; (2) interpretation of which species are considered to be most important to the states, U.S. Fish and Wildlife Service and others; (3) gaps in data and research needs; and (4) critical life requirements.

Biologists can learn much about water quality from the biological community the water body supports. Methods for assessing and predicting mineral mining impacts on aquatic communities have been reviewed and analyzed (Mason 1978).

The presence of emergent plants such as cattails may indicate conditions suitable for muskrats. Vegetation on the banks of ponds and streams helps control erosion and higher plants provide shade which prevents extremely high water temperatures. Over hanging vegetation also provides habitat for insects, some of which drop into the water and are used as food by fish and other aquatic organisms. Duff and Cooper (1976) suggest that vegetation must be twice as high as the distance to water to be effective for shade and temperature control. A buffer strip of vegetation along streams, e.g., between a stream and a newly constructed road, helps reduce erosion and sedimentation and, at the same time, provides food and cover for wildlife. For relatively level areas, Trimble and Sartz (1957) suggest that protective strips of vegetation should be at least 50 feet wide for erosion control, with an increase of four feet for each one percent of slope. Shorebirds, sometimes found along surface-mined area impoundments or streams, use gravelly or sandy beaches with little vegetation and which slope gradually into the water.

Land Use Data

Klimstra and Jewell (1973) questioned the application of "previous use" as a guideline for reclamation of surface-mined areas. They pointed out the need of flexibility to allow for new land use ideas and to capitalize on innovative designs in land formation to satisfy needs for recreation and other purposes. However, in assessing the suitability of an area for fish and wildlife production, information on many aspects of previous, current, and proposed land use is needed.

Maps, preferably topographic maps and/or aerial photographs, on which vegetation (to be treated in the next subsection) and land use are shown by overlays, are invaluable to planners and managers. These should encompass not only the proposed or abandoned mine site, but also surrounding areas, because, as stated earlier, animals may range outside of the mine site. Fields, types and varieties of crops grown, woodland areas, wetland areas, areas undisturbed by mining, brushy fencerows, streams, natural or man-made ponds, roads, buildings, power lines, and so forth should be indicated on the map.

A major purpose of including areas adjacent to the mine site in the land use analysis and on the maps is for use in planning management activities to complement and supplement habitat requirements of the desired species or biological communities. For example, creation of a permanent impoundment on a mined site may attract species or provide habitat for organisms not previously found in the area; or development of travel lanes in the form of brushy field borders or wooded stream courses may enable species on the mined site to utilize an adjacent area for food, cover, or water.

Needs for information on land use for planning include data on the varieties of crops grown, harvesting dates and harvesting methods for agricultural crops, as related to food and cover values for wildlife; use of agricultural chemicals, including soil amendments, adjacent to the mined site; and land uses other than agriculture and forestry in adjacent sites. It is important that local and regional planners be consulted with respect to the latter. Information on the historical use of the land also is important.

Remote sensing is of value in providing both historical data and current information on land use in advance of surface mining. Much information comes from aerial photography which shows the land cover as long ago as the 1930s or 1940s in relation to present cover. Satellite imagery also can provide other information complementary to that which can be obtained by on-the-ground surveys. A framework of a national land use and land cover classification for use with remote sensor data has been developed by Anderson et al. (1976). This approach employs the features of widely used classification systems. In a later discussion of this system, Witmer (1978) stated that up to that time eleven states had participated in matching-fund cooperative agreements for land use and cover mapping and that several Federal and regional agencies are using the system.

The article by Witmer is one of eight papers published in the October 1978 issue of the Journal of Forestry dealing with land and resource classification.
this report were papers by Nelson et al. (1978); Frayer et al. (1978); Bailey et al. (1978); Hirsch et al. (1978); and Driscoll et al. (1978). Driscoll et al. (1978) discussed land classification through remote sensing involving use of electronic and photographic remote sensing systems that provide data secured by both aircraft and satellites. The LANDSAT satellite provides the most common example of electronic data. They pointed out that multivariate statistical methods are helpful in analyzing information of this type. Also, they observed that, in aerial photography, infrared film is superior to panchromatic (black and white) or "normal" color films for most vegetation mapping and that color and special films are advantageous for identification of trees and shrubs in medium scale (1:24,000) imagery. Hirsch et al. (1978) pointed out that no single approach of land classification can serve all purposes and identified the needs for development of new ways to use a number of systems simultaneously and for continued emphasis on communication mechanisms.

Early aerial photographs and topographic maps are obtainable in the eastern United States from the U.S. Geological Survey, Distribution Center, 1200 South Eads Street, Arlington VA 22202 and from such agencies as the USDA Soil Conservation Service, Agricultural Stabilization and Conservation Service, and Forest Service. Satellite (ERTS) imagery, valuable in showing the extent of change in surface mining and the importance and influence of sedimentation and other pollution, but often at too small a scale for detailed planning for surface mine reclamation, can be obtained from NASA and from the EROS Data Center, Sioux Falls, South Dakota. Moran and Eagleson (1978) designed and pilot-tested a real-time "biosensor" for remote water quality monitoring and satellite data retrieval. In this system they used fish breathing rates as a measure of biological response to water quality change.

Aerial photography providing coverage of current surface mining operations may come either from government sources or from mining operators or their engineering consultants. For purposes of fish and wildlife planning biologists should advise on types of photography needed. This may result in significant savings and ensure that the photography can be used for habitat evaluation or for other purposes.

If care is not taken, surface mining may affect areas which are unique because of their geologic features, habitat provided for threatened or endangered species, or for some other reasons. Protection of such areas is afforded by section 522 of P.L. 95-87. Such tracts of unique natural heritage should be identified and given protection. Section 522 of the law and subsequent rules and regulations require State or Federal regulatory authorities to identify lands unsuitable for all or certain types of mining. One approach to achieving this is the West Virginia Heritage Trust Program described by the Nature Conservancy (1978). This program, originally developed as a cooperative venture of the Nature Conservancy and the West Virginia Department of Natural Resources, is now operating under the auspices of the latter department. Through this program a continuing inventory of West Virginia's natural heritage has been established along with an information system to collect, manage and disseminate this inventory information. A major strength of the program is its ability to provide, through transparent overlays on topographic maps, the precise location of the unique units, together with other pertinent information. This helps decision-makers in determining which areas are most worthy of protection.

In assembling data on land use, the presence of exposed acid-forming materials on a watershed should be noted. This is of especial importance if ponds are to be constructed as part of the management program. In Ohio, Riley (1960) found that lakes with a concentration of such materials on the watershed had water with a pH of 2.4 while 100 feet away, where no concentration of "gob" (mostly marcasite, FeS2) existed, the pH of the water tested 6.1. He found that when this toxic material was buried with an average of about three feet of nontoxic spoil material, the ponds had water suitable for a variety of plant and animal life. Also, in Illinois mined areas, a majority of the waters exhibiting a pH of 5.1 or less resulted from acid drainage from exposed refuse such as gob and slurry (Haynes and Klimstra 1975).

In addition, in the collection and analysis of data on land use, it is desirable to note the timing and amount of use of pesticides, effects of some of which are long-lasting, and to identify barren or other areas which are subject to accelerated erosion.

**Vegetation and Its Management**

An application for a permit to mine and reclaim an area is usually required by the regulatory agency to include a map delineating existing vegetative types and describing plant communities within the proposed permit area. Though Section 779.19 of the Permanent Regulatory Program provides for such mapping, preparing a cover map is a common procedure in managing the plant cover of a habitat. When a map or aerial photograph is required, sufficient adjacent areas should be included to allow evaluation of the area as habitat for fish and wildlife. Vegetational surveys of relatively undisturbed wooded areas made prior to surface mining provide good indications of the vegetation likely to occur there if, after mining, the area reverts to woodland. If the area has been disturbed before mining, perhaps even used for row-
crop agriculture, one approach to predicting the type of vegetation likely to develop ultimately over long periods of time is to examine the literature for studies describing the "climate climax" vegetation of the area. Work described by Braun (1950) is a good example.

Depending upon the extent to which drainage, ground water, and underlying soil and rock strata are disturbed by mining, wetlands which occur as a result of surface mining may be ephemeral or short-lived because of rapid percolation until the ground becomes consolidated by organic materials.

Vegetation is basic to wildlife. Natural vegetation reflects climate, soil and water conditions. A cover map indicating the nature and distribution of cover, if any, on the mined site and on the surrounding area is invaluable for wildlife planning and management. Barren spots on long-abandoned mined areas may indicate very acid conditions in need of correction; wetland areas and their interfaces with surrounding cover (edges) can serve as focal points for wildlife management; and reclaimed areas seeded largely to Kentucky 31 tall fescue and neither pastured nor cut—a condition observed in parts of West Virginia—offer possibilities for shrub plantings to improve conditions for wildlife and still keep soil erosion at a minimum. On some wetlands and on low-lying river floodplains, which also should be identified on the cover map, it is possible to establish alder thickets through seeding on moist soils as described by Burger (1975). Such thickets receive much use by the American woodcock in the eastern United States. Also, if the vegetation map shows an absence of overhanging vegetation along streams running through surface-mined areas, the manager may wish to recommend plantings suitable for riparian situations to aid in erosion control and provide shade and a source of insects for fish life.

Methods for making vegetative surveys, including vegetative sampling for large areas, are discussed in many publications such as Wildlife Investigation Techniques (Mosby 1963) and the more recent Wildlife Management Techniques available from The Wildlife Society (Giles 1971; Schemnitz 1980). The Handbook for Habitat Evaluation Procedures developed by Flood et al. (1977), contains habitat criteria and other valuable information applicable to the oak-hickory forest section of the Eastern deciduous forest. Wetlands of the United States (Shaw and Fredine 1956) provides a good overview of wetlands, their extent, and their value to waterfowl and other wildlife. A more recent report by Cowardin et al. (1979), widely distributed as an operational draft for field testing, provides information helpful in defining and classifying the wetlands of the United States.

On many older surface-mined areas, especially those mined 30 or more years ago and left untended or unmanaged, most revegetation has been through natural processes. The extent and nature of the revegetation for some of these areas, including results of seeding and planting by man, are described in wildlife-related publications cited in Part 1.

In addition, literally dozens of scientific articles and reports, based largely upon work done by the U.S. Forest Service, SCS, ARS, and the states, and dealing with successes and failures of various methods of treating spoil and revegetating mined land without particular reference to wildlife, have been published. References to most of these articles are included in various available bibliographies. Among the more recent bibliographies are:

6. Ecological Aspects of the Reclamation of Derelict and Disturbed Land (Goodman and Bray 1975). Although published in England, this bibliography contains many references to literature on surface-mined areas and their reclamation in the United States and many other countries of the world.

Other publications dealing with vegetation management or use of plants by wildlife include:

1. A Guide for Vegetating Surface-Mined Lands for Wildlife in Eastern Kentucky and West Virginia (Rafail and Vogel 1978). This is free upon request.
from the Eastern Energy and Land Use Team, U.S. Fish and Wildlife Service, Kearneysville, West Virginia 25430. The guide contains helpful information on equipment needed for, and methods of, preparing the seed bed; methods of planting, including recommended fertilization and seeding rates; requirements of plants suggested for wildlife plantings; and a list of dealers from whom planting stock can be obtained.


3. *Sources of Planting Stock and Seed of Conservation Plants Used in the Northeast* (or other regions).

The latter publications are produced and updated every two years for each of the SCS regions of the United States and are available from the Soil Conservation Service, e.g. Northeast Technical Service Center, Broomall, PA.

4. *Creation of Relatively Stable Shrublands with Herbicides: Arresting “Succession” on Rights-of-way and Pastureland* (Niering and Goodwin 1974). This publication deals with maintaining the shrub stage of succession desirable for many kinds of wildlife by preventing the invasion of trees. The authors found that, through ecologically sound techniques and selective application of herbicides, clones of several shrubs, once established, have virtually no tree invasion. Among these shrubs are huckleberry, greenbrier, low blueberry, witch hazel, speckled alder, sheep laurel, gray dogwood, and nannyberry. They found that pure stands of little bluestem grass also exhibited remarkable stability.

5. *Shrubs and Vines for Northeastern Wildlife* (Gill and Healy 1974). This handbook discusses 97 native and 3 naturalized shrubs or vines important to wildlife in the Northeast. Topics treated include range, habitat, life history, uses, propagation, and management of the species listed.


8. *Strategies for Protection and Management of Floodplain Wetlands and Other Riparian Ecosystems* (Johnson and McCormick 1978) is the proceedings of a symposium and contains papers dealing with management of vegetation in relation to fish and wildlife.


In Volume II of this work which deals more specifically with opportunities and approaches for fish and wildlife planning and management, several appendices are included in which plants selected for their wildlife value and ability to grow on surface-mined areas are listed along with sources of planting stock and seed. Among the references used in preparing this material—all included in the References Cited section of the current report—are: Armiger et al. (1976); Bennett (1971); Bennett, et al. (1976); Boyce and Merz (1959); Bramble (1952); Davis et al. (1971); DeGraaf and Witman (1979); Dirr (1975); DuPont (1978); Fowler and Adkisson (1977); Gellner (1975); Halls (1977); Jones et al. (1973); Kennedy (Undated); Kolar and Ashby (1978); Plass (1975); Rafaill and Vogel (1978); Sharp (1977); USDA Forest Service (1965); USDA Soil Conservation Service (1973 rev.); USDA Soil Conservation Service (1977a); USDA Soil Conservation Service (1978c); and Virginia Division of Forestry (1969).

Although, generally, plant species native to an area are preferable from the standpoint of long-term survival and probably require less maintenance, seed and planting stock may not be readily accessible. It is recognized that some exotic and specially developed forms of plants survive and grow well on surface-mined areas. A principal objective in reclamation is to establish vegetation quickly to control erosion and pollution. In doing so, however, the value of the vegetation for wildlife should be given every consideration possible.

**Preferences of People, and Socioeconomic Impacts of Mining and Reclamation**

In addition to information on the environment treated above, planners and managers—including biologists—and owner-operators must be aware of, and consider, people’s preferences and the socioeconomic impacts of surface mining and reclamation. Little information beyond anecdotes has been developed on preferences and impacts which are likely to be greatest in opening up hitherto undeveloped coal-rich areas in the West and in areas of expanded surface mining in the East. Some of the available references related to this subject are included in bibliographies prepared by Weiss et al. (1977) and Lewis et al. (1976). Streeter et al. (1979) discuss development of new human communities in previously sparsely populated areas including effects of solid waste disposal, fire, roadside kill and poaching of wildlife, increased recreational use of areas, and discussion of housing and land use requirements, and income.

Understandably, the landowner must decide whether or not his land will be mined and state his preference as to the use of mined land on his property. It is possible, however, that land owned by an individual or a private firm will be designated as unsuitable for mining in compliance with P.L. 95-87. Also, for abandoned
lands in need of reclamation and which the landowner has no plans to reclaim, and especially those with great potential for public use when reclaimed, the State or the Federal government may wish to acquire and reclaim the areas for the public good. In such cases, again, wildlife biologists have a role to play in developing information useful for decision-making, planning, and management.

Randall et al. (1978) conducted an informative case study of the benefits and costs of reclaiming coal surface mines in central Appalachia. The study area was the watershed of the North Fork of the Kentucky River near Hazard where, in 1974, there were 157 active surface mines. These authors stated, on page 473: "Our findings, in brief, are that, for our study region, the benefits of reclamation occurring under Kentucky regulations as of 1976 are unambiguously in excess of reclamation costs; the incremental benefits of reclamation under the federal bill as introduced in the 1977 Congress are positive, and under certain assumptions, exceed the costs; and even assuming the universal application of the best available reclamation technologies in the study region, surface mining for coal would generate some residual external costs."

Methods used in estimating benefits of reclamation and external environmental costs of surface mining in the study region under the 1976 Kentucky regulations were described. Five broad categories of environmental damage were identified: (1) water pollution, as it affected domestic, commercial and industrial users of water; (2) degradation of life-support systems for fish, wildlife, and recreation resources; (3) increased frequency and intensity of flooding; (4) damage to land, structures, and buildings; and (5) aesthetic damages. Some of the difficulties or limitations of the assessment, because of lack of an adequate data base, were mentioned and great care was urged in interpreting indications of the relationship between marginal costs and marginal benefits of reclamation.

**Fish and Wildlife Management**

With information collected as required by the Act for mining permit-reclamation plan applications, and for RAMP, and of the type described above, fish and wildlife managers should be able to make sound management recommendations. Ordinarily these will not differ materially from environmentally sound management approaches for other areas. They will recognize, however, opportunities for preserving unique biological communities and the habitat of threatened and endangered species, and for creating habitat diversity through development of impoundments, wildlife travel lanes, plantings, or other devices. Management recommendations will vary according to the location and nature of the mined site, surrounding land use, wishes of the landowner and/or the public, and requirements of the Act. Even when the mined land is reclaimed primarily for agriculture, there will be opportunities to take actions beneficial to fish and wildlife.

Publications devoted specifically to management of fish and wildlife on surface-mined lands are limited. Klimstra and Woof (in press) have prepared a guide for the enhancement of fish and wildlife on abandoned mine lands in the eastern United States. Good general references with information applicable to management on surface-mined areas include the classic *Game Management* (Leopold 1933), *Practical Wildlife Management* (Burger 1975), the U.S. Forest Service's *Wildlife Habitat Improvement Handbook* (USDA 1969), and *Wildlife Management Techniques* (Scheinert 1980). Many suggestions for habitat improvement for terrestrial and aquatic environments are included in these publications.

Technical advice on fish and wildlife management also can be obtained from the U.S. Fish and Wildlife Service, SCS, state biologists, universities, private conservation organizations, and other sources. For example, Funk (1972) provides information on overharvest of bass in small impoundments. Information on fish control through safe use of toxicants can be obtained from the Fish Control Laboratories, Fish and Wildlife Service, U.S. Department of the Interior, P.O. Box 862, La Crosse, Wisconsin 54601. Information on species suitable for stocking can be obtained from the SCS, the Office of Fishery Assistance, or area offices of the Fish and Wildlife Service, U.S. Department of the Interior, and from the respective state fish and wildlife agencies.

Farmers Bulletins 2250, *Warmwater Ponds*, and 2249, *Trout Ponds for Recreation*, available at local SCS offices, provide much valuable information on the construction, stocking, and management of such ponds. Biologists in the U.S. Fish and Wildlife Service's Office of Fishing Assistance can provide information on fertilization requirements in relation to fish stocking of surface mine lakes in the area in connection with fish management.

Contacts for state assistance in obtaining fish for stocking are included in an appendix to Volume II of this source book.

For a comprehensive list of organizations, agencies and officials concerned with the broad field of natural resources use and management, the reader may wish to refer to the *Conservation Directory* published annually by the National Wildlife Federation, 1412 Sixteenth Street, N.W., Washington, DC 20036.

Volume II of this 2-volume work focuses on opportunities and approaches for managing fish and wildlife on areas surface-mined prior to and following enactment of P.L. 95-87. The emphasis is on habitat management, particularly as related to vegetation and
water. This volume provides suggestions or guides for establishing woods, field border, and roadside plantings; it discusses wildlife travel lanes and vegetation management in old field and forested areas; it discusses the creation and management of impoundments for fish and for waterfowl and general wildlife purposes; and it describes other management approaches.

Composite Sketch of Possible Management for Fish and Wildlife on Abandoned and Recently Mined Areas

The following sketch of a hypothetical situation as might be found in Ohio shows some of the steps that can be taken to improve conditions for fish and wildlife on surface-mined areas and is indicative of the types of management measures treated in Volume II.

It is important for planners and managers to consider alternatives during reclamation to enhance fish and wildlife. The composite sketch assumes that high priority is given to fish and wildlife considerations for the reclamation or management of mined areas, both abandoned and recent. A part of this hypothetical example shows the results of strip mining years ago, but does not have high priority for reclamation under P.L. 95-87; another part of this area depicts very recent surface mining and is subject to reclamation under the provisions of this law. It is assumed, further, that the owner is interested in developing the area, as an entrepreneur, for public recreation and part-time farming. The land is partly in woods and partly in old fields and agricultural crops.

Among the management measures or approaches taken to enhance fish and wildlife and recreational use of the area are:

A. On an abandoned strip-mined site (left central portion)
   1. Flattening of spoil ridges and establishment of food plots;
   2. Clearing parts of wooded spoils to encourage growth of herbaceous plants and shrubs valuable to wildlife;
   3. Maintaining of impoundments left by mining—some for fish production and some for waterfowl;
   4. Flattening of spoil banks adjacent to impoundments for ease of access;
   5. Planting of outslope and old bench with conifers and shrubs to increase diversity;

B. On a recently mined site graded to original contour and seeded to grass-legumes (central portion)
   1. Maintaining, under provisions of P.L. 95-87, the impoundments resulting from mining—one with gently sloping banks for waterfowl, and one with steeper banks and deeper water at the edges for fish;
   2. Construction of small islands of non-toxic spoil materials within impoundments for use of waterfowl and other wildlife;
   3. Planting clumps of shrubs and conifers within the grass-legume-seeded disturbed site to increase habitat diversity;
   4. Using brush from the clearing of the mine site for shelter for wildlife;
   5. Plantings along the sides of haul roads for wildlife;
   6. Erection of bird perches and bluebird nest boxes for increased use of grass-legume-seeded areas by birds;

C. On areas adjacent to mine-disturbed areas—
   1. Providing access by retaining haul roads;
   2. Providing parking and picnic areas;
   3. Creating openings in adjacent wooded areas for additional diversity;
   4. Providing travel lanes connecting mined and adjacent areas, including crop fields affording wildlife food and cover;
   5. Developing field and woods border plantings;
   6. Disking old fields to stimulate growth of herbaceous plants valuable to wildlife and to regulate plant succession.

Volume II of this manual contains additional schematic sketches of (1) area mining (2) contour mining and (3) mountaintop removal mining. The sketches show general reclamation for fish and wildlife before, during and after mining. These sketches are intended as recommendations and not to supersede or take precedence over legal reclamation requirements issued by the Office of Surface Mining Reclamation and Enforcement, U.S. Department of the Interior, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, or any state surface mining regulatory agency.

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This quiet, calm country scene was once the site of a strip coal mine. Hanna Coal Co., Division of Consolidation Coal Co., mined the coal and returned the land to a forest by grading it to a rolling contour and planting hardwood trees.

(Photo, Hanna Coal Co.)
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Appendix A
Appendix B
Regional Offices of the U.S. Fish and Wildlife Service

Region 1
U.S. Fish and Wildlife Service
Lloyd 500 Building, Suite 1692
500 N.E. Multnomah Street
Portland, OR 97232

Region 2
U.S. Fish and Wildlife Service
P.O. Box 1306
Albuquerque NM 87103

Region 3
U.S. Fish and Wildlife Service
Federal Building, Fort Snelling
Twin Cities, MN 55411

Region 4
U.S. Fish and Wildlife Service
Richard B. Russell Federal Bldg.
75 Spring Street, S.W., Suite 1276
Atlanta, GA 30303

Region 5
U.S. Fish and Wildlife Service
One Gateway Center, Suite 700
Newton Corner, MA 02158

Region 6
U.S. Fish and Wildlife Service
P.O. Box 25486
Denver Federal Center
Denver, CO 80225

Region 7
U.S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, Alaska 99503
Appendix C

List of Regional Offices of the Office of
Surface Mining Reclamation and Enforcement

Director, Office of Surface Mining Reclamation and Enforcement
   Director
   U.S. Department of the Interior
   Office of Surface Mining Reclamation and Enforcement
   1951 Constitution Avenue, N.W.
   Washington, D.C. 20240
   (202) 343-4006

Region 1:
   Regional Director
   U.S. Department of the Interior
   Office of Surface Mining Reclamation and Enforcement
   950 Kanawha Boulevard, East
   Charleston, WV 25301
   (304) 342-8125

Region 2:
   Regional Director
   U.S. Department of the Interior
   Office of Surface Mining Reclamation and Enforcement
   530 Gay Street, S.W., Suite 500
   Knoxville, TN 37902
   (615) 637-2600

Region 3:
   Regional Director
   U.S. Department of the Interior
   Office of Surface Mining Reclamation and Enforcement
   46 E. Ohio Street
   Indianapolis, IN 46204
   (317) 269-2600

Region 4:
   Regional Director
   U.S. Department of the Interior
   Office of Surface Mining Reclamation and Enforcement
   818 Grand Avenue, Scarritt Building
   Kansas City, MO 64106
Appendix D

List of USDA - Forest Service State Representatives for Mining and Reclamation

**Alabama:**
USDA-Forest Service  
P.O. Box 40  
Montgomery, AL 36101  
(205) 832-7630

**Illinois:**
USDA-Forest Service  
317 East Poplar  
Harrisburg, IL 62946  
(618) 253-7114

**Indiana / Ohio:**
U.S. Forest Service  
1615 J Street  
Bedford, IN 46421  
(812) 275-5987

**Kentucky:**
U.S. Forest Service  
Daniel Boone National Forest  
100 Vaught Road  
Winchester, KY 40391  
(606) 744-5656

**Maryland / West Virginia:**
USDA-Forest Service  
180 Canfield Street  
Morgantown, WV 26505  
(304) 599-7484

**Ohio:**
See Indiana.

**Pennsylvania:**
USDA-Forest Service  
Northeasten Area State & Private Forestry  
370 Reed Road  
Broomall, PA 19008  
(215) 596-1673

**Tennessee:**
USDA-Forest Service  
P.O. Box 400  
Cleveland, TN 37311  
(615) 476-5528

**Virginia:**
Forest Supervisor  
George Washington National Forest  
Harrisonburg, VA 22801

**West Virginia:**
See Maryland
Appendix E

List of State Agencies Cooperating with the U.S. Department of Agriculture Forest Service in Administration of Various Forestry Programs

Alabama:
State Forester
Alabama Forestry Commission
513 Madison Avenue
Montgomery, AL 36130
(205) 832-6587

Illinois:
Division of Forestry
Conservation Area, R.R. #5
Springfield, IL 62707
(217) 782-2361

Indiana:
State Department of Natural Resources
Division of Forestry
613 State Office Building
Indianapolis, IN 46204
(317) 633-6517

Kentucky:
Division of Forestry
Bureau of Natural Resources
Departments for National Resources & Environmental Protection
618 Teton Trail
Frankfort, KY 40601
(502) 564-4496

Maryland:
Maryland Forest Service
Tawes State Office Building
580 Taylor Avenue
Annapolis, MD 21401
(301) 269-3776

Ohio:
Division of Forestry
Fountain Square
Columbus, OH 43224
(614) 466-7842

Pennsylvania:
Director, Bureau of Forestry
Dept. of Environmental Resources
P.O. Box 1467
Harrisburg, PA 17120
(717) 787-2703

Tennessee:
State Forester
Division of Forestry
2611 West End Avenue,
Room 302
Nashville, TN 37203
(615) 741-3326

Virginia:
State Forester
Virginia Division of Forestry
P.O. Box 3758
Charlottesville, VA 22903
(804) 977-6555

West Virginia:
1800 Washington Street E.
Charleston, WV 25305
(304) 348-2788
Appendix F

Locations of Regional Chairmen and Regional Offices of the U.S. Environmental Protection Agency

Region 1: (ME, NH, VT, MA, RI, CT)

Permit Development Section
Enforcement Division
Environmental Protection Agency
John F. Kennedy Federal Building
Boston, MA 02203
(617) 223-5061

Region 2: (NY, NJ, PR, VI)

Chief
Environmental Protection Agency
Permits Administration Branch
26 Federal Plaza
New York, NY 10007
(212) 265-9881

Region 3: (PA, WV, MD, DL, DC, VA)*

Environmental Protection Agency
6th and Walnut Streets
Philadelphia, PA 19106
(215) 597-8821

Region 4: (NC, SC, KY, TN, GA, AL, MI, FL)

Environmental Protection Agency
345 Courtland Street, N.W.
Atlanta, GA 30308
(404) 881-2328

Region 5: (MI, WI, MN, IL, IN, OH)

Chief
Environmental Protection Agency
230 S. Dearborn Street
Chicago, IL 60604
(312) 353-2200

*In Region 3, EPA issues permits for discharges in WV, only, except for Federal facilities. In PA, MD, and VA, the NPDES Permit Program has been delegated to the States.
Appendix G.

List of Abandoned Mine Lands Reclamation Program State Officials, Eastern United States

**Alabama:**
Alabama Dept. of Industrial Relations  
State Programs Division  
Industrial, AL 36130  
(205) 832-6753

**Illinois:**
Lieutenant Governor's Office  
214 State Capitol  
Springfield, IL 62706  
(217) 782-6310

**Indiana:**
Indiana Division of Reclamation  
P.O. Box 101  
Jasonville, IN 47438  
(812) 665-2513

**Kentucky:**
Bureau of Surface Mining  
Reclamation and Enforcement  
Division of Orphan Land Reclamation  
3rd Floor, Capital Plaza Tower  
Frankfort, KY 40601  
(502) 564-2141

**Maryland**
Maryland Bureau of Mines  
Drawer C  
Westernport, MD 21562  
(301) 359-3057

**Ohio:**
Ohio Dept. of Natural Resources  
Division of Reclamation  
Fountain Square, Bldg. B-3  
Columbus, OH 43224  
(614) 466-4850

**Pennsylvania:**
Dept. of Environmental Resources  
Office of Resources Management  
P.O. Box 1467  
Harrisburg, PA 17120  
(717) 787-2315

**Tennessee:**
Department of Conservation  
Division of Soil Conservation  
1720 West End Building  
Room 501  
Nashville, TN 37203  
(615) 741-1664 or -2665

**Virginia:**
Division of Mined Land Reclamation  
P.O. Drawer U  
Big Stone Gap, VA 24219  
(703) 523-2925

**West Virginia:**
Dept. of Natural Resources  
1800 Washington Street E.  
Charleston, WV 25305  
(304) 348-2754
Appendix H.

List of State Geologists, Eastern United States

Alabama:
Geological Survey of Alabama
P.O. Drawer 0
University, AL 35486
(205) 349-2852

Illinois:
Illinois State Geological Survey
Natural Resources Building
Urbana, IL 61801
(217) 344-1481

Indiana:
Indiana Geological Survey
611 North Walnut Grove
Bloomington, IN 47405
(812) 337-2862

Kentucky:
Director & State Geologist
Kentucky Geological Survey
311 Breckinridge Hall
University of Kentucky
Lexington, KY 40506
(616) 258-5863

Maryland:
Director, Maryland Geological Survey
Merryman Hall
Johns Hopkins University
Baltimore, MD 21218
(301) 235-0771

Ohio:
Ohio Division of Geological Survey
Fountain Square, Bldg. 6
Columbus, OH 43224

Pennsylvania:
Director, Pennsylvania Geological Survey
914 Executive House Apts.
P.O. Box 2357
Harrisburg, PA 17120
(717) 787-2169

Tennessee:
Department of Conservation
Tennessee Division of Geology
G-5 State Office Building
Nashville, TN 37219
(615) 741-2726

Virginia:
Virginia Division of Mineral Resources
Dept. of Conservation & Economic Development
P.O. Box 3667
Charlottesville, VA 22903

West Virginia:
WV Geological & Economic Survey
P.O. Box 879
Morgantown, WV 26505
(304) 292-6331
Appendix I.

List of State Engineers, Eastern United States

Alabama:
Chief, Engineering Section
Dept. of Conservation & Natural Resources
64 N. Union Street
Montgomery, AL 36130

Illinois:
Illinois Dept. of Conservation
Division of Engineering
618 William G. Stratton Bldg.
(217) 782-2605

Indiana:
Chief Engineer
Division of Engineering
Department of Natural Resources
608 State Office Building
Indianapolis, IN 46204

Kentucky:
Director
Division of Fish and Wildlife Resources
592 East Main Street
Frankfort, KY 40601

Maryland:
Maryland Water Resources Administration
Tawes State Office Building D-3
Annapolis, MD 21401
(301) 269-2265

Ohio:
Office of Chief Engineer
Dept. of Natural Resources
Fountain Square
Columbus, OH 43224

Pennsylvania:
Director, Bureau of Surface Mine Reclamation
Dept. of Environmental Res.
7th Floor, Fulton Building
Harrisburg, PA 17120
(717) 787-5103

Tennessee:
Division of Water Resources
Tenn. Dept. of Conservation
4621 Trousdale Drive
Nashville, TN 37220
(615) 741-6860

Virginia:
Virginia Division of Mined Land Reclamation
P.O. Box Drawer U
Big Stone Gap, VA 24219
(703) 523-2925

West Virginia:
WV Dept. of Natural Resource
Water Resources Division
1201 Greenbrier Street
Charleston, WV 24311
(304) 348-5905
Appendix J.

List of State Foresters, Eastern United States

**Alabama:**
Alabama Forestry Commission
513 Madison Avenue
Montgomery, AL 36130
(205) 832-6587

**Illinois:**
Division of Forestry
Conservation Area, R.R. 5
Springfield, IL 62707
(217) 782-2361

**Indiana:**
State Department of Natural Resources
Division of Forestry
613 State Office Building
Indianapolis, IN 46204
(317) 633-6517

**Kentucky:**
Division of Forestry
Dept. for Natural Resources & Environmental Protection
618 Teton Trail
Frankfort, KY 40601
(502) 564-4496

**Maryland:**
Dept. of Natural Resources
Maryland Forest and Park Services
Tawes State Office Building
Annapolis, MD 21401
(301) 269-3776

**Ohio:**
Chief
Ohio Dept. of Natural Resources
Division of Forestry
Fountain Square
Columbus, OH 43224
(614) 466-7842

**Pennsylvania:**
Dept. of Environmental Resources
Bureau of Forestry
Forestry Advisory Services
102 Evangelical Press Bldg.
P.O. Box 1467
Harrisburg, PA 17120
(717) 787-3444

**Tennessee:**
State Forester
Tenn. Division of Forestry
2611 West End Avenue
Nashville, TN 37203
(615) 741-3326

**Virginia:**
Virginia Division of Forestry
P.O. Box 3758
Charlottesville, VA 22903
(804) 977-6555

**West Virginia:**
State Forester
Dept. of Natural Resources
Division of Forestry
1800 Washington Street, East
Charleston, WV 25305
(304) 348-2788
Appendix K.

List of Fish and Wildlife Agencies, Eastern United States

Alabama:
District Fisheries Supervisor
P.O. Box 163
Tuscaloosa, AL 35403
(205) 752-5932

Environmental Biologist (Game)
Dept. of Conservation &
Natural Resources
64 North Union Street
Montgomery, AL 36130

Illinois:
Department of Conservation
Division of Planning and Design
601 William G. Stratton Building
Springfield, IL 62706
(217) 782-4543

Indiana:
Director
Department of Natural Resources
Division of Fish and Wildlife
607 State Office Building
Indianapolis, IN 46204
(317) 633-7696

Kentucky:
Kentucky Dept. of Fish
and Wildlife Resources
Capitol Plaza Tower
Frankfort, KY 40601
(502) 564-3400

Maryland:
Chief
Technical Services Division
Maryland Wildlife & Non-Tidal Fisheries
Department of Natural Resources
Tawes Office Building
Annapolis, MD 21401
(301) 269-3195

Ohio:
Ohio Division of Wildlife
Fountain Square, C-4
Columbus, OH 43224
(614) 466-7313

Pennsylvania:
Division of Land Management
Pennsylvania Game Commission
P.O. Box 1567
Harrisburg, PA 17120
(717) 787-9612

Pennsylvania Fish Commission
Robinson Lane
Bellefonte, PA 16823
(814) 359-2754

Tennessee:
Tennessee Wildlife Resources Agency
P.O. Box 40747
Ellington Agricultural Center
Nashville, TN 37204
(615) 741-1431

Virginia:
Virginia Commission of
Game & Inland Fisheries
Box 565
Tazewell, VA 24651
(703) 988-4121

West Virginia:
Department of Natural Resources
Division of Wildlife Resources
Room 815, 1800 Washington Street, E.
Charleston, WV 25305
(304) 348-2771
Volume I, Part I of this 2-volume manual provides general information on the extent and nature of surface mining in the East, the amount of reclamation that has been accomplished, postmining land use alternatives, and environmental effects of surface mining in the past. The report covers much of the information available on fish and wildlife responses to habitat alterations caused by mining and reclamation. Information is presented concerning the capabilities to support fish and wildlife of mine spoils and land forms resulting from mining.

Part 2 introduces P.L. 95-87 and its related Rules and Regulations, outlining some of the major purposes of the Act referring to fish and wildlife and summarizing roles of agencies responsible for administering and implementing the Act. The relevance of some other Federal environmental laws, and assistance that can be rendered by other agencies in carrying out fish and wildlife conservation programs on surface-mined lands are discussed.

Part 3 details sources of information and assistance for developing data needed for preparing applications for mining permit-reclamation plans and for managing fish and wildlife on surface-mined areas.

Fish, Wildlife, Biota, Fauna, Reclamation, Surface Mining, mining, benches, highwalls, BTCA, Coal mining, habitat, haul roads, heavy metals, pollution control, land use, soil erosion control, spoil/overburden, revegetation, lands unsuitable for mining, mining laws, wildlife management, mining effects, nutrients, pH, planning, silt, spoil, acid mine drainage, water quality, threatened and endangered species
As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the national parks and historical places, and providing for the enjoyment and use of life through outdoor recreation. The Department administers our energy and mineral resources and works to assure that their development is in the public interest. The Department also has a major responsibility for the administration of Indian affairs in the 56 Native American communities and for Alaska Native administration.