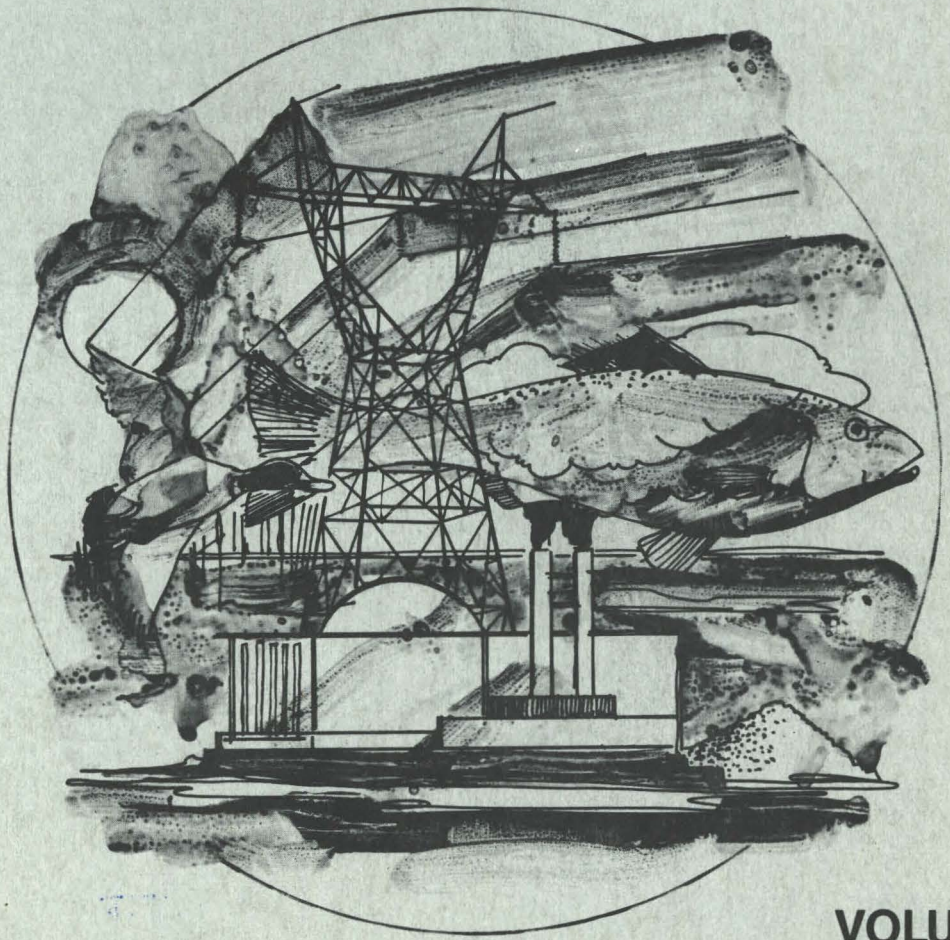
Biological Services Program

MANAGEMENT OF TRANSMISSION LINE RIGHTS-OF-WAY FOR FISH AND WILDLIFE



VOLUME 1

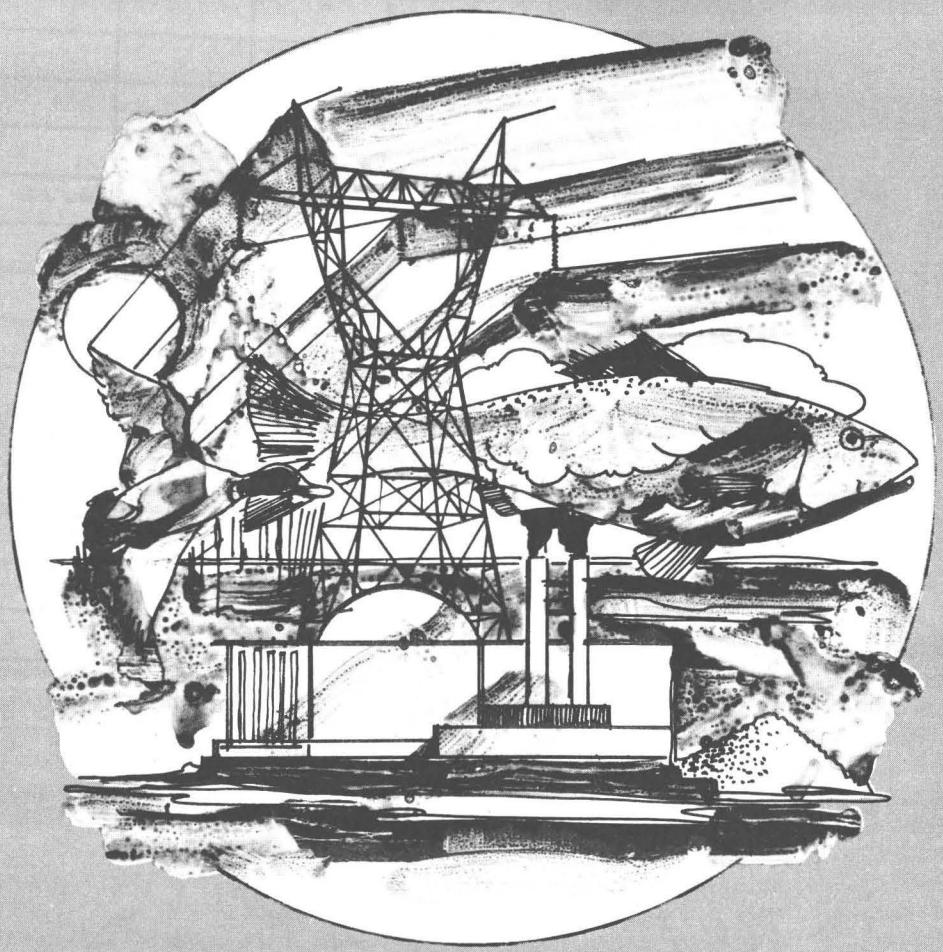
BACKGROUND INFORMATION

Fish and Wildlife Service

U.S. Department of the Interior

MANAGEMENT OF TRANSMISSION LINE RIGHTS-OF-WAY FOR FISH AND WILDLIFE

VOLUME 1
Background Information



Biological Services Program

FWS/OBS-79/22

MANAGEMENT OF TRANSMISSION LINE RIGHTS-OF-WAY FOR FISH AND WILDLIFE

VOLUME 1

BACKGROUND INFORMATION

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Performed for:
Power Plant Project
Office of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior

Energy Research and Development Administration,
Nuclear Regulatory Commission, and
Federal Energy Regulatory Commission of the
Department of Energy

Fish and Wildlife Service

U.S. Department of the Interior

DISCLAIMER

The opinions, findings, conclusions, or recommendations expressed in this manual are those of Asplundh Environmental Services and do not necessarily reflect the views of the Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior, nor does mention of trade names or commercial products constitute endorsement or recommendation for use by the Federal government.

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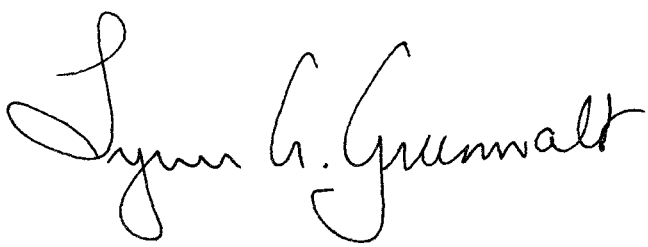
Foreword

The amount of land used for electric power generation and transmission in the United States is expected to increase substantially in the near future. Presently, over 300,000 miles of overhead transmission lines carry electric power for our homes, factories, and offices. The lands beneath those transmission lines, called rights-of-way (ROWs), can provide valuable habitat for fish and wildlife, if managed with that purpose in mind.

This manual is the result of a cooperative effort between Federal agencies and regional and local utilities to document the wildlife management and vegetation maintenance currently in use and to develop a step-by-step approach to ROW management that results in management strategies that not only enhance fish and wildlife habitat, but are cost-effective and also assure electric transmission reliability.

Management of Transmission Line Rights-of-Way for Fish and Wildlife is a three-volume reference manual that provides general background information on wildlife management and vegetation maintenance techniques and specific information on selected plants and wildlife species of the Eastern and Western United States. A step-by-step approach to ROW management planning identifies areas suitable for specific wildlife management planning and assures that all available habitat is evaluated and best utilized to benefit fish and wildlife.

With this kind of information and approach, biologists and ROW managers will be able to assess the management implications of transmission line ROW siting and other habitat modifications on fish and wildlife and provide information to decisionmakers. We believe this manual is a major step in providing the type of information necessary to incorporate environmental considerations into resource development decisions.



Director, U.S. Fish and Wildlife Service

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues which impact fish and wildlife resources and their supporting ecosystems. The mission of the Program is as follows:

> To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.
>
> To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major land and water use changes.
>
> To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decision-making process to prevent or minimize the impact of development on fish and wildlife. Biological Services research activities and technical assistance services are based on an analysis of the issues, the decisionmakers involved and their information needs, and an evaluation of the state-of-the-art to identify information gaps and determine priorities. This is a strategy to assure that the products produced and disseminated will be timely and useful.

Biological Services projects have been initiated in the following areas:

- Coal extraction and conversion
- Power plants
- Geothermal, mineral, and oil shale development
- Water resource analysis, including stream alterations and western water allocation
- Coastal ecosystems and Outer Continental Shelf development
- Systems and inventory, including National Wetlands Inventory, habitat classification and analysis, and information transfer.

The 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 who arrange for contracting Biological Services studies with States, universities, consulting firms, and others; Regional staff who provide a link to problems at the operating level; and staff at certain Fish and Wildlife Service research facilities who conduct in-house research studies.

Preface

Electric transmission rights-of-ways (ROWs) occupy approximately five million acres of land throughout the United States (Asplundh Environmental Services 1978).[1] With few exceptions, however, utility companies have regarded wildlife habitat management as coincidental to their ROW maintenance procedures. This is because utilities, although strictly regulated by the State public service commissions, are licensed only to provide electricity at the most economical rate to customers.

In recent years, wildlife habitat has been decreasing rapidly due to developmental projects and very efficient agricultural methods. Transmission line ROWs, however, constitute one land use development which holds great potential for benefiting wildlife. By incorporating basic wildlife management strategies into existing clearing and maintenance practices, cost-effective programs may be developed that enhance wildlife habitat and continue to meet electric transmission reliability requirements.

SCOPE AND PURPOSES

This manual brings together for the first time ecological information on selected plants and wildlife on a nationwide basis and demonstrates how this information may be incorporated into ROW wildlife management plans based on existing techniques. The manual does not attempt to evaluate the various potential land use alternatives associated with ROWs. Wildlife management is the only option considered here. The management practices presented are offered as suggestions only and are not meant as rules or regulations that must be followed.

The objectives of this manual are:

1 to provide U.S. Fish and Wildlife Service (FWS) biologists and utility ROW managers with a reference source to aid them in developing and implementing fish and wildlife management plans on overhead electric transmission line ROWs and,

2 to encourage more cooperation between groups in developing and implementing these management plans.

Suggested wildlife management strategies and guidelines for vegetation maintenance are presented for all biological ecoregions in the United States in the introduction (see "Identifying Biological Ecoregions") with considerations for cost-effectiveness and electric transmission reliability.

Although the manual focuses on electric transmission line ROWs, it may be of help to anyone involved with land, vegetation, or wildlife management in unique areas. Such areas as pipeline ROWs, railroad ROWs, roadway ROWs, logging areas, or "leftover" bits of agricultural lands—such as gullies, odd corners, or fence rows—are all places where some of the information in this manual may be used to improve wildlife habitat. The manual may also prove useful during the process of transmission corridor selection by providing information on management potential for wildlife in different vegetation communities.

It is fully recognized that this publication does not represent the final word on wildlife management on ROWs. Future work in this field will no doubt result in innovations not contained in this manual. Novel approaches may be needed in the areas of setting management objectives and incorporating them into wildlife management plans, inventorying resources in special linear habitats such as ROWs, relating the effects of ROW habitat management to wildlife populations in adjacent habitats, and determining the value of ROW habitat to various wildlife species. These are among the topics that must receive more attention in the future. The National Power Plant Team solicits all comments and suggestions on these and other related subjects.

Any suggestions or questions regarding this manual should be directed to:

Information Transfer Specialist
National Power Plant Team
U.S. Fish and Wildlife Service
2929 Plymouth Road
Ann Arbor, Michigan 48105
(313) 668-2365

[1] Asplundh Environmental Services. 1978. Benefit analysis—use of 2,4,5-T for vegetation management on rights-of-way. Asplundh Environmental Services, Willow Grove, PA. 44 pp.

Acknowledgments

Asplundh Environmental Services (AES) was responsible for conducting this project and preparing the initial drafts of the manuscript. AES staff members Paul A. Johnston, plant ecologist, and Phil Simpson, wildlife biologist, coordinated the many parts of this extremely complex project. The following individuals are gratefully acknowledged for their contributions to the development and organization of the information contained in this publication.

David M. Armstrong, University of Colorado—ecological information on selected wildlife species of the Rocky Mountain States; organization and development of selected wildlife species list.

Richard R. Braham, North Carolina State University—ecological characteristics and plant species lists for dominants and common associates for the Outer Coastal Plain Forest and the Southeastern Mixed Forest provinces.

William C. Bramble, professor emeritus, Purdue University—organization, style, and format of the manual; plant species lists and corresponding ecological characteristics for the Laurentian Mixed Forest, the Eastern Deciduous Forest, and the Prairie Parkland provinces.

William R. Byrnes, Purdue University—administrative and organizational help in finalizing the format and style of the manual.

Kenneth L. Carvell, West Virginia University—project format and style; technical assistance in many chapters.

Leslie W. Gysel, Michigan State University—technical editor for the ROW resource assessment and review of wildlife habitat management techniques chapters; project organization.

Joan Hett, University of Washington—plant listings, ecological characteristics, and wildlife information for the Columbia Forest, the Willamette—Puget Forest, and the Palouse Grassland provinces, and the Sitka Spruce—Cedar—Hemlock Forest, the Cedar—Hemlock—Douglas-fir Forest, the Silver Fir—Douglas-fir Forest, the Sagebrush—Wheatgrass, and the Ponderosa Shrub Forest sections.

Robert Hobdy, State Division of Forestry (Hawaii)—listing and description of the selected plant species for the Hawaiian Islands.

John L. Launchbaugh, Kansas State University—plant species listings and ecological characteristics for the Prairie Parkland, the Prairie Brushland, the Tallgrass Prairie, the Great Plains Short-grass Prairie, and the California Grassland provinces.

John W. Marr, University of Colorado—development of the plant ecological characteristics tables; dominant plant and common associate species for the Douglas-fir Forest and the Ponderosa Pine—Douglas-fir Forest sections, the Wyoming Basin Province, and all of Alaska.

Sidney T. McDaniels, Mississippi State University—plant species lists and ecological characteristics for the Everglades.

Robert E. McWhorter, Natural Resource Consultants (with Kansas Fish and Game Department at time of the study)—wildlife information for all prairie provinces.

William J. Neidig, vice president, Asplundh Tree Expert Company—cost data on ROW construction and maintenance methods.

Harold H. Prince, Michigan State University—format and organization of plant species tables.

Patrick J. Rusz, Grand Valley State College—chapters on ROW assessment guidelines and the literature review of the wildlife habitat management techniques applicable to ROWs; ecological characteristics of bird species.

Richard L. Stephenson, Ecological Consulting Services—selected plant species and ecological characteristics for the Lahontan Saltbush—Greasewood, the Great Basin Sagebrush, and the Bonneville Saltbush—Greasewood sections, and the Upper

Gila Mountains Forest, the Mexican Highlands Shrub Steppe, the Chihuahuan Desert, the American Desert, and the Colorado Plateau provinces.

Richard D. Taber, University of Washington—plant listings, ecological characteristics, and wildlife information for the Columbia Forest, the Willamette—Puget Forest, and the Palouse Grassland provinces, and the Sitka Spruce—Cedar—Hemlock Forest, the Cedar—Hemlock—Douglas-fir Forest, the Silver fir—Douglas-fir Forest, the Sagebrush—Wheatgrass, and the Ponderosa Shrub Forest sections.

Charles F. Yocom, Humboldt State University—technical review and organization of selected plant and wildlife tables; plant and wildlife species ecological characteristics for the Redwood Forest and the California Mixed Evergreen Forest sections.

Paul J. Zinke, University of California—plant species and ecological characteristics for the Sierran Forest and the California Chaparral provinces.

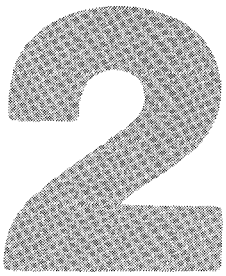
Additional thanks go to State game agencies for providing technical assistance, materials, and data throughout the study. Assistance was also provided by several U.S. Fish and Wildlife Service Ecological Services Offices and by many conservation and wildlife organizations in all 50 states.

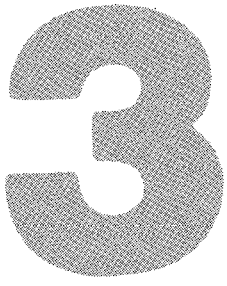
Also helpful in this study were the ROW department heads and personnel of 75 utilities selected to represent all geographic areas of the United States. The cooperation of the Edison Electric Institute is gratefully acknowledged. The literature search was facilitated by a cooperative agreement between the Electric Power Research Institute and the U.S. Fish and Wildlife Service.

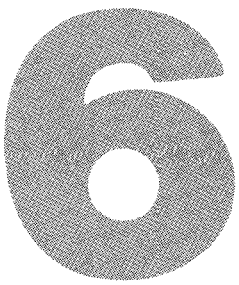
Numerous utility companies and Federal, State, and private agencies participated in the review process of various drafts of this manual and their willing cooperation was sincerely appreciated. Special thanks are extended to Dean Miller, Public Service Company of Colorado, for coordinating the review by the utility industry.

The final organization, editing, rewriting, proofreading, and production of this publication was the responsibility of Francine H. Scherger and Midwest Public Interest Communications, Ann Arbor, Michigan. Judy Stopke, The Art Dept., Ann Arbor, Michigan, designed the publication. The success of this project is due, in large part, to their efforts.

Contents

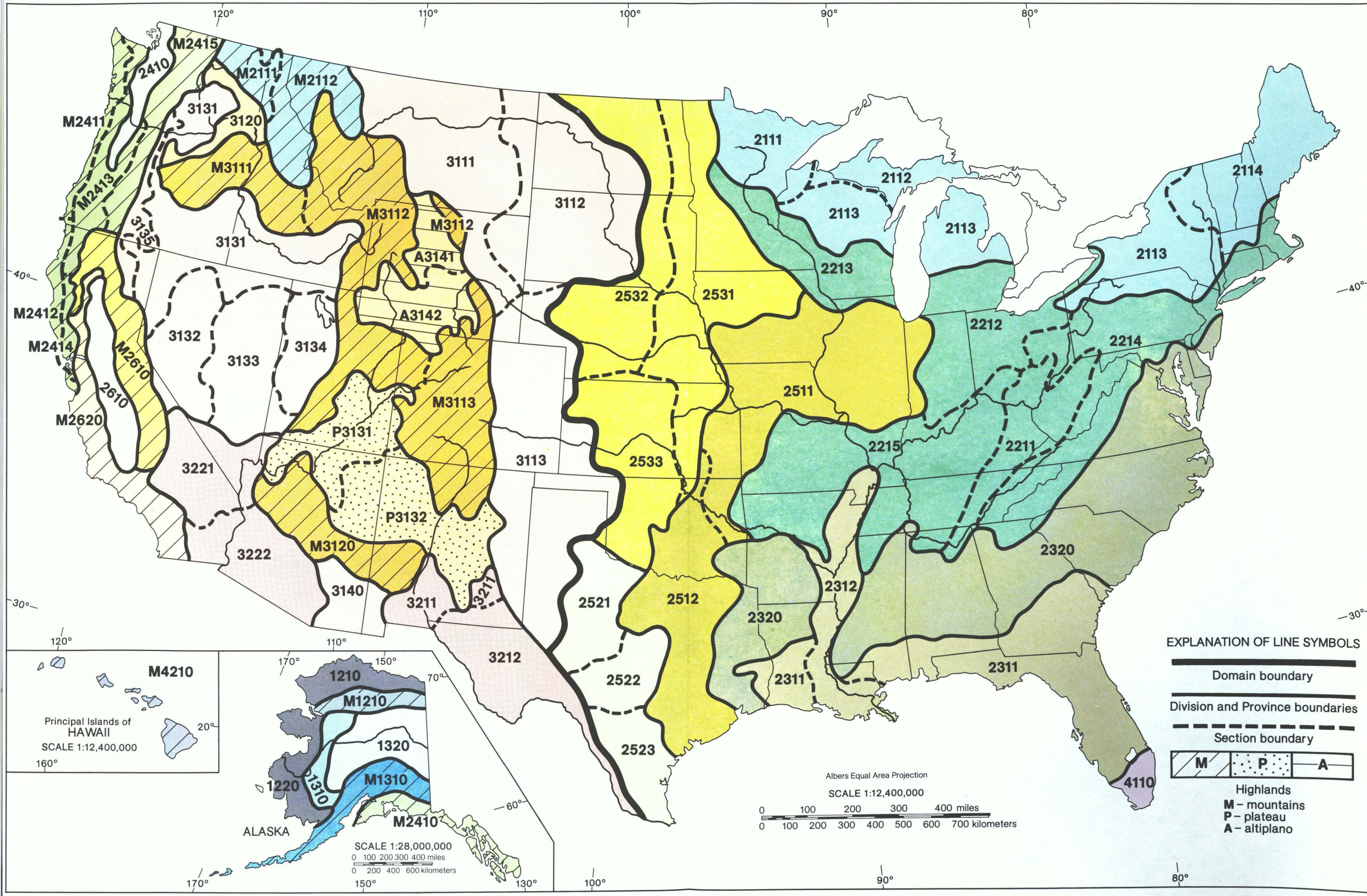






Illustrations

Tables


120°
110°
100°
90°
80°
40°
30°
M2415
2410
M2111
M2112
M2411
3131
3120
M3111
3111
M2413
3112
M3112
M3112
3135
3131
A3141
A3142
M2412
M2414
3132
3133
3134
M2610
2610
M2620
M3113
P3131
3221
3113
P3132
M3120
3222
3140
3211
3211
3212
2111
2112
2113
2113
2113
2114
2213
2532
2531
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2214
2511
2215
2211
2533
2320
2312
2521
2512
2320
2522
2311
2311
2523
4110
M4210
Principal Islands of
HAWAII
SCALE 1:12,400,000
160°
20°
170°
150°
70°
60°
1210
M1210
1320
1220
1310
M1310
M2410
ALASKA
SCALE 1:28,000,000
0 100 200 300 400 miles
0 200 400 600 kilometers
170°
150°
130°
Albers Equal Area Projection
SCALE 1:12,400,000
0 100 200 300 400 miles
0 100 200 300 400 500 600 700 kilometers
EXPLANATION OF LINE SYMBOLS
Domain boundary
Division and Province boundaries
Section boundary
M
P
A
Highlands
M – mountains
P – plateau
A – altiplano

EXPLANATION

DOMAIN	DIVISION	LOWLAND ECOREGIONS		HIGHLAND ECOREGIONS*	
		Province	Section	Province	Section
1000 POLAR	1200 TUNDRA	1210 Arctic Tundra		M1210 Brooks Range	
		1220 Bering Tundra			
	1300 SUBARCTIC	1310 Yukon Parkland		M1310 Alaska Range	
		1320 Yukon Forest			
2000 HUMID TEMPERATE	2100 WARM CONTINENTAL	2110 Laurentian Mixed Forest	2111 Spruce-Fir Forest 2112 Northern Hardwoods-Fir Forest 2113 Northern Hardwoods Forest 2114 Northern Hardwoods-Spruce Forest	M2110 Columbia Forest (Dry Summer)	M2111 Douglas-fir Forest M2112 Cedar-Hemlock-Douglas-fir Forest
	2200 HOT CONTINENTAL	2210 Eastern Deciduous Forest	2211 Mixed Mesophytic Forest 2212 Beech-Maple Forest 2213 Maple-Basswood Forest + Oak Savanna 2214 Appalachian Oak Forest 2215 Oak-Hickory Forest		
	2300 SUBTROPICAL	2310 Outer Coastal Plain Forest	2311 Beech-Sweetgum-Magnolia-Pine-Oak Forest 2312 Southern Floodplain Forest		
		2320 Southeastern Mixed Forest			
	2400 MARINE	2410 Willamette-Puget Forest		M2410 Pacific Forest	M2411 Sitka Spruce-Cedar-Hemlock Forest M2412 Redwood Forest M2413 Cedar-Hemlock-Douglas-fir Forest M2414 California Mixed Evergreen Forest M2415 Silver Fir-Douglas-fir Forest
	2500 PRAIRIE	2510 Prairie Parkland	2511 Oak-Hickory-Bluestem Parkland 2512 Oak + Bluestem Parkland		
		2520 Prairie Brushland	2521 Mesquite-Buffalo Grass 2522 Juniper-Oak-Mesquite 2523 Mesquite-Acacia		
		2530 Tall-grass Prairie	2531 Bluestem Prairie 2532 Wheatgrass-Bluestem-Needlegrass 2533 Bluestem-Grama Prairie		
	2600 MEDITERRANEAN (DRY-SUMMER SUBTROPICAL)	2610 California Grassland		M2610 Sierran Forest	
				M2620 California Chaparral	
3000 DRY	3100 STEPPE	3110 Great Plains Short-grass Prairie	3111 Grama-Needlegrass-Wheatgrass 3112 Wheatgrass-Needlegrass 3113 Grama-Buffalo Grass	M3110 Rocky Mountain Forest	M3111 Grand Fir-Douglas-fir Forest M3112 Douglas-fir Forest M3113 Ponderosa Pine-Douglas-fir Forest
		3120 Palouse Grassland		M3120 Upper Gila Mountains Forest	
		3130 Intermountain Sagebrush	3131 Sagebrush-Wheatgrass 3132 Lahontan Saltbush-Greasewood 3133 Great Basin Sagebrush 3134 Bonneville Saltbush-Greasewood 3135 Ponderosa Shrub Forest	P3130 Colorado Plateau	P3131 Juniper-Pinyon Woodland + Sagebrush-Saltbrush Mosaic P3132 Grama-Galleta Steppe + Juniper-Pinyon Woodland Mosaic
		3140 Mexican Highlands Shrub Steppe		A3140 Wyoming Basin	A3141 Wheatgrass-Needlegrass-Sagebrush A3142 Sagebrush-Wheatgrass
	3200 DESERT	3210 Chihuahuan Desert	3211 Grama-Tobosa 3212 Tarbush-Creosote Bush		
		3220 American Desert (Mojave-Colorado-Sonoran)	3221 Creosote Bush 3222 Creosote Bush-Bur Sage		
4000 HUMID TROPICAL	4100 SAVANNA	4110 Everglades			
	4200 RAINFOREST			M4210 Hawaiian Islands	

Key to letter symbols: M-mountains, P-plateau, A-altiplano

Introduction

This manual was designed to allow the user maximum flexibility. The suggested management strategies may be used on a wide variety of sites. Because the knowledge and judgement of the individual biologist or ROW manager is essential to implement these strategies, this manual has attempted to bridge the gap between the expertise of these two professional groups. The manual cannot make ROW experts out of biologists, or vice versa, but essential information is presented to help practitioners of one discipline better understand the goals of the other.

ORGANIZATION OF THE MANUAL

The manual is divided into three volumes — a general volume providing background information on wildlife management and vegetation maintenance on ROWs, and two volumes containing ecological information on selected plant and wildlife species and responses of various plant species to vegetation maintenance practices. For your convenience, this information has been synthesized into parallel volumes — volume 2 contains information on plants and wildlife of the Eastern United States; volume 3 discusses plants and wildlife of the Western United States.

Identifying Biological Ecoregions

Robert G. Bailey's 1976 map, "Ecoregions of the United States," was used by the authors to identify biologically similar areas within the United States. Bailey divides the United States into 31 biological provinces; he further subdivides these provinces into 61 biological sections (see plate 1). For our purposes, a province is defined as "a broad vegetation region having a uniform regional climate and the same type or types of zonal soils." A section is defined as "a subdivision of a province based on local climatic variation." The existence of two domains, or "subcontinental areas of related climates," are reflected in the organization of this manual. For convenience, the flora and fauna of the Eastern and Western United States are treated separately, disregarding Bailey's domain classifications. Alaska and Hawaii are considered with the Western provinces.

Generalizing Life History/Habitat Requirement Information

Life history/habitat requirement information contained in this manual of necessity has been generalized. Emphasis is on those factors that will benefit ROW managers. Due to the magnitude of a study of this type, all plant and animal species cannot be recognized. Species lists should not be interpreted as being the ideal species composition for any one site within a section; plants, local disturbances, climatic and edaphic factors, etc., will influence species composition of different sites. These variations, in turn, may affect local wildlife community composition.

Chapter Content

Volume 1, "General Background," contains information applicable to both volumes 2 and 3.

Chapter 1, "Using this Manual," contains a step-by-step discussion of the proposed use of this manual for: investigating the wildlife management potential on a right-of-way, assessing the resources on the right-of-way, identifying wildlife management priorities and objectives, and formulating and implementing the wildlife management plan. A discussion of four general vegetation management strategies—herbaceous, stable shrub, mixed woody, and passive—as well as a key to aid in the selection of the appropriate management strategy for a particular ROW, is followed by a detailed example that illustrates the step-by-step management technique.

Chapter 2, "Engineering Constraints in ROW Management," provides a basic review of the ROW siting and construction process. The basic parameters within which a transmission line must be designed and constructed are outlined.

Chapter 3, "Land Use Rights," discusses the various practices used to acquire a ROW and the feasibility and practicality of implementing wildlife management strategies under various landownership situations.

"ROW Maintenance Methods and Costs" are the subject of chapter 4. Selective and nonselective vegetation maintenance methods, methods for slash disposal and restoration, and techniques that alter other environmental components are discussed along with their current cost and extent of use. Relative costs are compared by technique and use in different areas of the United States.

Chapter 5, "Right-of-Way Resource Assessment," suggests guidelines that may aid the user in identifying and quantifying habitat factors that must be considered during the development of a specific management plan.

Chapter 6, "Wildlife Habitat Management Techniques," contains a thorough literature review of

← ***Plate 1*** Ecoregions of the United States

presently used management techniques applicable to ROWs in the United States. Methods of mechanical manipulation, brush piling, herbicide application, planting and seeding, streambank management, and prescribed burning are discussed. An extensive bibliography is provided in the references section of the chapter.

Three general appendixes are located at the end of volume 1 and contain information pertinent to all three volumes: General appendix A lists plants of the Eastern and Western United States and Alaska and Hawaii, alphabetically by common name. General appendix B contains an alphabetical listing by common name of wildlife—mammals, birds, amphibians and reptiles, and fish. Both appendixes list the scientific names used within the text; occasionally, a common name appears more than once, usually with a different scientific name, indicating the regional variation in common name usage. Following the scientific names in general appendix A is a list of the provinces in chapter 2 of volumes 2 and 3 in whose descriptions they are included. Parentheses indicate that in those provinces the species is found but under a different common name. Following the scientific names in general appendix B is a key that associates the species with a table or tables in chapter 3 of volumes 2 and 3.

General appendix C provides approximate equivalents of decimals to fractions and English to metric measurements.

A glossary operationally defines the terms in the text and offers supplemental definitions to scientific or biological terms.

An index to plant communities, selected wildlife species, and biomes is included. The numbers following each entry are the unique chapter section numbers that indicate the place within the manual where the subject is discussed.

Volumes 2 and 3 contain specific material relating to the Eastern and Western United States, respectively. Each volume contains three chapters:

Chapter 1, "Plant Responses to ROW Maintenance Methods," provides information on sprouting, reaction to competition, and other factors that determine plant responses to disturbances. The techniques for vegetation manipulation presented in this chapter emphasize the maintenance of electric reliability while enhancing vegetation for wildlife habitat. Provinces are discussed individually or in groups of biologically similar areas.

Chapter 2, "Selected Plant Species," presents for each province and, when appropriate, for each section or subsection, plant species associated with general plant communities, differentiated by moisture conditions, successional trends, and height stratifications. Descriptive ecological characteristics, such as habitat, growth form, fruit, and general wildlife use are also given for each plant.

Chapter 3, "Selected Fish and Wildlife Species," discusses the characteristics of certain mammal, bird, and amphibian and reptile species that should be given special consideration in ROW management planning. A brief province-by-province description of the fauna present is followed by a lengthy table that details the ecological characteristics of the selected species and several additional tables that provide information on bird nesting habitat and list U.S. endangered/threatened fish and State endangered/threatened fish and wildlife.

A list of references cited is provided for each chapter within all three volumes and follows the chapter text.

EDITORIAL CONVENTIONS

Cross-referencing between the three volumes has been accomplished by assigning each section within a chapter a unique section number. The section numbers run consecutively across all three volumes beginning with chapter 1 of volume 1.

These chapter section numbers are not to be confused with the section numbers referenced within provinces. Those section numbers are four digit numbers that relate directly to Bailey's map (plate 1). To further differentiate between chapter sections and province sections, chapter sections are always referred to with the generic "section," as in section 38. Province sections are referred to as proper nouns, as in Section 2212.

Figure and table numbers have been keyed to the chapter section (or, in some cases, the province, section, or subsection) to which they relate. For example, there are three sections in chapter 4—4, 5, and 6. Figures are found only in sections 4 and 6. The figure numbers are: 4.1, 4.2, 4.3, 4.4, 6.1, 6.2, and 6.3. The first number indicates the unique chapter section in which the figure is found. The second number indicates which figure is being referenced. Within chapter sections, figures are numbered sequentially; the numbering begins anew with each section. Note that in the example above, there are no figures in section 5.

Tables, in the forms of charts and graphs, found within the text are numbered in the same manner as figures; that is, sequentially within each chapter section. In volumes 2 and 3, however, an additional numbering scheme has been devised to facilitate the use of the detailed information on selected plant and wildlife species found exclusively in the tabular material.

In chapters 2 and 3 of these volumes, province descriptions are followed by the two sets of tables: Selected Plant Species tables and Ecological Characteristics tables. Each table carries an identification label that specifies:

Province number - **chapter section number** . **1 or 2** [**Section number or Subsection number**] **caption**

where: *Province number* relates directly to Bailey's map (plate 1),
chapter section number is the unique number assigned to each section within a chapter. The numbers run sequentially across all three volumes of the manual beginning with chapter 1 of volume 1. *1* indicates that this is a Selected Plant

or Wildlife Species table; .2 identifies an Ecological Characteristics table.

Section number also directly relates to Bailey's map (plate 1). Whenever possible, individual descriptions of specific sections and subsections are presented. In these cases, the number enclosed in brackets will indicate which section or subsection is being considered.

caption is a narrative description of the table contents.

For example,

Table 2210-33.1 [2215] Selected Plant Species Common to the Oak—Hickory Forest

specifies that this is the Selected Plant Species Table for Province 2210, Section 2215, and that the province is discussed in chapter section 33.

Running heads are included to further facilitate manual use. The running heads indicate the unique section number and the content of the section (an abbreviated version of the title). Running feet indicate page number and chapter number and title.

REFERENCE CITED

Bailey, R.G. 1976. Ecoregions of the United States. U.S. For. Serv., Ogden, Utah. map.

1

Using this Manual

Electric utility companies are licensed and regulated to provide uninterrupted electric energy to their customers. Utilities are not wildlife management agencies, although many companies do maintain their transmission line rights-of-way (ROWs) in a manner somewhat compatible with wildlife resources. This manual is intended as a reference document to be used by ROW managers when its content is applicable to their overall ROW objectives. Much of the material presented in this manual will be familiar to companies that have existing programs that include wildlife management considerations. For those utilities currently without wildlife management concerns, it is hoped that this manual will encourage the development of such practices as an integral part of their ROW maintenance routine.

This chapter provides an overview of the manual's organization and illustrates how it is intended to be used. It is not feasible to develop and implement a wildlife management plan for every segment of ROW in a utility's transmission system. When it is feasible to develop a wildlife management plan, the information and guidelines contained in this manual may assist biologists in doing so.

Four basic phases are involved in the development of a wildlife management plan on a given ROW: **A)** investigation for wildlife management potential, **B)** assessment of resources on the ROW, **C)** identification of wildlife management priorities and objectives, and **D)** formulation and implementation of the wildlife management plan. Each of these phases involves a number of procedural steps which are discussed in this chapter (figure 1). Chapters in the manual pertinent to each step are indicated as appropriate.

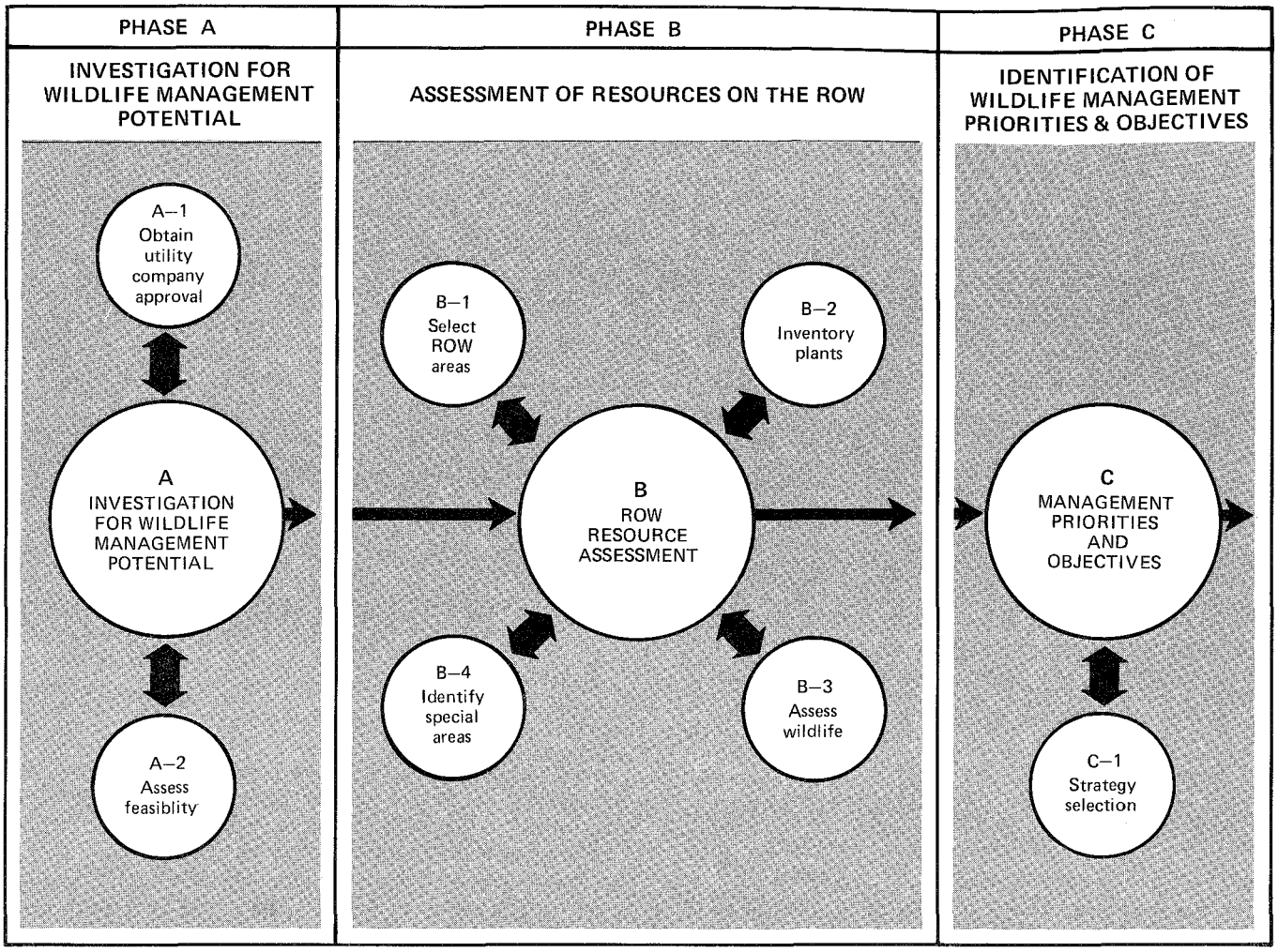


Figure 1 Four phases of wildlife management plan development

These phases and steps should not be thought of as being discrete, separate operations, but rather as parts of a continuous process—from inception to implementation—that often overlap in time and integrate without definite boundaries.

1 STEP-BY-STEP USE

PHASE A—INVESTIGATION FOR WILDLIFE MANAGEMENT POTENTIAL ON A RIGHT-OF-WAY

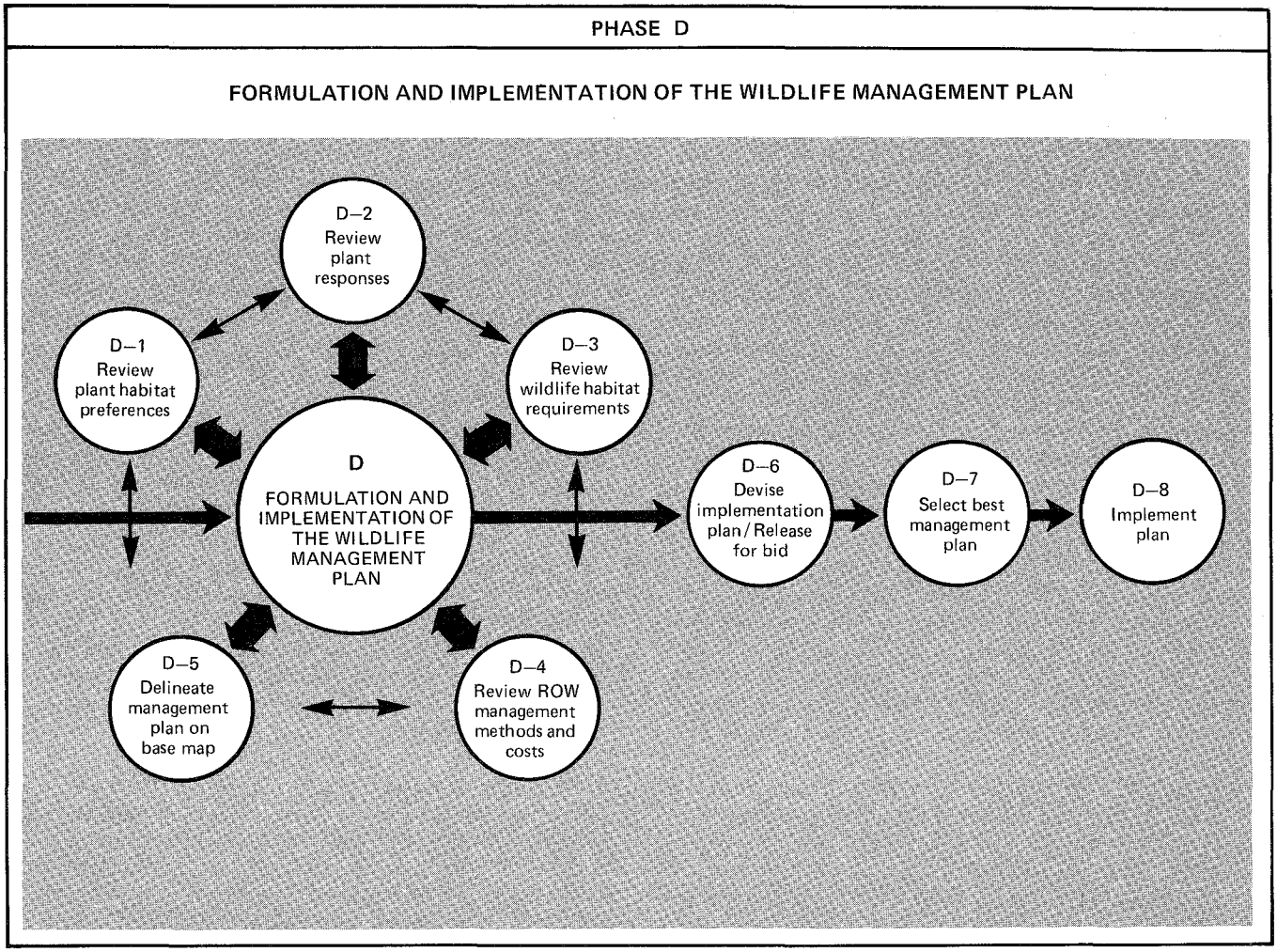
Step A-1 Obtain Utility Company Approval

The potential for wildlife management on a particular ROW will depend largely on whether or not a particular utility considers wildlife management to be an important part of their ROW maintenance policy. Without such a commitment by the utility decisionmakers, a wildlife management plan cannot be developed or implemented. However, after it has been decided to incorporate wildlife management concerns into the utility's ROW policy, engineers and biologists can begin to investigate the potential for developing a management program.

Step A-2 Assess Feasibility

The feasibility of implementing a wildlife management plan on segments of a ROW must be assessed with regard to the legal and physical constraints of the transmission system. ROW managers will be familiar with these conditions, but biologists may not be. Therefore, two chapters in this volume are devoted to these subjects. Chapter 2, "Engineering Constraints in ROW Management," discusses the physical limitations imposed by a transmission line and the associated ROW. Chapter 3, "Land Use Rights," considers the legal constraints imposed by the means of acquisition and adjacent land use of ROWs.

On a given ROW, there will probably be numerous segments with high potential as wildlife habitat. Due to the various constraints imposed by land use rights and engineering requirements, however, many of these candidate areas will be ineligible for wildlife management. Thus, the segments targeted for management have to be identified through consultations among biologists, engineers, and



land use personnel. Only after specific management sites have been identified is resource assessment feasible.

PHASE B — RESOURCE ASSESSMENT ON THE RIGHT-OF-WAY

Step B-1 Select ROW Areas

The areas of the ROW selected for inclusion into the company's wildlife management plan must be those where land use, ROW ownership, and terrain are compatible with the implementation of a management plan. Base maps should be prepared for the areas selected for management. Plan and profile maps used by the utility's Engineering Department can serve as excellent base maps, since they already include the transmission line, tower, and ROW delineation; land ownership; topography; and stream and road crossings.

Step B-2 Inventory Plants

The plant communities on and adjacent to the ROW should be inventoried. Some factors to consider when evaluating these plant communities are cover type, community structure, sensitivity to disturbance, fire potential, and location of tall trees that might interfere with conductors. These factors are discussed in more detail in chapter 5 of this volume, "Right-of-Way Resource Assessment." Plant communities should then be delineated on the base maps.

Step B-3 Assess Wildlife

Populations of selected wildlife species both on and adjacent to the selected ROW should be assessed. Factors to be considered in this assessment are discussed in chapter 5 of this volume, "Right-of-Way Resource Assessment."

Step B-4 Identify Special Areas

The adjacent land uses and any special or critical areas should also be noted and mapped on the base maps. Information regarding such areas is also found in chapter 5.

Once the above information has been collected and mapped, utility officials will have a better idea of present and future ROW management options. This will help in determining short- and long-range objectives that the utility company may want to achieve.

PHASE C — IDENTIFICATION OF WILDLIFE MANAGEMENT PRIORITIES AND OBJECTIVES

After the wildlife-related resources of the ROW have been assessed, the formulation of specific management goals and objectives for the selected ROW segments may begin. This is a key step in the development of a management plan and determines the final form and structure of the strategy to be implemented.

Wildlife management objectives may be designed to affect a particular species, such as the creation and maintenance of ruffed grouse habitat, or may be more generalized with no designated target species, such as the encouragement of habitat diversity. Although there is no right or wrong way to express the management objectives, several basic considerations common to all wildlife management programs on ROWs influence all policy decisions.

The first of these basic considerations is the nature of the existing plant and wildlife communities on and adjacent to the ROW. Information on local existing conditions should be readily available from local biologists and from the ROW resource assessment. The management plan devised must be compatible with the existing resources; it cannot be "forced" onto the environment. The plant community established on the ROW should retain a natural affinity with the surrounding vegetation. Native plant species should be encouraged and exotics should be used sparingly, if at all.

Cost is a very real constraint that must be taken into account when setting wildlife management goals. A particular management objective, desirable from a wildlife standpoint, may be too expensive for actual implementation. It would be futile and inefficient to spend time and money developing an objective that is uneconomical to establish on a ROW.

Finally, and most importantly, there must be adequate opportunity for local public viewpoints to be heard. The management plan developed should reflect wildlife priorities of citizens and/or governmental agencies that are directly affected by the management programs on the ROW (Tillman 1973). The willing cooperation of adjacent landowners is essential to a successful ROW management plan.

Where easements are in effect (see chapter 3), the utility company often has little say in how the ROW is managed. For example, in some situations the creation or enhancement of ring-necked pheasant habitat in heavily farmed areas may be the most desirable use of the land for wildlife, but because the ROW is under easement and the owner wishes to farm the land, the ROW manager must abide by the owner's wishes and cannot manage the ROW for wildlife. State or private conservation agencies, educational groups, hunting and fishing organizations, and others should also be permitted to comment on proposed ROW management plans in their areas of interest. Tillman (1973) discusses in more detail the importance of public input in formulating wildlife management objectives and priorities.

Step C-1 Select Appropriate Management Strategy

After determining the priorities and objectives of the management plan it is necessary to decide upon a strategy for fulfilling these priorities and objectives and to develop a scheme for implementing the strategy. The management strategies proposed in this chapter should be used as guidelines to aid in the development of the management plan.

Wildlife management strategies for ROWs can take many forms. Four basic strategies are discussed here and can be applied throughout the United States: herbaceous ROW strategy, stable shrub ROW strategy, mixed woody ROW strategy, and passive ROW strategy. These general strategies are described in some detail in section 2, along with a key for relating each of the plant community types likely to be encountered on a ROW to one of the four basic strategies.

The strategies are based on three general plant community types (herbaceous, stable shrub, mixed woody), each of which is structurally unique but may be composed of a wide variety of plant species, depending on region and location. Communities (and strategies) were selected and generalized so that any community encountered in the field could be placed in one of the community categories.

After a strategy has been selected, site-specific design modifications will be required before a final management plan can be developed. These will occur as the various steps within the formulation of the management plan are considered. The eight steps presented under Phase D have been separated for clarity but must be considered together as a single process because of their inherent interrelationships.

PHASE D — FORMULATION AND IMPLEMENTATION OF THE WILDLIFE MANAGEMENT PLAN

Step D-1 Review Plant Habitat Preferences

The general habitat preferences for the plants found during the ROW resource inventory should be reviewed. This review will provide information as to which plants should or should not be encouraged for the benefits of line reliability, erosion control, wildlife, ROW stability, aesthetics, etc.

Step D-2 Review Plant Responses

Review the responses of selected plant species on the ROW to various control and manipulation techniques (see chapter 1 of volumes 2 and 3). This review will help determine which methods will most effectively maintain the vegetation and benefit wildlife.

Step D-3 Review Wildlife Habitat Requirements

Review the habitat requirements for the various wildlife species in the areas of the ROW. Plants that serve as cover and/or food species should be noted; any other characteristics of wildlife species that may be important to the ROW management plan should be considered. These special characteristics may vary depending on the species, area of the country, ROW vegetation, and what is actually considered important about various species by the local public and the utility (see chapter 3 of volumes 2

and 3). Some common characteristics to watch for are the presence of seed-eating or browsing animals if seeding or planting is desired on the ROW. Animals that utilize low-growing vegetation types are noteworthy. Animals that may cause damage to wooden utility poles (if used) are also important (e.g., woodpeckers, bears, porcupines). A local biologist should be consulted regarding other characteristics of species to consider.

Step D-4 Review ROW Maintenance Methods and Costs

Feasible ROW maintenance methods should be reviewed along with their relative costs to determine which methods are the most cost-effective. Cost ranges for commonly used ROW methods are presented in chapter 4 of volume 1. The costs of implementing management strategies can be estimated from required combinations of ROW methods.

Step D-5 Devise the Management Plan

After Steps D-1 through D-4 are completed, the actual management plan can be devised. Several alternatives may be proposed and their respective merits evaluated in light of cost-effectiveness and compatibility with the previously defined objectives. The proposed plan(s) should then be delineated on a base map.

Step D-6 Devise Implementation Plan/ Release for Bids

Once the management plan has been developed, the specific tasks involved in implementation and any alternatives must be devised. For example, the locations of access roads, methods to be employed at streams and marshes, and other special requirements must be presented in detail on maps. These specifications can then be released by the utility company for bidding by contractors.

Step D-7 Select Best Management Plan

Based on the bids for the specifications and alternatives presented, the most cost-effective management plan is selected. By selecting from various alternatives and groups of alternatives, final costs can be kept within normal budgetary limits.

Step D-8 Implement the Plan

The final step in wildlife management plan development is the actual implementation of the plan by the contractor, with the ROW manager or biologist seeing that the specifications for wildlife management are carried out. The ROW manager and/or biologist also assumes the responsibility of altering the specifications in the field as needed.

2 GENERAL MANAGEMENT STRATEGIES

The first part of this section is a "key" for identifying elements in a plant community through a process of elimination. The community is divided into groups according to certain distinguishing characteristics; each group is further divided into successively smaller groups leading eventually to a single general strategy. A discussion of the general strategies follows the key.

KEY TO PLANT COMMUNITIES

I. FORESTED
- A. Conifer canopy
  - 1. Understory present
    - • *Strategy* — Favor broadleaf woody plants by using either pure shrub or mixed woody plant communities, or a combination of the two. This adds diversity to the overall habitat and increases woody browse in the area.
  - 2. Understory not present
    - • *Strategy* — Develop herbaceous communities; some broadleaf woody material is also desirable. Herbaceous plants reduce erosion and increase food and cover for ground-nesting birds and small mammals.
- B. Broadleaf canopy
  - 1. Understory present
    - a. Ground cover present
      - • *Strategy* — With all vegetation components present, aim at increasing the weakest component present.
    - b. Ground cover not present
      - • *Strategy* — Develop herbaceous communities.
  - 2. Understory not present
    - a. Ground cover present
      - • *Strategy* — If shrubs can be encouraged, develop a pure shrub community. This would help retard tree invasion. If shrubs are not common in the area, or if the site is unsuitable for shrubs, develop mixed woody plant communities to add diversity to the site.
    - b. Ground cover not present
      - • *Strategy* — Encourage low-growing woody and herbaceous plants by using the pure shrub and/or the herbaceous strategies.
- C. Brushland (forested areas where the major canopy species have not reached mature height)
  - 1. Ground cover present
    - • *Strategy* — Encourage low-growing and herbaceous plants by using the pure shrub and/or the herbaceous strategies and emphasizing the edge effect.
  - 2. Ground cover not present
    - • *Strategy* — Encourage low-growing woody and nonwoody plants by using the pure shrub and herbaceous strategies.

II. NONFORESTED
- A. Grasslands (areas dominated by grasses, but also containing various mixtures of other nonwoody plants)
  - 1. Grassland areas proper — lacking woody plant invasion

- *Strategy* — Encourage plants that add to the overall diversity of the site by using the herbaceous strategy. If applicable, also encourage low-growing woody plants by using the pure shrub strategy.

2. Areas of significant woody plant growth within the grasslands, such as riverbanks, lakesides, and other wet areas.
   - *Strategy* — Maintain and encourage these unique areas to add habitat diversity. Use mixed woody plant communities strategies with the pure shrub strategy.

B. Shrubland
1. Moist shrubland
   a. Ground cover present
      - *Strategy* — Favor passive management in these areas. Where disturbance is unavoidable, use pure shrub and herbaceous strategies.
   b. Ground cover not present
      - *Strategy* — Encourage nonwoody plants by using the herbaceous strategy.
2. Wetland shrublands
   - *Strategy* — Passive management is advised to minimize disturbance. If disturbance is unavoidable, use the herbaceous strategy to prevent erosion and increase diversity.
3. Dry site shrublands
   a. Dense stands
      - *Strategy* — Generally, use the herbaceous strategy to prevent erosion, increase diversity, and provide fuelbreaks. On very steep slopes and in other special situations, a passive strategy may be preferable.
   b. Open steppelike stands
      - *Strategy* — Use passive management generally, but if moisture conditions permit, use the pure shrub strategy.

III. SPECIAL AREAS
A. Desert areas
   - *Strategy* — Use a passive strategy for desert and desertlike conditions. Minimize disturbance whenever possible because many desert plant species only slowly regenerate.

B. Open areas (areas with little or no natural vegetation)
   - *Strategy* — Utilize passive management over any active strategy which may prove very costly and have only limited success because of extreme rockiness, shallow soils, or local extremes of acidity or salinity. Small, non-eroding, open areas may be beneficial.

C. Bogs, swamps, other wetlands
   - *Strategy* — Use passive management, minimizing disturbance whenever possible. To maintain a bog, prevent conifer invasion so that succession is retarded and the bog is preserved.

D. Agricultural areas
   - *Strategy* — Use a combination of herbaceous, pure shrub, and mixed woody strategies to create a varied habitat that will provide areas of year-round cover. In most cases where easements are in force, agricultural land will be farmed and no management will be possible; farmers will not allow it.

E. Urban and suburban areas
   - *Strategy* — Develop highly diverse edge areas emphasizing songbird nesting, perching habitat, and favoring desirable urban wildlife using herbaceous and pure shrub strategies.

HERBACEOUS ROW STRATEGY

The herbaceous ROW strategy (figure 2.1) consists of encouraging nearly pure stands or mixtures of annual and perennial forbs and grasses. Structurally, these stands are uniform in height and pose no threat to transmission reliability. The strategy is generally applicable to all domains of the country.

Herbaceous vegetation is easy to establish and develops quickly in a dense ground cover. Site preparation and seeding are common practices when soil is disturbed during the construction of new ROWs. Cultivated grasses and legumes are used to reduce erosion quickly, but seeding of native species is more beneficial to wildlife and should be encouraged. A discussion of these species and methods is found in section 23.

Several methods offering a range of costs to choose from may be used to maintain herbaceous vegetation. Selective herbicide application and hand cutting of invading woody plants may be used; these methods create minimal environmental impact, but their costs are high. Mowing encourages desirable mixtures of grasses and forbs, but frequent treatments are needed to suppress woody invasion. Broadcast herbicide applications are relatively inexpensive in many areas of the country, but repeated treatments will, in many instances, cause a

Figure 2.1 Herbaceous right-of-way

change in vegetation composition to that of a nearly pure grass ROW. These methods, their effects on wildlife habitat, and the use and relative costs for various areas of the United States are detailed in chapters 4 and 6 and should be studied before proceeding.

Advantages — Generally, a low ground cover will provide breeding cover for a variety of ground-nesting songbirds and game birds. If escape cover is available nearby, small mammals and larger herbivores will graze on desirable plants. When small mammals and birds utilize these areas, raptors are also found because their prey are visible and accessible.

When a herbaceous ROW parallels or traverses a forested area, the edge effect will be maximized and will benefit wildlife species preferring this habitat type. This type of ROW will, however, add little diversity when it passes through or near existing herbaceous or agricultural lands. Shrubby areas, such as the western chaparral areas, have a high fire potential as stands mature. In these areas, herbaceous ROWs can provide fuelbreaks as well as browseways in dense, overly mature chaparral stands (Nord and Green 1977).

Information about vegetation and wildlife for each ecoregion in the Eastern United States is found in volume 2; information for each ecoregion in the Western United States is found in volume 3. These data provide a base from which specific management plans for specific biological communities can be developed.

Disadvantages — In this ROW strategy, cover may be inadequate or of the wrong type for some wildlife species, exposing them to predators or hunters. In forested areas, continuous cover types may be broken up by the ROW, effectively isolating some animal populations. Trespass and vandalism problems may be created by the easy access to previously isolated areas.

Grasslands — The plains and prairies of the United States, Divisions 2500 and 3100 (see plate 1) are covered with native grassland vegetation that could be allowed to develop naturally on ROWs. Management of prairie vegetation is normally accomplished by burning or selective grazing, but these practices are usually not performed on ROWs. Woody communities in grassland areas are of special significance and are discussed with the mixed woody and stable shrub strategies.

Wetlands — Bogs and other nonwoody wetlands, although herbaceous, are discussed with the passive ROW strategy.

Other special areas — Herbaceous areas may be desirable around tower sites, permitting easy access to towers and adding diversity to ROWs maintained generally to other strategy types. Because of its value for erosion control, this type should be considered for use near stream and road crossings. If visual screens are required, narrow strips of herbaceous vegetation could be used in the most sensitive areas, such as steep banks, streambanks, and access roads.

STABLE SHRUB ROW STRATEGY

The stable shrub ROW strategy (figure 2.2) consists of encouraging pure stands or mixtures of shrubs. Herbaceous plants are interspersed throughout individual stands as ground cover filling small spaces between stands. Densities of herbaceous plants generally vary inversely with the density of the shrubs (i.e., high density shrub stands have a low density herbaceous component). Structurally, these stands vary in height with different species and do not threaten transmission reliability. The strategy is generally applicable to some portion of each domain in the United States.

Shrubs are difficult to establish from seed in many areas; planting of seedlings is expensive; results are unpredictable (U.S. Forest Service 1969). Management of naturally established shrub communities has produced some promising results (Richards 1973), but more research is needed.

Several methods at a variety of expense may be used to maintain stable shrub communities. Selective herbicide applications or hand cutting of tall-growing woody plants create little environmental impact, but are costly. Fire is commonly used to rejuvenate shrub stands, but its usefulness on ROWs is limited. Mowing and plowing may also be used where slope is not a limiting factor, but not all species respond to these methods. Broadcast herbicide applications are relatively inexpensive to use in many areas of the country, but care must be taken because many shrubs are sensitive to herbicides at concentrations required to kill tall-growing species. These methods, their effects on wildlife habitat, and the use and relative costs for various areas of the United States are detailed in chapters 4 and 6 of volume 1 and should be studied before proceeding.

Advantages — This strategy provides dense, low- to moderate-height escape and breeding cover for a variety of songbirds and upland game birds. Woody browse is produced in quantity along with large amounts of herbaceous growth. Fruits of a variety of species are common in season and available to songbirds, upland game birds, and browsers. Shrubby ROWs paralleling or traversing forested areas add diversity and edge to the area and moderate the effect of the opening on adjacent trees. A shrub ROW also affords a good protective crossing between forested areas for wildlife.

Disadvantages — Some shrub communities, particularly in chaparral areas of the West, may become so dense that they effectively form a barrier to browsing animals. Under these conditions, browseways may be constructed and maintained by periodic cutting or sheardozing of brush; dozing should only be used when adequate protection against erosion has been taken.

If native shrubs are not already established near the ROW, it may be very difficult and expensive to achieve this ROW cover type. An additional problem is that a pure shrub ROW may make utility maintenance access more difficult.

Grasslands — The plains and prairies of the United States, Divisions 2500 and 3100 (see plate 1), contain relatively few woody plant communities. Natural wooded communities are concentrated primarily on streambank or floodplain areas (Weaver 1968). Manmade

Figure 2.2 Stable shrub right-of-way

shelterbelts make up a second significant wooded area in the Great Plains. Both floodplains and shelterbelts should be evaluated for use of the stable shrub strategy. Native shrubs can be encouraged in floodplain areas, while a wide variety of cultivated native and exotic shrubs have been developed for shelterbelt plantings.

Wetlands — The borders of bogs, swamps, and other wetland areas contain dense stands of wetland shrubs. These communities are discussed with the passive ROW strategy unit.

Other special areas — Flowering shrubs and other species with aesthetic or ornamental value may be planted on ROWs in residential and recreational areas to create songbird habitat and foods. These plantings will benefit wildlife as well as provide the opportunity for ROW users to observe these animals.

MIXED WOODY ROW STRATEGY

The mixed woody ROW strategy (figure 2.3) consists of developing communities dominated by mixtures of tall-growing woody seedlings, sprouts, and root suckers associated with shrubs, all growing on a matrix of herbaceous vegetation. The tall-growing woody vegetation will be influenced by the original forest composition, but with time, species resistant to herbicides, vigorous sprouters, those capable of developing large clonal colonies, and invasion-type species will tend to dominate the ROWs. Shrubs will include those species capable of withstanding the partial shade and competition created by the taller plants. Herbaceous plants will vary depending on whether they are growing under the shade of woody plants, on the edge of such clumps, or in full sunlight between these communities. This strategy is generally applicable to all domains of the country, but is especially appropriate to deciduous forest areas.

Mixed woody vegetation is easy to establish and develops quickly into dense clumps of sprouts and root suckers. Native vegetation is always used; seeding or planting is impractical and unnecessary to develop this type of ROW community. Small, highly disturbed areas may be planted with cultivated grasses or legumes, but these will only serve as a cover crop until native vegetation develops.

Several methods with a range of costs may be used to establish and maintain this vegetation. Periodically cutting all plants back to a specified height by mowing may be used, but this method tends to encourage clonal species and the most vigorous sprouters. Mowing must be done at regular intervals and, thus, is costly. Selective herbicide application and hand cutting will allow more accurate manipulation of species composition; both methods, however, are costly. Broadcast herbicide applications are relatively inexpensive in many areas of the country, but repeated treatments with some herbicides may reduce brush density, eliminate desirable species, and encourage resistant species. All of these management methods, their effects on wildlife habitat, and the use and relative costs for various areas of the United States are detailed in chapters 4 and 6 and should be studied before proceeding.

Advantages — The mixed woody strategy provides a very diverse habitat capable of benefiting a wide range of wildlife species. Although tall-growing species cannot be allowed to mature, height, spacing, density, and species composition may be manipulated within specified ranges.

Figure 2.3 Mixed woody right-of-way

Where a ROW parallels or traverses a forested area, the edge effect will be maximized using this strategy. Properly used, this strategy can add diversity to any vegetation type.

Browse, fruits, and mast can be produced on this type of ROW. Cover is adequate for a variety of wildlife species. Shrub and small tree-nesting birds will be favored.

Disadvantages — This ROW type must be constantly monitored because of the large amounts of tall-growing species in the ROW area. Regular maintenance of the ROW and access roads will be necessary.

Grasslands — Woody vegetation in the plains and prairies of the United States, Divisions 2500 and 3100 (see plate 1) are limited to floodplain areas and shelterbelts. The mixed woody strategy is ideally suited to these areas where it can add to and complement the surrounding habitats.

PASSIVE ROW STRATEGY

The passive ROW strategy consists of minimizing the impact of maintenance activities on sensitive sites. Sensitive areas include wetlands, ridgetops, steep slopes, and shallow soils. Within the range of an endangered species, suitable habitats may also be considered for the passive strategy, but will vary depending on the specific requirement for the individual species.

Many factors relating to the passive strategy should be considered during the design and routing of a new ROW. During construction, additional local site factors may also be considered, but after construction, little can be done except to minimize disturbance in these areas.

Wetlands — For wetland crossings where conflicting considerations (such as the potential for bird strikes with transmission lines) do not prevent it, the following general guidelines (taken from Crabtree et al. 1978 and White and Byrnildson 1967) should be used in routing and construction of ROWs:

1 Follow existing utility clearings.
2 Follow the edges of tree and shrub communities.
3 Avoid dividing habitats whenever possible and cross the shortest length of the wetland. (However, sometimes the narrow part of the wetland will be where the flight paths of shorebirds, waterfowl, etc. are concentrated and, thus, where collision risk is highest.)
4 Cross low-growing communities instead of forested wetland areas.
5 Schedule activities during periods of least impact to wildlife (i.e., avoid nesting and young-bearing seasons) when possible.
6 Schedule construction during low water periods.
7 Reduce the size, number, and frequency of construction vehicles in wetlands.
8 Use culverts to avoid altering drainage in wetland areas.

Stream crossings — For stream crossings, the following general guidelines should be used in routing and construction of ROWs:

1 Cross streams at right angles.
2 Cross streams at points of narrow width and/or the lowest banks.
3 Avoid crossing potential fish spawning areas (i.e., gravel beds).
4 Schedule activities to avoid fish spawning periods.

Other special areas — For ridgetops, steep slopes, and shallow soils, the following general guidelines should be used in routing and construction of ROWs:

1 Maintain vegetation compatible with the overall profile to minimize adverse aesthetic impact of a ROW through wooded areas.
2 Reduce vehicle size, number, and frequency of travel in these areas.
3 When disturbance is unavoidable, use cover or nurse crops to aid revegetation.

3 EXAMPLE

As an aid to using this manual, a hypothetical example has been developed and simplified to show the interrelationships of the basic steps required to develop a wildlife management plan.

A utility, the Western Conservawatt Electric Company, has an overhead transmission system typical of many in the Western United States. Western Conservawatt's service area includes Sections 3131, 3132, and 3135 of Province 3130, the Intermountain Sagebrush (figure 3.1). The system consists of 985 pole miles of transmission lines rated at voltages of 69, 138, 230, 345, and 500 kV and 648 pole miles of subtransmission lines rated at voltages of 22, 34.5, and 69 kV (figure 3.2). The service area extends over a wide variety of physical, sociological, and ecological conditions. Since the early 1920's, when the first transmission lines were built, the company's general policy has been to acquire use of land through easements whenever possible. Thus, less than 20 percent of the company's ROWs are owned outright, having been acquired through fee simple purchases. The remaining 80 percent are held under easements granting the company varying rights and obligations regarding vegetation maintenance. (See chapter 3, Land Use Rights.)

Current public awareness has prompted an investigation into the potential for initiating a wildlife management plan on the company's ROWs. The company's vegetation manager is working in cooperation with a local biologist interested in wildlife management on transmission line areas. Either person could have initiated the process, but both felt they could make optimum use of their time and talents working together.

PHASE A—INVESTIGATION OF WILDLIFE MANAGEMENT POTENTIAL

Step A-1 Utility Company Approval

When the idea for wildlife management on the ROWs was proposed, Western Conservawatt's policymakers met and discussed the actual legal and physical constraints that influence their transmission system. The meeting resulted in utility officials accepting the idea of developing wildlife management plans where feasible. The company then established appropriate policies for their ROWs to include a positive commitment to active wildlife management and provided an indication of the relative intensity of management that would be implemented on the system.

Step A-2 Feasibility Assessment

Backed by the commitment of the utility, the team (vegetation manager and local biologist) became familiar with all necessary background information about the transmission system. During this process, the vegetation manager recognized that some of the easements as well as all of the land the utility owned outright would be suitable for a wildlife management plan. The local biologist began to formulate a preliminary idea of the type of wildlife management plan that would be most compatible with the company's transmission ROWs.

PHASE B—RESOURCE ASSESSMENT

Step B-1 ROW Selection

Through a process of elimination, candidate areas suitable for development of a wildlife management plan were selected. The team began to narrow down areas for inclusion in the plan by first identifying and eliminating areas where adjacent land uses made wildlife management impractical. They performed this step for all lines or line areas they could identify. In this example, however, the process will be followed for a single ROW only, the Watertown-Milton 230 kV line (figure 3.3).

Along the Watertown-Milton 230 kV line, four segments of ROW were identified as suitable for further assessment (figure 3.4). The land use rights associated with these segments were evaluated. The team now knows that some portion of each segment has both suitable land use patterns and rights associated with it. Further assessment causes the team to eliminate several of the segments.

Segment A is located near an urban area and agricultural land. Western Conservawatt owns small parcels of land at each end, but these areas contain a power generation plant and substation. The area in between is mainly farmland, with easements that do not allow any management. Segment C is mostly Bureau of Land Management lands, managed for grazing livestock. Easements do not allow wildlife management in this area. One small parcel within the segment is owned by Western Conservawatt, but it is rocky with virtually no vegetation. Segment D contains a State park area in which most of the easements do not allow for management by the utility. A section where Western Conservawatt does have these rights is currently being negotiated in expansion plans for the park. Future heavy recreational use of the area, however, would severely limit any wildlife management plans.

Segment B has mostly wooded-brushy areas under easements that would allow wildlife management. Included in this segment are 10 miles of a mainly wooded

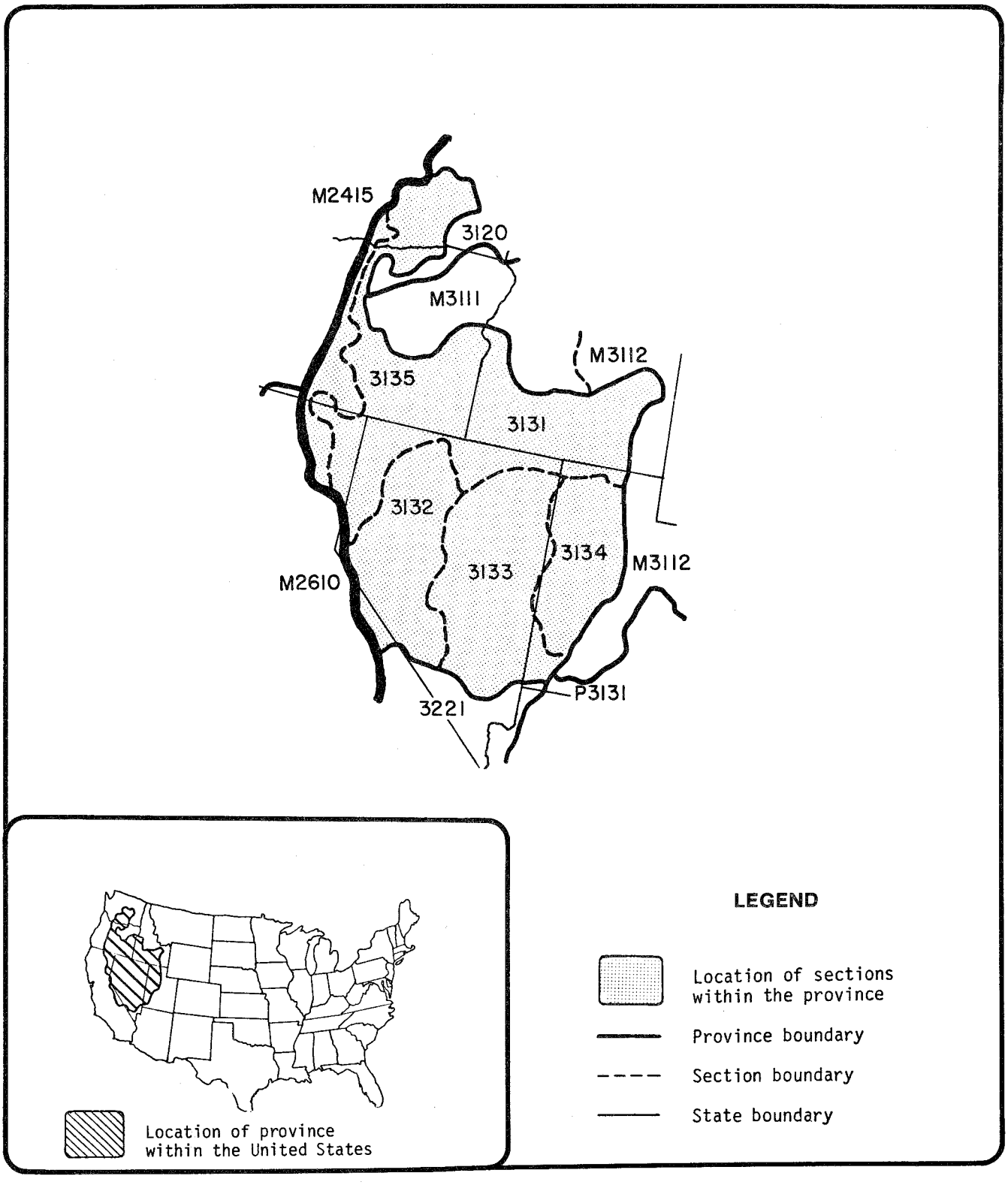


Figure 3.1 Service area of Western Conservawatt Electric Company

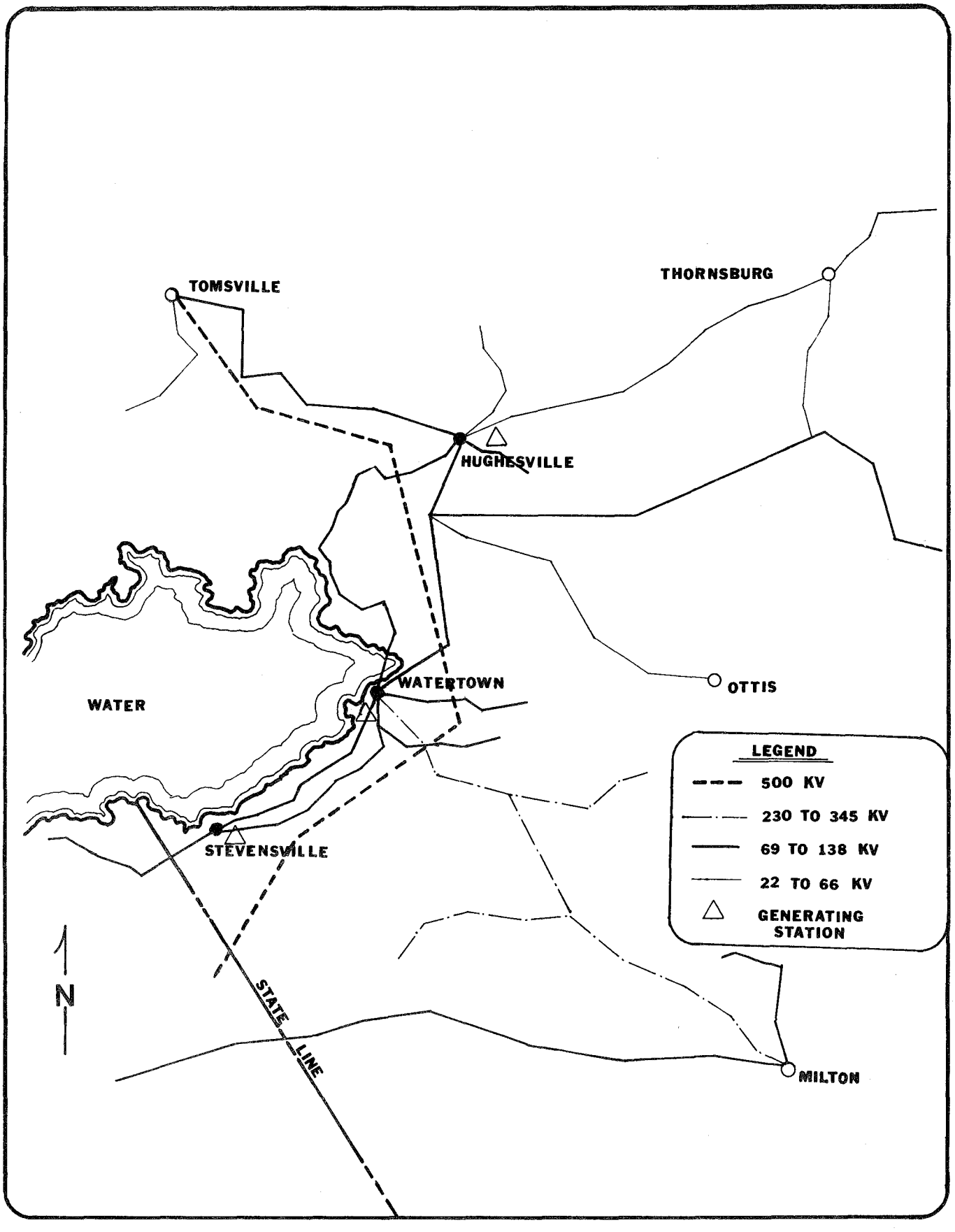


Figure 3.2 Western Conservawatt's transmission system

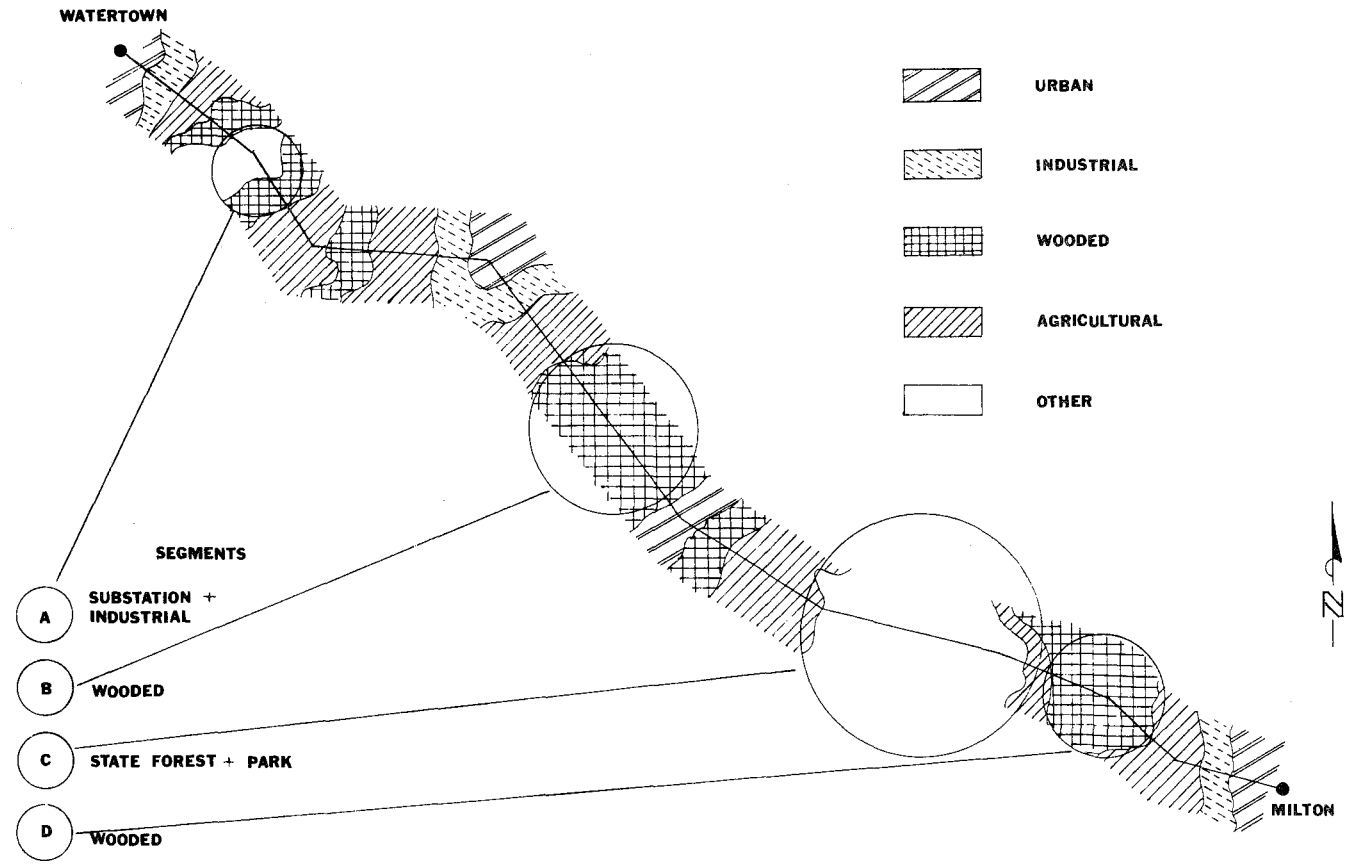


Figure 3.3 Land use pattern along the Watertown-Milton 230 kV transmission line

area of which the team chooses 5 miles for an intensive resource assessment (Steps B-2, B-3, and B-4). Base maps are essential to this resource assessment and are available in the form of plan and profile maps (figure 3.5) for the ROW area from Western Conservawatt's Engineering Department. These maps identify specific landowners, line and tower locations, topography, access and other roads, and stream crossings.

Step B-2 Plant Inventory

Using the guidelines and checklist found in chapter 5, appendix 5-a, the team identified the plant communities on the ROW and designated them on the base map (figure 3.6). The ROW segment under investigation descends a mountain on the eastern side, going from a relatively high elevation to a somewhat lower plateau level. In mountainous terrain, main ROW sections need no management when conductors span valleys and are too high to be within growth ranges of the vegetation beneath.

This particular ROW segment contains predominantly lodgepole—ponderosa pine stands in the higher elevations off the ROW. The ROW itself is a mixture of invading pines, *Ceanothus* spp., and various bunchgrasses. As the ROW descends in elevation, it traverses mainly a pinyon—juniper community. At the very lowest elevations, the ROW passes through chaparral.

Step B-3 Wildlife Assessment

The team also identified the wildlife habitat available in the area (figure 3.7). Initially, the team relied on published literature and contact with State biologists to identify the species that are present. This information was supplemented by field observations. Wildlife species found in the area include mule deer, elk, black bear, porcupine, coyote, and mountain quail. A wide variety of songbirds are present most of the year, with greater diversity down the mountain, away from the pure forest stands. Small mammals, as well as a few species of raptors, are also present.

The team knew that no wildlife species in the State are included on the U.S. Endangered/Threatened Species List; some wildlife species, however, were included on the State list. Although no golden eagles or nests had been seen in the ROW area, the habitat seemed to be ideal for them. The abundance of large trees for nesting plus the numerous prey species were indications that this area could support the golden eagle.

The team contacted the State Department of Conservation for a final check and received the same reply: it does not appear that any eagles are presently in the area. The State biologists mentioned that the eagles' problem is not so much destruction of habitat as it is the illegal shooting of the birds by ranchers or hunters.

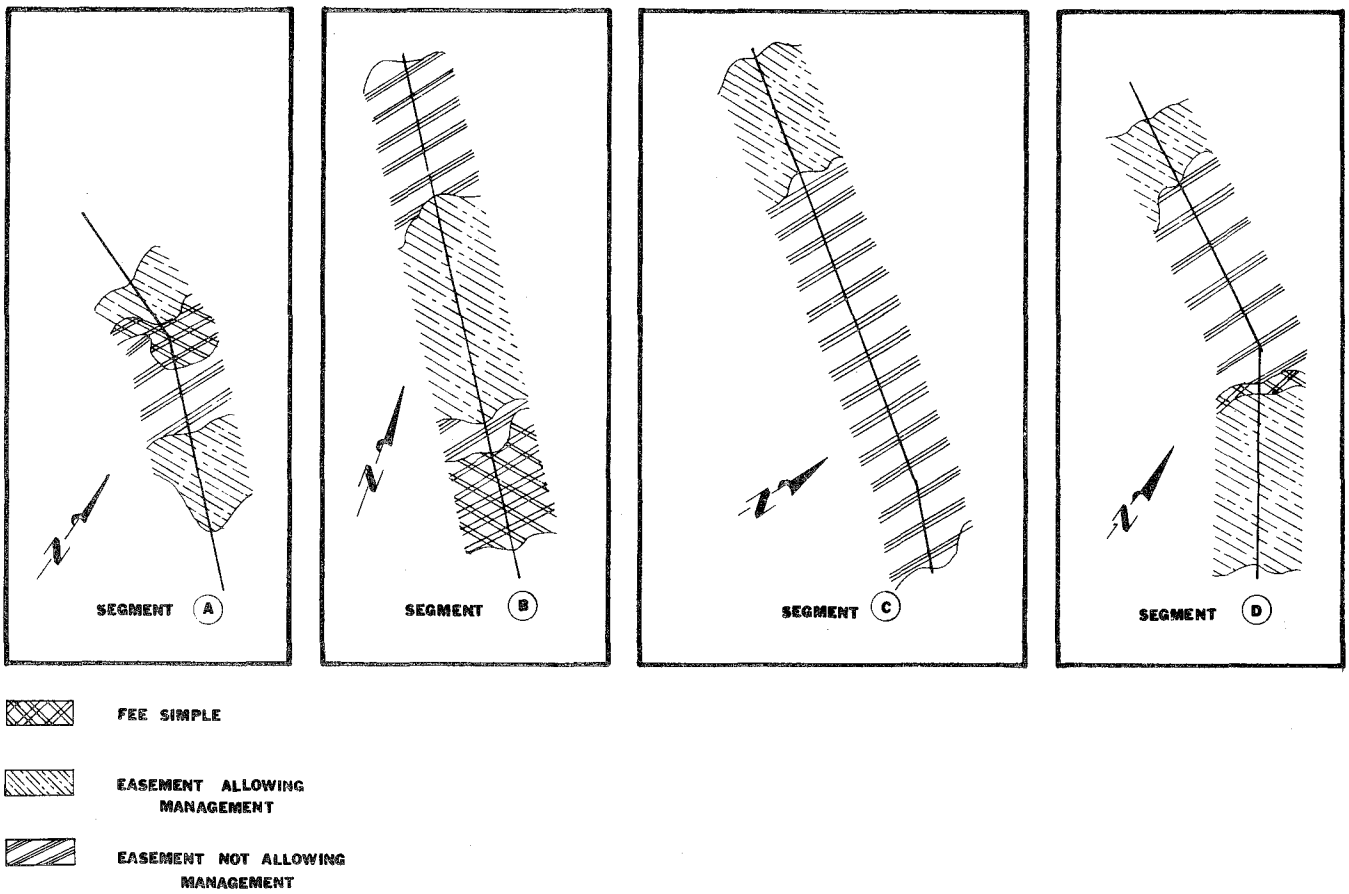


Figure 3.4 Segments along Watertown-Milton line suitable for further assessment

Step B-4 Identification of Special Areas

The team marked several other management factors on the base map, including the location of danger trees, den or mast-producing trees, brush piles or slash buildups, wetland areas, and the presence of endangered species habitats (figure 3.8). During this process, the team also indicated the relative intensity of management suitable for each area. When all field data had been collected and entered on the base map, the team was ready to select the wildlife management strategy.

PHASE C — IDENTIFICATION OF WILDLIFE MANAGEMENT PRIORITIES AND OBJECTIVES

The team is now in the position to determine the wildlife management priorities and objectives for the ROW. Based on the ROW resource assessment, cost, and public input (obtained through interviews with local residents, consultations with State wildlife officials, and a meeting with the local National Audubon Society chapter), general management priorities are decided upon:

1 Endangered species management — in areas in which endangered species are located, a species-specific management plan will be developed.
Note: this type of plan may include a passive management (minimum disturbance) policy.

2 Management for diversity — the plan will provide maximum habitat diversity beneficial to a large number of species occurring in the area.

An additional consideration that was brought up in the meetings with State wildlife officials was whether or not to allow hunting on the ROW. The presence of bear, deer, and elk typically draws several hunters to this region each fall. This particular section of line happens to lie in a straight line up the mountain. The low vegetation gives hunters an extra advantage in shooting at animals as they feed on or cross the ROW. Based on this information and because of the illegal eagle shootings that have taken place in the State, Western Conservawatt decides not to allow hunting on the ROW sections for which they can legally dictate policy.

Step C-1 Selection of Management Strategy

The team now consults the general wildlife management strategies outlined in section 2 to select the basic strategies to use in the area. After a careful evaluation, the team decides that the following combination of strategies should be used: the herbaceous ROW strategy for the pinyon—juniper area; the stable shrub ROW strategy for the small area at higher elevations.

Using the information gathered in Phases A and B and

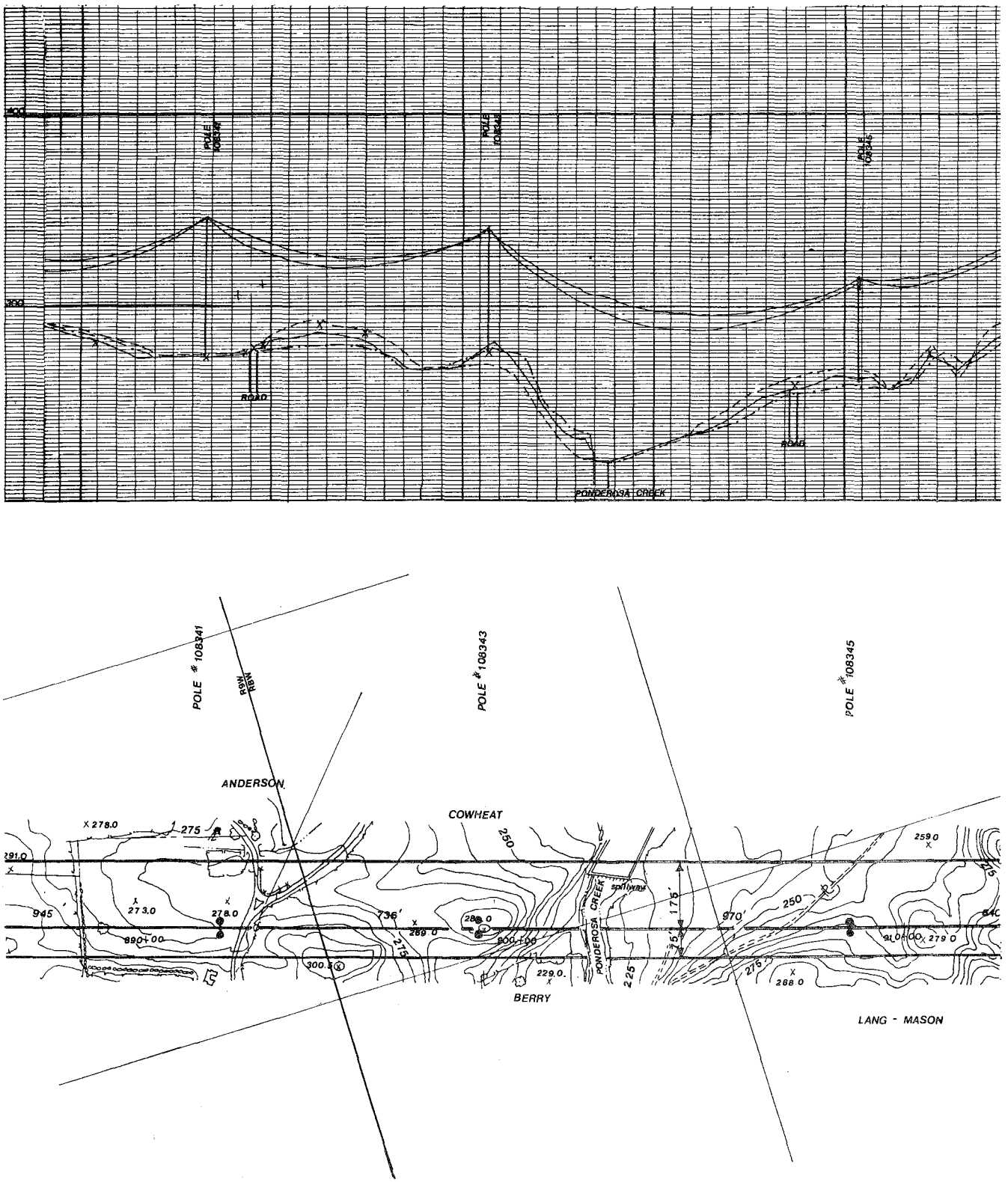


Figure 3.5 Plan and profile map for Segment B

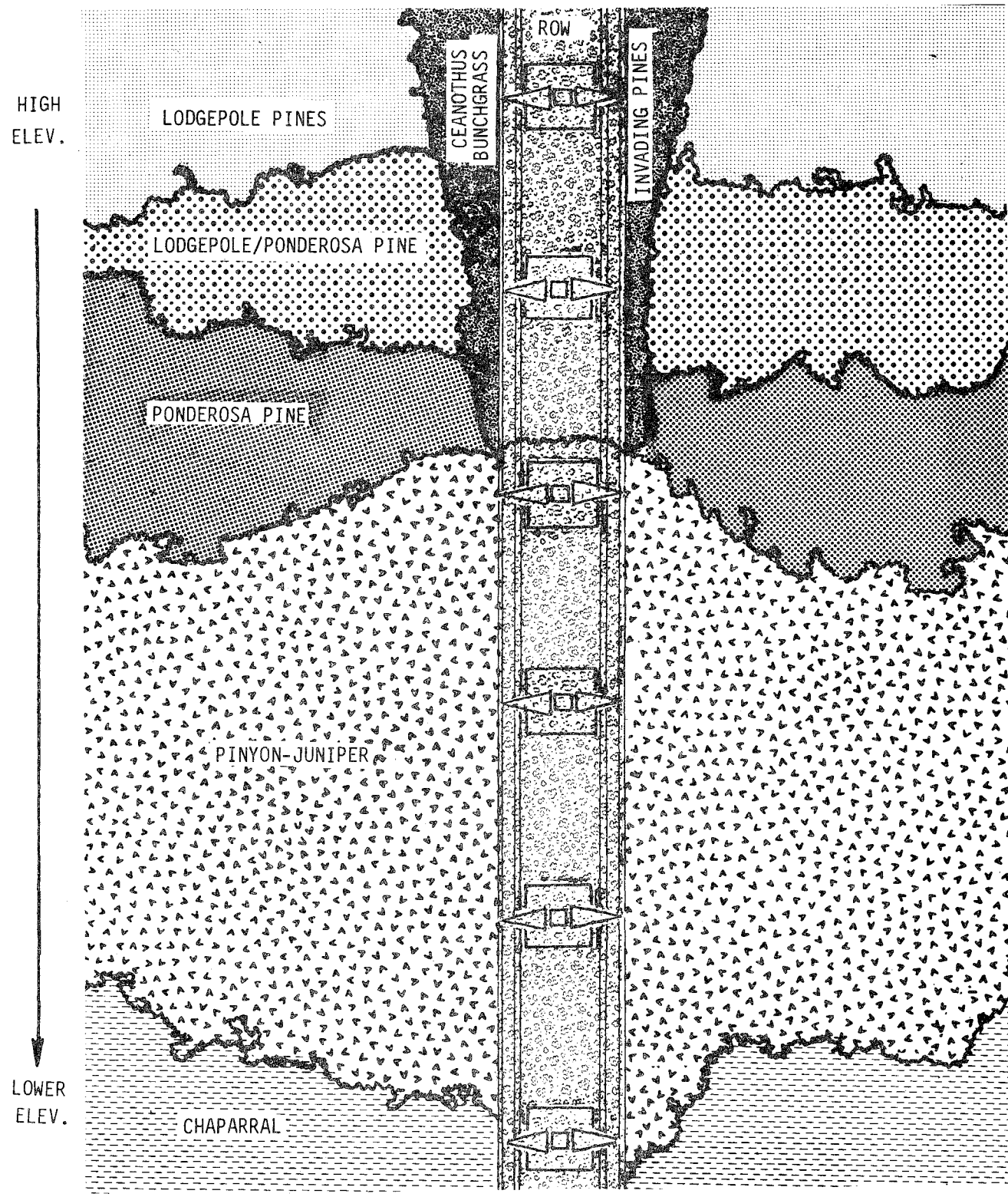
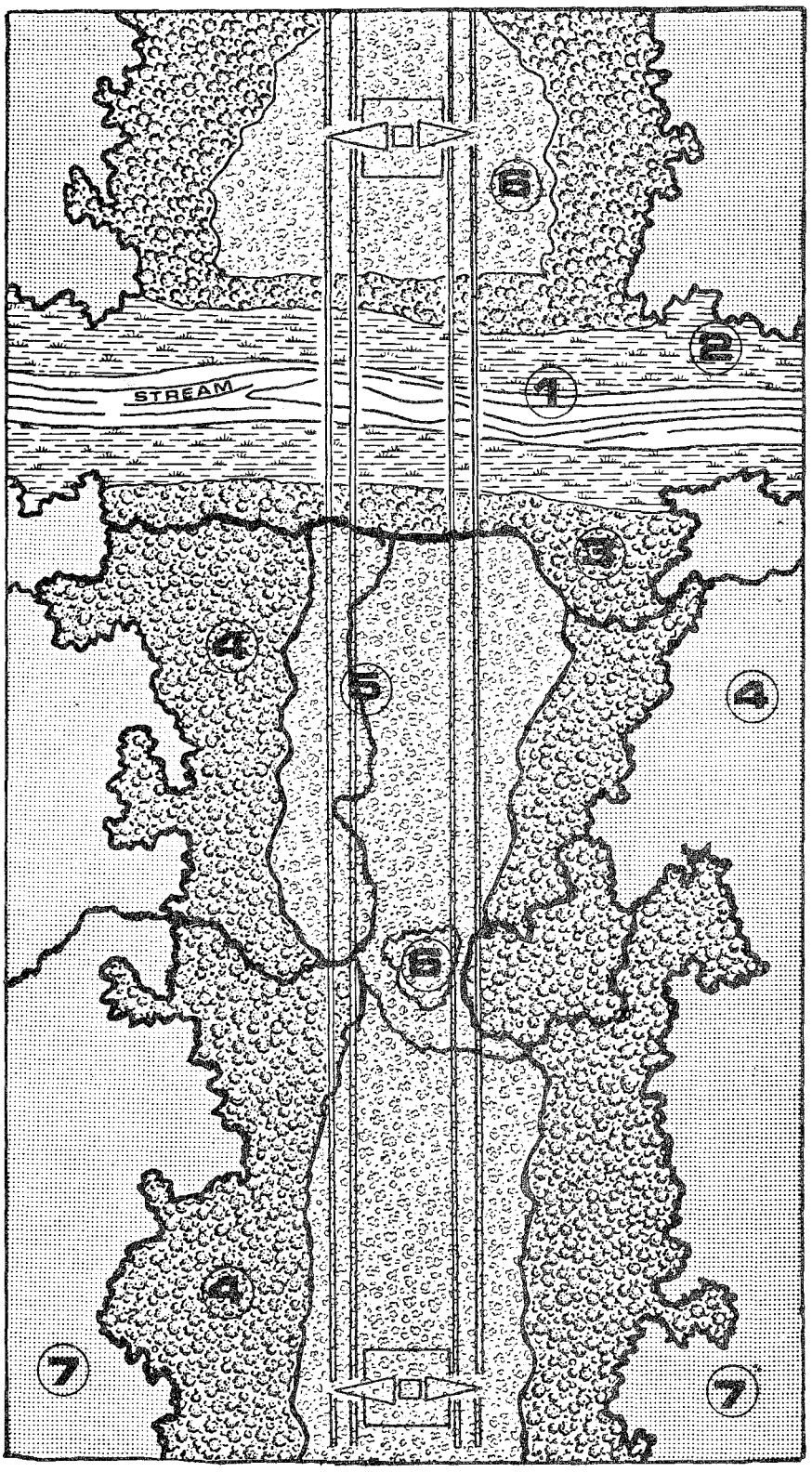


Figure 3.6 Plant communities present along Segment B



KEY

1.

Stream provides water for aquatic life, waterfowl, and muskrats.

2.

Sedge--cat-tail community provides food and cover for muskrats, waterfowl, and wetland nesting birds.

3.

Alder thicket provides escape cover and food for woodcock.

4.

Deer cover; browsing evident on smaller sprouts. Ruffed grouse habitat and feeding in the larger aspen areas.

5.

Diverse shrub--herb cover provides variety of nesting for songbirds. Cottontail rabbits also present.

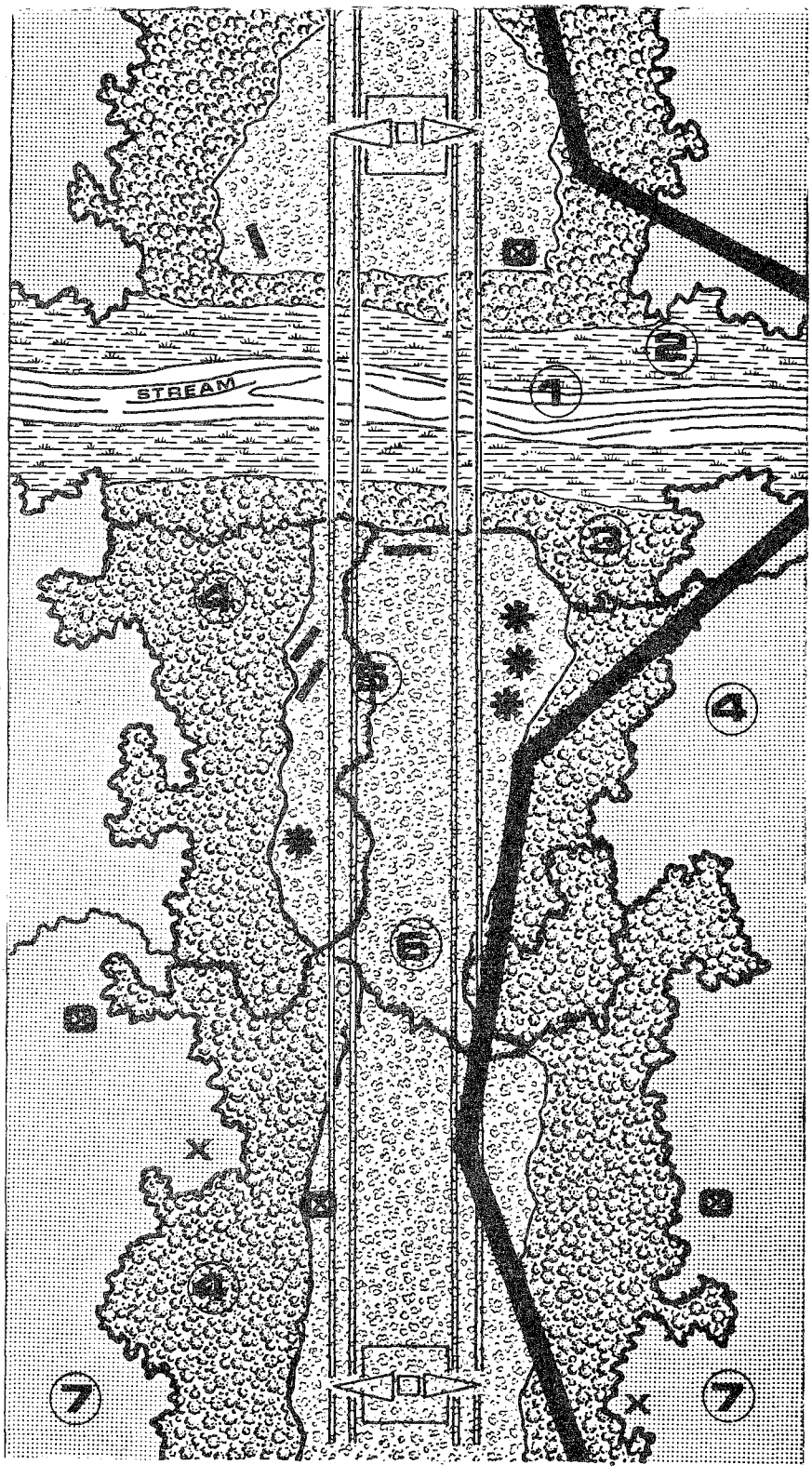
6.

Low herb cover provides early spring plants for grouse, deer, and songbirds to feed on.

7.

Mature white pine trees provide nesting cover for raptors. Old snags contain cavities for bluebirds and woodpeckers.

Figure 3.7 Wildlife habitats in Segment B



KEY

1.

Wetland--passive management.

2. & 3.

Sensitive areas, minimize disturbance. Selectively cut only potentially dangerous alders.

4.

Aspen and maple sprouts--selectively remove by cut and stump spraying taller individuals. Slash can be piled on edge of ROW.

5.

Shrub--herb cover needs no maintenance. Access road area could periodically be disced and planted to herbaceous cover.

6.

Mature forest (mostly white pine); only trees identified as potentially dangerous should be cut. If possible, topping and side cutting could be used to produce a snag valuable to wildlife. Mature aspen could be cut (if potentially dangerous) and left as drumming logs for grouse.

Access road

Brush piles

Cut logs

Snags

Danger trees

Figure 3.8 Identification of special areas in Segment B

the guidelines outlined in chapters 2 through 6 of this volume, the team begins to develop the management plan.

PHASE D — FORMULATION AND IMPLEMENTATION OF THE WILDLIFE MANAGEMENT PLAN

Step D-1 Plant Habitat Preferences

The team consults the Selected Plant Species tables for Province 3130 (volume 3, section 51) and finds that ponderosa and lodgepole pine are both categorized as tall-growing trees that will eventually have to be controlled on the ROW. Pinyon and juniper are both classified as low-growing trees that may at some time have to be controlled on the ROW. *Ceanothus* spp. and the present chaparral types (manzanitas and bitterbrush) are classified as low-growing shrubs that may be left on the ROW along with any grasses and forbs present.

The team finds additional pertinent information about these plants by examining the Ecological Characteristics Table (table 3130-51.2) found in volume 3, section 51. The data included in this table reveal that bitterbrush is important as food to small mammals and mule deer. Pinyon, juniper, and *Ceanothus* spp. all provide cover as well as food for small mammals, quail, mule deer, and elk. Manzanita berries are relished by wildlife; the plants form good cover for smaller animals. Both lodgepole and ponderosa pine furnish food in the form of seeds and needles. The trees themselves serve as cover for the various species of wildlife. The wood is gnawed by porcupines. The team also notes the growth forms and preferred habitats of these plant species.

Step D-2 Plant Responses

In this step, the team reviews the particular parts of volume 3, chapter 1 pertinent to Province 3130, with special regard to responses of the tall-growing plants on this ROW. This review reveals that ponderosa pine may be cut. If it does invade the ROW it will do so slowly because it competes poorly with the established grass. The same situation applies to lodgepole pine, but even more so, since it usually needs fire to regenerate. Both trees are susceptible to windthrow in shallow soils.

Also determined is the fact that pinyon — juniper areas are commonly altered by bulldozers, chain saws, and chaining or cabling. Openings created will usually grow up in grasses and forbs. Herbicides and fire also produce similar effects, with exceptions that snags will be left. Control of the method, however, to only the desired area to be treated is difficult.

Step D-3 Wildlife Habitat Requirements

The next step is to review the wildlife Ecological Characteristics tables in volume 3, chapter 3 for information on selected wildlife species found in the area (tables 65.5, 65.6, 65.7).

It should be noted that the mule deer's preferred cover types include conifer forests, pinyon — juniper areas, and chaparral types. Preferred foods that are also found in this study are bitterbrush, manzanitas, *Ceanothus* spp., and juniper.

Habitat requirements for elk include a forested/brushy mountain slope for cover that includes open grassy areas. Foods available in the area preferred by elk are *Ceanothus* spp., pine, and various grasses.

The black bear prefers dense thickets and forests and, as found in the inventory, already utilizes a blowdown near the ROW for a den. Foods preferred in the area are pinyon pine seeds, insects, and small mammals.

As found in the ecological characteristics for the coyote, this particular animal is extremely adaptable and does not necessarily require any management. Cover is any brushy or rocky area; the coyote's food preferences include a variety of plant and animal matter found in the area.

The porcupine is classified as a forest species and probably could not be managed for on the ROW itself. Its wood-gnawing habits may be a problem, however, if wood poles are used for the transmission line.

The mountain quail prefers edge areas of conifer forests in the mountains. Nesting habitat is provided by dense shrub growth. Ponderosa pine is a preferred roosting tree. Food preferences include insects and seeds of grass, *Ceanothus* spp., and manzanita.

Other selected wildlife species are checked in this manner. Songbirds observed in the area are checked in the Songbird Nesting Table (table 65.8) to see if they breed in this area and what nesting habitat they prefer.

Step D-4 ROW Maintenance Methods and Costs

The next step is to analyze which ROW maintenance methods are feasible and economical for this area of the country. The vegetation manager from Western Conservawatt is already familiar with these methods and costs, but the biologist is not. They note that bulldozing, selective cutting, and stem-foliage waterborne spraying are common methods used in this area (section 16). Various slash disposal methods are also commonly used, while seeding to restore ROWs is performed routinely.

The team notes that, in general, costs of ROW maintenance methods for this particular area are high in comparison to the rest of the country, so vegetation maintenance will be employed only where absolutely necessary.

Step D-5 Management Plan

Basically, the team has now gathered the information necessary for formulating the management plan. These considerations are all interrelated in the planning process (see figure 1).

The first decision the team must now make is how to best manage the potential danger vegetation on this ROW: ponderosa and lodgepole pine, pinyon pine, and juniper. Based on the information gathered from examining plant responses, the team decides that the best way to manage the ROW through the forested area is to selectively cut any pine seedlings, should they appear. The existing grass—*Ceanothus* spp. cover will also discourage the future establishment of pines. This ROW area cover serves another function: that of a fuelbreak. Since fires are common in ponderosa — lodgepole forests

in this area, a fuelbreak here is an aid to firefighters. The danger trees noted just off the ROW should be cut away from the ROW to maintain the integrity of the fuelbreak.

Since the *Ceanothus* spp. are very scattered and not large, it is decided not to remove them so they can serve as a food source to wildlife. Also noted in the plan is an avoidance (when possible) policy in the area of the bear den, especially in spring and summer when cubs might be present with their mother.

The pinyon—juniper habitat is valuable wildlife habitat as is, but taller plants should be selectively cut. The access road in this area can be bulldozed free of these species and will open up the area to forbs and grasses, also valuable to wildlife. Slash can be piled at the ROW edge, if breaks are provided to allow wildlife access.

The low-growing chaparral area is to be left undisturbed, especially because of its high maintenance costs. Manzanitas and bitterbrush serve as excellent wildlife cover and food. The access road can be bulldozed clear. Tower sites can be left with bare rock cover or with grass.

The final part of this step is to prepare these specifications formally and to delineate special treatment areas on the base map.

Step D-6 Implementation Plan

The implementation plan, containing the specifications and alternatives, is presented to Western Conservawatt officials. Upon approval, the utility releases the plan for bids in the same manner that all the company's vegetation maintenance specifications are released.

Step D-7 Selection of Management Plan

The final plan that is accepted by the utility is based on the most cost-efficient combination of base bids and selected alternates, allowing Western Conservawatt officials to initiate a management plan while staying within normal budgetary limits.

Step D-8 Implementation of Plan

As soon as the job is awarded and maintenance work begins, the planning team assumes the responsibility of being present in the field to make sure the plan is implemented according to the specifications. Since it may be necessary to change some specifications in the field, as problems arise, the presence of a team member is valuable. The team member may also discover ways to improve the plan in the future.

It should be pointed out that implementation of the wildlife management plan does not necessarily occur at one time. Due to budget and time constraints, different specifications in the plan may be performed on the ROW as they are needed until all specifications are finally worked into the maintenance program. Periodic evaluation of the effectiveness of the plan should be made and changes or new ideas implemented accordingly.

Note: Although this example is geared to formulating a wildlife plan on an existing ROW, the manual may also be used for new ROWs. The general steps to be followed are the same, but the vegetation present before a ROW is constructed gives even more flexibility to a wildlife management plan. Developing wildlife management specifications before construction helps reduce the impact on wildlife.

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2

Engineering Constraints in ROW Management

This chapter provides insight into the physical and biological alterations that occur when a transmission facility and ROW are constructed. The ROW alteration practices discussed are representative of those utilized by utilities throughout the United States and are not specific to any given utility company.

4 GENERAL ENGINEERING INFORMATION

Transmission lines in the United States carry electrical energy in two basic ways: alternating current (AC), and direct current (DC). The most common type is AC, in which the direction of electron flow within the line changes back and forth. In DC transmission, there is no change in the direction of electron flow. For purposes of discussion, the similarities between AC and DC are more important than the differences. Since AC transmission is presently much more common in the United States than DC transmission, the rest of this discussion will deal primarily with AC transmission lines.

AC transmission lines carry three-phase power; DC lines carry electricity at two polarities. Either AC or DC current may be single or double circuit. Thus, a three phase transmission line carries the specified voltage through three conductors or bundles of conductors (figure 4.1).

Each circuit has one conductor for each of the three phases. A double circuit line has six conductors. The conductor, usually a wire or cable, carries electric current and is fixed to the transmission structure by insulator strings. Conductors for some high voltage transmission lines are comprised of two or more wires strung in bundles, with one bundle required for each phase. Static or overhead ground wires are mounted on top of the structure to protect against lightning damage. Following is a discussion, of several physical and engineering parameters of transmission lines that may cause environmental alterations.

VOLTAGES

Transmission line voltage determines design specifications, construction methods, and considerations important in determining the environmental effects of electric power transmission. Transmission line voltage levels may be divided into three ranges:

1 high voltage transmission (HV) — 69 kilovolts (kV) to less than 230 kV;
2 extra high voltage transmission (EHV) — 230 kV to 765 kV;
3 ultra high voltage transmission (UHV) — greater than 765 kV.

These definitions may vary among utility companies. Higher voltage lines connect large generating units with major substations and switching points.

The surface area of the conductor determines, in part, the amount of energy a conductor can carry. Conductors with greater total surface areas carry more energy more efficiently than smaller conductors. In recent years, utilities have been upgrading lines by installing larger conductors. In many cases, new structures have been built because the original towers did not have the strength to support the larger conductors. Lines rated for 345 kV can carry up to six times as much power as 115 kV lines

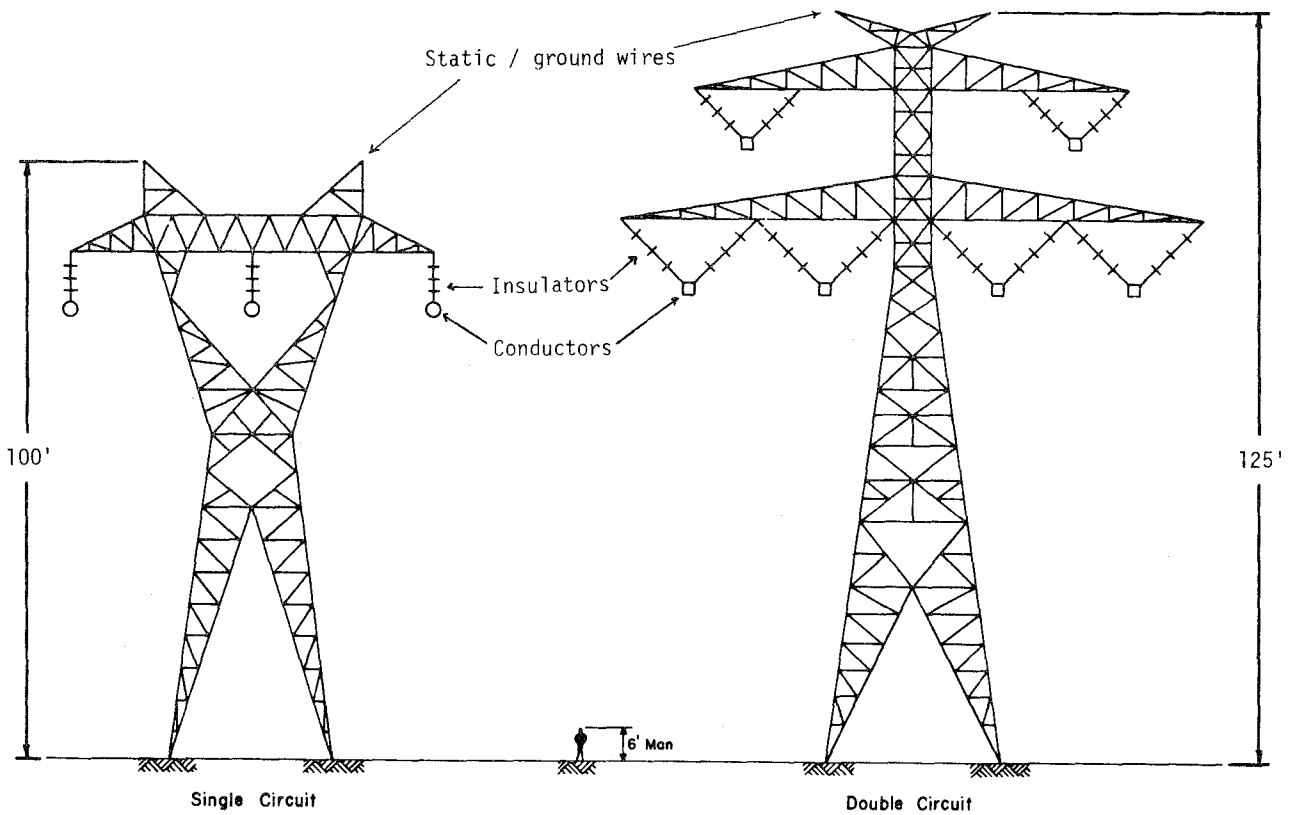

Figure 4.1 Example of single and double circuit tower construction

because of their increased voltage and current-carrying capability (Northeast Utilities Systems 1974). A 765 kV line can carry five times the energy of a 345 kV line (Northeast Power Coordinating Council 1975).

Each transmission line is designed for a maximum level of current flow, called rating. The flow of electricity through a conductor is opposed by an internal resistance which causes heat, expansion of the conductor, and conductor sag. Extended operation at high conductor temperatures may cause heat damage to the conductors.

CLEARANCES

Transmission line height reflects the requirements for protecting the line from interference due to tall trees. The amount of sag on a given conductor is determined by a number of variables, including distance between towers, tower height, conductor weight, capacity, and temperature. Conductors also swing laterally with the wind. Side clearance is figured by calculating the swing of the conductors in the worst possible conditions — i.e., high temperatures and high velocity winds. Minimum distances are kept between conductors of different phases or voltages to prevent "flashover," a sudden surge of voltage causing an arc between conductors (Northeast Utilities System 1974). Figure 4.2 illustrates the effect of varying conditions on adjacent tall-growing vegetation.

After the voltage and circuit are determined, economic, engineering, environmental, and safety considerations determine the design of the line. A principal decision is whether to use long spans and tall structures or short spans and short structures (Northeast Utilities System 1974). This decision influences both the location and design of the ROW.

RELIABILITY

Transmission line reliability refers to electric power being available whenever necessary. It is a component of an entire electrical reliability system including generation of electricity. Electrical outages due to transmission failure may have four basic causes: 1) natural phenomena; 2) system operation; 3) line or equipment failure; and 4) human actions, foreign objects, and unknown factors. Of greatest concern are outages caused by events external to the transmission system. These make up nearly 85 percent of the total failures. Typical causes include a conductor breaking from accumulated ice, fallen trees, aircraft, and windstorms. Lightning accounts for 42 percent of all outages and is the most frequent cause of line failure (Holberger et al. 1975).

RIGHTS-OF-WAY

ROW width requirements vary for individual lines and are determined by side clearance, distances required to minimize radio and TV interference, maintenance access,

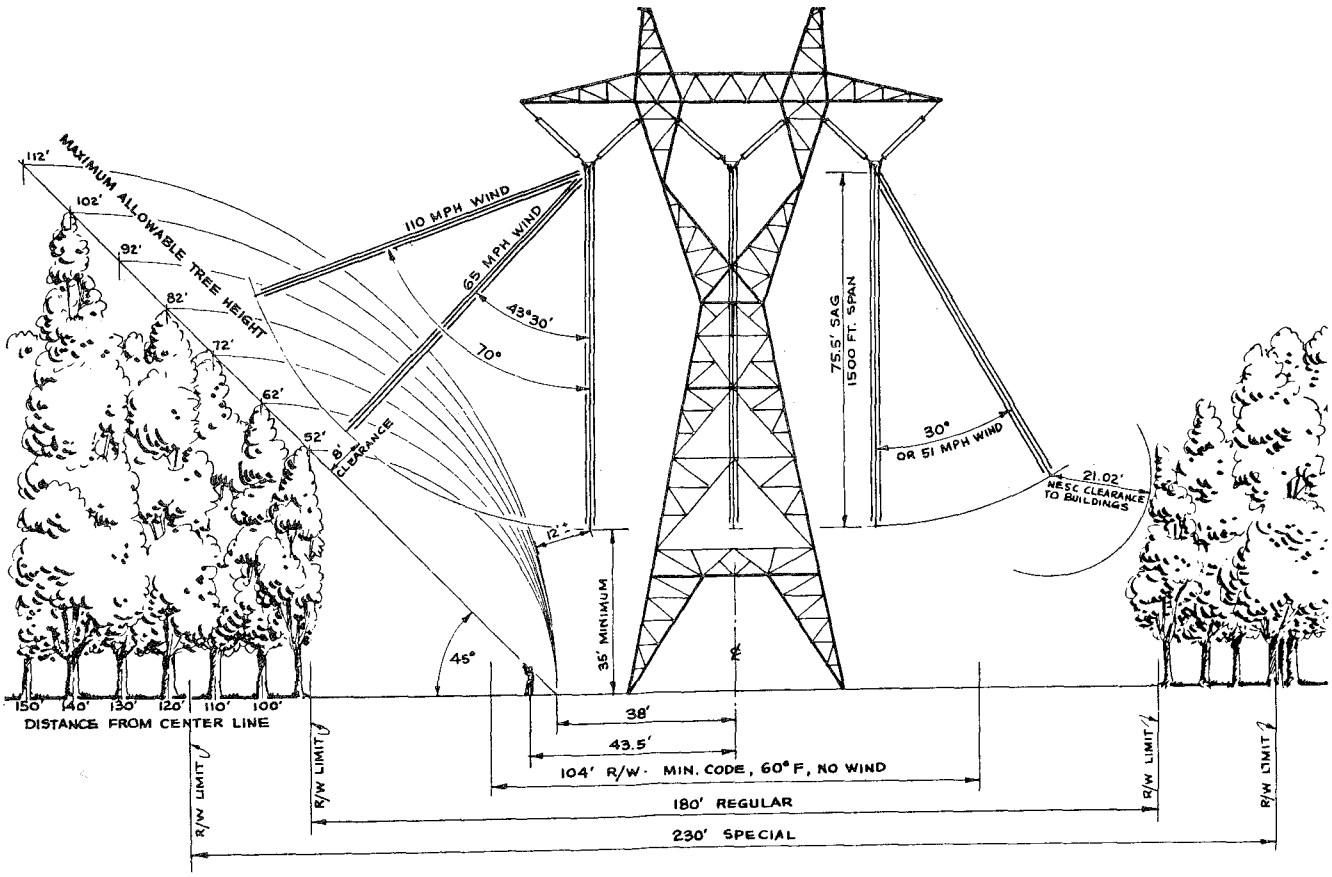

Figure 4.2 ROW width for 500 kV line as determined by wind speeds and adjacent vegetation

and possible future additional lines (Holberger et al. 1975). Table 4.1 illustrates typical ROW widths and approximate acres per mile (Detroit Edison Company 1973; Northeast Utilities System 1974; Holberger et al. 1975; Northeast Power Coordinating Council 1975).

Table 4.1 Typical ROW Widths

Line voltage	Typical ROW widths (ft)	Approximate acres/mile
115/138 (AC)	90-150	11.0-18.2
230 (AC)	100-150	12.1-18.2
345 (AC)	150-170	18.2-20.6
500 (AC)	135-200	16.4-24.2
765 (AC)	260-280	31.5-34.0
±400 (DC)	140-150	17.0-18.2

In addition to ROW access, utilities also require access to adjacent areas outside the ROW to cut trees that may potentially fall into the towers or conductors. Negotiations with property owners to cut or maintain these danger trees (figure 4.3) that are off the ROW are conducted at the time of ROW acquisition and may continue throughout the life of the line. The distance from the ROW that determines which trees are danger trees varies among companies and transmission line type.

STRUCTURE DESIGN

A variety of structure types and sizes (figure 4.4) are available for use with transmission lines. The three basic types are: 1) single poles made of wood, steel, or concrete; 2) double poles with cross braces, also made of wood, steel, or concrete; and 3) conventional steel lattice structures. Various patterns of guy wires are used in the basic design of some structures.

Structure type and size determine the extent of disturbance at the base for footings, assembly, and erection.

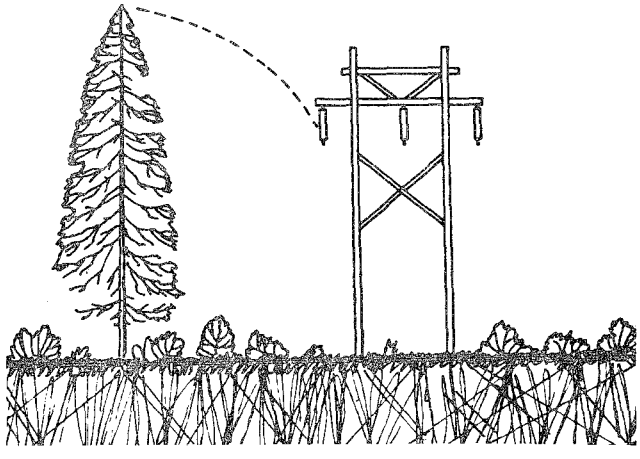

Figure 4.3 Danger tree

In ecologically unique or sensitive areas, the variations of structure design and helicopter-assisted construction can minimize impacts by reducing soil disturbance or total clearing. Structure height, ravines, topography, and other natural features affect the distance of the conductors from the ground.

5 RIGHT-OF-WAY SELECTION

In the transmission line planning process, terminal points are important. The transmission line route should be as direct as possible between terminal points. A ROW is not expected to vary from a straight line without reasonable engineering, cost, and/or environmental justification.

A transmission line point of origin (the source of power flow) may be a generating plant, switching station, another transmission line (by looping or tapping an existing line), or a step-down point from a larger voltage line (substation). Its end point is generally a substation at which the voltage is transformed into lower voltages. These lower voltages emanate from the station as distribution, subtransmission, or smaller transmission lines.

Criteria for route selection vary throughout the United States. They must be set by the utility, State regulations, public participation, or by all three. The considerations applied to route selection are highly varied and may be categorized as follows: ecological resources, engineering/economic factors, cultural resources, agricultural/forest resources, aesthetics, and socio-economic factors.

A common limiting factor in effective route selection on private lands may be a lack of specific information regarding habitats or unique features. Such areas have usually been studied or identified on public lands, and this public knowledge, coupled with little access difficulties, generally permits a more comprehensive transmission line routing study on public lands than on private lands.

The complexity of the route assessment depends on how many variations in land use, terrain, topography, etc., exist along the general alignment. The more diverse physical and other features are along a ROW, the more difficult are the assessment and the decisions. Homogenous land use between terminal points, however, calls for a less complex approach. Discussed below are factors affecting fish and wildlife that are often considered in route selection.

HABITAT TYPE

Fundamental to routing transmission lines is an identification and evaluation of the wildlife habitat the lines may affect. As discussed previously, it is often difficult to identify positively habitats on private lands, because of limited or no access to them. Aerial reconnaissance, when available, is an alternative technique used to identify habitats in inaccessible areas. Habitat mapping is usually done on aerial photographs and/or U.S. Geological Survey (USGS) quadrangle maps.

AQUATIC HABITATS

ROWs crossing water environments often present special problems in route selection and impact. River, stream,

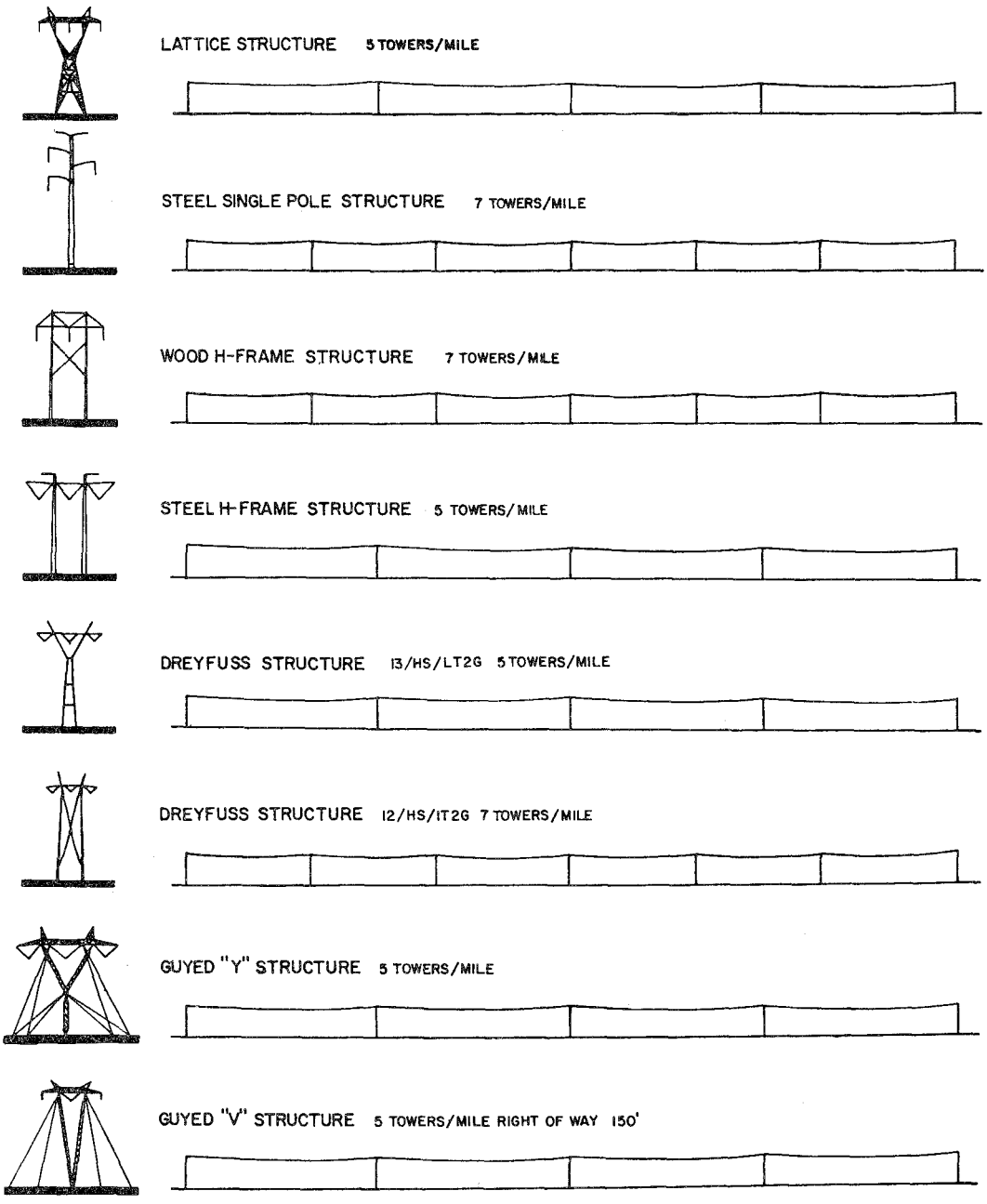

Figure 4.4 Alternative tower designs (from Kitchings et al. 1974)

wetland, and lake crossings are avoided when possible, usually because of increased costs and environmental impacts associated with these crossings. However, aquatic crossings may be made with limited impacts on fish and wildlife by giving adequate consideration to the following factors:

1 the approach to the crossings;
2 estimated soil losses;
3 bank stabilization;
4 influence on aquatic and riparian habitat and associated wildlife;
5 degree of vegetation removal and subsequent maintenance, including effects of herbicides; and
6 equipment crossing.

Limiting disturbances is most often associated with minimizing impact on vegetation.

VEGETATIVE COVER

The degree of vegetation removal on a new ROW depends on its location as well as on the techniques used for clearing and maintenance. When disturbances can be defined in terms of the extent of vegetation removed, route selection can minimize these disturbances. Long-range maintenance needs may also be developed at the time of route selection.

PLAN AND PROFILE SHEETS

Plan and profile sheets incorporate the survey maps and allow on-line drawings to be used in the field. These sheets are developed and used by many utility companies; however, not all companies have the resources or the need to develop comprehensive plan and profile sheets.

When developing plan and profile sheets, exact centerlines and structure sites are plotted for subsequent survey and staking. Many site-specific decisions are made about the placement of facilities in relation to other structures, water bodies, fence lines, property boundaries, roads, etc. At this time, all of the considerations reviewed and accepted earlier in planning are transferred to the plan and profile sheets. Drawings often include aerial photographs in addition to a vertical schematic and horizontal terrain profile. Various types of information are shown, such as clearing and slash disposal, means of access, types of herbicides to be used, no-cut or no-chemical areas, problem erosion areas, etc.

CROSSING DRAWINGS

Detailed site drawings to illustrate how transmission lines cross rivers and streams can be instrumental when constructing lines over habitats determined to be significant. However, because of the expense, drawings are not required by all companies or done for all crossings.

6 IMPLEMENTATION

The sequence of activities following route selection traditionally consists of survey, ROW acquisition, access planning, vegetation clearing (sometimes including stump spraying), brush disposal, construction, restoration, and maintenance.

SURVEY

Survey crews are usually the first representatives of the utility to acquaint themselves with the physical characteristics of the ROW.

RIGHT-OF-WAY ACQUISITION

ROW acquisition is a legal and contractual practice generally removed from ROW development (see detailed treatment in volume 1, chapter 3). Quite often during ROW acquisition, agreements are made with the individual landowner for special considerations of the transmission ROW location on or adjacent to the owner's property. These agreements are made known to the contractors before any clearing or construction begins. Such agreements are not always in the best interest of wildlife habitat.

ACCESS PLANNING

The requirement for a permanent access road (figure 6.1) along power transmission lines varies among utility companies and with the type of line. In any emergency, heavy equipment and/or helicopters are used for line repair. Access to the ROW is also needed during construction and maintenance.

Construction access trails within the ROW are 15 to 20 feet wide, depending on the tower design and type of construction equipment required. Meandering trails are constructed where feasible. The construction trail, with proper planning, can provide ready access to tower fabrication sites and blend with the existing environment.

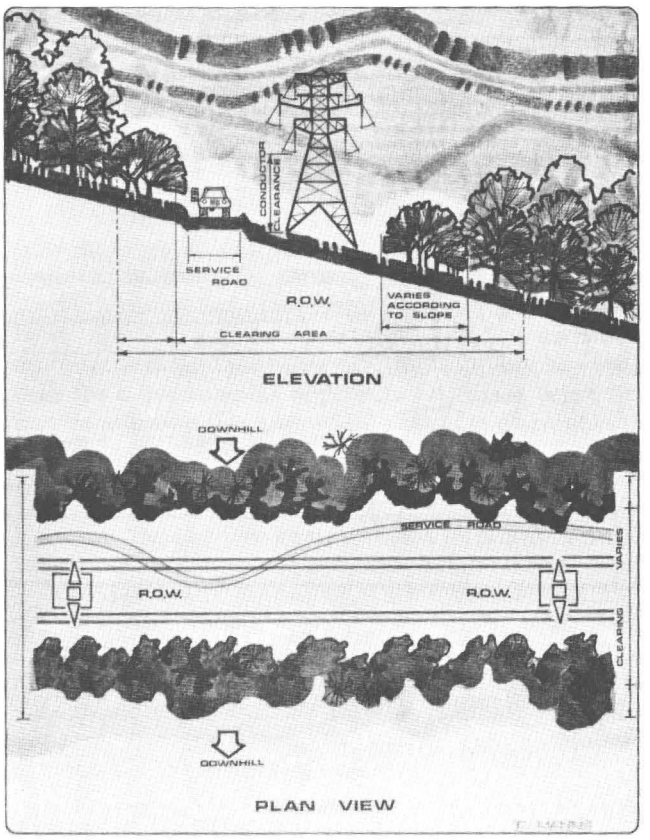

Figure 6.1 Typical access (service) road plan

Soil erosion is a critical concern in access road planning, although mitigation practices can reduce it. For example, roads may be located in areas that will not collect large volumes of natural runoff. Where large amounts of water are anticipated, water interceptor ditches can be constructed to prevent erosion. When practical, wood chips are used for erosion prevention and for repairing soil compacted areas.

Construction trails on marshy ground present a special problem. Where excessive damage to soils may occur due to wet conditions and heavy vehicular traffic, the access road may be stabilized by gravel, stone, mats, or other means.

The crossings of streams, rivers, or other water bodies by construction vehicles cannot always be avoided. In these cases, the streams are usually small (under 150 feet wide) and can be protected from damage from vehicular traffic.

Streambank approaches can be effectively protected by stone fill, flexible steel mats, or timber planking. On completion of construction, access trails are stabilized by grass cover, water bars, and grading of any scars or ruts.

VEGETATION CLEARING

No single method of ROW clearing is universally suitable or always applicable to an entire ROW. For planning purposes the ROW may be segmented into areas where specific types of clearing and slash disposal are required. The size of the areas and the specific combination of clearing and slash disposal methods vary with topography, line profile, and adjacent land use. Variations of cutting types include clear cutting, selective clearing, and no cutting.

Clear Cutting

Areas are cleared of all woody vegetation. Stumps of tall-growing trees are treated with a suitable herbicide to avoid sprouting. Clear cutting is considered beneficial to many species of wildlife because it causes an edge effect between or within plant communities by allowing grasses, herbs, and legumes to be introduced in the cut areas. Clear cutting is generally used in the following areas along the line route:

- Tower fabrication sites — The dimensions of these areas will be determined by the height and configuration of the towers. The areas must also satisfy requirements for tower erection.
- Access roads — These areas are cleared only when access is restricted between tower sites; they are usually 20 feet or less in width.
- Construction trails — These provide access within the ROW, are usually 15 feet wide or less, and often meander within the ROW to enhance visual obscurity.
- Conductor stringing sites — If possible, "setup" areas for tension stringing equipment are located in existing open areas to avoid additional clearing.
- Equipment staging areas — Additional clearing for equipment staging can usually be avoided.

Selective Clearing

Specifically designated species, types, or sizes of plants within specified areas of the ROW are removed. Selective clearing is more expensive than clear cutting and is often practiced only when the situation dictates. Points of maximum line sag and minimum clearance along the ROW determine the species and mature heights of vegetation selected for removal. Additional areas where selective clearing is used include:

- Vegetative screens — A width of vegetation is maintained to provide an adequate visual barrier, usually at road crossings and visually sensitive locations. Screens are generally composed of low-growing woody species extending from the edge of the road.
- Stream and river crossings — Mechanical clearing, which may result in soil erosion, is limited near streambanks. A buffer of low-growing plant species is maintained to check erosion, and the movement of equipment in these areas is held to a minimum.
- Danger tree areas — Danger trees must be removed or trimmed wherever they grow along the ROW. Danger trees may be identified by the following: directional lean, configuration, age and vigor, terrain, and soil structure present.

Selective cutting is not always a preferred technique in wooded areas. For example, in areas of dense second generation growth, individual trees may be spindly and have very few limbs. Understory species may be sparse or nonexistent. To cut selectively in these areas often results in unsightly residual vegetation that often perishes because of sunscald or frost on thin-barked species. The most practical areas for selective cutting are those with a well-established understory.

No Cutting

Special areas, such as valleys or where tower heights provide sufficient clearances, may be preserved, except for suitable access.

CHEMICAL TREATMENT

During initial clearing, chemical treatment is generally restricted to controlling stump sprouting. All chemical herbicides are applied in accordance with label directions and applicable Federal, State, and local regulations. Emphasis is placed on selective vegetation control, drift-free application, and avoiding contamination of water sources.

BRUSH DISPOSAL

In general, merchantable timber is the property of the landowner. Removal of the timber may be the responsibility of the landowner, the utility company, or both. As a precaution against disturbing access trails and erosion, many companies do not permit the landowner to remove timber. The landowner may request that the timber be cut to a specified size.

Nonmerchantable timber and slash are disposed of by windrowing; piling; drop, lop, and leave; removing; chipping; piling and burning; or pit burning. The method of

disposal generally depends on public demand, local and State regulations, practicality, and utility policy.

CONSTRUCTION

Footings

Design and installation of concrete footings for the support of structures is determined by the characteristics of soil and bedrock. The design is consistent with variations that allow for differences in tower loads or tower weights for the individual project.

Concrete installation for transmission towers requires the use of heavy equipment and large quantities of material. Before excavation, a general soil profile is obtained from test borings to establish information on depths to bedrock, soil strengths, and the groundwater table. In wet or boggy areas, alternative footing designs are often used, both for the structure and to minimize environmental disruption. Cast-in-place concrete footings require ready, reliable sources of concrete. If local sources of ready-mixed concrete are unsatisfactory, mobile batch concrete plants are utilized.

Tower Construction

The dimensions of tower fabrication sites must be adequate to assure safe construction and to prevent unexpected site disruption.

In addition to the type of tower, topography and condition of the ROW influence equipment needs. Motorized hydraulic cranes, although somewhat limited in boom length and capacity, have good mobility and cause less disturbance to the ROW than the larger capacity, mechanical cranes. Helicopter erection is becoming cost competitive with ground erection, especially in rough terrain or under other special circumstances.

Conductor Stringing

EHV conductors require a tension stringing method that uses a bullwheel puller and tensioner (figure 6.2). The use of tension during installation of conductors avoids the abrasion and scarring of the conductors that could occur if they were dragged along the ground and across fences and other obstacles. This precaution also avoids unnecessary radio and TV interference that damaged conductors might create.

Conductor stringing setup locations are flexible, with the stringing covering long distances from the tensioner to the puller (figure 6.3). Flexible stringing distances facilitate the selection of the best setup sites.

The stringing equipment is engine powered and available with noise abatement devices. This improvement is particularly beneficial in wildlife breeding areas and public use areas (Northeast Power Coordinating Council 1975).

RESTORATION

Restoration work required after construction cleanup consists mainly of grading and seeding of grasses and ground covers.

MAINTENANCE

Controlling woody vegetation so it will not interfere with the conductors (insuring reliability) is the common traditional definition of maintenance as it pertains to ROW vegetation. Current usage also includes the establishment of low- or slow-growing communities of plants that regenerate naturally, require little attention, and conform to the concept of transmission reliability. Vegetation maintenance practices consist of chemical, mechanical, and manual methods (section 15). Towers, conductors, and related electrical equipment are also maintained and repaired as required.

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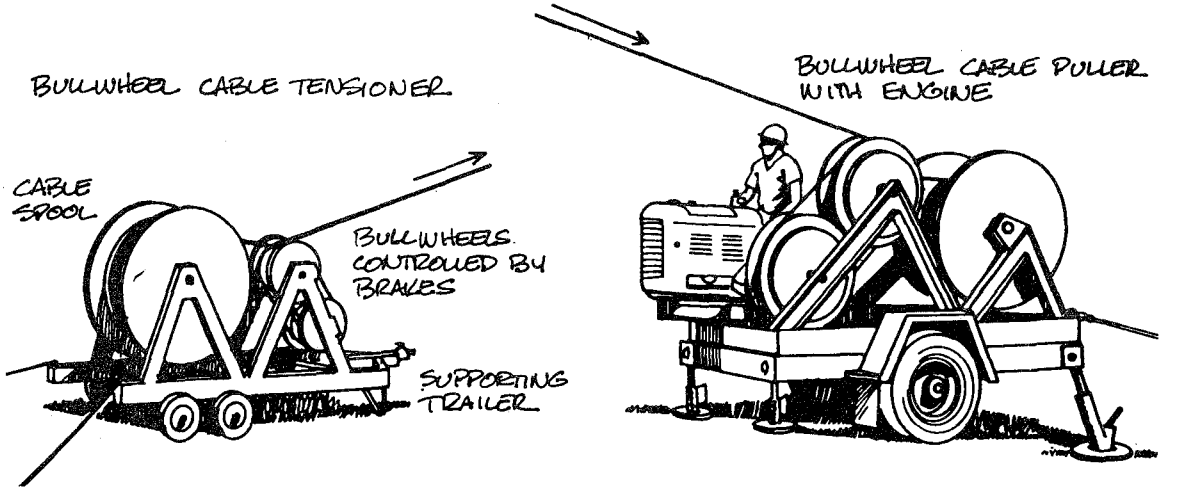

Figure 6.2 Bullwheel cable puller and tensioner

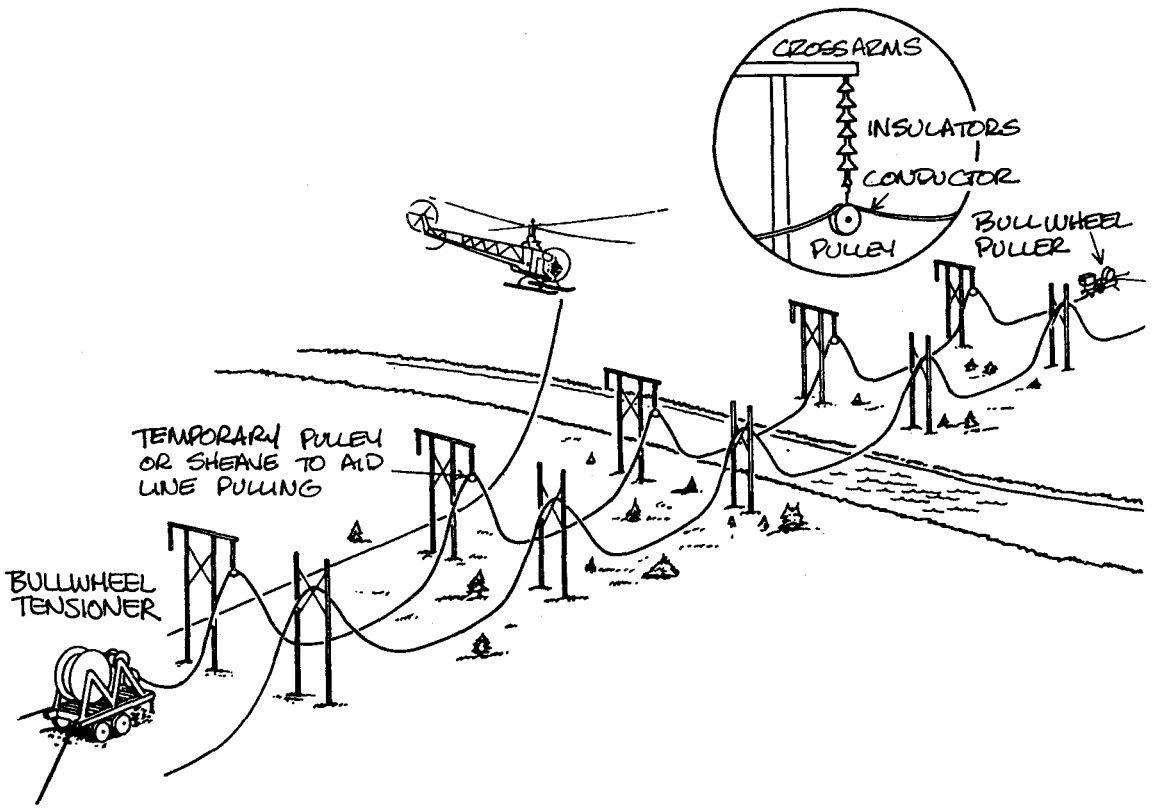

Figure 6.3 Stringing over long distances from tensioner to puller.

Kitchings, J.T., H.H. Shugart, and J.D. Story. 1974. Environmental impacts associated with electric transmission lines. ORNL-TM-4498. Oak Ridge Natl. Lab., Environ. Sci. Div., Oak Ridge, Tenn. 104 pp.

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3

Land Use Rights

There are over 250,000 circuit miles of electric transmission lines in the United States (Edison Electric Institute 1975). Most Americans are accustomed to the sight of tower structures supporting a number of large cables. One aspect of electric transmission lines that is often not understood by the general public, however, is the necessity of acquiring construction and management rights for these lines. Construction techniques and wildlife considerations on ROWs must be developed within the limits set by acquired rights. A primary objective of this discussion is to acquaint biologists investigating the practical possibilities of either mitigating impacts to wildlife habitat or developing long-term habitat management plans with the constraints imposed by land use rights associated with transmission line ROWs.

Most electric transmission lines are 115,000 volts (115 kV) or larger, with a minimum rural ROW width of 75 to 100 feet. Smaller lines, down to the size that serve individual residences, are referred to as distribution and service lines and are not included in this discussion. Distribution and service lines require considerably less ROW width.

Just as the edges of interstate highway ROWs are not marked in a special way, the edges of transmission ROWs are apparent only where development (e.g., a residential subdivision) has defined their limits or vegetation has been cleared to the ROW edge, as in a forested area. To the uninformed person, the ROW may appear unrestricted. ROWs do have specific bounds, however, that legally limit activities of the utility, the landowner (if it is an easement ROW), and the general public.

For this discussion, practices used in acquiring electric transmission line ROWs were reviewed to determine pat-

terns existing among utilities and to develop insight into the need for various rights. Seventy-five of the largest electric utilities throughout the 48 contiguous states provided general information about their acquisition practices. The information obtained from this survey was synthesized and forms the basis for the discussion in this chapter.

7 RIGHT-OF-WAY ACQUISITION PRACTICES

Electric utilities, including private, public, and quasi-public companies, use two basic practices to acquire the land rights necessary to build, operate, and maintain transmission lines. They use fee simple acquisition—buying the land outright—when it is necessary to keep all real property rights. They seek easement rights—rights to construction, operation, and maintenance—on smaller lines and/or when they wish the original landowner to retain all property rights.

Utilities planning to construct a new line or expand an existing one usually have standard policies that dictate acquisition practices. For various reasons, however, practices may vary along the length of the line. For example, a utility that usually seeks easement rights may acquire some fee ROW near each terminal point to insure access to the terminal for future lines. Fee title may also be acquired where multiple lines are planned and the cost of an easement is as much as the fee value, or when the landowner prefers fee title because the parcel of land is small and an easement would limit the existing or intended use of the property.

A primary criterion in the decision to acquire fee rights is the size of the proposed transmission line. A utility may have a policy to acquire in fee all transmission ROWs for lines rated 115 kV and larger. Another utility may acquire in fee only the higher voltage lines, such as 500 kV and 765 kV. Because higher voltage transmission lines serve many more customers, interruptions of the power supply on these lines are more crucial than are those on smaller transmission lines. Utilities can, in these cases, better control encroachment and interference with line operations through fee simple ROW acquisition.

8 ACQUISITION PROCEDURES

Acquisition of electric transmission line ROWs is the responsibility of the utility's Land Department, Real Estate Division, ROW group, or equivalent. Small utilities may have only a ROW solicitor or agent. The relationship of this department or person to other departments involved in planning, budgeting, construction, and maintenance of ROWs varies among utilities, but the following sequence of procedures appears to be typical:

1 Following a decision to expand a transmission system, the ROW or Real Estate Department studies cost estimates of the proposed plans.
2 After management authorization and determination of engineering design and type of ROW acquisition, actual ROW costs are budgeted by the ROW Department based on existing land values.
3 During line route selection, the ROW staff works with the Transmission Engineering and Environmental departments. ROW staff contribute information on existing ROW land uses and estimated land values in particular areas.
4 The ROW Department provides title information on the route selected and plots this information on ownership maps.
5 The ROW and Legal departments prepare all necessary documents and collect appraisal figures and records before beginning acquisition. To save time and maintain good public relations, it is important that appraisal information is accurate and objective so that realistic offers can be made at the beginning of a project.
6 Landowners are contacted by authorized acquisition personnel, who negotiate the agreements. These may include itemizing all of the unavoidable damages to the landowner's property, such as breakage of drainage tiles or removal of fences, associated with the ROW construction. Costs of such planned damages are discussed in general terms, only, at this stage.
7 Before construction begins, all agreements resulting from ROW negotiations are given to the department responsible for construction. Responsibility for adhering to specific agreements, such as stacking, burning, or removing cleared vegetation, is transferred to the construction engineers who continue the relationship with the landowners initiated by the ROW Department. This obligation is as important for fee title as it is for easement ROWs. The ROW agent, project engineer, and construction supervisor review the project before construction.
8 Following construction, the ROW Department recontacts landowners to settle on costs of planned damages. Unpredictable circumstances sometimes cause excessive damages, but these situations are handled individually.
9 Responsibility for landowner agreements is transferred to the ROW Maintenance Department, which continues contact with landowners over the life of the ROW.

9 FEE RIGHT-OF-WAY

Land acquired through fee simple acquisition is under total control of the utility (see appendix 3-a, "Fee Simple Right-of-Way Acquisition Form"). On fee title ROWs a utility has the right to permit any non-utility uses compatible with the transmission of electric energy. Agreements for using a fee ROW by a third party are recorded in letter form or in a license, permit, or lease (see appendixes 3-b, c, d). Licenses and permits are short-term authorizations granted for nominal payment and are revokable by the utility in a specified number of days upon written notice. Revocation of a license is usually due to improper use of the ROW by the licensee who is often liable for any caused damages. A lease is a stronger agreement and can be more difficult to terminate. The cost of leasebacks takes into account property taxes and

utility administrative costs. Commercial uses may have an annual rental based on land values or revenues. Examples of third party agreements are: 1) a license for car parking on the edge of a ROW, 2) a permit for a local nature club to use a ROW for field trips (excluding trail building and posting of signs), 3) a lease to farm on a ROW, 4) an agreement with a municipal agency for a baseball outfield (excluding bleachers and backstops), and 5) a letter authorizing a hunting club to plant wildlife foods on a ROW crossing their property.

Requests for reasonable non-utility uses by third parties are usually accepted. The degree of consideration given requests depends upon management opinion and the utility's response to public opinion. Third party use on fee ROWs can only be considered if it does not interfere with the rights of the original landowner. Where there are no limitations of land rights or safety, a utility may require adjacent landowners to agree to the third party's proposed use. This practice lessens potential conflicts when an aspect of the use, such as noise, will extend beyond the ROW edges.

In some cases on a few ROWs, the utility is responsible for control of encroachment and trespass. Protection against encroachment (any unauthorized or interfering use by non-utility persons) requires constant policing.

Fee simple ownership may be modified by a reservation, or conditional fee, whereby the former owner retains rights to certain uses of the land. In conditional fee acquisition, grantors reserve certain rights that do not interfere with transmission operations (e.g., farming, mining, landscaping, and gardening). These reserved rights, depending on the wording of agreements, may be assigned to the landowner's heirs or to new owners (see appendix 3-e). Fee acquisition, however, assures the utility of much better control of ROW usage.

10 EASEMENT RIGHT-OF-WAY

The more common of the two basic types of ROW acquisition practices is the easement. An estimated 85 to 90 percent of all transmission line ROWs throughout the United States are under easement. This figure is subject to opinion and statistical modification.

An electric transmission ROW easement is a legal instrument by which a utility acquires certain land use rights from the owner. Easements may be sought for subsurface rights (pipelines), surface rights, and above surface rights (air rights). Though electric transmission easements provide mainly surface and air rights, future development of underground systems may involve more subsurface easements. Several utilities that distribute gas as well as electricity acquire both surface and subsurface rights.

Variations of easement rights, such as permits and grants, give partial property rights to the utility, with fee title kept by the original landowner.

Easements are more clearly understood when defined by the "bundle of sticks" theory:

> The owner of a parcel of real estate in fee simple has all of the benefits of the ownership thereof, excepting those reserved to the state. This is the bundle of rights theory. This theory can best be remembered by visualizing a bundle of sticks, each one representing a right of the owner. This theory holds that the owner of a property in fee simple has all of the sticks except those retained by the state.
>
> Those rights reserved to the state are four: 1. Police power, 2. Taxation, 3. Eminent domain, and 4. Escheat. Without police power there could not be controls which maintain domestic order, public health, building codes, zoning, and so forth. Without taxation there would be no money to finance government or the public defense. Without eminent domain, there would be no projects in the public good, such as roads, power lines, waterways, and so forth. Escheat is the right of the sovereign to own those properties not in the ownership of others, such as properties of deceased persons not properly inherited by others. Without escheat there would be chaos as regards to the ownership of such properties.
>
> The easement gives the right to someone other than the owner to one or more of the sticks in the bundle. Ownership of the real property remains the same after an easement, except that the real property is subject to the rights of the outside party. The simplest illustration of this is the easement wherein passage over a portion of land is granted to another. The land and improvements are still owned by the original owner. The original owner may still do anything within the law regarding his property excepting that he may not prevent the person with the right of passage from using a portion of the total property as a means of ingress and egress within the scope of the easement document. [Derbes 1968]

Easements may be permanent or for a limited time. The permanent easement is most common on private lands. The words "forever," "perpetual," and "in perpetuity" are often used rather than "permanent." Permanent easements may state that ROWs must be used for the designated purposes within a certain time, or never vacated for more than a certain time.

A temporary easement is most common across public lands and may vary from 1 to 99 years. Renewal of the easement after its term is normal. ROW easements acquired from private owners "in perpetuity" usually remain perpetual easements even though titles may transfer. A perpetual ROW easement on private land remains perpetual when fee title is transferred to a public owner. A subsequent transmission line crossing of those public lands may be with temporary ROW grants, so a designated public area, such as a State or National forest, may have both permanent and temporary ROWs, as well as some fee ROWs.

ROW easements, which may be referred to as grants, permits, servitudes, agreements, etc., usually define the rights granted to the utility with variations of the following phrases: the right "to construct, reconstruct, operate, and maintain its electric lines consisting of . . . (number of structures and guy wires) . . . wires, cables, fixtures, and apparatus upon, across, over, under, and along . . . (description of property) . . . , including the right of ingress and egress to and from the said lines for any of the aforesaid purposes . . . , the right from time to time to trim and to cut down and clear away or otherwise destroy any and all trees and brush now or hereafter on said strip or on either side of said strip which now or hereafter, in the opinion of second party, may be a hazard to said tower, poles, wires, and cables . . . " (see appendix 3-f, clauses 1, 2, and 3).

These three rights: 1) to construct, reconstruct, operate, and maintain; 2) ingress and egress; and 3) to keep the ROW free of interfering vegetation, represent the pri-

mary needs for the easement. The rights can be stated in many ways, but even the most detailed easement normally makes no attempt to acquire more rights than necessary to meet the needs of the proposed transmission line.

ROW easements that include more than the basic needs vary greatly among utilities. A standard easement for one utility may be more detailed on access, for example, than a standard easement for a utility with adjacent service areas. Each utility has basic easement forms for different voltage lines. Though a basic form is preferred for consistency, clauses are often attached or modified.

Special agreements with landowners are important and may be conditional, written terms, or only simple notations accompanying the easement (see appendix 3-f, clauses 5 and 6).

Examples of special agreements in ROW easements are: 1) means by which vegetation is cut and disposed of (does the landowner harvest timber before construction, or does the utility handle it?); 2) handling of material excavated from footings; 3) off-ROW construction ingress and egress; and 4) control of vegetation on farmland.

A transmission line ROW extending 100 miles may cross numerous individual land parcels. If land use along the ROW varies, easement acquisition, construction, and maintenance can become complex. If land use is more consistent (extensive rangeland, desert, or open cropland), these tasks are simpler.

11 EMINENT DOMAIN IN RIGHT-OF-WAY ACQUISITION

The use of the power of eminent domain is a last resort for utilities. Eminent domain guarantees that if all other legal requirements are met a utility can build a transmission line that is in the public interest despite landowners' wishes. The authority for eminent domain is given to private utilities or a State utility commission by legislation in each State. All States except Delaware have passed this legislation. Under normal conditions, ROW condemnation, a court procedure by which the easement land is legally appropriated for public use, is necessary for less than 10 percent of all acquisitions on a project. In instances in which organized public opposition to a project has developed, more condemnations may result. State condemnation laws vary; some permit condemnation for fee title rights, and others only for easement rights.

12 RIGHT-OF-WAY ACCESS RIGHTS

INGRESS AND EGRESS

The right of access to a ROW (ingress and egress) permits utility crews to cross property of an easement or conditional fee grantor or to enter the ROW from a public road (see appendix 3-f, clause 2). Though means of access are usually not described in detail, utility crews rarely enter ROWs on which there is active land use without first telling the landowner of their intent and working out a plan agreeable to both parties. This promotes good will and reduces potential damages. In more remote areas that support little active land use, entry to a ROW by a utility requires less coordination with landowners.

In some instances, easements are sought only for rights to cross a separate land parcel to get to a ROW. These are under separate easement with a different landowner. Conditions for these easements vary (such as possible construction and maintenance of a permanent lane). Grantors of ROW easements or deeds of reservation (conditional fee) generally limit conditional rights to safe access.

THIRD PARTY ACCESS

The issue of third party access, although not usually dealt with legally, is common and comes up in ROW landownership and management. A third party is any person(s) other than an easement grantee or grantor, or a fee title buyer or seller; it usually refers to the general public.

The assumed right of the public to use ROWs is becoming a concern of ROW managers, who have an obligation to landowners; ROW agents, when negotiating easements; wildlife specialists; and organized recreation groups that may want to request use of ROWs in the future. Liability also concerns both the landowner and the utility.

On easement ROWs, the landowner normally has the responsibility of controlling non-utility access; this was one of the "sticks" in the bundle that the landowner kept. In any third party use of a ROW easement, authorization from the landowner is legally necessary and may be subject to review by the utility. A utility cannot, on its own, grant rights to a third party that it did not acquire from the landowner. The utility has the authority, however, to determine uses that are not compatible with transmission.

On fee ROWs, the utility is responsible and liable for third party access, except when the third party is an authorized user. Efforts to limit trespassing usually involve posting or fencing and result in varying degrees of success.

13 MAINTENANCE RIGHTS AND PRACTICES

After construction of a transmission line, two types of maintenance programs begin:

1 Facility maintenance, in which the structures, conductors, etc., are kept in efficient operating condition.
2 ROW maintenance, in which ROW surface conditions are controlled for safe and reliable operation.

Maintenance rights are specified in all ROW agreements (see appendix 3-f, clause 3). Though most agreements do not require utilities to give the landowner notice of entry or to follow a set schedule, giving notice is a common practice that helps avoid misunderstanding and promotes goodwill. Utilities generally compensate landowners for unavoidable damages (see appendix 3-f, clause 6).

ROW maintenance consists of:

1 Vegetation control to prevent trees, on and off the ROW, from reaching heights that could interfere with the operation of a line.
2 Site stabilization, including erosion control and prevention, and maintenance of culverts, waterbars, etc.
3 Trespass/encroachment maintenance. Some ROW agreements specify noncompatible uses (e.g., the erection of buildings). Others depend on regular inspection to determine encroaching activities (see appendix 3-f, clause 4). A number of utilities provide landowners and/or authorized ROW users with a booklet on limitations and suggestions for use of the ROW.

Of the three areas of ROW maintenance, vegetation control practices vary the most. The need to maintain vegetation on a transmission line is contingent on plant species, site characteristics, land use, and climate. Utilities try to tailor maintenance practices to land use and physical features in a cost-efficient way. A ROW in an area of tall, fast-growing vegetation is maintained differently than one in an area of tall, slow-growing vegetation.

14 IMPLICATIONS FOR FISH AND WILDLIFE MANAGEMENT

Wildlife management in this manual means the maintenance of vegetation for reliable electric transmission and for the enhancement of wildlife habitat in general, with special consideration directed to a particular wildlife species only when practical. Wildlife management strategies most adaptable to ROWs are generally those that stabilize vegetation at low-growing successional stages, using the conventional utility ROW clearing and maintenance techniques discussed in this manual.

Wildlife management considerations can best be incorporated into new ROWs by advanced planning. Traditional clearing and construction methods may require little, if any, modification to provide benefits for wildlife. ROW restoration and revegetation techniques may also include wildlife objectives. ROW ownership and land use rights have to be evaluated along with any construction cost alterations to determine the feasibility of wildlife management. Because of varying land use and available resources, wildlife management on new and existing ROWs is apt to be feasible only on portions of the ROW rather than on its entire length.

Interest in planning for wildlife habitat on ROWs may come from a number of sources outside of a utility. Special interest groups, private landowners, State and Federal wildlife agencies, and university researchers have in the past had various incentives to coordinate wildlife planning efforts with utilities. Numerous studies have been conducted of wildlife on ROWs and are reviewed elsewhere in this report. Most provide insights on beneficial aspects. As land use congestion decreases both available lands for public enjoyment of wildlife and available habitat for wildlife survival, incentives to look further at the availability of ROWs will increase.

In New York, wildlife concerns have been included in regulatory requirements by stipulating that wildlife management plans for the ROWs of new transmission lines must be developed. Similar regulations may eventually be adopted in other States as well.

Irrespective of the source of interest or objective for wildlife management, the land rights acquired by a utility are always a limiting factor. As technical capabilities of wildlife biologists are applied to utility rights and practices, strategies for wildlife management must incorporate conditions of individual agreements with landowners and stipulations of applicable laws. Any combination of the various land rights described may be encountered, whether the interest is in a ROW across a single parcel of land, either side of a waterway, a woodlot, an entire transmission line, or even a total utility service area.

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Edison Electric Institute. 1975. Statistical yearbook. New York, N.Y.

APPENDIX 3-A

Sample Fee Simple Right-ofWay Acquisition Form

KNOW ALL MEN BY THESE PRESENTS:

That_____,_____of_____, _____County,_____in consideration of One Dollar and other valuable considerations, the receipt whereof is hereby acknowledged, give, grant, bargain, sell, and convey unto_____the option to purchase, in accordance with the terms hereinafter stated, the following described premises:

This option shall continue in force until_____, and on or before that date_____may exercise this option and thereupon the above described premises shall be conveyed by Warranty deed free and clear of all encumbrances to_____ or_____heirs or assigns. Upon the delivery of said deed the further payment of_____Dollars shall be made therefore.

In the event that said Grantee is unable to contact said Grantor____, or any of them, to exercise this option, or to make said payment, it may deposit the same in_____at_____in the name of said Grantor_____, or any of them, and such deposit shall be deemed to be full performance by said Grantee of its obligations hereunder.

And for the consideration aforesaid I,_____of said_____do hereby covenant and agree to release all my right of dower, curtesy and homestead and all other statutory rights in said premises.

WITNESS_____hand_____and seal_____this_____day of_____19____.

Signed, sealed and delivered in the presence of:

_____ _____

STATE OF_____

_____ss In_____
in said County on the_____day of_____19___before me personally appeared _____each and all to me know, and known by me to be the part_____executing the foregoing instrument, and_____ acknowledged said instrument by_____executed to be_____ _____free act and deed.

_____
Notary Public
Justice of the Peace

APPENDIX 3-B

Sample License to Use Fee Right-of-Way

THIS REVOCABLE LICENSE, Made this _____ day of _____, 19____, by and between _____ Company, hereinafter referred to as "Licensor," and _____, hereinafter referred to as "Licensee."

W I T N E S S E T H :

THAT the Licensee has requested the right and privilege to enter upon and use that portion of the Licensor's property, hereinafter referred to as parcel of land, as delineated on a plat entitled _____, attached hereto, made a part hereof, and marked "Exhibit A," for the purpose stated below, and the Licensor is willing to grant such use subject to the terms and conditions as hereinafter set forth.

NOW, THEREFORE, in consideration of the right and privilege herein granted and the sum of _____ Dollars ($_____), paid by the Licensee to the Licensor in advance for the period _____ to _____, it is mutually agreed as follows:

1. LICENSOR hereby grants unto Licensee, and the latter hereby accepts a license to enter upon and use the parcel of land as delineated on the aforementioned plat solely for the purpose of _____.

2. LICENSOR shall have the right of ingress and egress over the said parcel of land to:

   a. Construct, operate and maintain present and/or future gas and/or electric facilities in, over, and under the said parcel of land and the right to make necessary openings and excavations for the purpose of examining, repairing, altering, or extending said electric and/or gas facilities provided that all openings and excavations shall be properly refilled and resurfaced and the parcel of land left in a good and safe condition.

   b. Make test borings or surveys on said parcel of land provided that such ingress and egress to the parcel of land does not unreasonably disturb the peaceful enjoyment of the licensee.

   c. Trim, top, and/or cut down and keep trimmed, topped, and cut down any trees or bushes on said parcel of land which, in the sole judgment of Licensor, may interfere with or fall upon the said present and/or future gas and/or electric facilities.

3. LICENSOR shall not be liable for any crop and/or other damage, regardless of cause, on the parcel of land.

4. LICENSEE, as part of the consideration hereof, agrees to:

   a. Accept the parcel of land in its present condition for the right and privilege hereby given.

b. Keep said parcel of land in good order and condition at all times.

c. Comply with all present and future applicable laws and requirements of public authorities in respect to the parcel of land or use thereof.

d. Indemnify and hold harmless the Licensor, its agents, employees, and assigns, from and against any and all liability and/or damage of person or property, including loss of life, sustained to any persons, whether the agents, employees, assigns, servants, invitees, contractors, or members of the family of Licensor or Licensee, while in and around the licensed parcel of land, whether resulting from acts of negligence on the part of the Licensor, its agents, employees, or assigns, or arising in any manner from the exercise of the right and privilege herein granted.

e. Not to assign this License or transfer in any manner any part thereof for any purpose.

f. Not to construct any buildings or structures of any kind or nature unless specifically provided for by this License.

g. Remove, upon termination of this License, all property belonging to the Licensee, surrender the right and privilege hereby granted and surrender possession of said parcel of land to Licensor upon termination in good order and condition.

5. THE PAYMENT hereunder by the Licensee of any sum or sums in advance shall not be held to create an irrevocable license for the period for which same is paid, but the Licensor may at any time revoke this License by giving the Licensee thirty (30) days' written notice and refunding the payment for the balance of the period for which the same has been paid.

THIS LICENSE may be renewed thirty (30) days prior to the expiration of the original term or any extension thereof for an additional like term by payment of the sum of_____ Dollars ($_____) in advance.

IN WITNESS WHEREOF, the parties hereto have caused this License to be duly executed the day and year first above written.

WITNESS

_____ BY: _____ (Seal)
General Supervisor, Real
Estate and Facilities Services

WITNESS:

_____ _____ (Seal)

_____ _____ (Seal)

Mailing Address: _____

_____ ZIP _____

APPENDIX 3-C

Sample Permit to Use Fee Right-of-Way

_____Company, hereinafter referred to as Company, hereby gives you permission for the calendar year of 19___ to use for_____ purposes only that part of its premises described as follows:

This permission is given with definite understanding that the land will be used for the above stated purpose only and that said premises will be kept clean and free of all weeds, and by acceptance of this permit, you agree to abide by and comply with all lawful orders of the weed commissioner, or such other orders or directives as may be made by any municipal or govermental agencies having jurisdiction over said premises. No vehicles or equipment are to be parked or materials of any kind are to be stored temporarily or permanently on said premises.

While enjoying the privilege of this permit, you will not in any way interfere with Company's operations nor damage or destroy any electric facilities, fences, gates, poles, or other property; and, further, it is agreed that you will assume all responsibilities in connection with the above privilege, holding the Company harmless from any and all claims for damage to property and/or injury to persons due to or arising out of the exercise of the permission herein given, such responsibility being acknowledged by the acceptance and signing of this permit.

The permission herein given is subject, however, to the right of Company to construct, erect, maintain, and patrol electric lines and related facilities over and across these premises without any liability of any kind to you. It is agreed that in the event Company deems it necessary, it may at its sole discretion, for any purpose, terminate and cancel this permit by giving you thirty (30) days' written notice at which time you will vacate and surrender said premises peaceably and quietly to Company.

The permission herein given is not assignable and shall not take effect until the duplicate original of this letter has been signed by you in the space provided and returned to this Company.

Very truly yours,

APPENDIX 3-D

Sample Lease to Use Fee Right-of-Way

THIS LEASE, made by and between _____ Company, a _____ _____ with its principal offices at _____ ("Lessor"), and _____ ("Lessee").

THAT LESSOR leases to Lessee the parcel of land ("the premises") in _____ _____ County, _____, described as follows:

TO HOLD for the term commencing on the _____ day of _____, 19____, and terminating on the _____ day of _____, 19____, Lessee paying therefore the rental of _____ Dollars ($_____), which has been paid at the time of execution and delivery hereof, the receipt whereof is hereby acknowledged.

Lessee agrees not to sublease the premises or any part thereof, or to assign this lease, without the written consent of Lessor, and further agrees to quit and deliver up the premises to Lessor peaceably and quietly on or before such termination date (notice of termination not being required), and further agrees to keep the premises in as good condition as at the commencement of said term.

Lessee hereby agrees that he will use the premises for farming or gardening purposes only, in accordance with accredited or approved agricultural methods.

Lessee agrees to cut or spray and keep cut or sprayed all noxious weeds on the premises at all times in compliance with the laws of the State and any local government, and with the orders and directives issued by the municipal Weed Commissioner and any and all public officials having jurisdiction. In the event Lessee does not cut the weeds or comply with such orders and directives issued by the said Weed Commissioner or other public officials having jurisdiction, Lessor or its agents, without liability to Lessee for damages to land or crops, reserves the right to enter upon the premises to cut or spray such noxious weeds as required, and Lessee hereby agrees to reimburse Lessor for any and all costs incurred by Lessor in doing such work immediately upon presentation of a bill therefor.

Lessor shall have the right at any time to enter upon said parcel of land herein leased for any purpose in connection with the inspection, construction, erection, maintenance, repair, or replacement of electric lines or related facilities upon, over, across, in, or beneath the premises wihout any liability to Lessee for any damage to land or crops.

If the premises or any part thereof should be sold or if it should become necessary or desirable for Lessor to have possession of the premises or any part thereof, Lessor may, at its option, terminate or cancel this lease, in whole or in part, by giving thirty (30) days' notice, in writing, to Lessee, who shall thereupon vacate the premises according to such notice; provided, however, in the event of any such cancellation, of the crops planted thereon have not been harvested, Lessee shall be paid a reasonable amount (which shall not in any event exceed the rental herein paid) for Lessee's labor in preparing the soil, and planting and cultivating the crops, which shall thereupon become the property of Lessor.

In the use of the premises for farming or gardening purposes contemplated pursuant to this agreement, while in proximity to electrical conductors presently existing or to be installed at some future date. Lessee hereby agrees to conform to the provisions and requirements of the administrative Code, Rules of Department of Industry, Labor, and Human Relations covering "Safety in Construction," Order "Ind 35.37 Electrical Hazards," and amendments thereto, and further agrees that no machinery, vehicles, or equipment exceeding twelve (12) feet in height shall be used, operated, or parked on the premises. Lessee shall, at all times, comply with the provisions of the State Electrical Code, compiled by Department of Industry, Labor, and Human Relations and the Public Service Commission and all amendments thereto.

If Lessee shall violate any of the terms hereof, he shall, at the option of Lessor, forfeit all his rights under this lease, and Lessor may immediately re-enter and take possession of the premises.

Lessee also covenants and agrees to indemnify and save harmless Lessor from any and all liability which may result from the exercise, by Lessee or his agents, of any of the rights contained in this lease.

The covenants herein contained shall bind the parties mutually and their respective heirs, executors, administrators, successors, or assigns.

If more than one person executes this lease as Lessee, singular terms herein used shall be read as it written in plural.

IN WITNESS WHEREOF, Lessor has caused this instrument to be signed this day of _____, 19___, and Lessee has hereunto set his hand and seal this___day of_____, 19___.

In Presence of:

_____

_____

_____

_____

COMPANY Lessor

By_____

_____(Seal)
Lessee

_____(Seal)
Lessee

APPENDIX 3-E

Sample Conditional Fee Right-of-Way Acquisition Form

In consideration of Twenty-Five Dollars ($25.00), the receipt of which is hereby acknowledged, the undersigned, for themselves, their heirs, administrators, successors, and assigns, hereinafter called the "Owners," being the owners of property in the_____Election District of_____County, acquired from _____by deed dated_____and recorded among the Land Records of said County in Liber_____No._____, folio_____, hereby grant(s) to _____Company, its successors and assigns, hereinafter called the "Company," the option to purchase in fee simple, exercisable at any time on or before_____, 19_____ , a parcel of this land as shown outlined in red on the attached plat.

Together with the right to: (1) have access at all times, using existing roads as far as practicable, over lands of the Owners, for the construction, reconstruction, modifications, operation and maintenance of the Company's utility facilities upon, over, or under the parcel of land; and (2) trim or cut down and remove trees on the Owner's land adjacent to the parcel which might at any time, in the sole judgment of the Company, be liable to interfere with or fall on any of the Company's facilities.

The price to be paid at settlement for the parcel of land and the rights on the adjacent land shall be_____Dollars ($_____), from which shall be deducted the amount paid for this option and any consideration paid by the Company to obtain the release of any liens or encumbrances.

It is understood and agreed that: (1) the Owners reserve to themselves, their successors, and assigns (for so long as they or any of them shall own land adjoining said parcel of land on both sides, that is, a single ownership on both sides) the right to cross and extend roads and to install public utility facilities, in, along, and adjacent to such roads, across said parcel at locations agreed to in writing by the Company, with the understanding that there shall be at least one such point of crossing permitted over said parcel and additional crossings permitted as needed and as approved by State and/or County regulatory agencies; any roads constructed and/or utilities installed pursuant to this reservation may remain permanently irrespective of ownership of land on both sides of said parcel; and (2) any crops which may be damaged on land adjacent to said parcel because of construction, reconstruction, modifications, operation, and maintenance by the Company shall be paid for at prevailing market prices.

Notice of intent to exercise this option shall be mailed to the Owners at _____whereupon the Company shall obtain immediate possession of the parcel of land.

Settlement shall be held within a reasonable time after the option is exercised and the Owners agree(s) to sign and deliver a deed conveying such land in fee simple and the rights mentioned herein to the Company, free of all liens and encumbrances upon payment of the consideration as stated above.

Company representatives may enter the property during the option period to make surveys and investigations.

The Owners agree(s) to cooperate with the Company in obtaining any necessary Zoning or other permits.

WITNESS: _____(Seal)

_____(Seal)

Dated _____, 19___

APPENDIX 3-F

Sample Clauses of Transmission Rights-of-Way Easement Instruments

1. FACILITY RIGHTS

. . . to place, construct, build, maintain, operate, replace, repair, remove, and reconstruct overhead and/or underground electric transmission and distribution lines and structures and necessary guys and supports for the transmission and distribution of electrical energy . . . and any subsequent additions thereto on the right-of-way, together with the right to erect and maintain or to permit others to erect and maintain overhead and/or underground communications circuits and equipment belonging to Grantee or others within the right-of-way;

. . . to construct, operate, use, maintain, inspect, repair, renew, replace, reconstruct, enlarge, alter, add to, improve, relocate, and remove, at any time and from time to time, electric lines, consisting of one or more lines of metal towers, poles, and other structures, wires, cables, including ground wires and communication circuits, both overhead and underground, with necessary and convenient foundations, conduits, pullboxes, guy wires and anchors, insulators and crossarms placed on said structures, and other fixtures, appliances, and appurtenances connected therewith, necessary or convenient for the construction, operation, regulation, control, grounding, and maintenance of electric lines and communication circuits, for the purpose of transmitting, distributing, regulating, and controlling electric energy to be used for light, heat, power, communication, and other purposes . . . .

. . . for the erection and continued operation, maintenance, repair, alteration, inspection, and replacement of the electric transmission, distribution, and telephone lines and circuits of the Grantee, attached to poles or other supports, together with guys, crossarms, and other attachments and incidental equipment thereon, and appurtenances, with the right to permit the attachment of the wires and fixtures of other companies or parties, ...

. . . build, maintain, alter, repair, operate, and remove transmission and/or distribution lines consisting of poles, towers, wires, equipment, and fixtures over and across the following described lands . . . .

2. UTILITY ACCESS RIGHTS

. . . to have free ingress and egress over adjacent lands or by means of existing traveled ways to and from the right-of-way at any time for the purposes herein recited.

. . . the right of ingress to and egress from said strip over and across said lands by means of roads and lanes thereon, if such there be, otherwise by such route or routes as shall occasion the least practicable damage and inconvenience to first party; provided that such right of ingress and egress shall not extend to any portion of said lands which is isolated from said strip by any public road or highway now crossing or hereafter crossing said lands; provided, further, that if any portion of said lands is or shall be subdivided and dedicated roads or highways on such portion shall extend to said strip, said

right of ingress and egress on said portion shall be confined to such dedicated roads and highways;

. . . and to use said right-of-way and easement for access to and from any part or parts thereof and any lands and rights-of-way of Grantee adjoining the same for the enjoyment of the rights of Grantee therin, and of ingress and egress to, over, and from the Premises and any adjoining lands of Grantor at any and all times for the purposes of exercising and enjoying any and all of the rights hereby vested in Grantee.

. . . with the right of ingress and egress to and from the same. In exercising its rights of ingress and egress the Grantee shall, whenever practicable, use existing roads and lanes, and shall repair any damage caused by its use thereof.

. . . and to pass along said strip to and from the adjoining lands and to pass over the Grantor's land to and from said strip as reasonably required.

. . . the right, permission, and authority to enter upon said strip of land for the purposes of constructing, patrolling, repairing, maintaining, and replacing said transmission line facilities and exercising the rights herein acquired. The furtner right, permission and authority is also granted to Grantee to enter in a reasonable manner upon the property of Grantors outside of said strip of land for the further purpose of access to said strip of land to construct, erect, operate, maintain, and replace said facilities.

The utility may not use any lands beyond the boundaries of the easement for any purpose, including ingress to and egress from the right of way, without the written consent of the landowner.

3. VEGETATION CLEARING AND MAINTENANCE RIGHTS

. . . the right from time to time to trim and to cut down and clear away or otherwise destroy any and all trees and brush now or nereafter on said strip and to trim and to cut down and clear away any trees on either side of said strip which now or hereafter in the opinion of second party may be a hazard to said towers, poles, and/or other structures, wires, or cables, by reason of the danger of falling thereon, or may interfere with the exercise of second party's rights hereunder; provided, however, that all trees which second party is hereby authorized to cut and remove, if valuable for timber or wood, shall continue to be the property of first party, but all tops, lops, brush, and refuse wood shall be burned or removed by second party;

In addition to the right of the Grantee to remove trees from said right-of-way strip, the Grantee shall also have the right to trim or top and to keep trimmed or topped any and all trees on the lands of Grantor within said right-of-way strip for a distance of 75 feet from the exterior lines of said right of

way strip, to such heights as in the judgment of Grantee, its successors, or assigns, shall be reasonably necessary for the proper construction, operation, and maintenance of said electric lines and communication circuits, but at no point outside of said right-of-way strip to a height of less than 50 feet.

. . . the right from time to time to cut, trim, and remove tree, brush, overhanging branches, and other obstructions which may injure or interfere with the Grantee's use, occupation, or enjoyment of this easement and the operation, maintenance, and repair of Grantee's electrical system.

. . . the right to the Grantee to cut, to control, or to eliminate by herbicides, and at its option to remove from the Premises or the lands of the Grantor adjoining the same on either side, any trees, overhanging branches, vegetation, obstacles, or obstructions which may endanger the safety or interfere with the installation, use, or enjoyment of all or any of the Grantee's facilities;

Grantee shall have the right to remove and keep removed all trees and brush from the above described right-of-way and may remove or top any other trees adjacent to said right of way whose height plus ten feet equals or exceeds the horizontal distance from the tree to the nearest conductor wire. All logs, limbs, and brush removed by Grantee in clearing the right of way will be burned or removed, unless otherwise mutually agreed between Grantor and Grantee.

. . . to clear and keep cleared by physical, chemical, or other means, said strip of trees, underbrush, and structures (the first clearing may be for less than the full width and may be widened from time to time to the full width) . . . .

The right, permission, and authority is also granted to Grantee to cut down and remove or trim all trees and overhanging branches now or hereafter existing on said strip of land, to cut down and remove brush, or apply chemicals for purposes of brush control, and to cut down and remove or trim such trees now or hereafter existing on the property of Grantor . . . located outside of said strip of land which by falling might interfere with or endanger said lines . . . the right, permission, and authority to enter in a reasonable manner upon property of Grantor . . . .

The utility shall control weeds and brush around the transmission line facilities. No herbicidal chemicals may be used for weed and brush control without the express written consent of the landowner. If weed and brush control is undertaken by the landowner under an agreement with the utility, he shall receive from the utility a reasonable amount for such services.

. . . to cut, trim, or remove "danger trees" growing adjacent to the right-of-way ("danger trees" being defined as trees which have branches or limbs overhanging the right-of-way and/or trees whose height plus_____feet exceeds the horizontal distance from the butt of the tree to the centerline of the transmission line); and . . . .

. . . also the right to cut down, trim, and remove and keep cut down and trimmed by mechanical means or otherwise, any and all trees, brush, or other undergrowth on said strip of land or adjoining the same, which, in the judgment of said Company, may at any time interfere with the construction, reconstruction, maintenance, or operation of said lines, poles, wires, guys, stub poles, fixtures, and apparatus, or menace the same, and in connection therewith, the right to remove, if necessary, the root systems of said trees, brush, or other undergrowth, and to spray said brush and undergrowth with chemicals for their removal and control, ...

"It is further agreed that evergreen trees under_____feet in height are to be excluded from the abovementioned tree cutting and tree trimming rights."

4. RESTRICTED ACTIVITIES

. . . that no act will be permitted within said strip which is inconsistent with the rights hereby granted; that no buildings or structures will be erected or constructed upon said strip; and that the present grade or ground level of said strip will not be changed by excavation or filling.

At no time shall any flammable material or any building of any kind be placed or erected within the boundaries of said right-of-way, nor shall any equipment or material of any kind that exceeds 20 feet in height be placed or used thereon by Grantor or by Grantor's heirs, successors, or assigns.

The Grantor covenants and agrees that no structures will be erected, or inflammable material placed or accumulated, or trees planted on said strip . . . of land, and Grantor . . . further covenant . . . and agree . . . that the elevation of the existing ground surface within said strip of land will not be altered by more than one (1) foot without the written consent of Grantee.

. . . the right to clear and to keep clear said easements and rights-of-way and the real property affected thereby, free from explosives, building, structures, equipment, trees, vines, brush, combustible materials, and any and all other obstructions of any kind, including, but not in any way in limitation of the generality of the foregoing, swimming pools and appurtenances, fences (other than farm, grazing, or pasture fences), and the parking of automobiles, trucks or other mechanical equipment, for protection from fire and other hazards and from interference with ingress and egress and with the unobstructed use of said easements and rights-of-way and every part thereof, ...

. . . to clear the right-of-way and to keep it clear of all trees, brush, buildings, signboards, mobile homes, wells, swimming pools, permanent or temporary structures of any type, and stored or parked personal property; and to remove obstructions of any kind and nature that might interfere with the use of this easement by Grantee or be hazardous or potentially hazardous to the use of same by Grantee;

. . . to control and to the extent reasonably necessary to prevent the construction or alteration within the limits of the right-of-way of transportation facilities (including but not limited to roads, railroads, and pipelines), other overhead or underground utility facilities, park and playground facilities, landfills, land excavations, water impoundments, and other land uses which might reduce the safety of or cause a hazard to the operation of the Grantee's facilities constructed on the hereinafter described right-of-way, or which might increase the cost of maintenance, operation, repair, removal, replacement, or reconstruction of said Grantee's facilities;

5. PERMITTED ACTIVITIES

Grantor reserves for Grantor and Grantor's heirs and assigns, across (but not longitudinally along) said right-of-way strip, rights for (1) underground water pipelines, (2) farm, grazing, or pasture fences, and (3) roads, provided, however that the exercise of such rights does not interfere with or endanger, in the opinion of Grantee, the operation or maintenance of the electric lines and communication circuits of Grantee, or Grantee's ready access to its said electric lines and communication circuits, or the exercise of any of the rights herein granted to Grantee. In addition to said reserved rights for water pipelines, farm fences and roads, Grantor and Grantor's heirs and assigns shall have only the additional right to cultivate the land within said right-of-way strip for any and all field or orchard crops which may be grown thereon or to use such land for grazing and pasturage, provided such uses shall not interfere with the rights herein granted to Grantee, its successors, and assigns. Grantor expressly agrees that Grantee, its successors, assigns, and agents shall not be liable for damage to, or removal of trees and vines, including loss of production, both present and future, where such damage, removal, and loss occurs as a result of the exercise of the rights granted herein. Grantor expressly agrees for Grantor and Grantor's heirs and assigns, that said right-of-way strip will never be used for cemetery purposes.

Subject to the foregoing limitations, said right-of-way may be used by Grantor for roads, agricultural crops, and other purposes not inconsistent with said easement.

Grantor shall have the right to cultivate or otherwise use the Premises in any way not inconsistent with the easement hereby granted, but no building, structure, or obstruction shall be placed by the Grantor under or within_____feet (measured horizontally) of the centerline of the electric power line.

"After construction of said electric transmission lines, Grantor shall have the right to plant and grow evergreen trees to a height not exceeding_____feet and/or fruit trees to a height not exceeding_____feet above the presently existing surface of the ground within said easement area, except that no trees shall be planted within_____feet of each side of the centerline of said electric transmission lines to the extent that, in the sole judgment of the Grantee, the said trees shall not in any manner interfere with, hinder, or impair the

construction, operation, patrolling, maintenance, reconstruction, renewal, addition to, relocation, or removal of said facilities or any part thereof, anything to the contrary notwithstanding; but Grantee may, from time to time, when it deems it necessary for the purposes aforesaid, remove any of said fruit and/or evergreen trees, provided it shall pay damages to Grantor for any such fruit trees ONLY so removed or damaged."

6. UTILITY (GRANTEE) COMMITMENTS

Grantor(s) reserves the right to be paid for damage to growing crops and to be paid for or have repaired by Grantee or its agents or independent contractors future physical damage to property of Grantor(s) caused by reason of Grantee's construction and maintenance activities and/or by reason of the exercise of the right of ingress and egress by Grantee.

Grantee shall promptly repair or replace all fences, gates, drains, and ditches damaged or destroyed by it on the Premises and shall pay Grantor all damages done to crops and livestock on the Premises proximately caused by the construction, operation, and maintenance of Grantee's Facilities. Any trees cut will be paid for by Board Measure, using Scribner's Lumber Rules at the market price in vicinity.

In constructing and maintaining high-voltage transmission lines on the property covered by the easement the utility shall:

1. If excavation is necessary, ensure that the top soil is stripped, piled, and replaced upon completion of the operation.

2. Restore to its original condition and slope, terrace, or waterway which is disturbed by the construction or maintenance.

3. Insofar as is practicable and when the landowner requests, schedule any construction work in an area used for agricultural production at times when the ground is frozen in order to prevent or reduce soil compaction.

4. Clear all debris and remove all stones and rocks resulting from construction activity upon completion of construction.

5. Satisfactorily repair to its original condition any fence damaged as a result of construction or maintenance operations. If cutting a fence is necessary, a temporary gate shall be installed. Any such gate shall be left in place at the landowner's request.

6. Repair any drainage tile line within the easement damaged by construction or maintenance.

7. Pay for any crop damage caused by such construction or maintenance.

8. Supply and install any necessary grounding of a landowner's fences, machinery, or buildings.

In consideration of such grant, Grantee agrees that it will repair or pay for any damage which may be caused to crops, fences, or other property of the undersigned by the construction, operation, maintenance, inspection, patrolling, or removal of said line. Grantor(s) covenants that no act will be permitted within the easement property which is inconsistent with the rights hereby granted;

"It is also understood that if a bulldozer is used to clear the said strip of land, then the said strip of land must be left passable during and after said operations and no piles of stumps, stones, or dirt are to be placed along either side of said strip of land which would prevent ready access to adjoining lands of the Grantor(s)."

4

ROW Maintenance Methods and Costs

The right-of-way (ROW) clearing, maintenance, and related cost information presented in this chapter is intended to provide an overview of clearing and maintenance methods currently being used in the United States. Information presented in figures and tables and summarized in discussions was obtained directly from utility ROW managers and industry records. Maintenance methods currently in use are summarized for each vegetation province. Cost information is presented by State or group of States that experience similar pricing constraints.

Clearing and maintenance work involves two distinct operations: clearing means the initial clearing of the ROW for construction of the transmission facility; maintenance represents the on-going effort to maintain the ROW once the initial clearing is complete.

The first section of this chapter provides a description of currently used ROW maintenance methods. The second section indicates the frequency of use of various methods and presents relative costs of these methods by State or group of States.

15 MAINTENANCE METHODS

This section describes cost-effective methods that can be used in initially clearing (capital clearing) a ROW and in maintenance operations on transmission line ROWs throughout the United States. Some methods are used in both capital clearing and in maintenance operations. Combinations of methods, such as chainsaw cutting and stump spraying, are also frequently used.

Clearing and maintenance methods are identified as either selective or nonselective, depending on their type and use. Selective vegetation methods consist of both manual and chemical work; nonselective methods include mechanical and chemical methods and burning.

SELECTIVE VEGETATION MAINTENANCE METHODS

Selective vegetation methods include those methods that treat individual plants or clumps of plants.

Manual

Chain saw cutting — This method involves chain saw cutting plants of predetermined "target" species and/or plants that exceed a predetermined height. This method is often used along with stump spraying.

Trimming — Trimming includes two different but related operations: topping and side trimming.

Topping involves cutting back large portions of the upper crown of the tree, usually to a predetermined height. Topping is done to maintain trees approaching full height under conductors. Removing more than 60 percent of the live crown, however, may result in the death of the tree.

Side trimming (figure 15.1) involves cutting back or removing the side branches that extend into the ROW area. Limbs should be removed at lateral branches. Removing more than half of the live crown in this manner may result in the decline or death of the tree. (For further information regarding tree tolerances and trimming, see Asplundh Environmental Services 1978.)

Girdling — This method involves completely removing a 3 to 5 inch wide band of bark from the trunk of the tree (figure 15.2). Bark and phloem must be completely severed to disrupt the flow of nutrients to the roots. Sprouting below the girdle may occur in some species.

Girdling is hard work, time consuming, and costly. It is advantageous, however, because it is a selective cutting method that leaves no slash, and the resulting snag may also benefit wildlife.

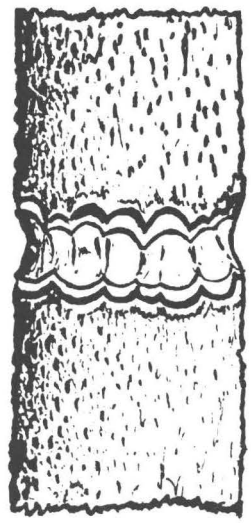


Figure 15.2 Girdling

Chemical

Frilling — Frilling (figure 15.3) can be performed in three basic ways:

1 By making a single line of overlapping downward axe or hatchet cuts completely around the tree (a frill girdle). Chips are left attached to the tree to provide a place for applied herbicide to collect.
2 By spacing cuts 2 inches apart and adding diluted or undiluted herbicide to each cut.
3 By making notches or "cups" with an axe at the base of the tree. Two downward axe cuts, one above the other, are made and the chips are pried out. Dry, crystalline herbicide, such as ammonium sulfamate, may then be added to each "cup."

Frilling may be done at any time, but is most effective during the peak growing season because the herbicide is more actively transported throughout the plant at that time.

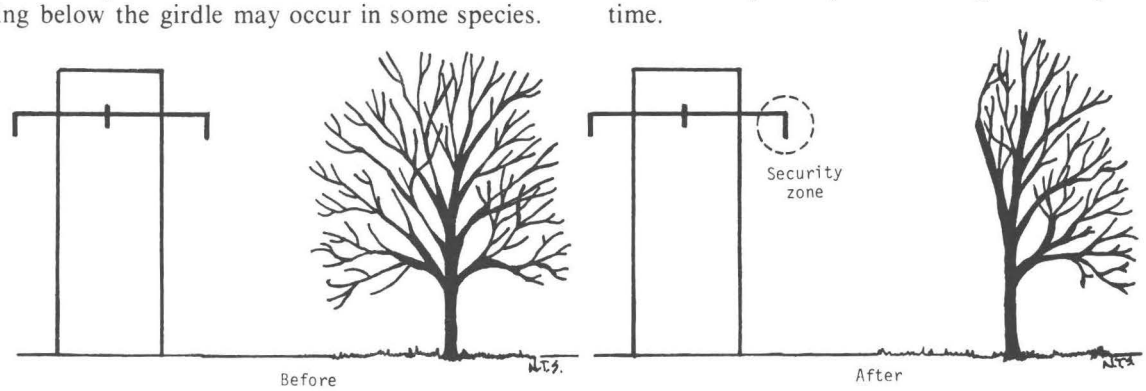


Figure 15.1 Side trimming

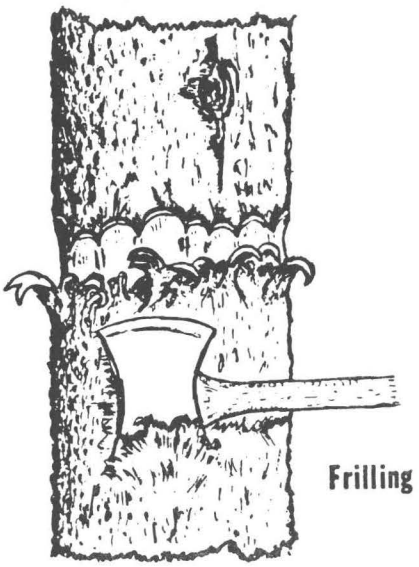


Figure 15.3 Frilling

Tree injectors and the hypo-hatchet - Typical tree injectors and hatchet-type tree injectors (figure 15.4) allow the operator to cut through the bark to expose cambium and apply herbicide in one operation. The operator makes spaced or continuous cuts around the base of a tree near the root collar and applies herbicide to each cut. Hatchet-type tree injectors allow the operator to make waist-high incisions on target species. Spaced cuts are usually used, but on species that are difficult to kill, continuous cuts may be needed. A variety of diluted or undiluted herbicides may be used in either type of equipment, depending on species and season.

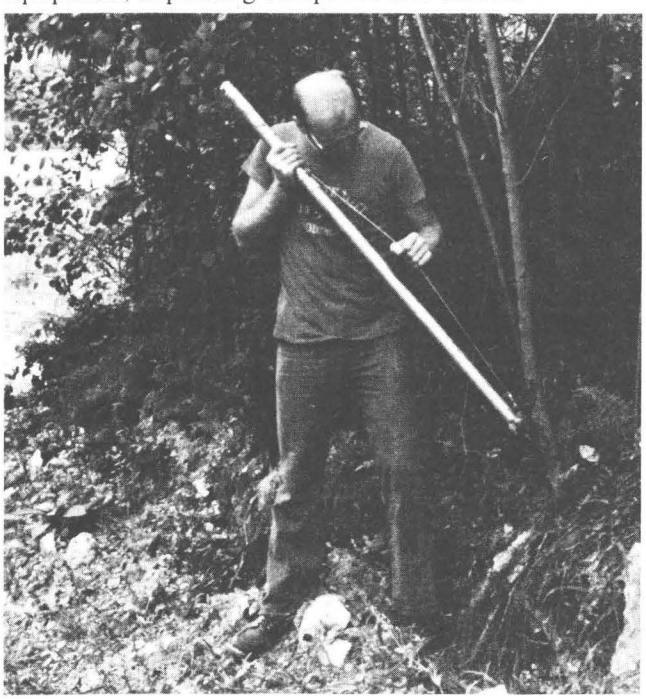


Figure 15.4 Tree injection

Cut and stump spraying — Cut and stump spraying involves two distinct operations. The first operation involves cutting the plant down. Stumps smaller than 4 inches may be "V-notched" to expose more surface area. The second operation involves applying herbicide to the newly cut surface, root collar, and exposed roots. Spraying should be applied to the point of runoff. This method usually will not prevent root suckering.

Basal spraying — Basal spraying involves applying herbicide with an oil carrier to the lower 18 inches of stem (figure 15.5). Each stem and any exposed roots are treated on all sides with herbicide to the point of runoff.

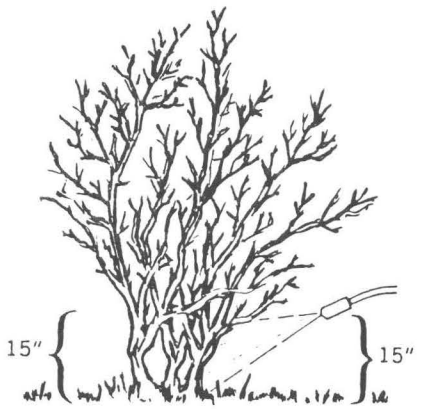


Figure 15.5 Basal spraying

Stem/foliage waterborne — Stem/foliage application using a water carrier is a summer treatment. The entire plant, all foliage and stems, is sprayed to the point of runoff. If applied later in the season, the chemical concentration should be increased.

Dormant stem spraying — Dormant stem spraying is a method used in a dormant season — fall, winter, or spring — after the foliage drops from the plants. Oil is used as a carrier. The stems of the target plants are sprayed to a height of 6 feet or 80 percent of tall stems. Thorough drenching of the root collar is critical for good control. This method gives control equal to summertime waterborne spray, except on root-suckering species. It may be preferable to use selective basal applications when brush density is heavy.

Growth inhibitors — Certain chemicals inhibit or retard plant growth. They may be applied to cut surfaces after trimming and pruning operations or as a foliage application to the tree crown. Current research has also indicated the possible future use of such chemicals by injection and bark-banding applications.

NONSELECTIVE VEGETATION MAINTENANCE METHODS

Nonselective vegetation maintenance methods include those methods that treat an entire area, altering all vegetation in that area regardless of the species or height.

Mechanical

Sheardozing — Sheardozing involves using a tracked

vehicle with a sharp, straight blade that shears off all stems protruding from the ground. Properly used, this equipment can sever trees up to 10 inches in diameter, but it works best on smaller plants. Soil disturbance can be minimized by sheardozing when the ground is frozen (figure 15.6).

Scalping — Scalping involves scraping off all plants and the top layer of soil. Wheeled or tracked vehicles provide the quickest and most economical means to achieve scalping. Wide moldboard plows can be used to scalp on gentle slopes that are fairly free of rocks, but a blade that can be raised or lowered, mounted on a 3-point hydraulic hitch on the rear of a tractor, should be used on steeper slopes. An adjustable bulldozer blade may also be used to scalp if done carefully.

Pushing — Pushing involves using a tracked vehicle with a standard blade and push bar to uproot larger woody plants. The uprooted plants can be removed or disposed of by standard slash disposal methods.

Brushraking and rootraking — Brushraking (figure 15.7) involves a tracked vehicle with a specially designed toothed blade that uproots and removes brush. The brushrake may also be used to move or pile previously cut trees and brush. Rootraking uses a brushrake with a cutting bar attached to the bottom of its teeth to sever roots below the soil surface.

Roller chopping — A roller chopper consists of a cutting blade mounted on heavy water-filled metal drums; choppers are pulled over the area by a tracked vehicle. The chopper can be used to treat shrubs and small trees to 6 inches in diameter by forcing them against the ground and cutting them into small pieces. This method creates minimal slash and site disturbance.

Figure 15.6 Sheardozing

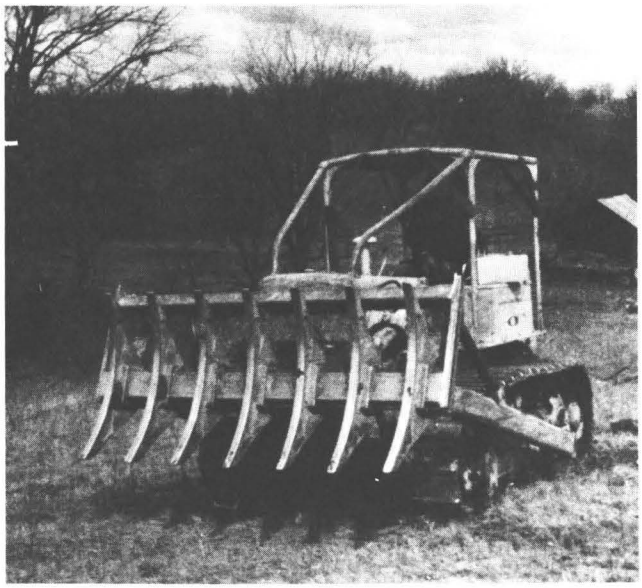


Figure 15.7 Brushraking and rootraking

Disking and plowing — Disking and plowing can be done using a variety of equipment from conventional tillage implements to heavy duty disks and moldboard plows. Disks cut, lift, and invert vegetation while scarifying the soil.

Mowing — Mowing involves using heavy rotary mowers, such as brush hogs, to cut woody plants and create a well-groomed appearance.

Chemical

Broadcast chemical spraying — Broadcast chemical spraying is done in two ways: low volume and high volume applications.

Low volume applications usually involve using water carriers, such as ground sprayers, power mistblowers, fixed-wing aircraft, or helicopters (figure 15.8). Best results are obtained when applications are made during periods of optimum growth after full leaf development. The object of low volume applications is to coat the leaves uniformly rather than drench the foliage.

High volume applications involve using water carriers to apply herbicides, but oil/water carriers give better top kills. This method is used on ground areas accessible to wheeled or tracked vehicles. Timing of high volume applications should follow the seasonal recommendation for low volume application presented above.

Dry herbicide applications — Dry, nonliquid herbicides are produced as pellets, granules, and beads. Applications to the soil surface may be made by hand or by using several mechanical devices. Dry herbicides are not recommended for use in wetlands or areas of standing water. Applications may be made at any time of the year, but late winter or spring applications are most effective because high soil moisture helps dissolve the herbicide and root growth is at a maximum, increasing the uptake of the herbicide. However, effectiveness of control will vary with soil type and plant species.

Figure 15.8 Broadcast chemical spraying (helicopter)

Soil-sterilants — Soil-sterilant herbicides are used in areas where the soil is to be made nonproductive of vegetation. Once applied, these herbicides are carried by moisture into the root zone of plants, thus controlling both established plants and germinating seedlings. These herbicides are available as powders that may be wetted for spraying or left in powder form for dry application.

Burning

Broadcast prescribed burning — Broadcast prescribed burning is the controlled application of fire to vegetation. It is used under conditions of weather, plant moisture, soil moisture, etc., that allow the fire to be confined to a predetermined area of the ROW. At the same time, it must produce the intensity of heat and rate of spread required to further certain planned objectives of control. Burning permits are required in most areas.

METHODS FOR SLASH DISPOSAL

Mechanical/Manual

Slash piling — Slash piling (figure 15.9) consists of collecting and piling slash in designated areas of a ROW. Mechanical slash piling may be done using wheeled or tracked vehicles to push slash into piles. Windrowing is a form of piling that consists of concentrating slash, usually along the edge of the ROW, to clear the intervening ground. Piling may also be done manually, especially in areas where heavy equipment would have adverse effects on soil or residual vegetation. Brush piling for the benefit of wildlife is discussed in section 21.

Drop, lop, and leave — Drop, lop, and leave consists of lopping all slash so that it lays close to the ground. This method is suited to areas where slash is light or where heavy equipment would damage the site.

Removal — Removal of slash involves physically removing slash from the area and disposing of it in another location, often a more suitable site on the ROW.

Chipping — Chipping involves using heavy-duty or whole tree chippers to chip slash. The chips can then be disposed of on the site or loaded into trucks and removed from the site (figure 15.10).

Burning

Piling and burning — Piling and burning involves collecting material as described above in piling slash. If a burning permit is required and obtained, the piles may be burned under proper atmospheric and wind conditions.

Pit burning — Pit burning involves digging a pit, approx-

Figure 15.9 Slash piling

Figure 15.10 Chipping

imately 10 feet wide and 15 feet deep, in which to burn slash. Often an "air curtain" incinerator is used. This mechanical device blows air into the pit causing complete combustion that results in a "cleaner smoke" that is also less visible. Slash is dumped into the pit with a front-end loader or bulldozer.

Note: In most areas permits may be needed before open burning can be used.

METHODS FOR RESTORATION

Grading

Grading to return the soil to its original contour is done on sites that will no longer be disturbed, such as cable pulling sites.

Seeding

Seeding with grasses or legumes is an important supplement to erosion control structures on access roads, tower sites, cable pulling sites, and assembly sites. Seeding is usually restricted to areas of high erosion hazard and is usually done to prevent erosion until natural vegetation is established. Ground seeding can be done using deep-furrow drills, seed dribblers, cyclone seeders, hand broadcasting, or hydroseeding (figure 15.11). Aerial seeding can be done using the hydrospider equipment (figure 15.12).

Planting

Planting native or exotic plants, usually woody, is done in areas of high visual impact or where immediate screening is desired. Native plants may be relocated from nearby sites as needed. This practice, however, is expensive and may not be totally successful.

Relocation of Vegetation

This method involves lifting the entire live plant from its original location and placing it on a new site. It is used to preserve certain plants that might otherwise be destroyed.

Note: It may be difficult to successfully plant or relocate vegetation.

METHODS THAT ALTER OTHER ENVIRONMENTAL COMPONENTS

Access Roads

Access roads should be located in a manner that will preserve site quality and minimize erosion.

Filter strips — A filter strip is a protective area of absorbent, undisturbed soil between access roads and streams. It should be wide enough to prevent road surface water from reaching the stream directly.

Culverts — Culverts may be constructed from metal, lumber, or logs (figure 15.13). They drain road-surface runoff, springs, seeps, and other small sources of water away from the road to prevent erosion.

Broad-based drainage dips — Broad-based drainage dips

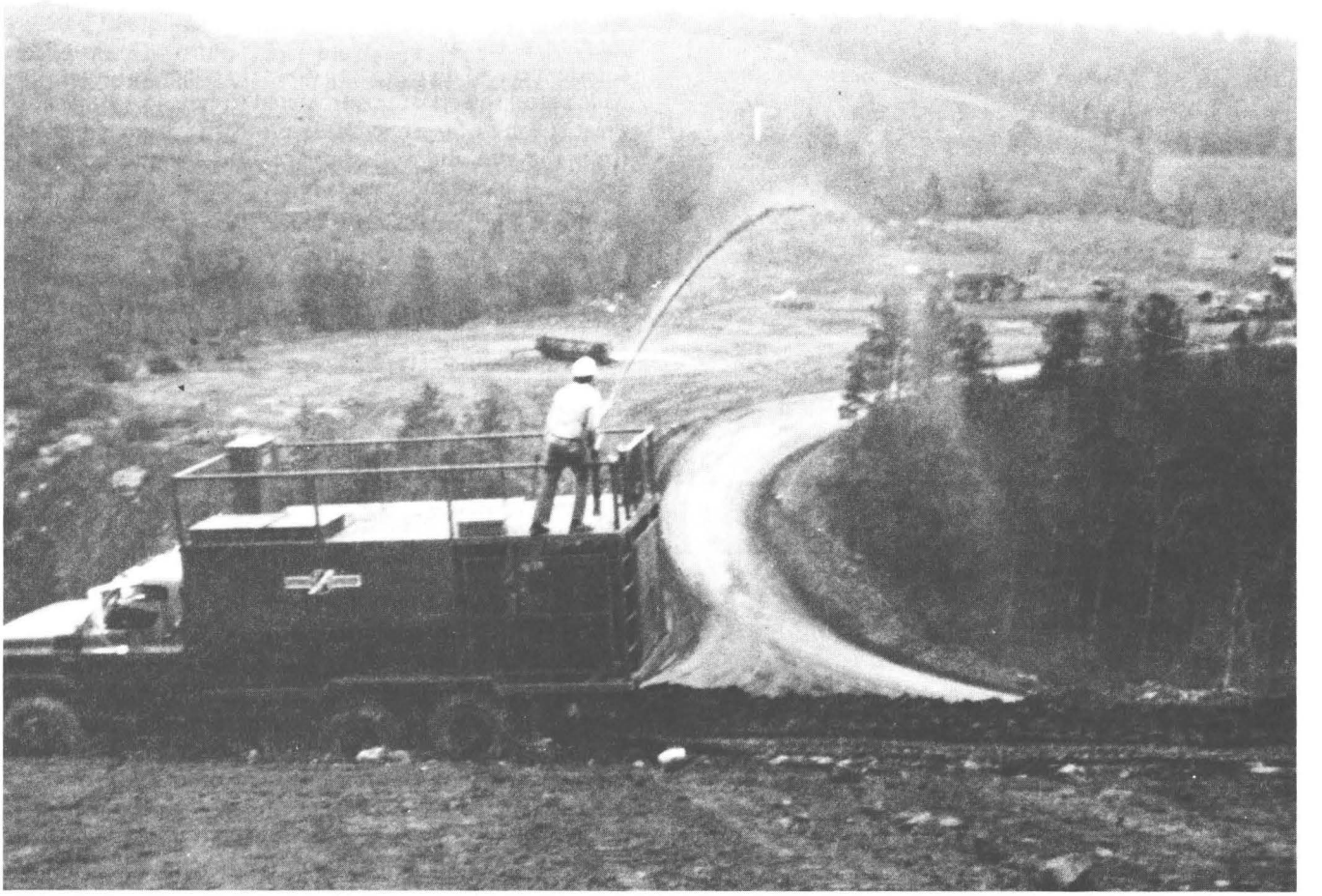


Figure 15.11 Hydroseeding

(figure 15.14) may be used instead of culverts for cross-drainage where no intermittent or permanent streams are present. If properly designed and installed, broad-based dips reduce the need for waterbars and are maintenance-free.

Waterbars — Waterbars, like culverts, provide cross-drainage and minimize erosion. They are "cuts" in bare soil areas, such as roads, that should be used when roads are to be closed to vehicles after construction. Waterbars can be constructed with handtools, but bulldozers are more commonly used.

Fords and stream erosion — Fords should be used to cross streams too large to be carried by culverts. Fords should be at right angles to streams and should not interfere with natural stream flow.

Tower Sites, Cable-pulling Sites, and Assembly Sites

Tower sites, cable-pulling sites, and assembly sites frequently require alteration of the soil surface contour. They comprise a relatively small percentage of the overall ROW area but are centers of activity during the construction phase of a transmission ROW.

Figure 15.12 Aerial seeding

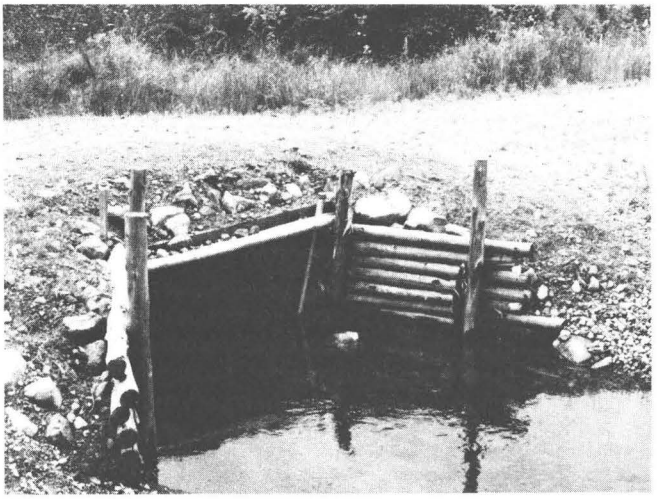


Figure 15.13 Culvert

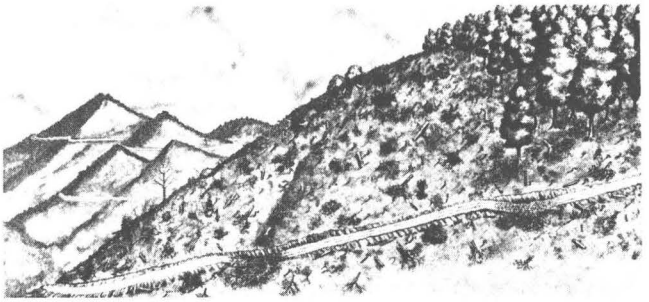


Figure 15.14 Broad-based drainage dip

Tower Sites — Tower site alteration ranges from relatively small disturbances, such as digging holes to accommodate poles, to grading an area of several hundred square feet and digging deep holes for concrete footers on which steel towers are constructed (figure 15.15). As the area becomes larger, consideration for drainage away from the site and soil slippage into the site becomes critical. Because the tower site is a permanent part of the ROW, its design and construction must be considered carefully.

Cable-pulling sites and assembly sites — Cable-pulling sites and assembly sites will be needed much less frequently than tower sites. They are short-term work areas and are usually selected because of easy access and suitability for use.

16 CURRENT USE AND COST OF CLEARING AND MAINTENANCE METHODS

CAPITAL CLEARING AND MAINTENANCE METHODS

The figures in this section summarize information on capital clearing and maintenance methods and provide an indication of the extent to which the methods are used by utilities throughout the country. Data presented are based on and show the percentage of electric utilities that use a certain method in some portion of their ROW maintenance program. The selective vegetation maintenance methods include chain saw cutting, trimming, girdling, tree injecting and hypo-hatcheting, cut and stump spraying, basal spraying, and stem/foliage waterborne

Figure 15.15 Tower site

methods. The nonselective techniques include sheardozing, scalping, brushraking or rootraking, roller chopping, mowing, broadcast chemical spraying, and dry herbicide applications. The data do not indicate the percentage of use of any particular method by each utility; rather the data show the percentage of utilities using the method. It should be emphasized that use by the utility industry of various methods represents their best effort at ROW maintenance, considering historical patterns, technology, and management constraints. As public awareness and concerns regarding ROW management intensify, utilities are striving to better document the long-term effects of each method they use. The data upon which the figures that follow are based were calculated from information supplied by ROW contractors and utility foresters (Asplundh Environmental Services 1978).

Eastern United States

The data obtained for seven selective maintenance methods confirm their use, with the exception of girdling and tree injector/hypo-hatchet methods, by most utilities in the East. Little variation in the overall pattern of use appears between province groupings (figure 16.1). Among the five nonselective techniques assessed for frequency of use, only roller chopping was not employed by a substantial portion of the utility companies in each province grouping (figure 16.2). The overall use of nonselective methods was similar throughout the East.

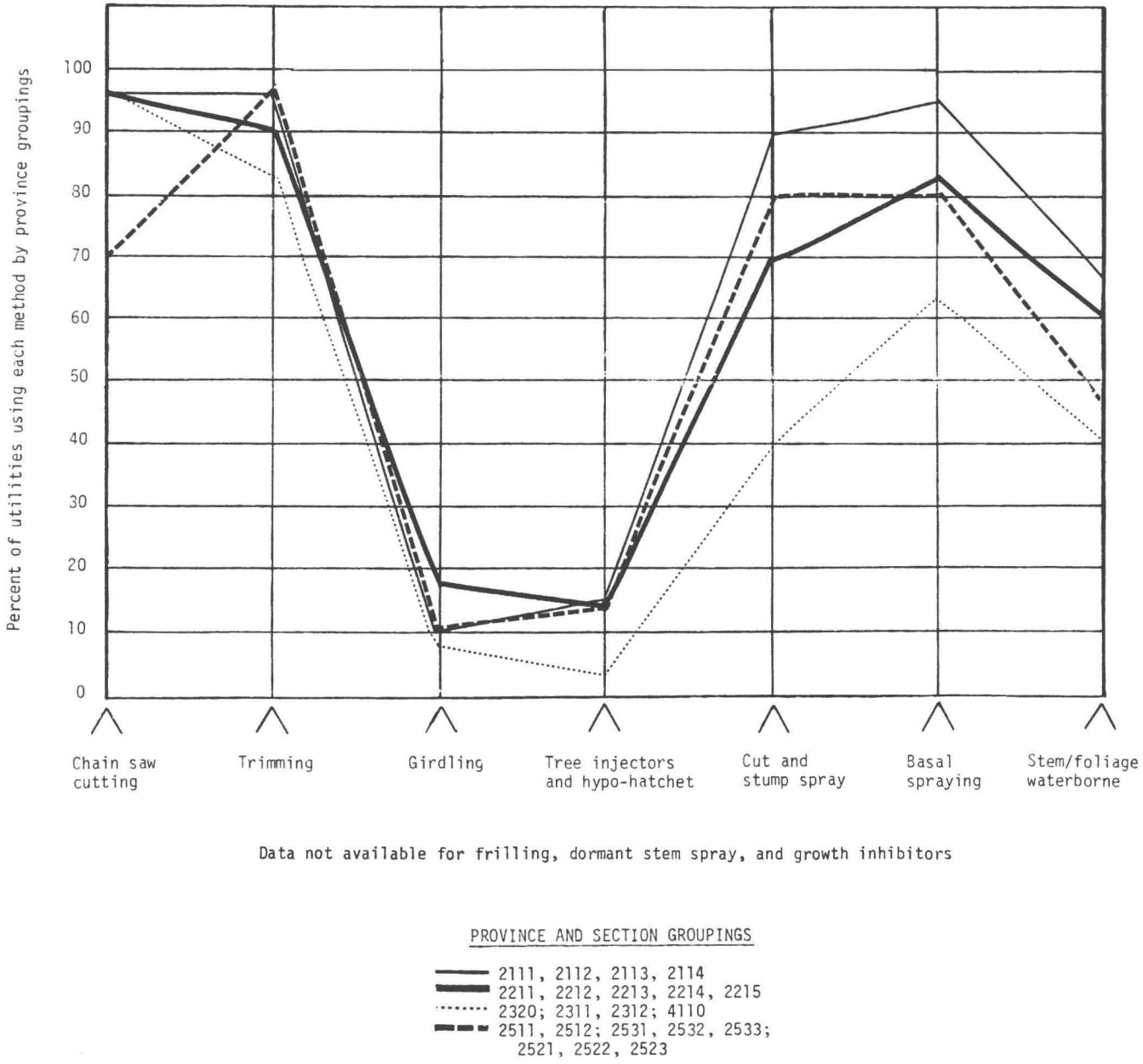


Figure 16.1 Selective vegetation management methods used in clearing and maintenance by utilities in the Eastern United States.

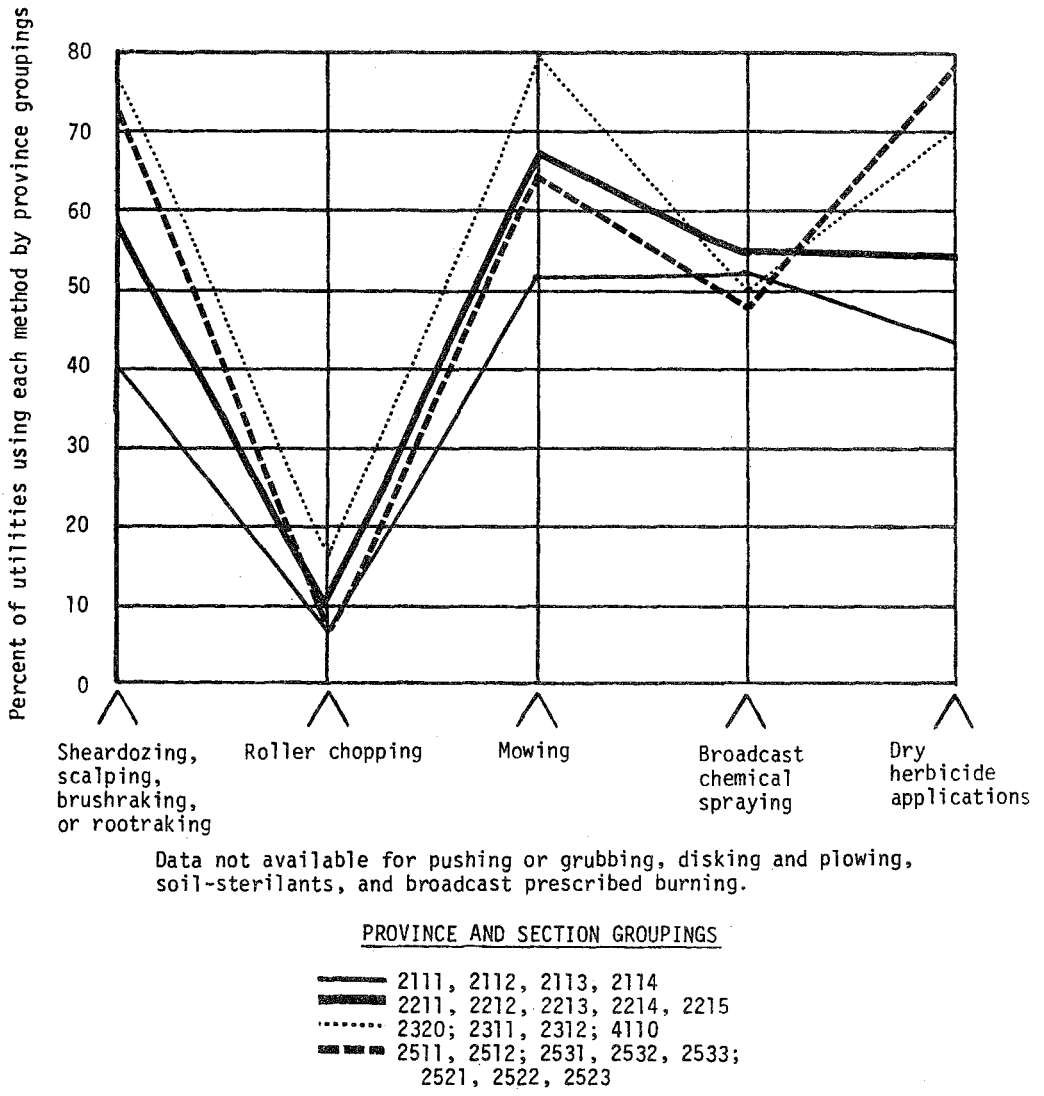


Figure 16.2 Nonselective vegetation management methods used in clearing and maintenance by utilities in the Eastern United States.

Use of slash disposal methods (figure 16.3) varies considerably among provinces, but all are used more than 40 percent of the time. Sections 2111, 2112, 2113 and 2114 (Province 2110) show the greatest variability between methods and display the trends of the remaining provinces (although with more exaggerated differences). These trends include: substantial use of slash piling; comparatively less use of drop, lop, and leave and removal methods; and more substantial use of chipping.

Restoration methods (figure 16.4) for eastern provinces depict substantial (greater than 40 percent) use of both grading and seeding, but seeding is used consistently more often than grading.

Province 2110, Laurentian Mixed Forest — Increased use of the following methods was noted within this province: cut and stump spraying, stem/foliage waterborne methods, and slash piling. Greater use is expected in the future for all methods compared with the rest of the country, with the exception of cut and stump spraying. Less use is expected for sheardozing, scalping, brushraking or rootraking, and dry herbicide applications as compared with the rest of the United States.

Province 2210, Eastern Deciduous Forest — More frequent use was noted for the following methods: mowing, cut and stump spraying, basal spraying, stem/foliage waterborne methods, and slash piling. Increased use is expected for roller chopping, mowing, basal spraying, broadcast chemical spraying, and slash piling.

Province 2310, Outer Coastal Plain Forest; Province 2320, Southeastern Mixed Forest; Province 4110, Everglades — More frequent use was noted for the following methods within these provinces: sheardozing, scalping, brushraking or rootraking, mowing, piling and burning, pit burning, and grading. Sheardozing, scalping, brush-

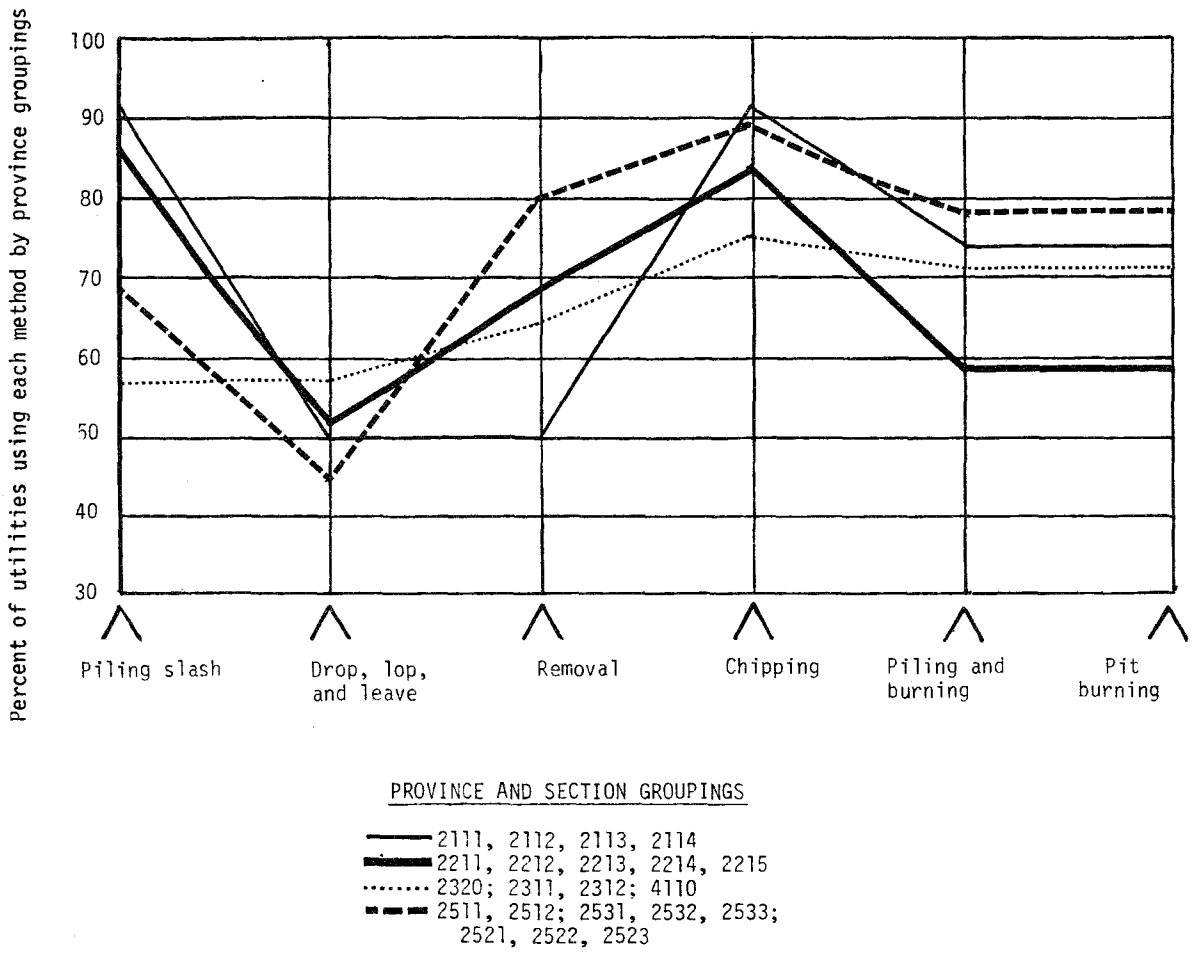


Figure 16.3 Slash disposal methods for utilities used in clearing and maintenance by utilities in the Eastern United States.

raking or rootraking, mowing, dry herbicide applications, piling and burning, pit burning, and grading are methods expected to increase in implementation. Cut and stump spraying use is expected to decline in use as compared to its utilization in the rest of the United States.

Province 2510, Prairie Parkland; Province 2520, Prairie Brushland; Province 2530, Tall-grass Prairie — Trends identified within this province grouping showed: 1) increased use of the following methods: sheardozing, scalping, brushraking or rootraking, cut and stump spraying, dry herbicide applications, piling and burning, and pit burning; 2) increased use is expected for sheardozing, scalping, brushraking or rootraking; and 3) less future use is expected for the drop, lop, and leave method.

Western United States

With the exception of utilities in the forested, northwest coastal provinces (Provinces 2410 and M2410) that make widespread use of basal spraying, western utilities are consistent in their overall use of selective maintenance methods (figure 16.5). Use among provinces of chain saw cutting, cut and stump spraying, and stem/foliage waterborne methods varies.

Of the nonselective methods, only mowing use varies greatly among province groupings; all other techniques are consistently used throughout the western provinces (figure 16.6).

Considerable variation exists between provinces in the use of slash disposal methods (figure 16.7), but all are used more than 25 percent of the time. A comparison of restoration methods employed in the Western United States provinces (figure 16.8) shows substantial use of both grading and seeding (greater than 15 percent), but seeding is used more consistently than grading.

Province 3110, Great Plains Short-grass Prairie; Province A3140, Wyoming Basin — Less use of stump spraying, selective foliage methods, and pit burning methods was noted. Less use is expected in the future of trimming, stump spraying, basal spraying, and selective foliage methods.

Province 2410, Willamette — Puget Forest; Province M2410, Pacific Forest — Significantly greater use is expected in the future for selective foliage and chipping methods.

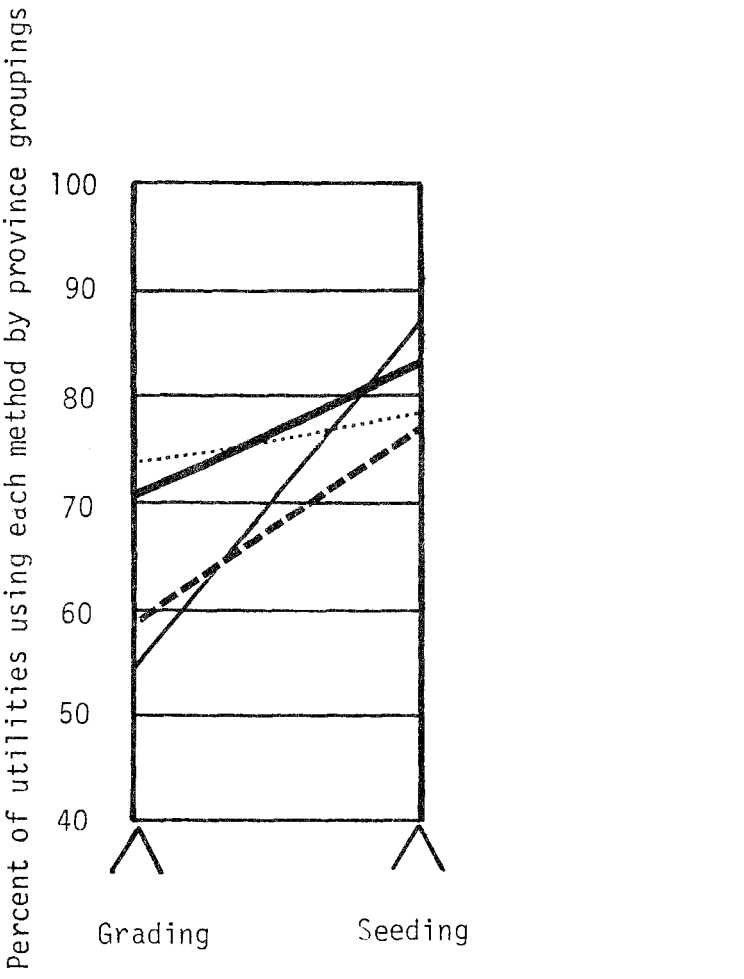


Figure 16.4 Restoration methods used in clearing and maintenance by utilities in the Eastern United States.

Province 2610, California Grassland; Province M2610, Sierran Forest; Province M2620, California Chaparral — Less use is expected for basal spraying and slash piling in these provinces.

Province M2110, Columbia Forest; Province M3110, Rocky Mountain Forest; Province M3120, Upper Gila Mountains Forest — Greater use was noted for drop, lop, and leave and seeding methods. Substantially less use was noted for trimming, stump spraying, and basal spraying methods. Less use is expected for trimming, stump spraying, basal spraying, and slash piling.

Province 3140, Mexican Highlands Shrub Steppe; Province 3210, Chihuahuan Desert; Province 3220, American Desert — Considerably less use was noted for chain saw cutting, trimming, and basal spraying methods. Less use is expected in the future for chain saw cutting, trimming, stump spraying, basal spraying, dry herbicide applications, and chipping methods.

Province 3120, Palouse Grassland; Province 3130, Intermountain Sagebrush — Less use was noted for trimming and basal spraying techniques. Less use is expected for trimming, basal spraying, and slash piling.

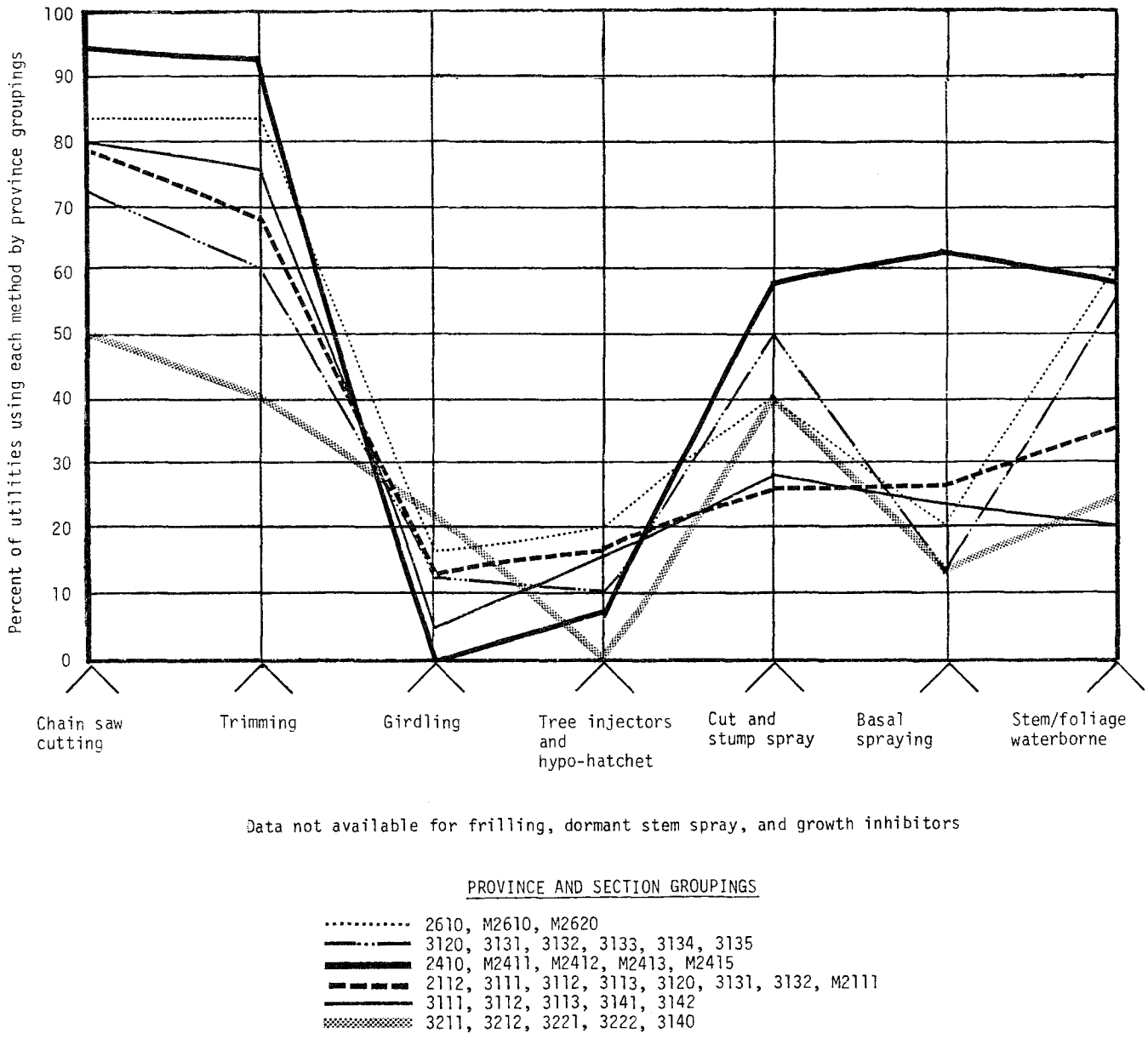


Figure 16.5 Selective vegetation management methods used in clearing and maintenance by utilities in the Western United States.

COST OF CLEARING AND MAINTENANCE METHODS

Because of the variables associated with clearing and maintenance methods, it is difficult to form generalizations about the cost of using these techniques. Even more difficult to prepare is a summary of associated costs for different areas within any particular region of the country. The cost of labor varies widely from utility to utility. Differences in terrain, accessibility (e.g., rocky, steep, or wet), or extremes in brush density are basic factors that must be considered when determining clearing and maintenance costs. These factors, in addition to State laws or public relations considerations (pertaining to specific management techniques), impose constraints that vary widely between locales.

Specific cost information on capital clearing practices and maintenance methods for all regions of the continental United States was obtained from ROW managers responsible for performing such work. This discussion attempts to provide greater insight into the actual averages and ranges of cost per acre of selective and nonselective capital clearing practices and maintenance methods.

The capital clearing costs discussed represent practices or combinations of practices used to perform an entire ROW clearing operation and include all of the categories described earlier: mechanical/manual clearing, chemical, slash disposal, and restoration.

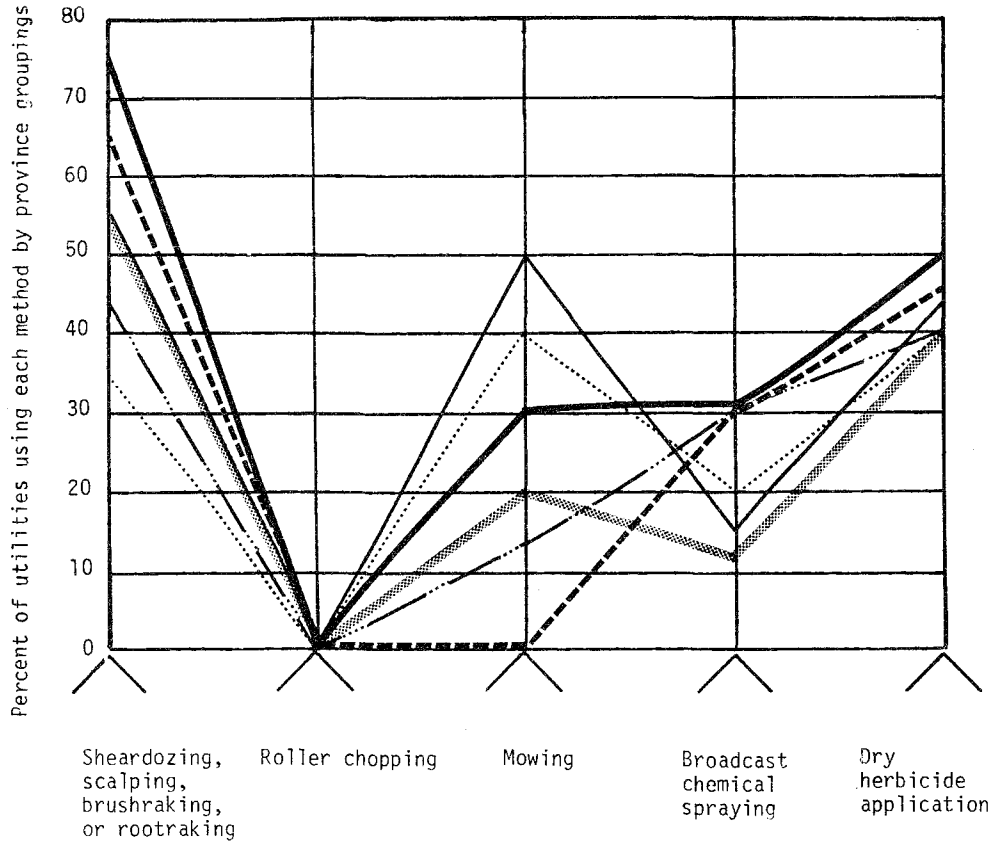


Figure 16.6 Nonselective vegetation management methods used in clearing and maintenance by utilities in the Western United States.

Maintenance costs are based on an average of all the maintenance methods combined: mechanical/manual clearing methods (bulldozing, roller chopping, topping/side cutting, etc.), chemical methods (stump spraying, selective foliage, etc.), slash disposal (burning, chipping, etc.), and restoration (seeding and fertilizing). Cost ranges represent the low and high extremes known to exist.

Capital Clearing — Continental United States

Overall, capital clearing costs range from $53 to $3000 per acre (table 16.1), with an average cost of $956. Selective capital clearing costs average $1000 per acre; nonselective costs average slightly less, $912 per acre. Overall, capital clearing practices performed in the Eastern United States average about $460 less per acre than practices performed in the Western United States ($726, Eastern; $1186, Western). Selective and nonselective practices average $256 and $663 per acre less, respectively.

Maintenance — Continental United States

Maintenance costs range from $17 to $1100 per acre, with an average cost of $181 per acre (table 16.1). Selective maintenance costs average $210 per acre; nonselective costs average much less, $152 per acre. Overall, maintenance methods in the East average $72 more per acre than in western vegetation provinces ($217, East; $145, West). Selective and nonselective methods average $68 and $77

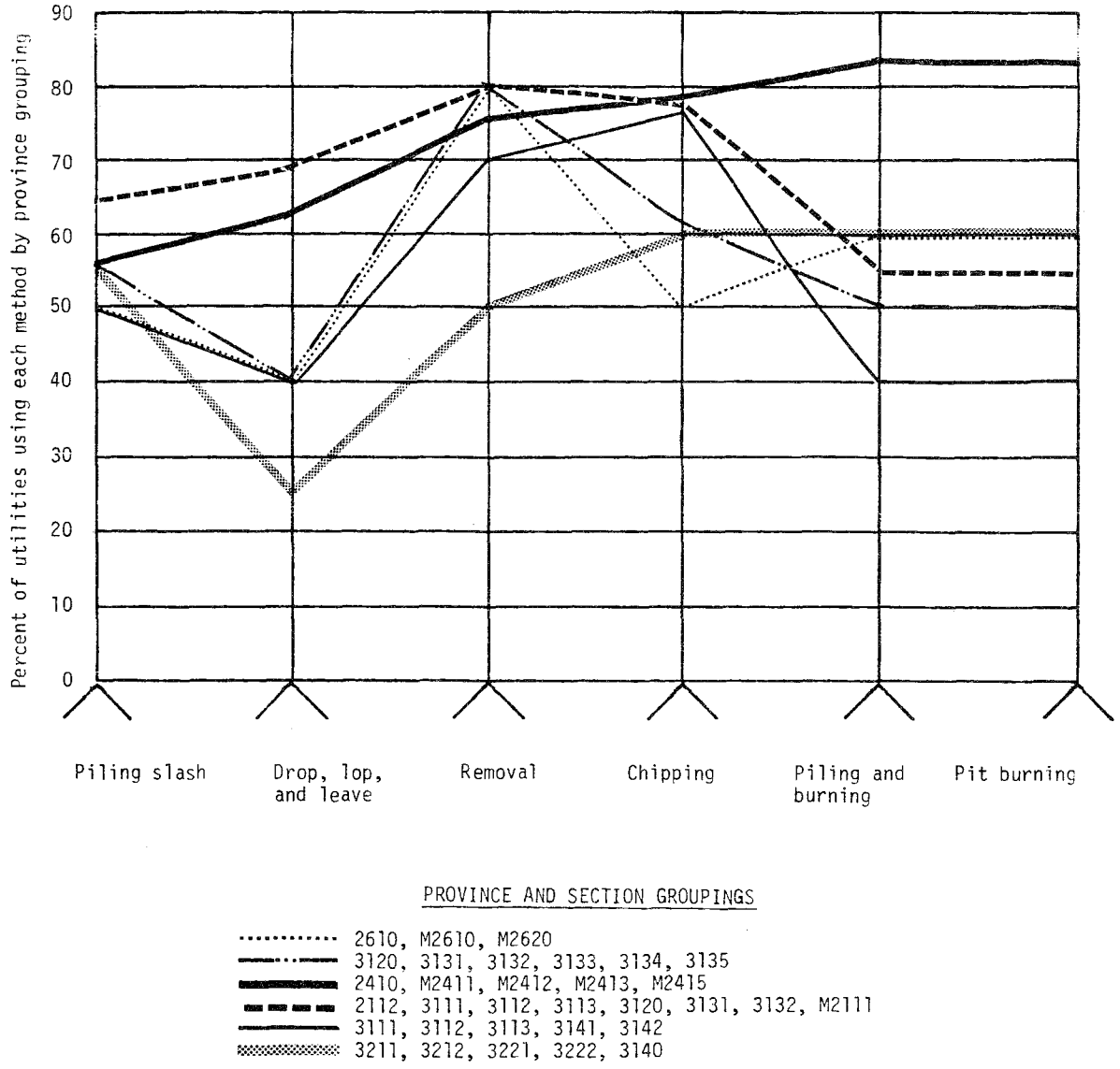


Figure 16.7 Slash disposal methods used in clearing and maintenance by utilities in the Western United States.

per acre more, respectively. The overall maintenance cycle in the Eastern United States averages 3.88 years. Maintenance cycles for the Western United States are so variable that a comparison would be meaningless.

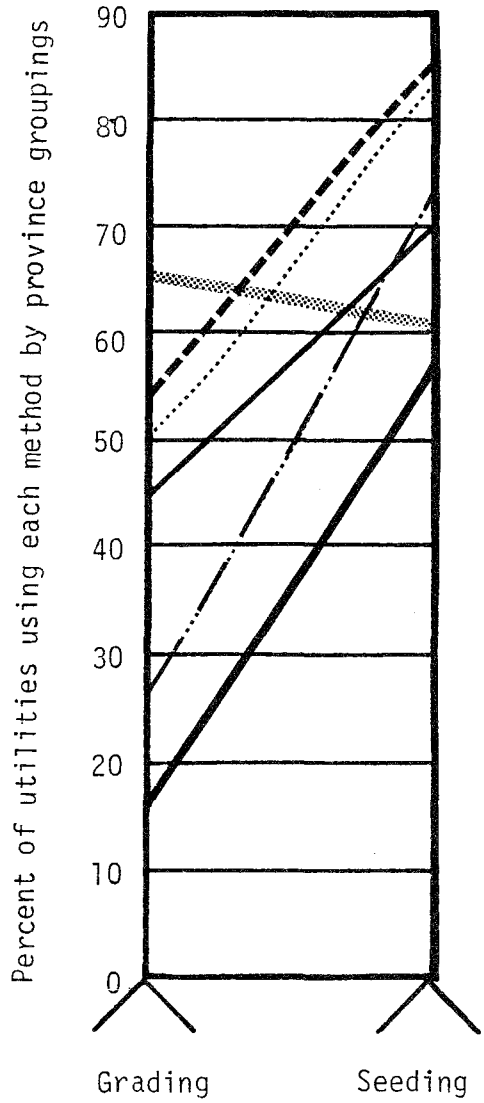
Selective Vegetation Maintenance Methods

Eastern United States — The cost for selective capital clearing practices averages $872 per acre (table 16.1). Selective maintenance methods average $244 with an average cycle of more than 3.9 years. The average cycle from low to high for selective maintenance ranges from 3.4 years (Provinces 2310, 2320, 4110) to 4.2 years (Province 2110).

Western United States — The cost for selective capital clearing practices averages $1128 per acre (table 16.1). Selective maintenance methods average $176 per acre; intervals between maintenance are highly variable.

Nonselective Vegetation Maintenance Methods

Eastern United States — For the Eastern United States the cost for nonselective capital clearing practices averages $580 per acre (table 16.1). Nonselective maintenance methods average $190 per acre; an average cycle is about 3.8 years. The average cycle from low to high for nonselective maintenance methods ranges from 2.9 years (Provinces 2310, 2320, 4110) to 4.9 years (Province 2210).



Data not available for planting and relocation of vegetation.

PROVINCE AND SECTION GROUPINGS

.....	2610, M2610, M2620
—·—·—	3120, 3131, 3132, 3133, 3134, 3135
▬▬▬	2410, M2411, M2412, M2413, M2415
- - - -	2112, 3111, 3112, 3113, 3120, 3131, 3132, M2111
———	3111, 3112, 3113, 3141, 3142
▒▒▒	3211, 3212, 3221, 3222, 3140

Figure 16.8 Restoration methods used in clearing and maintenance by utilities in the Western United States.

Western United States — The cost for nonselective capital clearing practices averages $1243 per acre (table 16.1). Nonselective maintenance methods average $113; intervals between maintenance are highly variable.

Cost Comparison among Methods

Because of the degree of variability involved (described earlier), specific site bidding is required to derive actual costs. Based on current actual costs, however, a relative cost comparison between methods can be made. The following list ranks the relative cost of clearing and maintenance methods on a per acre basis for selective, nonselective, slash disposal, and restoration groupings.

Selective Vegetation Maintenance Methods

Lower Cost
1 Chain saw cutting
2 Trimming
3 Cut and stump spraying
4 Girdling
5 Frilling
Higher Cost
6 Tree injectors and hypo-hatchet

Lower Cost
1 Stem/foliage waterborne
2 Basal spraying
3 Dormant stem spraying
Higher Cost
4 Growth inhibitors

Nonselective Vegetation Maintenance Methods

Lower Cost
1 Broadcast chemical spraying
2 Dry herbicide applications
3 Soil-sterilants
4 Mowing
5 Broadcast prescribed burning
6 Disking and plowing
7 Roller chopping
8 Brushraking
Higher Cost
9 Pushing or grubbing
10 Sheardozing/scalping/brushraking

Slash Disposal

Lower Cost
1 Drop, lop, and leave
2 Slash piling
3 Piling and burning
4 Pit burning
Higher Cost
5 Chipping
6 Removal

Restoration

Lower Cost
1 Grading
2 Seeding
Higher Cost
3 Planting
4 Relocation of vegetation

The relative comparison of costs presented above applies to all areas within the United States in which the particular methods are performed. As a general rule, chain saw cutting; drop, lop, and leave; grading; and/or seeding methods provide the lowest cost per acre for selective clearing, slash disposal, and restoration. Similar pricing constraints for methods currently used and summarized earlier may be characterized as low, average, average to high, or high, when individual states or groups of states are compared (table 16.2, figure 16.9)

The following States or groups of States in the East have the lowest costs of clearing and maintenance on a per acre basis when compared with all other states within the continental United States:

1 West Virginia, Virginia, Kentucky, North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Texas, Oklahoma.

Groups of States with average comparative costs include:

1 Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut;
2 Michigan, Ohio, Pennsylvania, Maryland, Delaware, New Jersey.

Groups of States generally having average to high comparative costs include:

1 Minnesota, Wisconsin, Illinois, Indiana.

States or groups of States with high costs, compared to the rest of the United States, include:

1 New York;
2 North Dakota, South Dakota, Nebraska, Kansas, Missouri, Iowa;
3 Washington, Oregon, Idaho, Montana, Wyoming, Utah, Colorado; and
4 California, Nevada, Arizona, New Mexico.

The comparative costs associated with the state groupings listed above point out the differences in pricing on a regional basis. Significant local variability and differences exist from utility to utility due to management, labor, standards and specifications, and legislative restrictions, as well as public sensitivity to various prac-

Table 16.1 Comparison of Selective and Nonselective Capital Clearing and Maintenance Costs and Cycles for the Eastern and Western United States

Practice/method[b]	Eastern U.S. Mean cost	Western U.S. Mean cost	Continental U.S. Mean	Continental U.S. Range/Low-High
Capital Clearing Practice				
Selective	$872	$1,128	$1,000	
Nonselective	580	1,243	912	
All capital clearing	726	1,186	956	$53-$3,000
Maintenance Methods[c]				
Selective	244	176	210	
Nonselective	190	113	152	
All maintenance	217	145	181	$17-$1,100

[a] Information obtained from Asplundh Tree Expert Co., 1977.

[b] Practices--combinations of methods used to perform an entire ROW clearing operation, including categories of mechanical/manual clearing, chemical, slash disposal, and restoration.

[c] Cost of maintenance operations are shown by the average of mechanical/manual clearing methods (i.e., bulldozing, roller chopping, topping/side cutting, etc.), chemical methods (i.e. stump spraying, selective foliage, etc.), slash disposal (i.e., burning, chipping, etc.), and restoration (i.e., seeding and fertilizing).

Table 16.2 Relative Costs of Capital Clearing and Maintenance Methods Used by Utilities for the Continental United States.

Method	Range of costs per acre[b] by state areas[c]							
	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8
Selective vegetation management methods:								
1. Chain saw cutting								
2. Trimming								
3. Girdling	ND							
4. Frilling	ND							
5. Tree injectors and hypo-hatchet	ND							
6. Cut and stump spray								
7. Basal spraying								
8. Stem/foliage waterborne								
9. Dormant stem spray								
10. Growth inhibitors								
Nonselective vegetation management methods:								
11. Sheardozing, scalping, and brushraking or rootraking	ND	ND						
12. Pushing or grubbing	ND	ND						
13. Brushraking or rootraking						LU	LU	LU
14. Roller chopping	ND	ND						
15. Disking and plowing	ND	ND						
16. Mowing	ND	LU						
17. Broadcast chemical spraying								
18. Dry herbicide applications								
19. Soil-sterilants								
20. Broadcast prescribed burning	ER							
Slash disposal: (Mechanical/Manual)								
21. Piling slash								
22. Drop, lop, and leave								
23. Removal								
24. Chipping								
25. Piling and burning								
26. Pit burning								
Restoration:								
27. Grading								
28. Seeding								
29. Planting								
30. Relocation of vegetation								

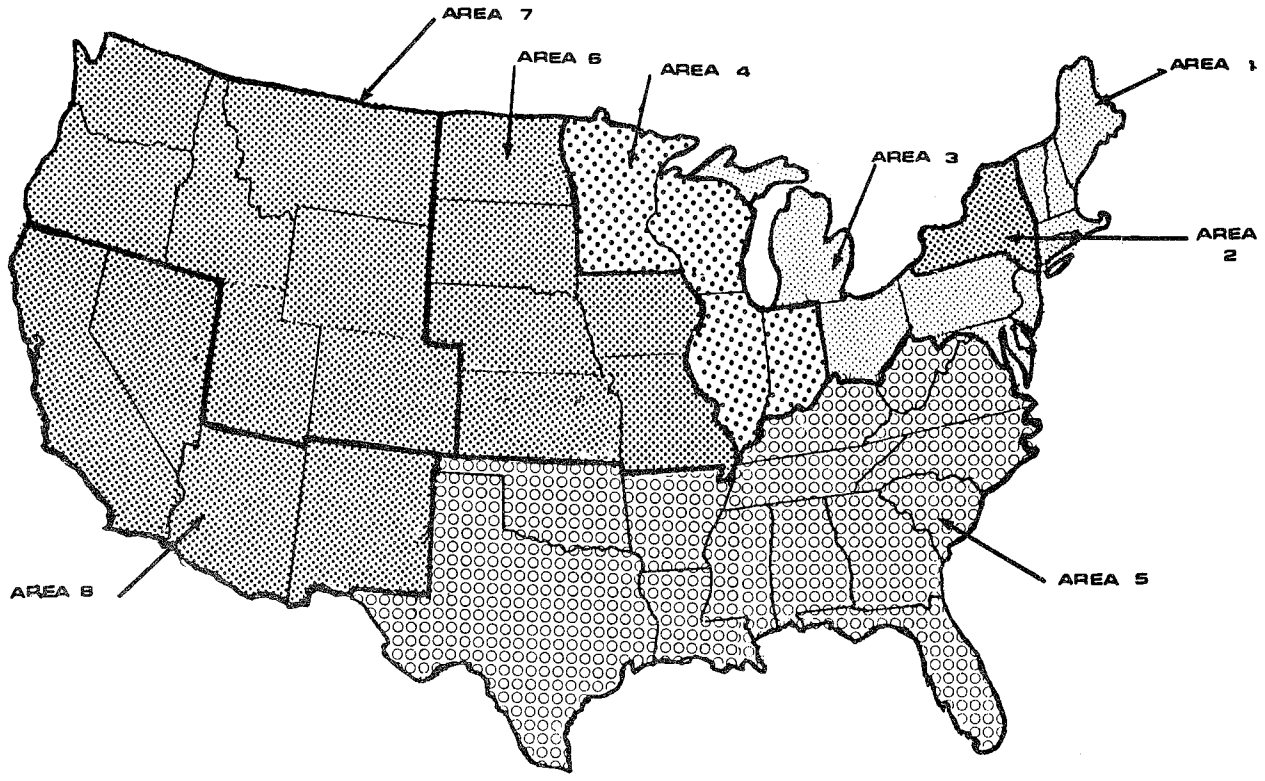
[a]Information obtained from Asplundh Tree Expert Co. 1977-1978.

[b]Symbols used for range of costs per acre are:

- L - Low
- A - Average
- A-H - Average to high
- H - High
- ND - Not done
- ER - Environmental restrictions
- LU - Limited use

[c]Similar state areas for documenting costs of methods are grouped as follows:

1 - ME, VT, NH, MA, RI, CT
2 - NY
3 - MI, OH, PA, MD, DE, NJ
4 - MN, WI, IL, IN
5 - WV, VA, KY, NC, SC, GA, FL, TN, AL, MS, LA, AR, TX, OK
6 - ND, SD, NE, KS, MO, IA
7 - WA, OR, ID, MT, WY, UT, CO
8 - CA, NV, AZ, NM



[a]Information obtained from Asplundh Tree Expert Co. 1977-1978.

Similar state areas for documenting costs of methods are grouped as follows:
1) Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut
2) New York
3) Michigan, Ohio, Pennsylvania, Maryland, Delaware, New Jersey
4) Minnesota, Wisconsin, Illinois, Indiana
5) West Virginia, Virginia, Kentucky, North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Texas, Oklahoma
6) North Dakota, South Dakota, Nebraska, Kansas, Missouri, Iowa
7) Washington, Oregon, Idaho, Montana, Wyoming, Utah, Colorado
8) California, Nevada, Arizona, New Mexico

Figure 16.9 General comparisons of relative costs for clearing and maintenance methods by State groupings

tices. The maintenance cycle or time interval between use of maintenance methods also varies, especially in the Western United States, and between utilities. For example, mowing may be done every year, but selective trimming as a maintenance method may be needed only once every 5, 10, or more years, depending upon specific site conditions.

Thus, the cost-effectiveness of maintenance approaches depends on specific site conditions (terrain, vegetation type and density, land use, etc.), required standards and specifications, and the expected life of the electric transmission facility.

REFERENCES

Asplundh Environmental Services. 1978. Economic and environmental aspects of contemporaneous electric transmission right-of-way management techniques. Empire State Electric Energy Research Corp. 3 vols.

5

Right-of-Way Resource Assessment

Habitat inventory and analysis is necessary for effective fish and wildlife management on any site. The purpose of this chapter is to help biologists and ROW managers evaluate the habitat on a specific site, so that an appropriate management strategy, one that incorporates the information included in chapter 1 of volumes 2 and 3, "Plant Responses to Management Techniques," can be devised. Emphasis is on factors applicable to a majority of ROWs in the United States; no emphasis is placed on special, local situations. The suggested methodology is based on an assumed need for rapid and inexpensive collection, synthesis, and evaluation of ecological data most relevant to wildlife management decisions. Where detailed analyses are needed for research or other purposes, additional literature sources should be consulted (Graham 1945; Lagler 1952; Leopold et al. 1971; Nihman et al. 1973; Gysel and Lyon 1977).

Because of the potential hazard to transmission reliability and the direct influence on management costs, height and density of tall-growing plants are the primary concerns of the ROW manager. Woody species that normally would not grow tall enough to interfere with conductors have also become a concern of ROW managers in recent years. These species add to the aesthetics of the ROW and compete with tall-growing plants for light, moisture, and root and crown space, thus reducing the invasion and growth rates of tall-growing species and decreasing maintenance costs.

17 SUMMARY OF DATA REQUIREMENTS

Data requirements for assessing resources and conditions on ROWs and adjacent lands are summarized in appendix 5-a. This data sheet may be used in the field, supplemented by maps and written descriptions. The ideal ROW resource evaluation data collection system must include all of those factors needed by the ROW manager and those habitat factors required to develop an adequate wildlife management strategy. Methods for gathering data and evaluating conditions are discussed in the rest of this chapter.

Sensitive areas, such as certain soils, wetlands, or habitats of rare and endangered species, may require more detailed analysis. Some of this additional information about sites may be available through other agencies (e.g., U.S. Fish and Wildlife Service, Soil Conservation Service, U.S. Forest Service, State agencies, or university extension services).

18 EVALUATION GUIDELINES

SURFACE GEOLOGY AND TOPOGRAPHY

The response of vegetation to management depends on overall site conditions. Rock formations, glacial deposits, and numerous other geological features affect composition and structure of vegetation (Gysel and Lyon 1977). Slope gradient, length, shape, and aspect help determine vegetation, water economy, microclimate (e.g., potential for frost damage), and erosion potential. Surface geology and topography also affect vegetation maintenance practices. Site conditions often limit use of heavy equipment. For example, steep slopes make bulldozing impractical.

Knowledge of the surface geology, topography, soils, and drainage is necessary to predict vegetation succession and habitat quality. Site preferences of various plant species are listed in chapter 2 of volumes 2 and 3.

CLIMATE

Information on climate conditions is available from local weather stations and is important for determining vegetation, fire risk, and erosion potential.

SOILS

Soil structure, moisture, fertility, and acidity also help determine the composition of plant communities. Soil fertility influences plant nutritive values and yields, which are important for wildlife (Denney 1944). Acidity (measured in pH units) is closely associated with productivity. Acidic soils and waters are frequently deficient in nutrients (Odum 1971). Sensitivity to disruptions and slow recovery characterize peat bogs, spruce swamps, and other acidic environments.

Data and maps from the USGS and published soil surveys of the U.S. Soil Conservation Service (SCS) are valuable in assessing overall site conditions. These data and interpretations may be supplemented if necessary by analyses of core samples from the ROW.

The soil erosion potential on a ROW can often be estimated by using published soil surveys or data sheets from the SCS. Erodibility values for soil types and erosion potentials, based on both erodibility and slope, are usually available for each soil series. In general, slopes of 0 to 6 percent have low erosion hazard; slopes of 7 to 18 percent have moderate erosion hazard; slopes of 19 percent and over have high erosion hazard (Barnard-Jackson-Raeder, Inc. 1975).

Delineation of soil types by the SCS, however, is based primarily on air photo interpretation and is often not reliable for use on narrow ROWs. Assistance in obtaining erodibility ratings based on core samples can often be obtained from local SCS offices. Where soil erosion hazard is high and detailed measurements of erosion potential are desired, the Universal Soil Erosion Equation (appendix 5-b) can be used.

WATER TABLE AND DRAINAGE ALTERATIONS

Drainage alterations may drastically influence the growth and survival of many plant species (Gysel 1975; Davis 1975). Raising the water table or restricting the movement of groundwater may saturate the rooting zone. Roots suffering from an oxygen deficiency are ineffective in assimilating nutrients and water (Boelter and Close 1974). Growth rates are significantly reduced and, in some cases, all trees in a stand die (Nelson 1951; Heninger 1974; Jeglum 1975).

Wetland drainage patterns are complex and easily disrupted. Compaction and/or subsidence of soils during construction or maintenance of ROWs can alter water table levels and drainage patterns. The subsequent dieback of sensitive species may extend one-half mile from the ROW and persist for over 30 years (Boelter and Close 1974; Jeglum 1975). Ponding, drowning, desiccation, dieback, and species changes may result from alteration of drainage patterns. Communities most susceptible to these problems are those with high water tables and poorly drained shallow soils (Heninger 1974; Crabtree et al. 1978).

ROW CHARACTERISTICS

Physical and engineering characteristics and maintenance records of the ROW are available from the utilities. This information may help determine what vegetation can be expected and/or allowed on or near the ROW.

FIRE POTENTIAL

Adjacent land use is an important evaluation not only for ROW management purposes, but for risks and liabilities to the utility when fire is possible. Where the potential for fire and subsequent damage to valuable resources is high, consideration should be given to management plans that enhance the value of the ROW as a fire break. Table 18.1 lists some criteria for making rough estimates of fire potential of lands adjacent to ROWs.

Fire risk can be estimated by analyzing the fire history of an area and by considering the frequency and nature of lightning and human activities (Deeming et al. 1972). Areas of high fire risk are often characterized by frequent cloud-to-ground lightning and human activities in-

Table 18.1 Some Criteria for Estimating Fire Potential on Lands Adjacent to ROWs

FACTOR	FIRE POTENTIAL LOW ← → HIGH		
Soil Organic content	Low		High (peat, muck)
Average slope (%)	0-20	21-40	40
Lightning	Thunderstorms infrequent	Thunderstorms common, but cloud-to-gound lightning seldom observed	Thunderstorms and cloud-to-ground lightning frequent
Man-caused risk	No high risk activities during critical seasons	Some high risk activities during critical seasons	Much high risk activities during critical seasons
Distance to nearest other firebreak (miles)	0.25	0.25-1.00	1.00
Fuel class	A	B	C D
Water table during critical seasons (feet below ground surface)	0	0-1	1
Length of critical fire season (months)	2, once/year	2-4, and/or more than once/year	4

volving campfires, burning of debris, and operation of various machines.

The physiography of an area also affects its fire potential. The spreading speed of fire varies directly with slope, aspect, and elevation. Areas with organic soils (e.g., peat bogs, "muck farms") are much more susceptible to fire than those underlain by mineral soils (Deeming et al. 1972).

By far the most important criteria for determining fire potential, however, are the quantity, distribution, and kind of fuel. Flammability varies with moisture content and size of fuels; dry, woody fuels 1 to 2 inches in diameter are one of the greatest fire hazards. For rough estimates of fire potential, fuels can be grouped into four general classes. These classes are ranked in table 18.1 according to their contribution to fire hazard and are briefly described below.

Class A — Short grasses with little woody fuel; shrubby covers with little dead material and in which living foliage does not burn readily (e.g., laurel, salal, vine maple, alder, mountain-mahogany); hardwoods where leaf litter compresses readily (e.g., maple — aspen communities); most croplands; low vertical or horizontal continuity of fuel; sparse cover.

Class B — Tall grasses with little woody fuel; hardwoods where the leaf litter does not compress readily (e.g., oak — hickory communities); fuel loading not continuous; low density.

Class C — Dense brush with substantial dead woody material and where living foliage burns readily (e.g., chaparral brushlands, low pocosins, sagebrush, inkberry); partially thinned conifer or hardwood stands with moderate amounts of slash; either horizontal or vertical continuity of fuel.

Class D — Clear-cut pine plantations or dense conifer stands with heavy buildup of downed tree material; deep litter with very high loading of dead woody material larger than 1 inch in diameter. Examples are mosses, lichens, peat soils, coastal Douglas-fir, and clear-cut ponderosa and other pines; fuel continuously vertical and horizontal.

General fire potential (based on climate) of lands in different areas of the United States can be obtained from State and Federal forest agencies. Critical fire seasons as determined by the National Fire Danger Rating System (Deeming et al. 1972) are also available.

Other climatic considerations influencing fire potential include: air turbulence, wind direction and velocity, temperature, relative humidity, atmospheric stability, amount and duration of rainfall, and lightning characteristics. Estimations of local "average bad" conditions should be obtained from local weather or fire stations.

VEGETATION

Vegetation within about one-half mile of the ROW should be classified according to cover type (e.g., dominant vegetation types and size classes). Boundaries of cover types should be delineated on an aerial photograph or other suitable base map to aid biologists or ROW managers in determining how a ROW can best contribute to area habitat diversity and wildlife food and cover. In many areas, basic cover type mapping can be done entirely by air photo interpretation; in others, some on-ground observations along selected transects are sary. Cover maps for Federal or State lands are often available from wildlife and forestry agencies.

Sensitivity Conditions

Criteria for evaluating sensitivity to disruptions of plant communities are listed in table 18.2. Conditions associated with sensitive communities include soil compaction, subsidence and erosion; alteration in drainage patterns (causing ponding and vegetation changes) and water table; sunscald; windthrow; and dieback. The latter three conditions are discussed below.

Sunscald — Opening a forest for a ROW causes immediate environmental changes. Many plant species grow and reproduce vigorously after exposure to complete sunlight. More sensitive species, however, may show stress, poor growth, and dieback (Davis 1975). Discoloration of leaves is the first sign of internal stress. Evidence of sunscald has been reported for beech, hemlock, white cedar, black spruce, red maple, and paper and yellow birch (Nelson 1951; Asplundh Environmental Services 1978; Crabtree et al. 1978). Sunscald severity varies with the width and orientation of the corridor, vegetative community, species, and average height and density of the stand (Downey 1976; Asplundh Environmental Services 1978; Michigan Public Service Commission in press).

Windthrow — Soil characteristics, such as a high water table or a cemented subsoil layer, affect the development of tree roots and determine the resistance of trees to wind (Nelson 1951; Mettert 1972). Openings in an otherwise continuous canopy may allow winds to fell numerous trees. Windthrow is most common in shallow, organic soils and may greatly increase the area affected by a ROW. Windthrow is less severe in narrower corridors and in those parallel to prevailing winds (Downey 1976; Crabtree et al. 1978).

Table 18.2 Some Criteria for Evaluating the Sensitivity of Vegetation Adjacent to ROWs

FACTOR	SENSITIVITY: LOW ← → HIGH				
A. Overall site characteristics					
1. Water table					
a. Depth (feet)	5	5-3	3-1	1-.3	.3-0
b. Seasonal variation	Never flooded		temporary flooding		seasonal flooding
2. Soil characteristics					
a. Soil formation	Other		peat		muck
b. Soil depth (feet)	6		6-3		3-1
c. Water erodibility (K value)	-0.23		0.24-0.36		0.37 +
d. Subsoil layer (if any)	10'/sand		clay (poorly drained)		rock, cemented
e. Soil fertility	High				Low
3. Topography					
a. Slope (%)	0-6		7-18		19 +
b. Elevation (feet)	0-5000		5000-7000		7000-9000
4. Drainage patterns					
a. Ponding in ROW/edge	no evidence		wet season only		severe ponding
b. Soil drainage characteristics	well-drained		fair		poor
5. ROW					
a. Orientation	Parallel to prevailing winds				Perpendicular to prevailing winds
B. Vegetative characteristics					
1. Community type	grassland	old field	shrubland	forest	wetlands, dunes, tundra
a. Wetland	shrub swamp		hardwood swamp		conifer swamp, marsh, bog
b. Age	young				old
c. Rooting characteristics	deep				shallow on surface
d. Proximity to regional ecotone	far		near		within ecotone
e. Sunscald (%)	-10	10-25	25-40	40-60	60 +
f. Dieback (%)	-10	10-25	25-40	40-60	60 +
g. Windthrow (%)	-10	10-25	25-40	40-60	60 +
2. Endangered or threatened fauna or flora	Known not exist	Probably not to exist	Possibly not to exist	Probably exist	Known to exist

Dieback — Two forms of dieback may occur on the edge of a ROW. Trees that have had limbs removed or are damaged by other activities may exhibit dieback of the terminal limbs or from cut areas. This type of dieback ranges in severity from affecting only one or two limbs to eventually killing the entire tree. It may also allow heart rot to develop in the tree.

Trees may also die back from the ROW edge due to a combination of exposure, changes in soil moisture, and sunscald, which slowly weaken and kill trees. This type of dieback is usually evidenced from successive stumps, which indicate gradual decline and death of successive trees.

Sensitive Communities

Large, continuous, sensitive communities are scarce in much of the Eastern United States (Forman et al. 1976). The number of species in a habitat is influenced by the size of the habitat (Galli et al. 1976; Forman et al. 1976). A habitat can be reduced so that it is too small to support some wildlife (Lancia 1974; Terborgh 1974). For example, sensitive conifer swamps are critical winter habitat for white-tailed deer in the northern Lake States (Verme 1965; Krefting and Phillips 1970). Utility ROWs cutting across these swamps can result in reduction or loss of deer yards by windthrow and dieback (Maine Department of Inland Fisheries and Game 1975; Crabtree et al. 1978).

Communities that are naturally sparsely vegetated and require considerable time for revegetation may also be classified as sensitive. Tundra communities and sand dune communities are slow-growing and extremely vulnerable to disruptions.

Old communities are more scarce than young ones, but are less vulnerable to serious disruption through fire and erosion (Mobley et al. 1965). Species associated with climax communities tend to be more susceptible to changes (Odum 1971; Lancia 1974).

Shallow-rooted species (e.g., beech, hemlock, sugar maple, red maple) are sensitive to compaction, which restricts root growth, and loss of litter, which gradually exposes the upper root surface (Heninger 1974). Death and loss of vigor have been attributed to the destruction of surface roots, soil compaction, and smothering (Asplundh Environmental Services 1978). Increased solar radiation on ROWs increases soil temperature and may affect root hardiness and hydrologic and nutrient cycles (Lancia 1974; Asplundh Environmental Services 1978). The severity of the consequences of root exposure depends on species, soil type, ground cover, and aspect.

A community within or close to a regional ecotone is often more sensitive than the same community in the heart of its range. For example, a northern coniferous forest may be converted to a hardwood community if disturbed at the southern limit of its range (Heninger 1974; Crabtree et al. 1978).

Right-of-Way Data Collection

Reconnaissance-type techniques described by Kuchler (1967), Gysel and Lyon (1977), and others generally apply to vegetation analysis on ROWs. However, modifications are necessary to meet the special needs of ROW managers.

In most habitat analyses the plant community is the ecological basis for making observations and organizing data (Gysel and Lyon 1977). Recognition of plant communities is usually based on gross differences in dominant species, size classes, density, or distribution. Delineation and mapping of communities should be an integral part of vegetation analysis on ROWs.

The clearance requirements of ROWs, however, lend support to use of nonecological "management zones" for mapping and organization of data. ROWs can be divided into three general management zones: the strip under the conductors, and the strip or zone on either side of this strip. Very wide or vegetationally diverse ROWs may be divided into four or more zones. Overlaying community maps and management zone maps may be useful in making management decisions.

Both communities and management zones may be described in terms of species composition, size classes, density, sociability (distribution), and diversity. Strip transects distributed for maximizing sampling across management zones should be used (for a thorough discussion of sampling methods see Gysel and Lyon 1977). "Formulas" are useful for describing overall structure of communities or management zones (Graham 1945; Gysel and Lyon 1977). Such formulas describe vegetation by strata (table 18.3).

Communities usually consist of from one to three strata: a ground layer of herbaceous plants and low shrubs, an understory of shrubs and young trees, and an overstory of older trees. These formulas may be modified to describe wetland habitats (table 18.4).

The formulas should be supplemented by written descriptions and/or tables describing in more detail species composition, abundance, sociability, diversity, and other components of the community or management zone.

The number of individuals per unit area provides important information about habitat structure and amounts of food and cover. Abundance classes (Gysel and Lyon 1977) for species or groups are: 1) rare, 2) occasional, 3) frequent, 4) abundant, 5) very abundant.

Sociability of plants is an important consideration in ROW management, particularly where selective techniques are practical. A qualitative rating scheme (Braun-Blanquet 1965) for distribution or sociability of individuals of a species in a community, or of a management zone, is: 1) solitary, 2) clumps or dense groups, 3) small patches or cushions, 4) small colonies or large carpets, 5) large, almost pure stands.

Diversity within a community or management zone depends on species composition, sociability, and structure. Mathematical diversity indexes yield useful information but require intensive sampling. A subjective estimate of each community or management zone in a ROW, although crude, can aid managers in management decisions.

Brush piles are often overlooked in vegetation analyses. Because of their importance to a number of wildlife

Table 18.3 Example of a Simplified Formula and Key for Vegetation by Strata

Community		Density	dbh	Height	B.A.
B	Red maple--red oak	III	10-15	30-45	60
	Red maple (black cherry)	II	.5-3	.5-2	
	Grasses--forbs	I		0-1	

a) Community - Letters may be used to indicated major community designations.

b) Plant species - Species forming a dominant part of the stratum are noted. Within a stratum, species are listed in order of relative abundance. Parentheses indicate a species of limited distribution in the community.

c) Density - The total area covered by the aerial parts of the plant is expressed as a percentage of total ground coverage.

I - Open tree and shrub cover; sparse forb and grass cover 0-40 percent
II - Partially closed crown or stem cover 40-80 percent
III - Fully closed crown or stem cover 80-100 percent

d) Diameter at breast height (dbh) - A range of diameters in inches at breast height (4.5 feet).

e) Height - The range is given in feet for each stratum.

f) Basal Area (B.A.) - The cross-sectional area of trees (measured at breast height) per acre in square feet is an index of cover and density.

g) Strata divisions - Strata are separated by horizontal lines. Overstory, understory, and ground layers are designated on the upper middle, and lower formula lines, respectively.

species, brush piles on or adjacent to ROWs should be inventoried. In assessing the importance of brush piles on a particular ROW, location, number, size, shape, and structure should be considered. These variables as related to wildlife are discussed in volume 1, chapter 6 (see especially section 21).

Some snags on managed forest lands are beneficial to wildlife, especially to woodpeckers, raptors, and other birds (Gale 1973). The most valuable snags on ROWs should be identified and mapped. Important factors for evaluating snags include hardness, height, diameter, and bark and limb condition. Wildlife preferences vary by species; table 18.5 lists general characteristics of snags that appear to be most valuable to wildlife.

Because preventing contact between vegetation and transmission lines is the essence of ROW management,

Table 18.4 Example of a Simplified Formula and Key for Wetland Habitats

Community	Species	Density	Height above water (ft)
F	Buttonbush--cat-tail	I	3-5
	Arrow arum--arrowhead	III	1-2
	Coontail--bladderwort--milfoil	II	Submergents

Numbers or symbols can be developed to fit specific needs of any investigator (Gysel and Lyon 1977)

Diameters and heights may be measured with a Biltmore stick and basal area with an angle gauge. Other parameters can be estimated.

Table 18.5 Some Characteristics of Snags Valuable to Wildlife

Component	Characteristic
Hardness	Soft, rotten
Height (ft)	20
Diameter at breast height (in)	15
Bark	Absent
Limbs	Absent or reduced to stubs

Source: Summarized from Gale 1973.

danger trees should be identified and mapped. Consideration of the factors listed below will help in the choice of control method: 1) directional lean, 2) conformation, 3) species, 4) age and vigor, 5) terrain, 6) soil type, 7) immediate hazard. Control of danger trees is discussed in detail in volume 1, chapters 4 and 6.

Abundance and diversity of wildlife species are closely related to the condition of vegetation. Condition of vegetation is influenced by site quality, management, and wildlife use (e.g., browsing pressure). Many plants suffer drastic loss of vigor when browsed heavily or when growing on marginal sites. Where ROW vegetation is in poor condition, techniques to improve the site (e.g., fertilization, prescribed burning) should be considered. Analysis of vigor should be based on new growth, size and condition of leaves and buds, and quantity and quality of fruits and seeds. Methods for counting fruits and seeds are available (Gysel 1956; Gysel and Lyon 1977), but are less practical than subjective estimates for ROW analyses.

A recent ROW management study showed that crown position is a useful index of vigor in hemlock (Asplundh Environmental Services 1978). Hemlocks with deep, full crowns that received both top light and side light were better able to withstand topping than were less vigorous trees. Crown dominance position may be a useful index of vigor of other species as well.

WILDLIFE POPULATIONS

Knowledge of existing wildlife populations should influence management decisions on ROWs. The observations of tracks and scat and a rough bird census should be an integral part of premanagement habitat evaluation.

Techniques for estimating populations and habitat values of many species are well-documented (U.S. Fish and Wildlife Service 1976; Flood et al. 1977). A discussion of criteria for species-by-species analysis is beyond the scope of this manual; however, habitat requirements of "selected species" are listed in volumes 2 and 3, chapter 3. Information about populations of endangered or threatened species is often available from State and Federal wildlife agencies.

Because of their potentially adverse effects on revegetation after habitat treatments, special attention should be given to populations of browsers. Criteria for evaluating the severity of browsing effects on revegetation are listed in table 18.6. The intensity and effect of browsing on revegetation is difficult to predict, but estimates can be made based on: 1) arrangement of cover types near a ROW; 2) density and type of vegetation in the ROW; 3) density of animals (browsers); 4) ROW width.

In the North, where deep snow prevents deer from moving far from evergreen shelters, a lack of nearby cover for deer can minimize winter browsing on ROWs. Similarly, a lack of suitable cover adjacent to ROWs can prevent overbrowsing by rabbits and other small mammals.

Many browsing species are "edge" species that prefer a variety of cover types within their home range. The interspersion of openings and brush on adjacent lands influences the degree of using ROW openings.

Density of vegetation also helps determine the browsing effect, since the diameter to which stems are browsed is directly related to the number of animals feeding and inversely related to the abundance of food (stems). Effects of browsing on species composition depend on the palatability and tolerance to browsing of the woody species in the ROW. According to Graham et al. (1963): "The effects on woody plants . . . seem relatively dependable and show clearly that an excessive number of deer exert a profound effect on the composition of low-growing plants, eliminating some and permitting the unpalatable ones to occupy greater areas."

The criteria in table 18.6 involve observation of browsing marks on vegetation both on and off the ROW and identification and mapping of important cover for browsers.

STREAM CHARACTERISTICS

Habitat analysis to determine the sensitivity of the stream to exposure to sunlight and the erodibility of the banks is essential to selecting an appropriate management strategy for ROW stream crossings. Other factors, such as sensitivity and important wildlife frequenting the streambank, should also be considered.

Criteria for evaluating ROW stream crossings are summarized in tables 18.7 and 18.8. These criteria and other methods for determining potential effects of ROWs on stream communities are discussed below.

The best way to estimate potential temperature changes at ROW crossings is to make actual in stream measurements of temperature above and below openings of similar width during critical seasons. The critical seasons for stream communities are when hot weather and low flows occur. The critical seasons vary in different areas of the country but can be determined by examining discharge and air temperature data for a specific area.

Great difficulties are encountered in obtaining measurements under "worst-case" conditions, and many areas traversed by both streams and ROWs have no suitable openings for comparison. Where such measurements and comparisons are not practical, subjective estimates can be made by persons experienced in aquatic ecology. Consideration of the criteria in table 18.8 should help such estimates.

Those streams most sensitive to exposure are generally shallow and wide (with a large surface area exposed to sun), with small sidecharges, little groundwater inflow, and resident populations of coldwater fishes. Accurate measurements of discharge, groundwater inflow, and fish populations are difficult and time consuming; however, all experienced aquatic ecologists can make reasonable estimates. Hydrodynamic and fish population data are sometimes available from State agencies. For general purposes table 18.7 can be used to evaluate fish habitat at ROW stream crossings. Brown et al. (1971) provide an empirical formula that can be used to estimate stream temperature increases.

Aquatic plant growth depends on complex relationships among light, nutrients, substrate, and current velocity. A subjective evaluation of the sensitivity of a stretch of stream to increased sunlight, however, may be made by a combination of judgement and the criteria

Table 18.6 Criteria for Evaluating Severity of Browsing

Factor	Evaluation criteria				
	Little browsing likely			Severe browsing likely	
1. Browsing on adjacent lands (% stems browsed)					
a. Preferred browse	10	10-30	30-60	60-90	90
b. All woody stems	10	10-30	30-60	60-90	90
2. Browsing on ROW (% stems browsed)					
a. Preferred browse	10	10-30	30-60	60-90	90
b. All woody stems	10	10-30	30-60	60-90	90
3. Maximum diameter of browsed stems at tip (inches)					
a. On ROW	1/16	1/16-1/8	1/8-1/4	1/4-1/2	1/2
b. On adjacent land	1/16	1/16-1/8	1/8-1/4	1/4-1/2	1/2
4. Abundance of browse on adjacent land	Abundant		Moderate		Sparse
5. Proximity to preferred winter cover of browsers[a] (miles)	1.0	0.5-1.0	0.25-0.5	0.1-0.25	0.1
6. Species of browser	Small mammal		Deer		Elk, moose
7. Tolerance of dominant plant species to browsing	Very tolerant		Moderately tolerant		Intolerant
8. ROW width	200	150-200	100-150	10-100	50
9. Browser density	Low				High
10. Vegetation density	Low				High
11. Vegetation type	Low palatability			Highly palatable	

[a]This criterion is most relevant in ecoregions where winter movements of browsers are restricted by snow. It applies only to large mammals.

described in table 18.8. Clear, shallow, slow-moving streams with stable sand or silt bottoms are most likely to develop extensive plant beds if exposed to light at ROW stream crossings. Unless extremely dense, increased plant growth will usually benefit stream fish populations.

Numerous factors influence the sensitivity of streambanks to erosion. The role of vegetative cover is discussed further in section 24. Other important factors include soil type, current velocity and direction, and bank slope.

Banks of organic soils subject to strong currents (e.g., at the outer edge of bends in the stream) are most susceptible to erosion. The Universal Soil Loss Equation (appendix 5-b) may be applicable for long, gently sloped banks. In most cases, however, subjective estimates must be made for "worst-case" conditions (e.g., high water, swift current, dormant or sparse vegetation).

OTHER CONSIDERATIONS

To minimize the many potentially negative impacts of ROW management, some factors not previously mentioned in this chapter should be considered. The aesthetic effect is important, particularly in highly populated areas or near major transportation routes. Where ROWs are used for recreation (e.g., hunting, use of off-road vehicles, hiking, horseback riding), the impacts of such uses on vegetation and/or wildlife should be considered in the decisionmaking process.

Where prescribed burning is considered as a possible management technique, air pollution, safety, and aesthetic concerns should be taken into account. Identification of critical resources and "sensitive receptors" (as frequently done for environmental impact assessment) is necessary for pre-burn planning.

Adjacent resources that might be affected should be carefully evaluated before applying herbicides. This is particularly critical near croplands, waterways, and urban areas.

Impact analysis should be an integral part of all habitat evaluation and decisionmaking. Methods such as those described by Leopold et al. (1971) and Nihman et al. (1973) are often helpful in assessing broad effects of a ROW management strategy.

Table 18.7 Some Criteria for Evaluating Fish Habitat at ROW Stream Crossings

FACTOR	RATING			
	POOR	FAIR	GOOD	EXCELLENT
Cover	No instream debris, no undercuts, smooth streambed	Some instream brush or shallow undercuts	Moderate undercuts, or brush, stumps	Extensive undercuts, stumps, brush in stream close to bank
Substrate[b]	100 percent organics or silt	25 percent gravel	50 percent gravel	100 percent gravel, rubble
Current speed	Uniform across channel	Mostly uniform across channel, some slack zones	Moderately variable	Extremely variable across channel with numerous "edges"
Pool/riffle ratio	Either pools or riffle absent	Moderately high or low	75:25 or 25:75	Near 50:50, with good interspersion
Width/depth ratio	High	Moderately high	Low	Very low

[a]Ratings for Cover and Substrate are from Crabtree et al, 1978.

[b]Applies primarily to habitat for coldwater fishes. However, because production of aquatic insects is closely related to substrate, streams with rubble bottoms are often good habitats for warmwater species as well.

Table 18.8 Some Criteria for Evaluating ROW Stream Crossings for Management Purposes

FACTOR	ESTIMATING RELATIVE SENSITIVITY OF STREAMS TO EXPOSURE TO LIGHT--TEMPERATURE RESPONSE				
	LEAST SENSITIVE →				MOST SENSITIVE
Minimum discharge (cfs)	30	20-30	10-20	5-20	0-5
Width/depth ratio (maximum)	4:1	4:1-10:1	10:1-30:1	30:1-50:1	50:1
Groundwater/surface runoff inputs during critical seasons (minimum)	HIGH		MODERATE		LOW
Coldwater fishes	Never present		Seasonally present		Resident

FACTOR (average summer condition)	ESTIMATING RELATIVE SENSITIVITY OF STREAMS TO EXPOSURE TO LIGHT--AQUATIC PLANT RESPONSE				
	LEAST SENSITIVE →				MOST SENSITIVE
Bottom type	Rock, rubble, gravel		Shifting sand and silt, hard clay		Stable sand and silt
Current velocity (ft/sec)	5	5-3	3-1	1-.05	.05
Depth (ft)	6	6-4	4-2	2-0	
Clarity	Turbid or Colored				Clear
Water fertility	LOW		MODERATE		HIGH

FACTOR	ESTIMATING RELATIVE ERODIBILITY OF STREAM BANKS				
	VERY ERODIBLE →				RESISTANT TO EROSION
Soil K value (below water line)	0-23		0.24-0.36		0.37
Maximum current velocity (ft/sec)	5	5-3	3-1	1-0.5	0.5
Current direction	At angle to bank				Parallel to bank
Bank slope (%)	19		7-18		0-6

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APPENDIX 5-A

Data Sheet for Assessing Resources and Conditions on ROWs and Adjacent Lands

1. GENERAL SURFACE GEOLOGY AND TOPOGRAPHY _____

   _____

   TOPOGRAPHY
   a. Slope length (ft or m) _____
   b. Slope gradient (percent _____
   c. Slope orientation _____
   d. Elevation _____

2. CLIMATE
   a. Rainfall factor _____
   b. Lightning risk of fire _____
   c. Critical fire season length (months) _____
   d. Prevailing wind direction _____

3. SOILS (data for each major soil type; corresponding map needed)
   a. Soil type _____
   b. Fertility _____
   c. Soil permeability _____
   d. Erodibility _____

   (Additional data is required to determine erosion potential by the universal soil loss equation (see appendix))

4. WATER TABLE AND DRAINAGE
   a. Water table depth _____
   b. Seasonal variation _____
   c. Ponding in or at edge of Row: Year-round _____ Seasonal _____ No _____

5. ROW CHARACTERISTICS
   a. Width (ft or m) _____
   b. Orientation _____
   c. Clearance requirements _____
   d. Maintenance history _____

      _____

      _____

   e. Special features _____

      _____

6. FIRE POTENTIAL
   a. Man-caused risk of fire (high risk activities during critical season) _____
   b. Nearest firebreak _____
   c. General type of land use (cropland, residential, other) _____

      _____

7. VEGETATION (Supplement data with maps and written descriptions)
   a. Sensitivity_____
   b. Off-ROW Data (for each major cover type)
      1. Cover type_____
      2. Size_____
      3. Proximity to regional ecotone_____
      4. Sensitivity to potential ROW management impacts (see pp.)_____
      5. Fire potential (see pp.)_____
      6. Browsing evidence_____
   c. On-ROW Data (for each community)
      1. Community formula (see pp.)_____
      2. Percent cover_____
      3. Sociability_____
      4. Size of community_____
      5. Rooting characteristics of dominant trees_____
      6. Browsing evidence_____
      7. Snags_____
      8. Brushpiles_____
      9. Ground litter and slash_____
      10. Danger trees_____
      11. Endangered or threatened flora_____

8. WILDLIFE POPULATIONS (Both on and off ROW)
   a. Endangered or threatened fauna_____
   b. Selected species_____
   c. Degree of browsing_____
   d. Nuisance species_____

9. STREAM CHARACTERISTICS (Measured or estimated during critical seasons
   a. Discharge (cfs or cms)_____ b. Width (ft or m)_____
   c. Maximum pool depth (ft or m)_____ d. Average depth (ft or m)_____
   e. Maximum surface temperature (°F or °C)_____
   f. Bottom type/substrate_____
   g. Width/depth ratio_____
   h. Pool/riffle ratio_____
   i. Groundwater/surface runoff inflow ratio_____
   j. Current
      1. Uniformity_____

2. Velocity (ft/sec or m/sec)_____
3. Direction(s) with respect to banks_____

k. Clarity_____
l. Water fertility_____
m. Canopy closure/shading (percentage)_____
n. Banks
1. Erodibility_____
2. Cover (vegetation)_____
_____
3. Slope (percentage)_____
4. Height (1)_____(2)_____
o. Fish populations
1. Coldwater fishes_____
_____
_____
2. Warmwater fishes_____
_____
_____
3. Fish cover (aquatic vegetation, brush, rocks, etc.)_____
_____
_____
_____

10. OTHER CONSIDERATIONS_____
_____
_____
_____

APPENDIX 5-B

Universal Soil Loss Equation

Estimating Erosion Potential

Four main factors determine the erosion potential of an area: climate, topography, soil characteristics, and vegetative cover.

The soil erosion potential on transmission ROWs (and adjacent lands) may be estimated by the Universal Soil Loss Equation as described by Wischmeier and Smith (1972). This equation is A = RKLSC where: A is soil loss in tons/acre/year, R is an index of the erosive force of rainfall, K is the soil erodibility factor, L is the slope length factor (the ratio of soil loss from an area's slope length to that from a 72.6-foot length of similar soil type and gradient), S is the slope gradient factor (the ratio of soil loss from an area's gradient to that from a 9 percent slope with similar soil type), and C is the vegetative cover factor.

For pre-management ROW analysis it may be desirable to eliminate "C" from the equation because of the close relationship between vegetative cover and management. Appropriate C values for different vegetative cover types are listed in Wischmeier (1972).

Erosion Slope length and gradient factors (LS) for assumed uniform slopes may be calculated from the values in the tables that are listed in Wischmeier (1972) ("C-values for Permanent Pasture, Rangeland, and Idle Land" and "C-factors for Woodland"). The effective slope length is the distance from the point of origin of overland flow to the point where deposition begins or the runoff water enters a well-defined channel (Foster and Wischmeier 1974). Values of the LS for slope percentages not shown may be computed thus:

$$LS = \sqrt{\lambda(0.0076 + 0.0053s + 0.00076s^2)}$$

where λ is the slope length in feet and s represents the gradient (slope percentage).

The value of L may be expressed as $(\lambda/72.6)^m$. m is significantly influenced by the interaction of slope length with gradient. The average value (0.5) is used in the slope-effect chart in Wischmeier and Smith (1972). On slopes steeper than 10 percent, a value of 0.6 for m is recommended (Wischmeier and Smith 1972). A value of 0.3 is applicable to very long slopes of less than 0.5 percent gradient. The equivalent slope length chart (Wischmeier and Smith 1972) provides a graphical method for determining the value of LS when conditions indicate a length exponent other than 0.5.

Where there are several slopes on a given field, slope characteristics of the most erosive segment of the field should be used. Averages tend to underestimate soil movement.

The slope-effect chart may be used for uniform slopes only. An irregular slope is one on which K or S varies with location on the slope. This slope may be divided into a series of segments such that the slope steepness and soil type within each segment can, for practical purposes, be treated as uniform. The

total soil loss from the slope is the sum of the losses from each segment. Equations and charts to help in the computation of LS on irregular slopes may be found in Foster and Wischmeier (1974).

The frequency, intensity, and duration of rainfall determine the amount of runoff produced. The rainfall erosion index (EI) for a particular storm is the product of total kinetic energy of rain (hundreds of foot tons/acre) and the maximum 30-minute intensity (inches/hour) (Wischmeier 1959).

To compute storm rainfall energy (a component of the EI value), a single storm was considered as rains separated by less than 6 hours. The rain gauge recorder chart provides a tabular record of intensities and the amount of rain falling at each of the successive intensity increments. The mid-value of a specific intensity increment is entered on the table and the corresponding energy figure from the table multiplied by the inches of rain falling at this rate describes the energy value of that increment of the storm. These partial products are accumulated to obtain the total energy value for the storm. Individual storm EI values for all rains of .5 inch or more are summed over time periods in computing R (Wischmeier and Smith 1958).

An isoerodent map (found in Wischmeier and Smith 1972) may be used to obtain R values for states east of the 104th meridian. These R values represent the locational average annual values for the EI parameter for 22-year weather cycles.

In the mountainous states west of the 104th meridian, the sporadic rainfall pattern prevents the use of isoerodents.

Locational values of the erosion index computed from rainfall records should not be considered representative of a large geographic area.

In areas such as the Pacific Northwest, a large part of the erosion is caused by runoff from thaw and snowmelt. The erosive potential of this runoff must be added to the local EI value to evaluate R (Wischmeier 1976).

The soil erodibility factor (K) may be obtained from the U.S. Soil Conservation Service (SCS) District offices for each soil series. However, rating adjustments are sometimes necessary for varying soil textures. Where soils maps and K values are not reliable (or available), a simple nomograph may be used to determine K values for exposed subsoils as well as undisturbed surface soils (see graph in Wischmeier et al. 1971). A few simple determinations from 4 inch diameter soil cores provide all the necessary data to read from the nomograph a soil's erodibility (K).

The K value read from the nomograph should be reduced by about 10 percent for soils with stratified subsoil that includes layers of small stones of gravel without a seriously impending layer above them.

The product of the above factors may be used as an estimate of the erosion potential of the ROW. Reliable estimates of soil loss should be limited to maximum slopes of 20 percent and slope lengths of 400 feet (Asplundh Environmental Services 1978). Additional information about specific locations, soils, or problems may be obtained from the Soil Conservation Service (1977).

6

Wildlife Habitat Management Techniques

This chapter summarizes the literature on fish and wildlife habitat management techniques for transmission line rights-of-way (ROWs). Techniques and results generated from studies aimed specifically at improving wildlife habitat on ROWs are reviewed. General wildlife management techniques, if compatible with ROWs, are also described. Techniques considered incompatible with ROWs are those that encourage uncontrolled growth of tall-growing trees and shrubs.

19 THE LITERATURE SEARCH

Although abundant literature is available on techniques to maintain vegetation on ROWs, only those sources containing documented benefits for wildlife have been considered.

SCOPE OF LITERATURE SEARCH

Wildlife Review and the indexes over the last 25 years of the journals listed below were searched:

Journal of Wildlife Management
Journal of Forestry
Journal of Mammalogy
Transactions of the North American Wildlife Conference
Journal of Soil and Water Conservation
Ecology
Journal of Ecology
Journal of Animal Ecology
Journal of Range Management
Transactions of the American Fisheries Society

Other primary sources included publications lists of academic institutions and Federal and State agencies, including the U.S. Fish and Wildlife Service and the U.S. Forest Service. Publications lists were requested from all major agencies and institutions listed in the National Wildlife Federation's *Conservation Directory* (1976) that regularly engaged in fish and wildlife research. Approximately 35 percent of the agencies and institutions contacted provided publications lists; several replied that lists were not available. Reference lists of the publications selected for review were sources of additional citations.

GENERAL CONTENT OF LITERATURE

A variety of techniques may be employed to control tall-growing vegetation and enhance fish and wildlife habitat. Although most of the literature documenting these techniques originates from authors in the Eastern United States, the practices described may be applied also to tall-growing vegetation in the West. Many authors advocate particular techniques (e.g., prescribed burning, herbicide application) or the use of certain cover types on ROWs. Egler (1957, 1962), U.S. Forest Service (1966), Goodland (1973a), and others state that low shrub cover types are most desirable on ROWs because they retard tree invasion and provide better wildlife habitat than herbaceous communities. Egler (1962), Arner (1977), and others suggest that a U-shaped ROW with tall-growing shrubs and/or low-growing trees along the outer edge can create habitat diversity. Others (Leith 1974) promote herbaceous communities.

> I would partly take issue with the statement of Egler (1958) that "in most cases shrub communities retard reforestation more successfully than do grasslands." While very dense shrub cover effectively inhibits tree invasion, sparser shrub cover often aids such invasion into old fields. I believe there is a much greater acreage of successfully stable meadow than shrubland in the Northeast and that stable meadow is easier to establish over a variety of conditions. [Richards 1973]

Roberts (1969) offers this observation about goals in ROW management:

> Within the wildlife profession there are differences of opinion as to the role of right-of-way in game management. Should the environment created by a pipeline or powerline right-of-way be primarily woody or herbaceous in nature? Some habitat managers feel that thick shrubby vegetation benefits a wider variety of wildlife than does herbaceous ground cover. In the writer's opinion, the forest type or land use pattern in a particular area should determine what type of right-of-way cover to favor. In other words, those practices should be followed that produce the greatest edge effect.

Other authors recognize the potential benefits of considering regional resources in ROW management. Arner (1977) recommends different strategies in various parts of the country. The diverse requirements of wildlife species and the practical limitations imposed by the size of ROWs, variable terrains, and surrounding land uses suggest that wildlife managers should consider each of the techniques available before prescribing a ROW treatment.

20 MECHANICAL MANIPULATION

Methods for mechanically treating vegetation include hand cutting, cabling, chaining, disking, scalping, and bulldozing. These techniques have been used to prepare seedbeds for planting, make browse and other forage available to wildlife, provide slash cover and snags for wildlife, and maintain openings. Most of the literature on mechanical manipulation, however, is related to logging and timber production. Many studies have been conducted in the high yield timber areas, such as the Douglas-fir, ponderosa pine, and mixed conifer forests of northern California and Oregon, the lodgepole pine—spruce—fir forests in Colorado, the pine forests of the South, and the ponderosa pine forests of Arizona.

Literature on mechanical manipulation of vegetation for wildlife on ROWs is scarce. Most of the studies were conducted in the Northeastern United States; some were conducted in the Southeast. The majority are concerned primarily with the initial clearing or logging of a site. Information on intermediate stages of succession (which is most pertinent to management of ROWs for wildlife) is limited.

CUTTING

Clear cutting and selective cutting have been used extensively to manipulate wildlife habitat. Clear cutting favors revegetation by shade-intolerant plant species and often provides valuable habitat for many wildlife species. If the soil is exposed during treatment, pioneer species (e.g., grasses or certain fruiting shrubs, such as blackberries and staghorn sumac) often invade. When climax or near-climax stages of vegetation are cut, revegetation is by much different plant species, whereas pioneer stages tend to reestablish themselves after cutting (Kittredge 1938).

The response of vegetation to selective cutting depends, of course, on the degree of disturbance to the community and the species removed. Light partial cuts generally favor shade-tolerant species, especially those already established in the understory, and tend to

advance forest succession rather than initiate earlier stages. Moderately heavy cuts and small openings favor midtolerant species. Cutting during the dormant season encourages sprouting of woody plants; cutting during the flowering or leaf development period can exclude or reduce the abundance of some woody species (Spurr and Barnes 1973).

The specific effects of any cutting operation depend on the composition of pretreatment vegetation, climate, topography, soil conditions, time of cut, and time since last cutting. The available literature clearly indicates that each of these factors should be considered before cutting.

Cutting on Rights-of-Way

Relatively little information is available about the specific effects on wildlife of clear cutting ROWs. A shift from chemical to predominately mechanical reclearing allows the normal invasion of many plants beneficial to wildlife, such as wild grape, greenbrier, partridge-pea, Japanese honeysuckle, and ragweed (Fowler et al. 1976). In fact, mechanical clearing of ROWs by the Tennessee Valley Authority has, in many cases, improved wildlife habitat and browse production. Clear-cut ROWs often attract a variety of wildlife (Foster 1956; Arner 1977).

Use of rotary mowers has become a common technique for ROW maintenance in the past few years (Arner 1977). Conventional mowers can cut woody plants up to 1.5 inches in diameter in relatively rough country. This method of clear cutting can be used during the growing season to exclude or reduce objectionable herbaceous plants as well as some woody species. Arner (1977) reports that mowing is required about every 3 to 4 years.

Selective clearing is another maintenance technique with potential for wildlife management. Cavanaugh et al. (1976) compared the effects of selective cutting and clear cutting on ROWs in New Hampshire and concluded that removing only those trees that interfere with the transmission line can create maximum wildlife diversity. They found that the number of browse plants and the wildlife that use them were significantly greater in selectively cut areas. They suggested that clumps of shrubs and small trees mixed with sparser vegetation, open grassy cover, and bare ground should be maintained where possible by selective cutting.

Selective cutting on ROWs has become the standard practice of the Metropolitan Edison Company in Pennsylvania because selectively cut ROWs appear to be more attractive and beneficial for wildlife (Ulrich 1976). Clear cutting is done only within 50 feet of metal towers, within 20 feet of wooden poles, and to maintain a 15 foot access road.

By favoring low-growing shrubs, ROW managers preserve valuable wildlife habitat and create a plant community that requires very little maintenance. White-tailed deer and rabbits use the ROW more, and their browsing helps keep the vegetation low (Tillman 1976a, b). Even after three years, the ROW may not need vegetation maintenance.

To obtain maximum benefit to wildlife, to minimize costs, and to avoid extensive future ROW maintenance, selective cutting must be carefully planned and based on detailed inventories of existing vegetation and other features (Goodland 1973a; Randall 1973). Selective cutting to create and maintain the U-shape first proposed by Egler (1957) has been promoted by Stalter (1973), Goodland (1973a), Randall (1973), Arner (1977), and others.

Taber (1975) reported that the U-shaped communities in Washington often include herbaceous vegetation in the middle of the ROW, bordered by low brush. Anderson et al. (1977) suggested that cutting to provide leafy understory at the forest edge and clumping understory vegetation can minimize the undesirable and maximize the desirable effects of ROWs on bird populations. Jackson (1976) stated that saving den trees and pruning low limbs on edge trees that do not "self-prune" enhance the value of a ROW for the red-cockaded woodpecker, an endangered species.

Pruning and topping rather than removing tall-growing trees is commonly done on ROWs, but only in urban areas or where the aesthetic effect is a concern. The costs of pruning and topping may be prohibitive. Information on effects of this selective cutting method on wildlife is lacking.

Clear Cutting on Other Sites

East-west clear-cut strips, 30 to 60 feet wide, provide an abundance of desirable wildlife foods by decreasing competition from less desirable plants (Yoakum and Dasmann 1971). Several other authors also document the beneficial effects of clear cutting on certain wildlife species (Pengally 1972, 1973; Hooven 1973a,b; Perkins 1974; Fransreb 1977). Several studies that document changes in wildlife habitat from clear cutting are discussed below.

Northwestern United States — Clear cutting is often used in the Pacific Northwest and Northern Rockies to produce browse for deer and other big game. Pengally (1963) found that logging at low elevations in Douglas-fir stands in the Northern Rockies improved habitat for white-tailed deer and elk. Reynolds (1966) recommended small clear cuts in spruce—fir stands for deer and elk. Gashwiler (1970) in Oregon, and Davis (1976) in Wyoming, found that clear cutting increased populations of some mice, voles, shrews, and other small mammals because of the increase in ground cover.

Hagar (1960) concluded that logging in Douglas-fir forests alters the composition of bird communities and may cause a temporary decline in numbers. Within a year after cutting in California, total bird numbers returned to pretreatment levels, while species composition remained different. The brushy successional stage that resulted 3 to 7 years after cutting supported more species and higher populations than other successional stages in the area. Vegetation in the cutover area included fireweed, miner's lettuce, Oregon-grape, tanbark-oak, western raspberry, gooseberry, tobacco brush, common thistle, bluegrass, hairgrass, knotweed, and poison oak. While clear cutting attracted deer and other large game, Hooven (1973a,b) found that patch cutting to achieve a mix of cut and uncut cover also benefited wildlife in Oregon.

North Central United States — Clear cutting stands of oaks, aspens, maples, basswood, and other trees is integral to habitat management for deer and ruffed grouse in the North Central United States (Jenkins and Barlett 1959; Graham et al. 1963). Gysel (1957), studying the effects of experimental cutting of aspen in Michigan, found that aspen root suckers dominated the area after cutting and provided an abundance of deer browse. The number of sprouts was much greater in clear-cut areas than in areas that were commercially cut. He also found that axe treatment of oak produced about twice as much browse as did chemical treatment. Krefting and Phillips (1970) recommended clear cutting strips in northern Michigan's mixed conifer swamps for white-tailed deer. However, clear cutting white cedar where large deer populations exist often results in poor regrowth of cedar because of overbrowsing by deer and rabbits. After cutting, cedar stands may convert to speckled alder communities. Krefting and Phillips (1970) also found that browsing was consistently heavier in clear-cut stands than in uncut areas. They noted that browse plants in clear-cut, mixed conifer swamps in Michigan included red, sugar, and mountain maples; yellow birch; red-osier dogwood; black ash; willow; mountain-ash; white cedar; and fly-honeysuckle.

The wildlife benefits of clear cutting in the Missouri Ozarks are closely related to the quality of the site (Crawford and Harrison 1971). Clear cutting produces many desirable wildlife food plants on high quality sites, such as slope bottoms; results are poorer on lower quality sites at higher elevations. On poor sites, competition from hickory and oak stems hinders growth of more desirable cover.

Eastern United States — Clear cutting has also improved conditions for certain wildlife species in the Eastern United States. Broods of ruffed grouse use clear-cut areas in Pennsylvania for dusting and feeding (Morton and Sedam 1938). The importance to grouse of the new growth produced by clear cutting aspen stands is discussed by Bramble (1973). Clear cutting old growth timber increases fruit-bearing shrubs, which benefit bear in Massachusetts (Lauckhart 1956). Cardoza (1976), however, noted that clear cutting even small tracts in Massachusetts may be detrimental to bear populations where there are no continuous wooded areas nearby.

Southeastern United States — Cutting in southern pine plantations quickly provides succulent woody sprouts and herbs (Perkins 1974). Within 3 to 5 years, woody species almost completely replace herbaceous vegetation. As succession advances, however, its value to wildlife declines. Scrubby hardwoods and underbrush result from clear cutting longleaf pine in the Gulf Coastal States (Campbell 1955). Because it is extremely intolerant of shade and cannot compete with the faster growing brush, the pine fails to reoccupy all areas it once dominated.

Ripley and Campbell (1960) found that clear cutting produced significantly more browse than did selective cutting in hardwood stands in North Carolina. Despite moderately heavy browsing by deer, tulip-poplar, northern red oak, white oak, and chestnut oak regenerated well. Clear cuts in Tennessee supported more small mammals than adjacent uncut forest (Ambrose 1975).

Southwestern United States — As in other areas of the country, the purpose of most clear cutting in the Southwestern United States is to produce better quality, merchantable timber. Production of browse for big game is a beneficial byproduct of well-planned cuts. Wallmo et al. (1972) found that clear cutting lodgepole pine and spruce—fir stands in Colorado produced more forage for deer. Maximum forage grew about 6 years after logging, and declined to pretreatment levels in 15 years. Patton (1974) observed similar results in eastern Arizona's ponderosa pine forests. Both deer and elk used the browse provided by Gambel oak, trembling aspen, buckbrush, New Mexican locust, mountain muhly, squirreltail, cinquefoil, and yarrow.

Selective Cutting on Other Sites

Besadny et al. (1968) reported that a selective brush management program for Wisconsin roadsides was attractive as well as beneficial to wildlife. Desirable shrubs were cut back to permit resprouting; low shrubs and trees that were aesthetically enhancing or valuable for wildlife were kept; large trees or diseased shrubs were removed. Downey (1976) advocated selective clearing of natural gas pipelines. He suggested designing vegetation removal to fit the site and using the U-shaped ROW where feasible.

Morton and Sedam (1938) reported that the Pennsylvania Game Commission wildlife habitat management program used release cuttings around wildlife food plants like grape, hawthorn, blackberry, mountain-ash, flowering dogwood, beech, huckleberry, and sumac to stimulate growth and fruiting. These were then maintained by periodic recutting. They suggested that some trees can be felled back into the uncut forest stands to provide escape cover and allow additional sunlight for shrub production at the edge of cutover strips. Stumps cut 12 inches above the ground produced the most sprouts; stumps from trees 13 to 24 inches in diameter at breast height (dbh) grew fastest. Crawford and Harrison (1971) recommended that oak and hickory sprouts be selectively controlled to release other plants, such as sassafras, grape, blueberry, blackberry, black gum, flowering dogwood, tick-trefoil, wild rose, goat's-rue, pussy's-toes, aster, hawkweed, and cinquefoil, on cutover areas in the Missouri Ozarks.

Several authors have advocated keeping snags in cutover areas for squirrels and birds. Fransreb (1977) found that snags provided the majority of the nest sites for many bird species in logged Douglas-fir stands in Arizona. Gale (1973) recommended that all snags, if possible, be left for woodpecker feeding and nesting in cutover ponderosa pine and mixed conifer areas in northern California. Snags should be soft or rotten, barkless, 15 inches or more in diameter, and 20 to 49 feet high. Conner and Crawford (1974) and Conner et al. (1975) made similar observations and suggested killing live trees by girdling and leaving them standing to

enhance cavity nesting sites in Virginia. This practice was also recommended to maintain habitat for pileated woodpeckers in northern Michigan (Rusz and Bourgeois 1976). Sanderson (1975) suggested that one den tree every 2 acres be left in cutover areas for squirrels. He emphasized the need to leave healthy trees instead of dead or dying trees for dens: potential den trees should have dead or dying branches 3 inches or more in diameter and a life expectancy of 25 years or more. Girdling is a possible technique for den tree management.

Another selective cutting technique for providing valuable wildlife habitat is "hinge cutting" or the "cut-and-bend" method. This method involves cutting selected trees just deep enough so that the tops can be pushed over, leaving a connecting strip of bark and wood. Burger (1973) hinge cut 6 to 8 foot tall conifers 4 to 5 feet above ground. He reported that the lower branches (no longer shaded) grew vigorously, while the connected tops grew upward again. This resulted in a low, dense, living brush pile which provided ideal winter cover for small game. Because hinge-cut trees in Pennsylvania remain alive 1 or more years after treatment, top browse continues to grow, and ground cover deteriorates more slowly (Forbes and Harney 1952). In areas not suitable for bulldozing, hinge cutting is the best technique for producing browse and cover for deer and rabbits. Benefits of this technique are most pronounced 1 to 2 years after treatment. Hinge cuts are especially attractive to ruffed grouse, quail, and rabbits if vines or shrubs grow in and on the cut tree (Shomon et al. 1966). Rusz and Bourgeois (1976) recommended this technique for creating tangles and drumming logs for ruffed grouse in northern Michigan.

BULLDOZING

Bulldozing is often used in transmission ROW clearing. It is becoming increasingly popular with wildlife managers, particularly in the North Central and Eastern United States. However, literature on bulldozing to improve wildlife habitat is scarce for others areas of the United States.

Typically, bulldozing to clear transmission ROWs is followed by seeding to prevent soil erosion and improve wildlife habitat. Arner (1960) reported that bulldozing and seeding on 9 miles of ROW in Maryland effectively controlled growth of unwanted woody vegetation. Woody species made up only 9 percent of the vegetation after three growing seasons. At the end of the seventh growing season, only about 20 percent of the vegetation was undesirable plants.

Smith (1959) studied effects of bulldozing on secondary succession on a ROW in North Carolina. He examined four areas that varied from 3 to 6 years in the time since they had been bulldozed and found that blackberry, broomsedge, aster, and pine dominated succession. These species were found on all sites regardless of soil type or time since treatment. Only water table levels and erosion appeared to be important to species composition. Smith concluded that bulldozing as a maintenance technique can drastically reduce the site quality and the productivity of slopes and ridges on ROWs. Several authors have advised against bulldozing on ROWs because of soil erosion (Pennsylvania Power and Light Co. 1971; Maine Department of Inland Fisheries and Game 1975).

Several studies, however, have indicated that bulldozing simply to topple or cut trees and break up brush, rather than scarify sites, can greatly improve habitat for certain wildlife species. Forbes and Harney (1952) conducted the most thorough of these studies in Pennsylvania. They described results of bulldozing in a variety of pole-sized stands that differed as to plant species composition, topography, and soil type. Bulldozers toppled and ran over vegetation, which in many cases created a dense junglelike growth that persisted 4.5 years despite heavy browsing by deer. Some of their conclusions from the Pennsylvania study are summarized as follows:

1 Minor variations in climate are not significant in determining the success of bulldozing.
2 Soil moisture and texture are important. In soft and moist ground, trees are more easily uprooted; stems break less.
3 Bulldozing in spring or late fall is easiest and most beneficial to deer. Sprouting is more likely to occur from a spring bulldozing.
4 Trees 2 to 4 inches in diameter sprout better than smaller or larger trees. Smaller trees tend to spring back when overrun, while larger trees require considerable effort to push over and thus increase the cost of an operation.
5 Overrunning trees after they have been pushed down is cheap and fast, but it damages the trees more than does bunting the trees down and then backing off. The latter method, however, lets the operator select the kinds of trees to remove or to leave standing.
6 In Pennsylvania, the four forest types best suited to bulldozing (in order of desirability) are beech—birch—maple, northern hardwoods transition, oak, and aspen. Shade-tolerant species are best suited to bulldozing. There was no root suckering of bulldozed aspen trees on any of the study areas.
7 Bulldozing has greatest value for deer, while cottontails, snowshoe hares, and grouse also benefit.
8 Bulldozing is cheapest using a large machine with a hydraulic lift blade and protection for vital parts. Trees are overrun in one direction. The site is free of large rocks and swampy ground. Most trees are 2 to 6 inches in diameter.
9 In Pennsylvania, bulldozing produces more deer browse and cover more cheaply for a longer period of time than other accepted techniques, including hand cutting and prescribed burning.

Gysel (1961) studied effects of bulldozing with conventional blades in northern Michigan. He reported good browse production in sugar maple, red maple, and oak stands, but poor results in willows. Bulldozing a community dominated by staghorn sumac resulted in a dense cover of blackberry, bracken fern, and grasses after

two growing seasons, and vigorous sprouting of staghorn sumac after five growing seasons.

Special tree cutter blades have also been used to provide browse in northern Michigan. Beale (1961) found that a tractor with a tree cutter blade could be used to stimulate browse, but results varied among sites. The amount of sprouting was better than with controlled burning or commercial cutting in aspen stands. Other trees and shrubs that sprouted well after treatment included black cherry, willow, red maple, oak, dogwood, and wild-raisin. Beale concluded that clear cutting with a "tree dozer" was efficient and economically competitive with other techniques, such as disking, aerial application of herbicides, and prescribed burning. Bulldozing with special cutter blades on other sites in Michigan also produced abundant browse (Cook 1969a,b).

OTHER MECHANICAL METHODS

Other mechanical techniques include chaining, cabling, and scalping or disking with various types of plows. These methods have been described by the U.S. Department of Agriculture (1965), Plummer et al. (1968), and Yoakum and Dasmann (1971).

Chaining breaks off or uproots plants by dragging a heavy (up to 100 pounds per link) anchor chain behind two tractors traveling parallel courses. The weight of the chain may be modified to control the degree of disturbance. Chaining efficiently removes young, willowy trees and is useful in preparing seedbeds for aerial broadcast seeding (Yoakum and Dasmann 1971).

Cabling is essentially the same procedure, except that a 1.5 inch cable is used instead of a chain. Cabling creates less disturbance than chaining and is useful for saving residual stands of valuable shrubs and herbaceous cover. It is usually ineffective with young, willowy trees, which simply bend and spring back. Data on specific effects of these two techniques on wildlife habitats are scarce. However, Plummer et al. (1955) have documented their effectiveness in seedbed preparation in Utah.

Conventional plows are sometimes used to eliminate certain undesirable woody species and to prepare seedbeds for planting. Scalping scrapes off the plants and part of the top layer of soil with a wide moldboard plow pulled by a tractor or jeep, or by bulldozing. This technique is used only for seedbed preparation. Disking may be used for controlling unwanted vegetation as well as for preparing seedbeds. Yoakum and Dasmann (1971) recommend plowing to a depth of 3 to 4 inches to control most nonsprouting plants and plowing to a depth of 4 to 6 inches to eradicate plants that spread by underground rootstocks or from the crown. A heavy-duty plow is required to eliminate root-sprouting species.

Deep, thorough plowing can be especially useful in keeping openings free of aspen root suckers in the Midwestern and Eastern United States. Light disking, skidding, and other disturbances of the forest floor benefit aspen reproduction, however, by reducing leaf litter for cutworms that often destroy the root suckers as they sprout (Graham et al. 1963). Cutworms have contributed to the failure of numerous aspen stands in Michigan where, after cutting, the ground has been covered with leaf litter.

Light disking and scalping can create favorable conditions for invasion of pioneer herbs and shrubs valuable to wildlife. Rusz and Bourgeois (1976) recommended light disking next to clumps of raspberry and blackberry to spread these fruiting shrubs for ruffed grouse, indigo bunting, and cottontail in northern Michigan.

METHODS OF SLASH DISPOSAL

There are four basic methods of dealing with the slash that results from mechanical treatment of vegetation: 1) burning, 2) piling, 3) chipping, and 4) leaving it where it falls. The effects of slash burning and brush piling are discussed in other portions of this chapter. Chipping has no direct effect on wildlife habitat. Leaving slash where it falls may have major effects on the vegetation that grows later and the wildlife that use it.

Conner and Adkisson (1975) found that breeding bird diversity in Virginia was greatest when slash was left and the area was not disked or burned. Insects inhabiting slash that is not piled or burned may attract woodpeckers to clear-cut areas (Conner and Crawford 1974). Leaving trees where they fell and cutting limbs to lie flush with the ground enhanced wildlife cover on a ROW in New York (Tillman 1976). Some disadvantages of this method, however, include increased fire hazard, interference with revegetation, and creation of habitat for forest insect pests. Leaving slash where it falls permits the ready use of logs for erosion control, provides small game habitat, maintains the soil structure, and reduces loss of soil nutrients (Dohrenwend 1973).

If slash is physically removed from a site, the means of removal can affect the post-treatment community. Skidding or pushing the slash with a bulldozer disturbs the soil and can influence the vegetation that grows later. The Metropolitan Edison Company in Pennsylvania uses hydraulic log or brush clamps in moving slash to minimize site disturbances (Ulrich 1976). Pennsylvania Power and Light Company (1971) uses wheeled or tracked equipment with brushrakes, forks, or winches to remove slash and minimize disturbances. The use of bulldozers for maintenance is not permitted on that company's ROWs.

Skidding slash has been found to be detrimental to regeneration of longleaf pine (Campbell 1955) and Douglas-fir (Hooven and Black 1976). However, it is often beneficial to aspen (Graham et al. 1963). Arnold (1953) found that 5 years after selective cutting in Arizona, changes in herbaceous cover were greatest on logging roads and skid trails. Surface disturbances generally benefited annuals and perennials. He suggested that erosion on skid trails can be minimized by draining with cross-ditches, by scattering slash, and by reseeding.

21 BRUSH PILING

Although few sources mention specifically the effects of brush piling on wildlife, Schofield (1955), Yoakum and Dasmann (1971), and Kight (1971) report

that piling brush, rather than leaving the cut brush in place on the ground, can provide cover, especially for rabbits.

BRUSH PILING ON RIGHTS-OF-WAY

Utility companies usually burn or chip brush rather than pile it. Documented exceptions are Metropolitan Edison Company in Pennsylvania and Connecticut Light and Power Company. Ulrich (1976) reported that Metropolitan Edison now establishes brush piles in preplanned areas near the edges of ROWs and in areas with few desirable plant species. Brush piles should not exceed 40 by 40 feet; piling in the downslope of natural depressions and gullies prevents soil erosion. According to Ulrich (1976), the brush piles provide food and cover for wildlife, help prevent soil erosion and sedimentation, and produce valuable forest humus.

At the suggestion of the Connecticut Board of Fisheries and Game, the Connecticut Light and Power Company changed from brush disposal to brush piling for wildlife (Hamrick and Bishop 1957). The company now informs all property owners next to ROWs that, if it is agreeable to them, brush from the side clearing will be piled in the woods for birds and rabbits. A majority of the landowners have cooperated in improving conditions for wildlife.

BRUSH PILING ON OTHER SITES

Shomon et al. (1966) recommended piling brush to provide escape cover for wildlife and to encourage burrowing by woodchucks. A variety of mammals, amphibians, and reptiles also use woodchuck burrows. Yoakum and Dasmann (1971) stated that brush piles increase the capacity of large clearings for upland game birds and cottontails. They also noted that grasses, forbs, and vines often grow up through the brush and add density and permanence to the pile. Hamilton and Cook (1940) suggest that brush piles are important to several species of small mammals. Large brush piles created by bulldozing may provide valuable escape cover for ruffed grouse in two grouse and woodcock management units in south central Michigan (Palmer and Ammann 1968). In Georgia, brush piling is the easiest way to immediately improve rabbit habitat (Kight 1971). Forbes and Harney (1952) suggested that brush piles created by bulldozing benefit rabbits and other wildlife in Pennsylvania. Turkey nests have been found in slash piles, and there may be advantages for turkey nesting in piling brush at the bases of trees or around logs (Yoakum and Dasmann 1971).

Several authors have suggested that size, shape, and structure of brush piles influence use by wildlife. Heaping brush over stumps or logs prevents settling (Shomon et al. 1966). In Michigan, loose brush piles improve winter habitat for ruffed grouse; denser brush piles improve habitat for rabbits (Rusz and Bourgeois 1976). Piles for rabbits in Georgia should be 10 to 15 feet in diameter and 4 to 6 feet high (Kight 1971).

Below are recommendations of Yoakum and Dasmann (1971) for brush piling for scaled quail, cottontail, and ring-necked pheasant:

Scaled quail—make slash piles 5 to 6 feet in diameter and about 3 feet high. Use rocks or logs to elevate the pile about 6 inches above the ground.

Cottontail—make piles 25 to 50 feet long, 5 feet wide and 4 feet high.

Ring-necked pheasant—pile brush loosely in field corners or along fence rows.

In summary, the available literature on brush piling indicates that there is great potential for incorporating this technique in ROW management plans. Some general conclusions are:

1 Brush piles benefit a number of species such as songbirds, upland game birds, small mammals, rabbits, raccoons, foxes, and skunks.
2 Brush piles are most effective if placed near habitat "edges" (where different cover types meet).
3 Long, narrow brush piles, less than 6 feet high, are preferable to higher, rounded piles for rabbits and possibly other wildlife. Upland game birds prefer loosely piled rather than crushed brush.
4 Brush piles are especially effective if placed where forbs, grasses, and vines, such as grape, greenbrier, and Virginia creeper, will grow in and on the pile and create a dense tangle.

22 HERBICIDE APPLICATION

Herbicides have been used to manipulate vegetation for several decades and are widely used for transmission ROW maintenance. Recently, wildlife managers have started to use herbicides in habitat management programs.

Literature on effects of herbicides on vegetation is voluminous; about one-half of the references concern ROW maintenance (Asplundh Environmental Services 1979). Effects of specific herbicides on various plant species have been documented (DeVaney 1968; Cody 1975; Bovey 1977); considerable information is available on application methods (DeVaney 1968; Carvell 1973; Barnhart et al. 1976; Bovey 1977). Some authors have suggested that herbicide-treated areas are often good wildlife habitats (Leonard and Cain 1961; Carvell 1973), but documentation of actual wildlife use after herbicide application is relatively scarce. Most studies have only compared the effects of different application methods or types of herbicides on vegetation. These studies suggest that when properly applied herbicides can contribute, depending on such factors as pretreatment vegetation (composition and height), soil characteristics, topography, type of herbicide, time of treatment, and application method, to effective, flexible habitat management.

TYPES OF HERBICIDES

A number of herbicides and additives are currently used for ROW maintenance and wildlife habitat management. They are grouped according to their mode of action and are briefly described below. Information on uses of various herbicides is summarized in table 22.1.

Table 22.1 Some Common Uses of Selected Herbicides

Herbicide	Action[a]	Uses	Special values and problems
Ammonium sulfamate (Ammate)	HGR	Stem-foliar application; treating stumps.	Especially effective in control of poison ivy, poison oak, and poison sumac. Safe for use around water and crops.
Trichlorobenzoic acid (TBA)	HGR	Often used to increase spectrum of kill as additive.	Spray drift may injure adjacent crops.
Bromacil (Hyvar)	HGR	Basal treatment in a water solution.	Leaves drop quickly after treatment, so brownout problems are eliminated. May persist in soil.
Dicamba (Banvel)	HGR	Often used in combination with other herbicides; controls sprouting of stumps and stubble.	Effective on hard-to-kill species including ash, gum, maple, pine, sourwood, mesquite, witch-hazel, creosote bush, sagebrush, and yaupon. Selective on grass.
Karbutilate	HGR	Basal treatment in a water solution; controls sprouting of stumps and stubble.	Persists in soil.
Picloram (Tordon)	HGR	Stem-foliar application; basal application; treating stumps. Used mainly in combination with other herbicides; effects are usually additive.	Effective against many woody plants. Delayed killing action; persists in soil. Various mixtures.
2,4-D	HGR	Stem-foliar application.	Kills both woody and herbaceous vegetation. Selective on grass.
2,4,5-T	HGR	Stem-foliar application.	More effective woody plant killer than 2,4-D. Selective on grass.
2,4-DP	HGR	Stem-foliar application. Controls root-suckering plant species.	
Silvex (2,4,5-TP)	HGR	Stem-foliar application.	Controls some species, including maple and oak, that are resistant to 2,4-D and 2,4,5-T. Persists in soil.
MCPA (2-methyl-4-chlorophenoxyacetic acid)	HGR	Stem-foliar application.	Safe around croplands. When added to other herbicides, gives wider spectrum control.
Dichlobenil	GI	Retards growth of young trees; prevents germination of seeds. Applied to the soil.	Effects both monocots and dicots.
Naphthalene acetic acid (Tree-Hold)	GI	Prevents sprouting from stumps and trimmed branches.	
Chlorflurenol	GI	Prevents sprouting from stumps and trimmed branches	
Fenuron	GI	Retards tree growth and germination of seeds. Applied to the soil.	Suitable as soil-sterilant in dry areas only.

Source: Summarized from Carvell 1973, Barnhart et al. 1976, and Bovey 1977.

[a]HGR--hormone growth regulator; GI--growth inhibitor

Hormone Growth Regulators

Hormone growth regulators are similar to naturally occurring auxins which are found in extremely low levels in plant tissues (Carvell 1973). Silvex, 2,4-D, 2.4,5-T[1], picloram, and dicamba are the most widely used hormone growth regulators (Barnhart et al. 1976). These herbicides kill plants by speeding metabolism in plant cells, causing the cells to die. Other herbicides, such as aminotriazole, are chlorophyll inhibitors; the triazines, simazine, and atrazine, and perhaps substituted ureas (e.g., monuron, diuron, and fenuron), also interfere with photosynthesis (Carvell 1973). More selective hormone growth regulators will likely be developed in the future.

Plant Toxins

Several herbicides kill plants by direct toxic action. Ammonium sulfamate, bormacil, and darbutalate are three of the most widely used plant toxins. They are particularly useful for brush control near crops that could be damaged by hormone growth regulators.

Growth Inhibitors

Certain chemicals, including maleic hydrazide, dichlobenil, and alpha naphthalene acetic acid, inhibit or retard plant growth (Carvell 1973). Technically, they are not "herbicides" (i.e., they do not kill plants), but they are being used increasingly in vegetation maintenance. According to Carvell (1973): "Chemical companies are doing extensive research on growth inhibitors. When economic and effective compounds are developed, they could find wide use in right-of-way control, particularly where selective spraying is used to encourage aesthetically desirable shrubs. Growth inhibitors eliminate the danger of brownout."

Additives and Formulations

Additives and special formulations developed over the years have increased the usefulness and safety of herbicides. Wetting agents, spreader stickers, emulsifiers, and cosolvents are examples of additives that increase herbicide effectiveness. Others mask the offensive odors of certain spray solutions.

Invert emulsions are formulations that reduce drift during herbicide applications from the air or from high-pressure equipment. They permit accurate application and careful control of the area sprayed (Carvell 1973).

Recently, Emulsavert was developed because invert formulations could not be mixed with other herbicides to increase the number of species controlled. These mixtures now allow greater flexibility in matching herbicide mixtures to the vegetation on a particular ROW (Carvell 1973).

APPLICATION METHODS

Stem-foliage Spraying

Stem-foliage spraying is done from either the ground or the air. On the ground, high-pressure pumps and spray guns thoroughly wet all foliage and stems of the target plants (Barnhart et al. 1976). Aerial application can give good coverage, but not enough spray penetrates lower portions of the plant and understory plants. For thorough kill, follow-up sprays 1 to 2 years after initial treatment may be necessary (Bovey 1977). Both aerial and ground treatments must be done during the growing season and full-leaf development period (Carvell 1973; Barnhart et al. 1976; Bovey 1977). Susceptibility of woody plants may be greater if there is a gradient between sugar levels in leaves and roots at the time of application (Brady and Hall 1976).

[1]Use of 2,4,5-T was recently suspended by the Environmental Protection Agency and mention of it, or of any other herbicide, does not constitute an endorsement by the U.S. Fish and Wildlife Service.

Basal Bark Treatment

For selective vegetation control or where other methods are unsafe or impractical, basal bark treatment is used. This method involves wetting stems from about knee level to the ground or root collar zone. Exposed roots should also be treated. This treatment may be performed in any season.

Dormant Cane Broadcast Spraying

This technique is used in the dormant season, when the stand is too dense for basal bark application. As in basal bark treatment, the lower part of the plants are drenched. According to Barnhart et al. (1976), this method can, with proper selection of herbicides, more effectively control root-suckering species than can basal bark application because some of the ground is also treated.

Tree Injection

Tree injection is a selective method of treating large stems resistant to basal bark applications. Herbicide tree injection can be done with commercial injectors or by frilling (making overlapping axe cuts around the bole of a tree and peeling the bark to wet the exposed wood). For best results, summer treatment is recommended; in winter, resistant species may require increased levels of herbicide.

Stump Treatment

Spraying or brushing the exposed wood of fresh-cut stumps can prevent sprouting. This is most effective if the outer bark is also treated to ground level.

Soil Application

Herbicides can be applied to the soil around undesirable woody plants either as dry pellets or as solutions. If pellets are used, the soil should be moistened either by rainfall or irrigation shortly after application for best results and, in some cases, must be moist before application (Bovey 1977). There is usually reduced kill during hot, dry seasons.

EFFECTS ON WILDLIFE HABITAT

Herbicide application is controversial among both wildlife ecologists and the general public. Some investigators have shown that herbicides can enhance habitat for certain wildlife species (Jenkins 1955; Krefting et al. 1956, 1960; Coulter 1958; Gysel 1962; Krefting and Hansen 1969) and should be used in habitat

management programs (MacConnell 1968). In contrast, other biologists have reported detrimental effects (Goodrum and Reid 1956; Tietjen et al. 1967). Much of the criticism of herbicides has arisen because of incidents of indiscriminate use (Carvell 1973).

Public criticism of herbicides has caused some utilities and government agencies to avoid using them. In spite of this, herbicides will continue to be used in vegetation maintenance. For example, in the Northeast and Pacific Northwest, where the terrain is rough and inaccessible, other methods are often impractical (Jenkins and Fisher 1970). The main advantages of herbicides are that they are easy to use and inexpensive compared to cutting, bulldozing, and seeding (Carvell 1973).

Effects on Rights-of-Way

Stem-foliage spraying is a common method for applying herbicides on ROWs. Numerous studies have shown, however, that root-kill of woody vegetation is often ineffective (Egler 1952; Roe 1953; Bramble and Byrnes 1955a,b; Niering 1957). In Connecticut, up to 80 percent of oaks, maples, and other tree species on ROWs live even after two foliage treatments (Niering 1957).

The effects on wildlife of blanket spraying vary a great deal. Mayer (1974, 1976) found that wildlife used broadcast-sprayed ROWs in New Hampshire, Georgia, and West Virginia more than adjacent lands. Important food and cover plants included greenbrier (in West Virginia and Georgia), blackberry (in Georgia and New Hampshire), swamp privet and white sassafras (in Georgia), and meadow spiraea and choke-cherry (in New Hampshire). Johnston (1973) and Carvell (1976) studied blanket-sprayed ROWs in Georgia, Minnesota, West Virginia, and Virginia and selectively sprayed ROWs in California, Louisiana, New Hampshire, New Jersey, and Oregon. They concluded that blanket-sprayed plant communities (mainly perennial grasses, ferns, some shrubs, and a few broadleaved perennials) had fewer perennial herbs and particularly showy summer and fall wildflowers than did selectively sprayed ROWs.

A long-term study in Pennsylvania of the effects of ROW herbicide applications found that wildlife used both broadcast and selectively sprayed plots where stable bracken, sedge, herb, and blueberry communities developed (Bramble and Byrnes 1969, 1976). Both broadcast and selective basal sprays increased plant diversity and available deer browse on a Michigan ROW (Gysel 1957, 1962). On a Pennsylvania ROW, Shrauder (1954) found that a selective summer basal spray produced more winter deer browse than did broadcast foliage application.

Many authors have advocated selective spraying to enhance the stability of shrub communities and wildlife habitat on ROWs (Egler 1949, 1952, 1953, 1954, 1956; Niering 1961). On ROWs on National forest lands in Ohio and Indiana, good wildlife habitat was created by selectively treating the outer edges and broadcast spraying the centers (Landes and Hamilton 1965). On a Michigan ROW, selective treatment to enhance wildlife habitat was recommended:

> The use of a broadcast, chemical spray, or the mechanical disking contemplated, would prove a needless expense and an inexcusable waste of valuable wildlife habitat in this particular area. [Foster 1956]

In Pennsylvania, selective basal spraying resulted in a stable shrub community with value for wildlife:

> The low blueberries, 6-24 inches high, are an abundant food supply for raccoons, bear, and birds. Goldenrod and fern-covers harbor an insect population needed by nestling grouse and turkey chicks. The taller shrubs at the side, the various dogwoods, viburnums, and hollies retain their berries until late in the winter. All these, as well as the colorful azaleas, give ample browse for deer. Rhododendron, laurel, and juniper provide the necessary cover for protection from enemies. [Ibberson and Egler 1951]

Selective basal spraying increased species diversity and kept valuable wildlife plants on a Connecticut ROW:

> As a result of the selective uses of herbicides, more than 48 species of shrubs and vines have been preserved along this limited section of right-of-way. In addition, four species of low-growing trees and over 80 species of herbaceous perennials (10 ferns, 15 grasses, sedges and rushes, and 59 forbs) add to the floristic diversity of the demonstration area .... Herbs of especial botanical or ornamental value include ladies' tresses *(Spiranthes cernua)*, butterfly weed *(Asclepias tuberosa)*, and cardinal flower *(Lobelia cardinalis)*. [Niering and Goodwin 1974]

Effects on Other Sites

Table 22.2 lists some uses of herbicides in habitat management. One of the earliest documented uses specifically for wildlife was in northern Michigan, where aerial spraying created openings for sharp-tailed grouse (Boyce et al. 1953). The treatment was of little value to the grouse, but it stimulated aspen resprouting and root suckering that benefited deer. This prompted substantial broadcast spraying for wildlife management in Michigan. Ruch (1956) reported profuse sprouting of willow and aspen. After 2 years, there was an increase of 4205 stems per acre, of which 66 percent were aspen, 29 percent willow, and 5 percent other species. Jenkins (1955) also found that herbicides stimulated resprouting of aspen. Gysel (1957) showed that herbicide treatment of a predominantly oak overstory improved habitat for certain wildlife, but the chemical treatments generated only one-half the browse produced by axe cutting. Use of 2,4-D often encouraged growth of blackberry and certain other desirable plants (Coulter 1958). Hamilton and Buchholtz (1953) and Zorb (1957) used broadcast spraying to prepare seedbeds for wildlife food plots.

In Wisconsin, McCaffery et al. (1974) found that to maintain wildlife openings that have been invaded by aspen, willow, and choke-cherry, pelletized picloram is less expensive, more convenient, and maintains the openings better than do liquid herbicides and mechanical methods. No root suckering of aspen or willow was evident after 2 years; broadleaved herbs did not reinvade treated spots, possibly because of residual chemicals or the invasion of bluegrass. Because of effects on nontarget species, including many important deer foods, the authors did not recommend broadcast application of picloram.

In Minnesota, Krefting et al. (1960) and Krefting and Hansen (1969) found that aerial spraying of 2,4-D

Table 22.2 Some Reported Uses of Herbicides in Wildlife Habitat Management

Herbicide and reference	Location	Year	Acres treated	Method	Cost/acre	Purpose and results
Various herbicides (Bowers 1954)	PA	1949-1951	26 studied	Selective ground spraying		Rabbit cover improvement by cutting and herbicide treatment along woodland edges, fence rows, and other areas. Herbicides showed promise in controlling tree growth and developing rabbit cover.
2,4,5-T (Liscinsky 1966)	PA	About 1952-1962	Limited sutdy areas	Selective foliage, basal spary, and stump spray		Develop clearings and shrubby thickets for woodcock breeding, nesting, and resting covers. Selective stump and basal spraying considered of practical value.
2,4-D (Ammann 1963)	MI	1956-	10,849	Aerial spray	$3.50	Control woody plants on sharp-tailed grouse habitat; fairly successful.
Dalapon and 2,4-D (Zorb 1957)	MI	1955-1956	11 (Study area)	Ground spray		Chemical tillage for establishment of wildlife food patches; effective grass control.
2,4-D, 2,4-D and TCA Mixture, Dalapon, Amitrole (Steenis et al. 1958)	MD, NY, DE, and elsewhere	1955-1958	Study areas			Cat tail control to improve waterfowl habitat; 2,4-D ineffective; 3,4-D and TCA fairly effective; Dalapon good to erratic control; Amitrole good results.
2,4-D (Krefting and Hansen 1969)	MN	1958-1966	16 (Study area)	Aerial spray	$4.00	Increased deer browse quality and quantity; considered cheap, convenient method where accessibility difficult or labor for cutting costly.
2,4-D and/or 2,4,5-T (Landes and Hamilton 1965)	IN and OH (National Forests)	1965	Small study areas	Selective basal spraying and stump and frill treatment	$30.00-$48.00	Development and maintenance of shrub edges in wildlife openings and utility ROWs in national forests.
2,4-D and 2,4,5-T Mixture, Picloram, 2,3,6-TBA and Dicamba (Scott 1965)	MD	1965	Research plots	Foliage sprays		Control of multiflora rose; good results.
Appropriate herbicide (Anon. 1967)	WI	1967	12 mi of roadside studied	Selective cutting, stump treatment, and basal spraying	Cheaper than mowing with added benefits	Maintenance of shrubby vegetation on roadsides for scenic values, erosion control, wildlife habitat, and safety requirements. Developed and endorsed by many Wisconsin agencies.
Tordon (McCaffery and Creed 1969)	WI	1968	About 82	Ground spray	$11.40-$28.13	Maintain grassy forest openings for deer forage.
Herbicides (Nixon 1968)	OH	1968	Guides for state wildlife areas	Selective ground spraying		Selective release of squirrel food-producing shrubs and small-growing trees on old field edges and of mast trees.
2,4-D and 2,4,5-T (Linde 1969)	WI	1959-1964	700	a. Aerial spray b. Ground foliage spray	a. $5.57 b. $1.98-$3.00 (Meadows) $19.00 (Dikes)	a. Woody plant control in meadow development. b. Meadow development and brush control on impoundment dikes.
2,4-D and/or 2,4,5-T (Davis 1969)	OH	1969	Guides for management on wildlife areas	Selective basal spraying and stump or frill treatment		Release of fruiting shrubs in old fields, openings, and edges for ruffed grouse.
Herbicides--soil-sterilants (Sanderson and Bellrose 1969)	US and Canada	1969				To manipulate wetland vegetation.
Tordon 10K (McCaffery et al. 1974)	WI	a. 1972 b. 1972-1973	a. 146 b. 954	Selective use of pellets	a. $19.15 b. $13.41	Selective control of woody plants in wildlife openings; good results.

continued

Table 22.2 (Concluded)

Herbicide and reference	Location	Year	Acres treated	Method	Cost/acre	Purpose and results
2,4-DP (McCaffery et al. 1974)	WI	1972-1973	a. 974 b. 620	Stump spray	a. $21.06 b. $19.06	Selective control of woody plants in wildlife openings.
2,4,5-T and 2,4-D (Milonski 1975 pers. comm. to Landes)	MO	Recent years	200/yr. 700/yr.	Ground foliage. Basal spray and tree injector.		Eradicate unwanted woody plants from old fields. Selective removal of unwanted stems in forest stands to increase mast and forage.
Simazine, Dalapon, Amitrole-T, and/or Amizine-W (Wilson n.d.)	IN	No date, current management guide		Ground spray in strips or spots		Improve survival of woody cover plantings by removing competing grasses and weeds.
a. Bladex b. Paraquat CL c. Atrazine d. 2,4-D and 2,4-DP 3. Tordon (Cannon 1975 pers. comm. to Landes)	OH	1974	a. 346 b. 120 c. 775 d. 265 e. 30	a, b, and c: Tractor boom sprayer. d. Treating individual stumps--235 e. Foliage spray		a, b, and c: Cornfield weed control for Canada goose and upland game management. d and e: Selective release of shrubs in old fields and forest openings.
a. 2,4,5-T b. Silvex (2,4,5-TP) (Dalziel 1975 pers. comm. to Landes)	IA	a. 1968-1970 b. 1972-1973	a. 250/yr. b. 62.5	a. Aerial spray b. Basal and frill spray		a. Willow control in marsh; fair results 1 yr., excellent 2 yrs b. Release of desirable tree species in timber stands.
2,4,5-T or 2,4,-D and 2,4,5-T (Landes & Hamilton 1965)	IN and OH (National Forests)	a. FY 1975 b. FY 1974 c. FY 1973	a. 150 b. 34 c. 54	Selective basal, cut stump, and frill spray	a. $30.00-$50.00 b. $100.00 c. $100.00	Selective development and maintenance of shrubby cover in old fields; satisfactory except for root-suckering species.

Source: From Landes 1976.

effectively reduced (common) hazlenut and other low-preference browse species and increased the supply of better browse plants for deer in trembling aspen, jack pine, oak, and upland brush cover types. Basal broadcast spraying of 2,4-D in a stand of pole-sized balsam fir and white spruce stimulated resprouting of mountain maple (Krefting et al. 1956); spring spraying produced more browse than did fall applications. Selective herbicide application maintained desirable plant species for wildlife along edges of openings on National forest lands in Indiana and Ohio (Landes and Hamilton 1965).

In western Oregon, the response of wildlife to herbicide-induced changes depends on habitat preferences. Borrecco et al. (1972) found that aerial spraying reduced the number of grasses, forbs, and overall ground cover, while Douglas-fir and most shrubs survived better on treated areas. These changes affect the seasonal use of plots by deer. Deer mice increase, while grass-loving species, such as the Oregon vole, decrease. Trailing blackberry, a preferred food of mule-tailed deer, grow more vigorously.

Mueggler (1966) and Lyon and Mueggler (1968) found that sprouts from shrubs preferred by elk and deer did not continue to grow well after aerial spraying. The optimal time of application varied among individual plant species, and no one best time for all purposes was determined. All treatments, regardless of season, killed redstem ceanothus *(Ceanothus sanguineus)*, the most desirable browse plant in the study area. Thus, Mueggler (1966) concluded that 2,4-D and 2,4,5-T should not be used where redstem ceanothus is abundant.

In Virginia, Trumbo and Chappell (1960) studied habitat responses to selected basal applications of monuron and fenuron and to frill treatments of ammate and 2,4,5-T. They concluded that herbicides showed potential for creating wildlife clearings and controlling undesirable trees and shrubs. In west central Alabama, Carter et al. (1975) found that plots treated by selective herbicide application had more diverse wildlife habitat than did mechanically treated sites. Applying herbicides aerially on upland, pine, and hardwood sites in the Southeastern United States may benefit deer, rabbit, and (temporarily) grouse, but may harm squirrel, turkey, and raccoon populations if large areas are sprayed (Chamberlain and Goodrich 1962). Brunett (1971) compared effects of herbicide application, cutting, and burning on a wide floodplain in Louisiana. Sprouting on herbicide-treated plots was poor compared to that on the

cut and burned plots during the first growing season after treatment; during the second growing season, sprouting was equally abundant on all plots. Brunett also found that nutritive value and usage of sprouts on the herbicide-treated plots were much poorer than on the cut and burned areas.

Broadcast spraying blackjack and post oak brush in Oklahoma with herbicides such as 2,4,5-T and silvex killed 50 percent or more of the oaks and released native grasses (Elwell 1968). The dead trees stood for 10 years or longer and protected the soil from erosion. In the California foothills, frilling and stump treatments with herbicides controlled oaks and caused a five-fold increase in ground forage after 3 years (Harvey et al. 1959).

In contrast, Tietjen et al. (1967) observed that broadcast spraying of 2,4-D in a mountain meadow in western Colorado reduced forb abundance and, as a result, reduced populations of the western pocket gopher by 80 to 90 percent. Populations of other small mammal species were not affected. Keith et al. (1959) reported similar results in another area of Colorado.

23 PLANTING AND SEEDING

For several decades wildlife managers have been concerned with planting and seeding to provide wildlife food and cover, control soil erosion, and inhibit growth of unwanted vegetation. Numerous studies (Edminster 1941; Graham 1941, 1942, 1947; Dambach 1945, 1948; Allen 1949; Edminster and May 1951; Anderson and Compton 1958; Anderson, W.L. 1965) have documented effects of planting and seeding on wildlife, mostly on farmland and public wildlife management areas.

Both short- (1 to 5 years) and long-term effects have been documented, with most of the emphasis on planting and seeding to encourage a single species (e.g., bobwhite, ruffed grouse, white-tailed deer). Literature on planting and seeding ROWs for wildlife is relatively sparse and based primarily on studies in the mid-Atlantic and Southeastern United States.

PLANTING AND SEEDING ON RIGHTS-OF-WAY

Several significant studies of planting and seeding ROWs were made in the Southeast to determine which species were capable of producing cover that is both valuable to local wildlife and compatible with ROW maintenance. The most economical method to provide good wildlife cover and food, according to Woodhouse and Baynes (1976), is to plant tall fescue *(Festuca arundinacea)* and Chinese lespedeza in the main part of the ROW and a 12 foot wide strip of VA-70 type shrub lespedeza along one side. Planting Chinese lespedeza and annual rye (*Lolium* sp.) on ROWs in Georgia eliminated brush sprouting and seeding, and stabilized soils (Leith 1974). Kihl (1973) advocates seed mixtures of fescue or Chinese lespedeza for erosion control, and 50 percent legumes and 50 percent grasses for wildlife food and cover. The primary ground cover seeded on ROWs in the Southeast, except Florida, is Chinese lespedeza, which serves well as a soil stabilizer but has limited value for wildlife. Seeding bahigrass *(Bahia spp.)* with crimson clover *(Trifolium pratense)* or Kobe lespedeza *(Lespedeza striata)* effectively retards brush invasion and provides nutritious summer and winter food for local game species (Arner 1966). Annual mowing is the only maintenance required.

> A greater amount of nutritious wildlife food can be produced and a more economical reduction of woody vegetation can be obtained through the use of mechanical equipment (bulldozer and cultivator) or controlled burning when these treatments are combined with the application of fertilizer and seed, than any other technique now in current use. [Arner 1960]

Arner (1960) also reported that seeding maple-leaved viburnum and hairy lespedeza on unscarified soils failed and that hog-peanuts showed some promise, especially in areas with bracken fern. He demonstrated that fertilizing was necessary for survival and seed production of seeded legumes, partridge-pea, and Kobe lespedeza.

Success with planting and seeding on ROWs has prompted a number of utility companies, especially in the Southern United States, to experiment with seeding and to encourage owners of land traversed by ROWs to do the same (North Carolina Wildlife Resources Commission 1975). Many of the utilities recommend that interested owners seed with browntop millet, grain sorghum, rye, and oats, or grasses and shrubs. The Tennessee Valley Authority (TVA) seeds ROWs with the objectives of the local landowners in mind; if the landowner has no preference, Kentucky 31 fescue *(Festuca arundinacea* var.*)* is sown (Fowler et al. 1976). Although not valuable to most wildlife species, this fescue is excellent for controlling erosion and it is soon replaced by native plants.

PLANTING AND SEEDING ON OTHER SITES

Grasses and Legumes

Various species of grasses and legumes have been recommended for wildlife food and cover. Burger (1973) recommended native grasses because they provide a tall, overhead canopy with open travel space at ground level for small animals. These grasses furnish better cover during northern winters than do brome or other exotics. Richards (1973) stressed using native warm-season grasses, particularly little bluestem, big bluestem, and switchgrass, rather than cool-season grasses in the Northeast. Although they are more difficult to grow than cool-season grasses, these species were recommended for newly-cleared sites. Burger (1973) reported that perennial grasses and forbs provide much good food over a long season when planted in mixtures. Plant and seeding disturbed sites is common in the West. Plummer et al. (1955) and Hungerford (1965) recommend a mixture of species on mountainous lands in the intermountain eco-regions. Tables 23.1 and 23.2 list food patch mixtures and seeding recommendations for wildlife plantings in the Eastern United States. Table 23.3 lists the adaptation and uses of species for seeding in various precipitation and vegetation zones on lowland and mountainous areas in the intermountain ecoregions.

Arner (personal communication in Hubbard 1962) recommended sowing fescues, rye grasses, bush-clovers, partridge-peas, and beggar peas for quail management in

Table 23.1 Food Patch Mixtures for Planting in Spring for the Eastern United States

Species	Pounds
Mixture #1 for 5 acres	
Buckwheat	10.0
Grain sorghum	9.0
Foxtail millet	15.0
Proso millet	15.0
Kaffir	9.0
Sudangrass	5.0
Soybeans	15.0
Cowpeas	13.0
Vetch	9.0
Total pounds	100.0
Mixture #2 for 5 acres	
Buckwheat	15.0
Foxtail millet	15.0
Sudangrass	15.0
Soybeans	25.0
Cowpeas	30.0
Total pounds	100.0
Mixture #3 for 5 acres	
Proso millet	17.5
Grain sorghum	25.0
Sunflower	7.5
Total pounds	50.0

Source: From Shomon et al. 1966.

the Southeastern United States. Joselyn and Tate (1972) established that reproduction of ring-necked pheasants on roadsides in Illinois could be substantially increased by replacing bluegrass sods with a mixture of brome and alfalfa (*Medicago* sp.).

Wildlife managers have long advocated use of legumes in wildlife food and cover patches. Legumes dominate the list of perennial forbs high in wildlife and conservation values because they tend to furnish more food (at least as seed) than do grasses, and also promote nitrogen fixation in the soil (Burger 1973). Seeds of legumes often best satisfy the nutritional needs of stressed animals, because they contain up to 31 percent crude protein and are easy to digest (Short and Epps 1976).

The lespedezas have been used extensively in wildlife programs in the Southern United States (Davison 1945). Hunter (1954), Rosene (1956), and Gehrken (1956) noted that Chinese lespedeza is site-tolerant, easy to seed, and good for erosion control and wildlife cover. Hunter (1954) reported that bobwhite preferred lespedeza to natural borders for roosting cover and foraging, on a year-round basis, and recommended Chinese and an annual lespedeza as best suited for conditions in Arkansas. Arner (1951), however, reported that Chinese lespedeza was not very palatable to wildlife because of its high tannic acid content. Chinese lespedeza will produce excellent soil-binding cover on erodible slopes and poor soils where few other plants can survive (Burger 1973). However, the wildlife value of bicolor lespedeza *(Lespedeza bicolor)* has been highly overrated. Rosene (1952) reported on its several limitations: "First, border plantings 10 years old and over give ground rapidly to woody plant invasion. Second, many plantings lose seed production by their fifth year, and third, a considerable investment in time, fertilizer, and farm equipment seems to be necessary."

The disadvantages of bicolor lespedeza as a food for bobwhite have been well-documented (Blackwell 1955; Durell 1955; Gehrken 1956; Rosene 1956). Other annual species of lespedezas, primarily Kobe and Korean, have been shown to be excellent soil stabilizers when combined with Chinese lespedeza (Hunter 1954).

Shrubs and Low-growing Trees

Among the numerous shrub and tree species planted for wildlife, those most widely used are autumn olive *(Eleaegnus umbellata)*, multiflora rose *(Rosa multiflora)*, Chinese lespedeza, and several species of viburnum and dogwood in the East, and sagebrush, saltbush, bitterbrush, and snowberry in the West. McArthur et al. (1974) recommended sagebrush, rabbit brush, mat saltbush, bitterbrush, and snowberry as the most valuable wildlife forages for big game in Utah. Beale and Smith (1970) reported that during the late fall and winter, when nearly all forbs were dry, the diet of antelope was over 91 percent browse—mostly sagebrush and black sagebrush. After a 10 year study in California, Hubbard (1962) recommended bitterbrush as the most valuable herbage producer as well as the most palatable and nutritious plant for deer in the Southwest. Aldon (1973) recommended four-wing saltbush in New Mexico as an excellent soil stabilizer, an all-season forage plant for grazing animals, and good food for cover for wildlife. Borrell (1950) recommended Russian olive *(Eleaegnus angustifolia)* as one of the best food and cover plants in the West and Midwest.

In the East, Edminster (1950) recommended seven species for use as wildlife food: silky dogwood, autumn olive, Chinese lespedeza, tartarian honeysuckle, northern bayberry, multiflora rose, and purple-osier willow *(Salix purpurea)*. He found that tartarian honeysuckle offered good wildlife shelter, especially for shrub-nesting birds, and summer and early fall food for many songbirds. Sheldon and Causey (1974) found Japanese honeysuckle to be the most important year-round food for deer in Alabama. The fruit and dense vegetation of Japanese honeysuckle furnishes food and cover for many other species of mammals and birds (Jackson 1974). Thickets of autumn olive also furnish cover and food for many species of wildlife (Allan and Sheiner 1959). The berries are particularly attractive to songbirds, bobwhite, ruffed grouse, and ring-necked pheasant. Autumn olive is the

Table 23.2 Seeding Guide for Wildlife Plantings in the Eastern United States

Seed	Rate of seed per acre	Lime	Fertilizer	Size of patch	Planting time
Food patch mix #1, #2	20 lbs	According to lime requirement test for 6-6.5 pH	300-400 lbs per acre 5-10-10	0.25-1 acre	Spring
Food patch mix #3	10 lbs	According to lime requirement test for 6-6.5 pH	300-400 lbs per acre 5-10-10	0.25-1 acre	Spring
Rye	3-4 pecks	According to lime requirement test for 6-6.5 pH	300-400 lbs per acre 5-10-10	0.25-1 acre	Early fall
Wheat	1-1.5 bu	According to lime requirement test for 6-6.5 pH	300-400 lbs per acre 5-10-10	0.25-1 acre	Early fall
Soybeans	0.5-2 bu	According to lime requirement test for 6-6.5 pH	300-400 lbs per acre 5-10-10	Up to 5 acres	Late spring
Corn	10 lbs; 40 in between rows	According to lime requirement test for 6-6.5 pH	400-500 lbs per acre 5-10-10	Up to 5 acres	Late spring
Japanese millet	25 lbs	According to lime requirement test for 6-6.5 pH		0.25-1 acre	Late spring
Buckwheat	1-1.5 bu	According to lime requirement test for 6-6.5 pH	300 lbs per acre 5-10-10	0.25-1 acre	Early summer
Birdsfoot trefoil with grass	6 lbs with 3 lbs orchardgrass	According to lime requirement test for 6-6.5 pH	At seeding 300 lbs per acre 5-10-10 Annual top dressing 300 lbs 0-14-14	0.25-1 acre	Early spring or late summer
Sericea lespedeza	15 lbs	Maintain pH 5.8	At seeding 300 lbs per acre 5-10-10 Annual top dressing 300 lbs 0-14-14	Long strips	Spring
Bicolor lespedeza	16 lbs	Maintain pH 5.8	At seeding 300 lbs per acre 5-10-10 Annual top dressing 300 lbs 0-14-14	Long strips	Spring

Source: From Shomon et al. 1966.

Table 23.3 Adaptation and Recommended Use of Species for Seeding in Various Precipitation and Vegetation Zones on Lowland and Mountain Areas in the Intermountain Region

Species	Lowlands				Mountain lands		
	Below 8 in precipitation	8-12 in precipitation	Above 12 in precipitation	Salty soils	Mountain brush[b]	Aspen[c]	Subalpine
		Grasses[d]					
Sand dropseed	C	C					
Bottlebrush squirreltail	C	C					
Indian rice-grass	C	C	C		C		
Russian wild rye	C	B	B	B	C		
Crested wheatgrass (standard)	B	A	A		B		
Crested wheatgrass (fairway)	B	A	A		A	C	
Bulbous bluegrass		X	X		X		
Bluebunch wheatgrass		B	B		B	C	
Beardless wheatgrass		B	B		B	C	
Pubescent wheatgrass		C*	A		A	B	
Intermediate wheatgrass		C*	A		A	B	
Western wheatgrass		C*	B		C	C	
Beardless wild rye		C*	B	C	C	C	
Big bluegrass		C*	C		C		
Mountain rye			X		X		
Great Basin wild rye			X		B	C	
Tall wheatgrass			B	A	B	C	
Tall fescue				B*		C	
Bulbous barley					B	C	
Blue wild rye					B	B	
Bearded wheatgrass					B	B	
Smooth brome (southern strain)			C*		A	A	B
Smooth brome (northern strain)					C	A	A
Slender wheatgrass					B	B	C
Mountain brome					B	B	C
Meadow brome					B	B	B
Kentucky bluegrass					X	X	X
Tall oat grass					A	A	A
Orchardgrass					B	A	C
Reed canary-grass					B*	B	B*
Timothy					B*	A	B
Meadow foxtail					B*	A	B
Sheep fescue (Sulcata)						C	C
Red fescue (sod-forming)						C	C
Subalpine brome							B
Winter rye		X	X		X		
		Legumes[d]					
Alfalfa		C*	B		B	C	
Sicklepod milk-vetch		C*	B		B	C	
Chickpea milk-vetch		C*	B		B	B	C
Yellow sweet clover			X*	B*	X	C	
Strawberry clover				X*			
Birdsfoot trefoil					C	C	
Mountain lupine						C	B
Alsike clover						C*	C*

continued

Table 23.2 (Concluded)

Species	Lowlands				Mountain lands		
	Below 8 in precipitation	8-12 in precipitation	Above 12 in precipitation	Salty soils	Mountain brush[b]	Aspen[c]	Subalpine
Other broadleaf herbs[d]							
Summer cypress				X			
Five-hook bassia				X			
Palmer penstemon		X	X		X		
Wastach penstemon					X	X	
Showy goldeneye					X	X	X
Common cow parsnip					C	C	C
Sweetanise					C*	C	C
Shrubs[d]							
Winter-fat	C	C	C		C		
Four-wing saltbush	C*	C	C		C		
Antelope bitterbrush		C	C		C	C	
Oldman wormwood			X		X	X	
Blueberry elder			X		C	C	

Source: From Plummer et al. 1955.

[a]Letters indicate the following:
A--Proved to be productive and widely adapted for seeding throughout the zone or type.
B--Valuable over much of the zone or type, but value or adaptation either more restricted or not as well determined as species designated A.
C--Value or adaptation more restricted than those species designated B, but useful in some situations.
X--Recommended for special uses or conditions, usually as pure stands.

[b]Applicable also for seeding openings in the ponderosa pine zone.

[c]Applicable also for seeding openings in Douglas-fir and spruce timber.

[d]An asterisk (*) after a letter indicates that a species is adapted only to better than average sites in the zone or type.

shrub most preferred by wildlife managers in Michigan (Zorb 1966). Edminster (1950) recommended the planting of bittersweet because it produces viney tangles and fruits for ruffed grouse, pheasant, bobwhite, rabbits, squirrels, and songbirds.

Edminster (1950) also found that multiflora rose was one of the best shrubs for erosion control, wildlife cover, and farm conservation. Use of this shrub, however, is controversial. Many consider it a pest because it spreads easily from seed (Scott 1965), but Burger and Linduska (1967) report that this was not the case in 5 to 7 year old hedgerows which appeared to be used by bobwhite as headquarter areas and travel lanes (see also Kabat and Thompson 1963). Gysel and Lemmien (1955) found that of the seven species of trees and shrubs investigated in Michigan, multiflora rose was the only species used intensively by cottontail, white-tailed deer, and songbirds for both food and cover throughout most of the year. Gordinier (1958) recommended several species for wildlife management in southern Michigan: autumn olive, honeysuckle, multiflora rose, lespedeza, western sand cherry *(Prunus besseyi)*, silky dogwood, and highbush-cranberry. For improved wildlife habitat, he also advocated spacing rows 6 to 8 feet apart, rather than contiguous rows, to permit forb and grass growth between shrubs.

LIMITATIONS AND SPECIAL USES

The literature clearly indicates that planting and seeding

can be an effective and economical technique for ROW maintenance and wildlife management. There are, however, limitations to these techniques. Sometimes the species that is best for retarding growth of unwanted trees may not be the best for wildlife food and cover or for erosion control. Economy and/or site limitations may also restrict the possible seed mixtures and species for planting. In the South, in particular, fertilizer or lime is often needed to insure the success of certain legumes, grasses, and shrubs; the rising cost of fertilizer may limit its use in the future. In arid regions of the United States, lack of precipitation may hinder revegetation after seeding. A study by Northern Arizona State University (1975) showed that on a ROW through a pinyon—juniper woodland in Arizona, unseeded areas revegetated more rapidly than seeded areas. In other areas of the United States, preparation of an adequate seedbed may be costly.

Nevertheless, reseeding will probably continue to be used on ROWs and other sites where quick revegetation is needed to prevent soil erosion and to restore biotic productivity (such as after severe burns or clearing of steep slopes or streambanks). The numerous choices of seed mixtures and plant species may also make this technique valuable in other special cases, such as in management of rare or endangered species.

24 STREAMBANK MANAGEMENT

Stream crossings deserve special consideration because of the fragility and importance of riparian ecosystems. Opportunities for direct instream management of fish and wildlife resources (e.g., construction of current deflectors and shelters) are limited by economic and/or legal constraints. Wise management of the streambank vegetation, however, is necessary and feasible for both ROW maintenance and natural resources management. Streambank vegetation can serve the following ecological purposes (Meehan et al. 1977):

1 Stabilize streambanks to prevent soil erosion and sedimentation.
2 Shade the stream, thus minimizing fluctuations in water temperature and maintaining cooler water.
3 Provide food and cover for both terrestrial and aquatic wildlife.
4 Provide overhead cover and shade to protect fish from predators.
5 Produce terrestrial insects that fall into the water and become fish food.
6 Provide leaf litter that stimulates aquatic insect populations, the staple food of many stream-dwelling fish species.

Most utility companies are required by law to minimize adverse impacts on streams. Accordingly, most have some type of policy for curbing erosion and sedimentation. Some utilities also avoid using herbicides at stream crossings (Bonneville Power Administration 1976). Mortars or helicopters for carrying lead lines allow minimal disturbance of streambanks during transmission line installation; however, this practice can be expensive (Miller 1968; Electrical World 1972). Goodland (1973a) recommended that this practice be mandatory for stream crossings and steep slopes. Tower siting and design that maximizes line clearance over streams can further lessen clearing needs and subsequent disturbance (Dohrenwend 1973). However, where disturbances are unavoidable or have already occurred, some active streambank management may be necessary. Periodic control of streambank vegetation may also enhance fish and wildlife habitat.

Effective techniques for erosion control as well as the importance of preventing soil erosion and sedimentation are well documented (American Society of Agricultural Engineers n.d.; Young 1968; and U.S. Forest Service 1969). Numerous authors have recommended planting and seeding for erosion control along streams. Some have recommended certain plant species that are also important food and/or cover for wildlife. Yoakum and Dasmann (1971) suggested that Russian olive provides important wildlife food as well as prevents erosion when planted on streambanks to prevent erosion and provide wildlife cover. Lagler (1952) recommended planting canary-grass, fescues, sod, willow, white cedar, and smooth alder on low streambanks, and pine and hardwoods on high banks.

Brush control can sometimes cause erosion along streams. Day (1976) studied effects of herbicide application at nine transmission ROW crossings: one small, one medium-sized, and one large stream in New Hampshire; three similar streams in West Virginia; and three in Georgia.

> Repeated broadcast spraying of herbicides on riparian areas is undesirable and results in vegetation largely of low-growing herbaceous plant communities, unsuitable as a natural buffer zone for stream habitat. This study indicates that accelerated streambank erosion (i.e., caving, deposition, siltation) and increases in temperature and light intensity can be attributed to the manipulation of riparian vegetation. [Day 1976]

The literature indicates that a variety of plants are suitable for erosion control if streambanks are undisturbed. However, ROW stream crossings are attractive to fishermen, hikers, etc., and bank trampling often hinders revegetation. Thorny plants or brushy tangles may effectively discourage foot traffic on erosion-prone streambanks, but this technique has received little attention. Prickly-ash, hawthorn, black raspberry, blackberry, and wild rose controlled erosion by discouraging foot traffic as well as anchoring the soil on an erosion-prone riverbank in northern Michigan (Taube 1967). Fallen trees and brush deter people from trampling erodible banks of a popular Michigan trout stream (Schmidt and Rusz 1974).

Streambank vegetation also affects water temperatures (Brown 1969, 1970; Brazier and Brown 1973). Change in stream temperature may be one of the most important impacts of ROWs (Herrington and Heisler 1973). Table 24.1 indicates the temperature changes that might occur with removal of shade and

Table 24.1 Increases in Stream Temperature that Might Occur with Removal of Shade

Length of stream exposes (ft)	Rate of flow (cu ft/sec.)	Flow direction	Temperature change (°F)
1,100	1-1.9	E-SE	4
150	.04- .05	S	13
60	.05- .10	N	4
30 (Fireline)	.05- .10	N	2

Source: From Brown 1969.

suggests that ROWs may expose sufficient lengths of stream to cause substantial changes in temperatures. Groundwater, however, could moderate such effects. The sensitivity of coldwater fishes to increases in stream temperature is well-documented (Lagler 1952; Hynes 1970).

Streambank vegetation can provide important fish cover, particularly in small streams (Lagler 1952; White and Byrnildson 1967; White 1973). Dense, overhanging vegetation is usually more effective fish cover than trees set back from the water's edge. White (1973) stated that ". . . even quite broad and dense coverings more than a fraction of a meter (a foot or two) above water surface, such as tree canopy, serve poorly in comparison with objects in the water or very close above stream surface." Studies by McCrimmon and Kwain (1966) and others of trout responses to vertical variation in cover support this statement.

The role of streambank vegetation in providing fish cover in the United States is thoroughly discussed by White and Byrnildson (1967). Some of their conclusions and recommendations regarding bank vegetation along Wisconsin trout streams are summarized below:

1 Low, overhanging vegetation forms excellent shelter for trout. Tall grasses and low brush are best because they provide trout with shade as well as protection from physical disturbances.

2 Trees and high brush that shade important aquatic plants, such as watercress *(Barbarea vulgaris)*, waterweed *(Elodea canadensis)*, and swamp-buttercup, as well as terrestrial grasses and low shrubs, should be removed from banks of streams that will not be excessively warmed by the sun (i.e., those receiving groundwater). Planting trees along streams is not recommended unless reducing stream temperatures is critical. Controlled burning, selective cutting, and selective use of herbicides are possibilities for controlling unwanted trees and high brush along streams.

3 Small willows protect banks from erosion and do not shade streams excessively. Many types of willows maintain relatively deep, tough root systems that control erosion and form banks with inverse ledges and grooves where trout hide. To develop and maintain dense stands of saplings necessary for continuous "root revetment," willows require basal pruning at intervals of about 3 years. Large willows can be detrimental because their shade prevents growth of dense stands of sapling willows, grasses, and aquatic plants. In addition, their limbs split and break easily, fall into streams, and often cause dams that can be detrimental.

4 Alders serve as good cover only when their branches actually drape in the water. They are beneficial only on streams wider than 40 feet and should be prevented from forming dense, continuous thickets along small trout streams.

5 Grasses mixed with broadleaved annuals are best for developing food-producing turfs on streambanks. Streams less than 15 feet wide should be kept entirely free of brush. Along streams 15 to 30 feet wide, very low bushes will not cause damage, but high brush and trees should be cut regularly or eliminated.

6 Canary-grass is excellent for stabilizing banks and providing overhanging cover for trout. It is durable, it grows in dense, continuous stands 2 to 8 feet high, and it drapes in the water during all seasons. Reed canary-grass sometimes dams extremely small channels and so should not be seeded along streams less than 4 feet wide. Many other herbaceous species (e.g., sedges, short grasses) are less beneficial. Bluegrass, with its short blades and weak shallow root system, provides only scanty cover; its turf is too weak to protect even moderately steep banks.

Literature on the role of streambank vegetation in providing fish food is scarce. Some terrestrial insects produced on streambank vegetation fall into the water and provide food (Yoakum and Dasmann 1971), but autumn leaf litter may be more important to food production in many streams. Leaf litter adds nutrients and can stimulate primary production in aquatic systems (Goldman 1961). The leaf litter is also colonized by bacteria and is an important food source for stream-dwelling insects (Coopes 1974; Schmidt and Rusz 1974). Streams with banks dominated by deciduous vegetation often produce more aquatic insects than those with coniferous bank cover. Preliminary results of research indicate that the ability of aquatic insects to break down leaf litter varies among tree and shrub species. Further research may show the most advantageous species for streambank vegetation.

No single type of vegetation cover is ideal for each of the ecological roles discussed above. Herbaceous or low shrub communities provide little temperature-moderating shade and contribute minimal organic material to streams. Some herbaceous communities are not effective in controlling erosion and provide little fish cover. Others, such as those dominated by canary-grass, provide good overhanging fish cover and prevent bank erosion. Tall shrubs and low-growing trees provide shade, but this shade may not be beneficial to fish. Wildlife considerations further complicate the choice of

plant community. Clearly, management must serve the needs of each individual stream.

The use or disuse of herbicides around water courses depends upon policy decisions by different Federal and State agencies and individual utilities. The effects of herbicide contamination on water, soil, vegetation, and aquatic organisms are covered by a wide number of references which were not reviewed in this manual.

25 PRESCRIBED BURNING

Prescribed burning, although used extensively for wildlife management and to inhibit growth of unwanted vegetation, is not commonly used on ROWs. Some goals of prescribed burning, however, that may be compatible with ROWs are:

1 Creating favorable conditions for grasses and forbs, especially legumes;
2 Setting back mature woody vegetation to provide browse and other wildlife foods;
3 Returning nutrients to the soil to induce vigorous plant growth and fruiting and to improve nutritive value of plant parts;
4 Stimulating invertebrate populations to provide food for young game birds;
5 Reducing wildfire hazard by removing duff and litter from the forest floor;
6 Removing slash from cutover areas; and
7 Inhibiting growth of unwanted hardwoods.

Literature on prescribed burning to improve wildlife habitat is abundant compared with literature on other techniques. There have also been numerous studies documenting effects of wildfires (Lyon and Stickney 1966; Kruse 1972; Hansen 1973; Irwin 1975).

Despite substantial use and information on the effects of fire on wildlife habitat, prescribed burning techniques are not well-understood. The effects of prescribed burning depend on variables such as climate, composition and density of the pre-fire cover, inherent soil fertility and moisture, intensity of the fire, time of burning, and time between burns. There has been no systematic study of the relative importance of these variables in determining the structure and composition of post-fire communities, because most studies have been based solely on post-fire observations. Furthermore, most studies have been short-term (1 to 5 years) and deal only with effects on a single game species (e.g., deer, elk, or quail). Prescribed burning has seldom been used for management of ROWs. The associated literature is reviewed below.

BURNING ON RIGHTS-OF-WAY

The only significant studies of prescribed burning on ROWs were conducted in the Southeast. Arner (1959) found that on an Alabama ROW burning reduced woody vegetation when herbaceous vegetation was sufficient to produce a "hot" fire. He also found that burning combined with fertilizing and seeding greatly increased food available for bobwhite. Cliburn (1967) reported that summer burning on a Mississippi ROW effectively controlled undesirable woody growth, killing hardwoods and pines up to 2.5 inches in diameter and increasing food for deer and rabbits. Arner (1977) recommended prescribed burning for ROW maintenance and to provide food and cover for wildlife, but cautioned, however, that burning on thoroughly bulldozed ROWs is not necessary and is probably harmful to certain bobwhite foods (e.g., Kobe lespedeza) that require some protective shade (e.g., from grasses) (Arner 1960). Hurst (1972) found more insects on burned ROWs than on sprayed ROWs.

Despite the effectiveness of prescribed burning for ROW maintenance and wildlife management in the South (Arner 1960; Cliburn 1967), power companies have been reluctant to use this technique because, as Arner stated:

> Invariably the power company officials voiced the same following objections: 1) The heat generated by fire would damage the suspended lines. 2) Wooden poles (still used on a number of lines) would catch fire. 3) The cost of preventing fires from spreading to adjacent forest lands would be prohibitive.
>
> Investigations at Mississippi State University refuted the validity of these objections. Maximum-minimum thermometers were suspended approximately 12 feet above the ground where the controlled burning was going on. The maximum temperatures did not exceed 150° F and rarely attained this temperature. A power line right-of-way over one mile in length containing wooden poles was burned without any protection provided for the poles. During the burning operation, the poles were watched by personnel with fire fighting equipment, but no portion of these poles was ignited. Costs would be increased only slightly if poles surrounded by highly inflammable vegetation were protected by plowing a fire lane. In most instances such precautions would not be necessary. It was found that the total cost of fire plowing, burning (using 5 men), and travel time to and from the burned area was well under $7.00 per acre. Foresters for large wood-using industries in the area report strip burning costs as low as $4.00 per acre. [Arner 1960]

Concerns of utilities regarding the use of this technique include possible violations of air pollution standards, safety, liability for damage to adjacent lands, and a general lack of expertise to do the job. Also, in many areas of the country, waiting for proper weather conditions (wind, temperature, moisture, etc.) would be costly to the utility and would disrupt maintenance schedules.

The discussion that follows covers general effects of burning throughout various regions of the country. No discussion of the methodology itself is included.

BURNING ON OTHER SITES

Effects on Plant Nutritive Values

Several authors have demonstrated that burning often improves the nutritive value of plants because it returns nutrients to the soil (Vlamis et al. 1955; Dills 1970). Asherine (1974) measured food values in serviceberry, redstem ceanothus, mountain maple, and willow after burning in Idaho. He found that protein content was lower in redstem ceanothus after burning but higher in the three other species. The fat content of all four species was lower the first year after burning, but higher the second. He attributed the preference of big game for burned sites to the succulence of the plant tissue. In another study in Idaho, Leege (1969) found that spring-

burned serviceberry twig growth was 26 percent higher in protein than unburned serviceberry twig growth. Einarsen (1946) reported that browse in burned areas was richer in protein and enabled deer to survive better in winter.

In the Southeast, Greene (1935) and Daubenmire (1968) found that plants on burned areas contained more protein, calcium, and phosphorus than those on unburned areas. DeWitt and Derby (1955) reported that the protein content of greenbrier, red maple, and flowering dogwood foliage in Tennessee increased significantly the first season after a low-intensity fire, but found no effects in the second year; high-intensity fires produced significant increases in protein content in both years. Lay (1957) found that burning in spring and summer increased the protein content of browse as much as 43 percent and the phosphoric acid content as much as 78 percent, although burning in any season produced some increases over pre-burn levels.

Brunett (1971) compared effects of prescribed burning, cutting, and herbicide application on the palatability and nutritive value of deer browse in Louisiana. He reported that burning and cutting produced more nutritious sprouts of some species, while burning produced superior values in other species (e.g., yaupon). Ribinski (1968) found that wildfires in a mixed-oak forest in Pennsylvania did not greatly alter the protein content of red maple, white sassafras, and witch-hazel.

Effects on Vegetation and Wildlife

The effects of fire vary in different geographic areas (Ahlgren 1963; Vogl 1967). Some of the documented effects of burning on vegetation and wildlife in the United States are discussed below.

Northwestern United States — Several studies in the Northwest have shown that fire can greatly alter vegetation and improve habitat for certain wildlife. In an intensive study of vegetation before and after a fire in northern Idaho, Leege (1968) found increased sprouting of all shrub species following the burn. Moore (1976) reported that redstem ceanothus seedlings (a preferred elk browse) sprouted in abundance after "hot burns." Orme and Leege (1974) found that emergence, growth, and survival of redstem were better after fall burning than following spring burning in Idaho. Hotter fires produced the best results. They recommended that burning be done in the fall after frost cures herbaceous fuels and before rain.

On 9 of 11 winter elk ranges in Glacier National Park (Montana) periodically burned since 1910, secondary succession after burning has been characterized by a mosaic pattern of shrub and conifer communities, related apparently to moisture gradients (Martinka 1974). Leege and Hickey (1971) made a detailed analysis of vegetative composition before and after another burn in Idaho and found that only 3 of 11 species of shrubs did not grow back after burning.

Fire was unsuccessful in stimulating regrowth of mountain-ash (Krefting et al. 1956). Lyon (1976) found that revegetation was very slow after a very hot fire in a lodgepole pine—Douglas-fir community in the northern Rocky Mountains: vegetation covered only 35.7 percent of the area after 4 years. Meadow-sweet and dwarf huckleberry constituted 90 percent of the shrub cover after the fire, and only pre-fire species were found on the burned site.

In a study of another fire in Idaho, Lyon (1966) found that total ground coverage was 69 percent 2 years after the fire, and shrub density and multiple sprouting had doubled. Two species, snowberry and elderberry, became more prolific than before the fire, while mountain-ash was eliminated. Lyon estimated that forage values doubled following the fire, that wildlife values would peak about 15 years after it, and that the vegetation would return to pre-fire character in about 40 years.

North Central United States — Fire has also been shown to benefit wildlife habitats in the North Central United States. Irwin (1975) reported that both moose and deer heavily used a burned area previously dominated by balsam fir and white birch in northern Minnesota. Ahlgren (1966) reported a large invasion of deer mice in burned jack pine tracts in northeastern Minnesota. He noted that most of the diet of deer mice is seeds, which are more available after a fire because of the serotinous cones of jack pine. Red-backed vole and chipmunks did not frequent the burned area until the third year following the fire when there was a greater variety of fruits and seeds and denser cover.

Ammann (1963) found that sharp-tailed grouse habitat in northern Michigan was improved by various treatments including prescribed burning, which increased the abundance of blueberry, an important food for sharp-tailed grouse.

Vogl (1967) summarized effects of fire on prairies, northern pine—hardwoods, bracken grasslands, and pine barrens in Wisconsin:

1. Controlled burning of prairie vegetation produces spectacular increases in green herbage. This is maintained for grasses and forbs the second season after burning, but shrubs return to pre-burn levels. The ground cover reverts to pre-burn conditions within 4 to 6 years, and burning once during this time helps to maintain maximum productivity. Initial burns may have to be conducted almost every other year until the brush is reduced. After that, fires at less frequent intervals, perhaps once every 10 years, can maintain brush prairie savanna.
2. Fires often convert northern pine forest to dense tangles of chest-high bracken fern, blackberry, and hazelnut, and tree sprouts and root suckers. Single burns usually do not transform the site, but only result in a temporarily disturbed version of the pre-burn vegetation. Repeated hot fires can convert northern pine hardwoods to bracken grasslands, "stump prairies," or barrens.
3. Fire, especially hot fires, stimulate bracken grasslands. Fire retards invading trees and expands bracken grasslands. The dense shade-producing canopy of bracken fern and competition from grasses also helps retard tree invasion. The wildlife manager's problem is not so much to maintain such openings, but to make them more productive to wildlife. Intense burns increase juneberry and blueberry (excellent grouse and deer foods) and wild lettuce (*Lactuca*, sp., a deer browse) and decrease the less valuable bracken fern.
4. Hot fires reduce oak and jack pine. Intervals should be about 10 years to allow for buildup of fuels necessary for a hot fire to set back trees and stimulate blueberries and juneberries. Prairie grouse also flourish after such treatments.

Fire is essential to natural reproduction of jack pine. Prescribed burning of jack pine barrens in northern Michigan is part of the on-going management program for the endangered Kirtland's warbler (Mayfield 1960; Line 1964). Jack pine thickets resulted from a wildfire in Wisconsin in 1925; a dramatic increase in the population of snowshoe hares followed (Grange 1965). Fire also stimulates aspen root suckers, a staple of deer and rabbits (Strothmann and Zasada 1957).

In the North Central United States there is lush herb growth following fire (Vogl 1964). Species present on burns are mostly annuals, reproduced by seed, with a few vegetatively sprouting species. Vogl also noted that fire often retards growth of brush species for at least 2 years after burning, allowing other plants, including trees, to become established.

Westemeir (1972) recommended prescribed burning to improve and maintain greater prairie chicken habitat in Illinois. He compared March and August burning:

> . . . nesting hens were more attracted to the vegetation that develops after an August burn . . . . March burns appear better for encouraging the development of native prairie vegetation and stimulating legumes. Burning in August appears better for such domestic grasses as redtop and timothy, which have matured and are essentially dormant in August.
>
> . . . a desirable feature of burning in August in southern Illinois is that nearly 2 months of the growing season are still left, during which a sod can green up before frost . . . March burns usually result in more complete removal of vegetative debris and there is little time for vegetative growth and duff accumulation prior to the initiation of the earliest . . . nests . . . [Westemeir 1972]

Fire has also been used to maintain prairies in Minnesota (Tester and Marshall 1962) and North Dakota (Kirsh and Kruse 1972).

The effects of fire on oak—hickory types in the Missouri Ozarks have been the subject of two investigations. In a 10 year study, Loomis (1977) found that wildlife food grew in large quantities for 4 years after a fire. Thereafter, production greatly decreased but was still well above that on the unburned control area. Lewis et al. (1964) found that summer or early fall burning produced more wildlife food than spring burning. Forbs and legumes (preferred by deer and turkeys) increased, and the proportion of grasses decreased. Hardwood sprout survival was reduced by burning in summer or fall, but not in the spring. However, fall burning was not recommended because of the amount of bare soil it leaves exposed over winter on the steep slopes of the Ozarks.

Northeastern United States — Hallisey and Wood (1976) found that burning scrub oak in central Pennsylvania did not eliminate pre-fire species nor enhance the invasion of new ones. The ratio of herbs, woody shoots, and foliage to the total production also was essentially unchanged by fire. However, total forage production on burned plots was double that on unburned plots, regardless of the number of times they had been burned or the time elapsed since last burning. They recommended burning every 5 years for maintaining maximum woody browse.

Sharp (1971) studied the effects of fire on grouse foods in oak—hickory habitats in Pennsylvania. He found that key food plants, including sedges, panic-grasses, grape, and elderberry appeared after the burn even though none of these could be found before burning. He concluded that fire benefits ruffed grouse habitat by: 1) cleaning up litter and accumulated mulch, 2) rejuvenating plants, and 3) preventing and controlling diseases in grouse food plants. He suggested fires every 2 to 5 years to maintain good grouse habitat.

Euler (1974) noted four times as many songbirds feeding on recently burned areas as on unburned areas in New York. He stated that spring fires are effective in maintaining openings where principle invading species are red maple, sugar maple, and white pine. Arrow-wood and nannyberry, both woody shrubs, produced up to 1.7 new stems for every stem that was burned. Ruffed grouse and white-tailed deer used burned areas extensively.

The most striking change following burns in Connecticut grasslands was the production of more floriferous, more vigorous, and taller stands of bluestem (Niering et al. 1970). Burning forest stands in Connecticut generally reduced the density of smaller stems within the understory with no major observable damage to larger trees up to 12 inches in diameter. One year after burning, there was 100 percent mortality of black birch in the 1 to 2 inch class; stem kill of 1 to 2 inch hickory and black and white oak exceeded 50 percent. Shrub cover, especially greenbrier, was drastically reduced by a combination of fire and subsequent rabbit browsing. However, burning favored spotted wintergreen, flowering dogwood, and shrubby viburnum.

Southeastern United States — In the Southeast, prescribed burning has long been used by both foresters and wildlife managers to maintain subclimax vegetational communities. Table 25.1 summarizes some recommendations of the U.S. Forest Service for burning for wildlife in the South. Annual burning is necessary to maintain high-quality bobwhite habitat:

> Birds especially attracted to recently burned-over ground are robins by the hundreds or thousands, bluebirds, mourning doves in flocks, mature sparrows, both migratory and resident, flickers and other woodpeckers that become feeders on burns, pine warblers, and many others. Quail and turkey are also attracted to burns. [Stoddard 1931]

Lay (1956) found that burning in a southern pine forest increased 3 of the 4 most desirable deer browse species: French mulberry (*Calicarpa americana*), herbs, and viburnum. Yaupon, American holly, greenbrier, raspberries, blackberries, herbs, grasses, and sedges were reduced by the burn.

Burning increased available deer browse in Tennessee (Dills 1970) and in Virginia (Mumaw 1965). Two post-burn growing seasons were required before available browse production in a burned mixed-pine—hardwood forest surpassed that on similar unburned areas (Dills 1970). Burning, therefore, could be effectively and inexpensively used by wildlife managers to manipulate deer range.

Forage grasses and native legumes were more than twice as abundant after a burn on pasture land (Greene

Table 25.1 Some Wildlife and Cover Types for which Prescribed Burning is Recommended by the U.S. Forest Service for Habitat Management in Southern National Forests

Species/group	Summary of recommendations
Wild turkey	Burn pines every 3-5 years; exclude fire from other cover types and transition zones between hardwood swamps and pines; burns in December to February are best.
Bobwhite quail	Burn pine types in winter.
Ruffed grouse	Burn bear oak-dominated slopes to retain openings and to revive decadent or overstory-suppressed bear oak stands.
Mourning dove	Burn open pines; winter burns are preferred.
Woodcock	Burn pine types at 5-8 intervals in early winter.
Wood duck	Burn pocosin, titi, and savannah cover types.
Songbirds	Burn pine stands and openings during winter.
Red-cockaded woodpecker	Burn to maintain parklike stands in winter.
Fox squirrel	Make cool winter burns at 4-5 year intervals in pine types.
White-tailed deer	Burn pine stands on a 3-5 year rotation; favor late winter burns; preserve open prairies by burning.
Black bear	Burn pine stands every 3-4 years.
Wild hogs	Burn pines every 2-3 years during winter for huckleberries, and every 3-5 years where huckleberries are scarce.
Raccoon	Burn to maintain openings and to regenerate bear oak.
Rabbits	Burn pines every 3-5 years.
Alligator	Burn pocosin, titi, and Carolina bays during late summer or fall if they become choked with woody vegetation. An area-wide analysis should precede any use of fire in alligator habitat.

Source: Summarized from U.S. Forest Service 1971.

1935). Prescribed burning improves blueberry production and the quality and quantity of forage (Jenkins 1950). Prescribed burning can help revive decadent or suppressed stands of bear oak and thus improve habitat for ruffed grouse, raccoons, and other wildlife (U.S. Forest Service 1971). Vigorous new stands of reed appear immediately after fire (Hughes 1966); the greatest foliage production of this species is expected 3 to 4 years after burning in open cane, and 2 to 3 years after burning in forested range (Hughes 1957).

Some studies, however, have revealed negative aspects of prescribed burning and indicate that, as elsewhere, the season for burning is important in the Southeast. Brunett (1971) reported that summer burning in Louisiana created favorable conditions for germination and growth of loblolly pine and tremendously decreased the amount of brush. He also stated that burning too frequently (e.g., every 1 or 2 years) in winter can eliminate some choice browse plants. He concluded that burning in winter every 3 years was most desirable and recommended that no summer burning be done on deer range. Stoddard (1963) suggested that there may be temporary reductions in some wildlife foods after burning, since many fruit-bearing shrubs, such as huckleberry, blueberry, blackberry, dewberry, gooseberry, inkberry, dwarf oak, chinquapin, and a few others, cannot fruit the year of a burn. However, they bear heavily 2 to 4 years after fire. Stoddard (1962) and Mobley et al. (1973) recommended against summer burning where there might be significant mortality of ground-nesting birds or other wildlife.

Some authors have stated that fire is generally destructive to pine and hardwood trees in the Southeast (Moore 1956; Dixon 1965). Davis and Cooper (1963) suggested that prescribed burning destroys young pines less than 15 feet high. Moore (1956) found that burns during August in Alabama killed many hardwood saplings and almost eliminated pine reproduction. Winter burns (during the dormant season) usually do not kill hardwoods but simply "knock them back" (Dixon 1965).

Southwestern United States — Prescribed burning has been used extensively in the Southwest to improve livestock range and wildlife habitat. However, most of this burning has been in the California brushfields (e.g., chaparral and chamise types), and in the mesquite, sagebrush, semidesert shrub, juniper—pinyon woodlands, and other shrub and low tree communities where little transmission ROW maintenance is necessary. Hence, active management of transmission ROWs for wildlife in these areas is not likely to be economically feasible.

There have been several studies, however, on prescribed burning and wildfires in some southwest grasslands and in pine—hardwood types in upland areas (Weaver 1951, 1958, 1959; Biswell 1958, 1963, 1967, 1972; Burcham 1959; Kallander 1969; Lawrence and Biswell 1972). Prescribed burning in ponderosa pine communities in California allowed more herbaceous vegetation, greatly reduced tree reproduction in the understory, and added great variety to any ponderosa pine grassland (Biswell 1972). These findings are supported by similar findings of Weaver (1951, 1957, 1958, 1959, 1967) and others.

Heady (1972) reviewed literature on prescribed burning in oak woodland—grass types in California and concluded that fire usually does not significantly alter the pre-fire seed crop in annual-dominated grasslands and has little impact beyond temporary changes in botanical composition. He further stated that prescribed burning is no longer used to control certain undesirable annual grasses and that there is no other reason for extensive burning of annual grassland.

Although there is little literature on the effects of fire on wildlife habitat in areas of the Southwest often invaded by tall-growing trees, it appears that prescribed burning can be effective in increasing wildlife food and cover in ponderosa pine grasslands and certain other cover types. There is little information on burning montane chaparral to improve wildlife habitat; however, the well-documented benefits of burning lowland chaparral types suggest that fire would be effective. Effects similar to those in the Northwestern United States (e.g., vigorous sprouting and fruiting, increased yields of forage) can be expected when shrubs are burned.

However, the literature suggests that results may vary depending on the amount of precipitation after the burn (Gartner and Thompson 1972). Revegetation may be delayed in dry years, so burning in fall or winter may produce more dependable revegetation.

26 ADDITIONAL WILDLIFE HABITAT CONSIDERATIONS

WETLANDS

Wetlands are areas where the water table is at, near, or above the surface of the land during a significant part of most years (Sather 1976). These areas include marshes, mudflats, swamps, bogs, wet meadows, flood plains, and the margins of rivers, streams, lakes, ponds, and reservoirs. Streambank management was discussed in section 24.

ROW ownership, adjacent land ownership, and the narrow width of the ROW make it infeasible for utilities to manage wetlands for wildlife. Instead, utilities attempt to minimize wetland impacts of ROW construction and maintenance.

Construction and maintenance in wetlands may cause direct habitat loss, addition of chemicals and suspended solids, and modification of water levels and flow regimes (Carvell 1976). Besides the direct degradation or loss of habitat for waterfowl, fishes, and furbearers, the fluctuation of water levels caused by flooding or draining may be detrimental to marginal vegetation (Boelter and Close 1974).

In long, linear construction projects, a drainage ditch, spoil bank, or access road may act as a dam that retards or prevents normal water movement. These special features become critical in coastal areas where interference with freshwater flow causes saltwater intrusion into the wetlands (Darnell 1976). Where access roads are to be maintained in wetlands, cross-drainage should be permitted to maintain existing drainage patterns.

Activities such as placement of transmission towers will disturb the submerged soil in the wetland causing redistribution of sediments, nutrients, etc.; increased turbidity; and, possibly, modification of water circulation patterns. Increased turbidity reduces light penetration, which in turn reduces photosynthesis but increases water temperature (Darnell 1976). Damage to aquatic organisms depends on the duration of increase in fine sediment; however, invertebrates recolonize quickly after fine sediment has been removed (Crabtree et al. 1978).

Mortality of waterfowl and other birds (e.g., pelicans, raptors, shorebirds) through collisions with transmission lines in wetland areas is a matter of growing concern (U.S. Fish and Wildlife Service 1978). Recent bibliographies (Avery et al. 1978; Dailey 1978; and Asplundh Environmental Services 1979) summarize the available information on this subject. Compared to other reported sources of mortality, waterfowl losses at transmission lines may not be great overall (Stout and Cornwell 1976; Anderson 1978), but the impact of this mortality source on local populations may be significant (Harrison 1962).

Not only are waterfowl and other birds killed by transmission lines, but the lines may affect the flight behavior of birds (Meyer 1978). The presence of overhead lines and supporting towers may render otherwise suitable wetland habitat unattractive to certain species of birds. Such an effect, however, has never been documented. Research currently in progress in Oregon (Lee 1978) and Minnesota (Welford and Korschgen n.d.), and now being developed in North Dakota (Trauger 1979), will give further insight into the direct and indirect effects of transmission lines on birds in wetland habitat, and will hopefully provide means for predicting future impacts and for mitigating them when necessary. To reduce the incidence of bird collisions, it has been recommended that transmission lines not be sited through wetlands (Anderson 1978; U.S. Fish and Wildlife Service 1978), but not all wetlands are high risk collision areas, and other factors must also be considered when evaluating impacts of powerlines (Meyer 1978).

ENDANGERED/THREATENED SPECIES HABITAT

Perhaps one of the most environmentally difficult situations a utility company faces is that of an endangered or threatened species on an existing or planned ROW. Many endangered/threatened species habitats have already been identified by State or Federal wildlife agencies. For such sensitive habitats, consideration should be given to identifying the extent of the habitats, which could vary from a few square feet to several miles. Sometimes routing around such species habitat may be possible. Close cooperation between utility personnel and State or Federal biologists is needed at this point. A management plan may be developed that is compatible to both the species' habitats and the utility.

While a ROW may create an edge area beneficial to certain wildlife species, at the same time it may also bisect a habitat. Terborgh (1974) pointed out that fragmenting habitats may result in isolated habitats too small to support the species it originally supported. A ROW may act as a barrier to animal movement (Schreiber and Graves 1977) and, in the case of certain endangered species, could possibly cause reproductive isolation (Schreiber et al. 1976). There is currently insufficient information to assess adequately this "barrier effect."

27 SUMMARY

A variety of techniques exists for providing fish and wildlife habitat while maintaining vegetation on transmission line ROWs in a variety of biotic communities. Mechanical techniques to remove vegetation completely often: 1) temporarily eliminate site protection and most wildlife cover, 2) remove or bunch nutrient capital, and 3) maximize microclimate extremes.

The effects depend mainly on pretreatment cover, degree of soil disturbance, and method of slash disposal.

Brush piling is a valuable technique for habitat management and can help minimize adverse effects of clearing to a number of wildlife species. Chipping or burning brush piles is expensive and has little or no wildlife benefit. Studies have shown that bulldozing to simply topple trees can improve habitat for certain wildlife without scarification, but this technique has aesthetic drawbacks. Of the mechanical techniques, selective cutting, if carefully planned, has the most potential for wildlife, but may not be economically feasible in areas with limited access or with dense cover types.

Herbicide application is among the most frequently used techniques for ROW maintenance. There are many kinds of herbicides and application methods. This technique does not physically disturb the soil and, if properly planned and used, can effectively enhance wildlife habitat. However, care must be taken to avoid contamination of nontarget species, degradation of water quality through runoff, and residual effects due to bioaccumulation and the persistence of some chemicals.

Planting and seeding can meet the specific requirements of selected fish and wildlife species. Seeding is often necessary to prevent soil erosion and restore wildlife values after bulldozing, disking, or severe burns; however, costs are often high.

Prescribed burning is often used by wildlife biologists to enhance production of herbs and shrubs. Plant nutritive values often increase greatly after burning. Burning also makes possible the germination of seeds of certain species (e.g., jack pine). However, utility companies have seldom used prescribed burning because of safety concerns, lack of experienced personnel, air pollution regulations, and potential damage to transmission facilities.

There is no single technique or single cover type clearly best suited for ROW management in all situations. Choice of technique and cover type should be made with careful consideration of the land around a particular area as well as pretreatment cover in the ROW itself. Combinations of techniques (e.g., bulldozing and seeding, spraying and burning, selective cutting and brush piling) can sometimes minimize adverse impacts of a single technique and maximize wildlife values.

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Appendixes

GENERAL APPENDIX A

List of Selected Plants

Common name	Scientific name	Province(s)[a]
	Eastern United States	
Acacia	Acacia rigidula	2520
Agrimony	Agrimonia spp.	2210
Agrimony, common	Agrimonia eupatoria	2310
Air plant	Tillandsia spp.	4110
Alder, smooth	Alnus rugosa	2110, 2210
Alder, smooth	Alnus serrulata	2320
Alder, speckled	Alnus rugosa	2110, 2210
Alder, white	Clethra acuminata	2210, 2320
Alexander	Angelica atropurpurea	2210
Aloe, American	Agave virginica	2210
Alvaradoa, Mexican	Alvaradoa amorphioides	4110
Amorpha, clusterspike	Amorpha herbacea	2320
Anemone, rue-	Anemone quinquefolia	2110, (2210)
Anemone, rue-	Anemonella thalictroides	2210, (2310), 2320
Anemone, wood-	Anemone quinquefolia	2110, 2210
Anemonella	Anemonella thalictroides	(2210), 2310, (2320)
Arbutus, trailing	Epigaea repens	2110, 2210, 2320
Arrow-root	Thalia geniculata	4110
Arrow-wood	Viburnum dentatum	2110, 2210
Arrow-wood, downy	Viburnum rafinesquianum	2110, 2320
Arrowhead	Sagittaria spp.	2320
Ash, black	Fraxinus nigra	2110, 2210
Ash, Carolina	Fraxinus caroliniana	2310, 2320, 4110
Ash, green	Fraxinus pennsylvanica	2210, 2310, 2320, 2510, 2530
Ash, mountain-	Sorbus americana	2110, 2210
Ash, pumpkin	Fraxinus tomentosa	2310, 2320
Ash, white	Fraxinus americana	2110, 2210, 2310, 2320
Aspen, large-toothed	Populus grandidentata	2110, 2210
Aspen, trembling	Pouplus tremuloides	2110, 2210
Aster	Aster spp.	2110, 2210
Aster	Aster caroliniensis	4110
Aster	Aster concolor	2310
Aster	Aster elodes	2320
Aster, calico	Aster lateriflorus	2310
Aster, hairy	Aster pilosus	2320
Aster, heath	Aster ericoides	2320, 2530
Aster, large-leaved	Aster macrophyllus	2110, 2210
Aster, meadow	Aster puniceus	(2110), 2210
Aster, purple-stemmed	Aster puniceus	2110, (2210)
Aster, single-stem bog	Aster hemisphericus	2320
Avens, white	Geum canadense	2210
Azalea, smooth	Rhododendron arborescens	2210
Azalea, swamp	Rhododendron viscosum	2310
Bachelor's button, white	Polygala baldwinii	4110
Baldcypress	Taxodium distichum	2210, 2310, 2320, 4110
Baldcypress, pond	Taxodium ascendens	2310, 2320, 4110
Balsamscale	Elyonurus tripsacoides	4110
Baneberry, red	Actaea rubra	2110, 2210
Baneberry, white	Actaea pachypoda	2110, 2210, 2320
Banyan tree, wild	Ficus citrifolia	4110
Barley, little	Hordeum pusillum	2520, 2530
Basil	Satureja calamintha	2210
Basswood	Tilia americana	2110, 2210
Basswood, white	Tilia heterophylla	2210, 2310, 2320
Batis	Batis maritima	4110
Bayberry, northern	Myrica pensylvanica	2310, 2320
Bearberry	Arctostaphylos uva-ursi	2110
Beautyberry, American	Callicarpa americana	2310, 2320, 4110
Bedstraw	Galium spp.	2210
Bedstraw	Galium circaezans	2310
Bedstraw, cleavers	Galium aparine	2210, 2320, 2510
Bedstraw, fragrant	Galium triflorum	2110, 2210
Bedstraw, hairy	Galium pilosum	2320
Bedstraw, pretty	Galium concinnum	2210
Bedstraw, rough	Galium asprellum	2110
Beech	Fagus grandifolia	2110, 2210, 2310, 2320
Beech, blue	Carpinus caroliniana	2110, 2210, 2310, 2320
Beechdrops, Virginia	Epifagus virginiana	2310
Beggar ticks	Bidens spp.	2510
Beggar ticks	Bidens mitis	4110
Beggar ticks	Bidens pilosa	4110
Bellflower, American	Campanula americana	2310
Bellwort	Uvularia spp.	2110
Bellwort	Uvularia perfoliata	2210
Bellwort, large-flowered	Uvularia grandiflora	2110, 2210
Bergamot, wild	Monarda fistulosa	2320
Bilberry, sour-top	Vaccinium myrtilloides	2110
Birch, black	Betula lenta	2210
Birch, bog	Betula pumila	2110
Birch, gray	Betula populifolia	2110, 2210
Birch, paper	Betula papyrifera	2110, 2210
Birch, river	Betula nigra	2210, 2310, 2320
Birch, yellow	Betula lutea	2110, 2210
Bishop's-cap	Mitella nuda	2110
Bitter bush	Picramnia pentandra	4110
Bittersweet	Celastrus scandens	2210, 2310
Black-eyed Susan	Rudbeckia hirta	2210
Blackberry	Rubus spp.	2320, 2510
Blackberry	Rubus allegheniensis	2110, 2210, 2510
Blackbrush	Acacia amentacea	2520
Blackroot	Pterocaulon pycnostachyum	4110
Bladdernut	Staphylea trifolia	2210, 2320, 2510
Bladderwort, awn	Utricularia subulata	2310, 2320
Bladderwort, horned	Utricularia cornuta	2310
Blazing-star	Liatris punctata	2210, (2510), (2530)
Bloodroot	Sanguinaria canadensis	2110, 2210, 2310, 2320
Blue flag	Iris versicolor	2110, 2210, 2320
Blue flag, southern	Iris virginica	2210
Blueberry	Vaccinium spp.	2110
Blueberry, Blue Ridge	Vaccinium vacillans	(2210), 2320
Blueberry, ground	Vaccinium myrsinites	2310, (4110)
Blueberry, highbush-	Vaccinium corymbosum	2210
Blueberry, low early	Vaccinium vacillans	2210, (2320)
Blueberry, low late	Vaccinium angustifolium	2210
Blueberry, shiny	Vaccinium myrsinites	(2310), 4110
Blueberry, smallcluster rabbit-eye	Vaccinium virgatum var. tenellum	2310
Bluestem, big	Andropogon gerardi	2510, 2530
Bluestem, cabaris	Andropogon capillipes	2320
Bluestem, cane	Andropogon barbinodis	2520, 2530
Bluestem, gulf	Andropogon maritimus	2310
Bluestem, little	Andropogon scoparius	(2210), (2310), 2510, 2520, 2530
Bluestem, sand	Andropogon hallii	2510, 2520, 2530
Bluestem, seacoast	Andropogon littoralis	2510, 2520
Bluestem, silver	Andropogon saccharoides	2520
Bluets, common	Houstonia caerulea	2320
Bluets, purple	Houstonia purpurea	2310
Bogbean	Menyanthes trifoliata	2110
Boneset	Eupatorium perfoliatum	2210
Boneset, false	Kuhnia eupatorioides	2310
Borreria	Borreria terminalis	4110
Box-elder	Acer negundo	2110, 2210, 2310, 2320, 2530
Bracken	See "Ferns"	

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Brome, annual	Bromus spp.	2530
Brome, downy	Bromus tectorum	2510
Brome, Japanese	Bromus japonicus	2530
Broomsedge	Andropogon scoparius	2210, 2310, (2510), (2520), (2530)
Broomsedge	Andropogon virginicus	2310, 2320
Broomweed	Gutierrezia spp.	2520
Broomweed	Gutierrezia dracunculoides	2520
Brownhair	Tephrosia spicata	2310
Buckbrush	Symphoricarpos orbiculatus	(2210), (2510), 2530
Buckeye, Ohio	Aesculus glabra	2210
Buckeye, painted	Aesculus sylvatica	2320
Buckeye, sweet	Aesculus octandra	2210
Buckeye, yellow	Aesculus octandra	2210
Buckthorn	Bumelia reclinata	4110
Buckthorn, alder-leaved	Rhamnus alnifolia	2110
Buckthorn, false	Bumelia lanuginosa	2210, 2310
Buckthorn, yellow	Rhamnus caroliniana	2210
Buckwheat-tree	Cliftonia monophylla	2310
Bugleweed	Ajuga reptans	2210
Bulrush	Scirpus spp.	2310, 2510
Bulrush, American	Scirpus americanus	2510
Burning-bush	Euonymus atropurpureus	2210, (2320)
Bustic	Dipholis salicifolia	4110
Buttercup, kidneyleaf-	Ranunculus abortivus	2210
Buttercup, swamp-	Ranunculus septentrionalis	2110, 2210
Butterfly-weed	Asclepias tuberosa	2110, 2310, 2320
Butternut	Juglans cinerea	2210, 2310
Butterwort, small	Pinguicula pumila	2320
Butterwort, yellow	Pinguicula lutea	2310
Buttonbush, common	Cephalanthus occidentalis	2210, 2310, 2320, 4110
Buttonplant, smooth	Spermacoce glabra	2310
Buttonweed	Diodia virginiana	4110
Buttonweed, rough	Diodia teres	2530
Buttonwood	Conocarpus erecta	4110
Cabbage, skunk	Symplocarpus foetidus	2210
Cajeput tree	Melaleuca quinquenervia	4110
Camellia, mountain-	Stewartia pentagyna	2210
Cane	Arundinaria gigantea	2210, 2310, 2320
Cane, southern	Arundinaria tecta	2210, 2310, 2320
Cankerberry	Solanum bahamense	4110
Caper tree, bay-leaved	Capparis flexuosa	4110
Caper tree, Jamaica	Capparis cynophallophora	4110
Capeweed	Lippia nodiflora	4110
Cardinal flower	Lobelia cardinalis	2320
Carpetweed	Mollugo verticillata	2510
Carrion-flower	Smilax herbacea	2210, 2320
Carrot, wild	Daucus carota	2210, 2320
Cat-claw	Pithecellobium keyense	4110
Cat-claw	Schrankia nuttallii	2210, 2510
Cat-tail	Typha latifolia	2210, 2210, 2320, 2510
Cat-tail, narrowleaf	Typha angustifolia	2320
Catalpa, northern	Catalpa speciosa	2310
Catalpa, southern	Catalpa bignonioides	2310
Cedar, white	Thuja occidentalis	2110
Cheat	Bromus secalinus	2530
Cherry, black	Prunus serotina	2110, 2210, 2310, 2320, 2510
Cherry, Carolina laurel	Prunus caroliniana	2310
Cherry, choke-	Prunus virginiana	2110, 2210, 2510
Cherry, fire	Prunus pensylvanica	2110, 2210
Cherry, West Indian	Prunus myrtifolia	4110

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Chestnut	Castanea dentata	2210, 2320
Chew stick	Gouania lupuloides	4110
Chinquapin	Castanea pumila	2210, 2310, 2320
Chinquapin, Ozark	Castanea ozarkensis	2210
Chokeberry, black	Aronia melanocarpa	2210
Chokeberry, red	Aronia arbutifolia	2210, 2320
Christmas berry	Lycium carolinianum	4110
Cicely, sweet	Osmorhiza claytoni	2110, 2210, 2310
Cinnamon, wild	Canella alba	4110
Cinquefoil	Potentilla spp.	2210
Clearweed	Pilea pumila	2210
Clematis, curly	Clematis crispa	2320
Clethra, summer-sweet	Clethra alnifolia	2310
Clover, bush-	Lespedeza spp.	2210, (2510)
Club-moss	Lycopodium spp.	2110, 2210
Club-moss, bristly	Lycopodium annotinum	2110
Club-moss, Carolina	Lycopodium carolinianum	2310
Club-moss, foxtail	Lycopodium alopecuroides	2310, 2320
Club-moss, shining	Lycopodium lucidulum	2110
Cocklebur	Xanthium spp.	2110
Coffee, wild	Colubrina arborescens	4110
Coffee, wild	Psychotria undata	4110
Cohosh, blue	Caulophyllum thalictroides	2110, 2210, 2320
Coltsfoot, sweet	Petasites palmatus	2110
Columbine	Aquilegia canadensis	2110, 2320
Comfrey, wild	Cynoglossum virginianum	2210
Compass plant	Silphium laciniatum	2510, 2530
Coneflower	Rudbeckia spp.	2520
Coneflower, clasping	Rudbeckia amplexicaulis	2510
Coneflower, prairie	Ratibida columnifera	2520, 2530
Conradina	Conradina grandiflora	4110
Coontie	Zamia pumila	4110
Coral bean	Erythrina herbacea	4110
Coralberry	Symphoricarpos spp.	2510
Coralberry	Symphoricarpos orbiculatus	2210, (2510), (2530)
Coreopsis	Coreopsis falcata	2320
Coreopsis, narrowleaf	Coreopsis lanceolata	2530
Cornel, dwarf	Cornus canadensis	2110
Cornel, stiff	Cornus foemina	4110
Cottonwood	Populus spp.	2510
Cottonwood, eastern	Populus deltoides	2210, 2310, 2320, 2510
Cottonwood, plains	Populus sargentii	2530
Cow-wheat	Melampyrum lineare	2110, 2210
Crab's eye	Abrus precatorius	4110
Crabwood	Gymnanthes lucida	4110
Cranberry	Vaccinium macrocarpon	2110
Cranberry, highbush-	Viburnum trilobum	2110
Cranberry, small	Vaccinium oxycoccos	2110
Cress, bitter	Cardamine douglassii	2210
Cress, spring-	Cardamine bulbosa	2210
Cross-vine	Bignonia capreolata	2210, 2310, 2320
Croton	Croton spp.	2310, 2510, 2520
Croton, New Mexican	Croton punctatus	2320
Croton, pineland	Croton linearis	4110
Croton, Texas	Croton texensis	2520, 2530
Croton, tropic	Croton glandulosus	2510
Crowfoot	Ranunculus spp.	2110
Crown-beard	Verbesina laciniata	4110
Crown-beard, yellow	Verbesina occidentalis	2320
Cucumber-root	Medeola virginiana	2110, 2210
Cucumber-tree	Magnolia acuminata	2210, 2310, 2320
Cudweed	Gnaphalium falcatum	2510, 2530
Currant, black	Ribes americanum	2110
Currant, flowering	Ribes odoratum	2530
Currant, skunk	Ribes glandulosum	2110
Currant, swamp	Ribes lacustre	2110
Currant, swamp red	Ribes triste	2110

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Dahoon	Ilex cassine	4110, 2310
Daisy, Englemann	Engelmannia pinnatifida	2520
Daisy, ox-eye-	Chrysanthemum leucanthemum	2110, 2320
Dandelion	Taraxacum officionale	2110
Deerberry	Vaccinium stamineum	2210, 2310, 2320
Devil's claws	Pisonia aculeata	4110
Dewberry	Rubus flagellaris	2210
Dewberry	Rubus hispidus	2110, (2210)
Dewberry, southern	Rubus trivialis	2310
Dewberry, swamp	Rubus hispidus	(2110), 2210
Dilly, wild	Manilkara bahamensis	4110
Dittany	Cunila origanoides	2210
Dog fennel	Eupatorium capillifolium	2310, 4110
Dogbane	Apocynum androsaemifolium	2110, 2210
Dogwood, alternate-leaved	Cornus alternifolia	2110, 2210
Dogwood, flowering	Cornus florida	2210, 2310, 2320
Dogwood, gray	Cornus paniculata	2210
Dogwood, Jamaica-	Piscidia piscipula	4110
Dogwood, pale	Cornus obliqua	2210
Dogwood, red-osier	Cornus stolonifera	2110, 2210
Dogwood, round-leaved	Cornus rugosa	2110, 2210
Dogwood, silky	Cornus amomum	2110, 2210, 2310, 2320, 2510
Dogwood, swamp	Cornus stricta	2310, 2320
Dropseed, sand	Sporobolus cryptandrus	2530
Duck-potato	Sagittaria latifolia	2110
Dutchman's-breeches	Dicentra cucullaria	2210
Dutchman's-pipe vine	Aristolochia durior	2210
Elder, common	Sambucus canadensis	2110, 2210, 2310, 2510
Elder, red-berried	Sambucus pubens	2110, 2210
Elephant-foot	Elephantopus tomentosus	2320
Elm, American	Ulmus americana	2110, 2210, 2310, 2320, 2510, 2530
Elm, red	Ulmus rubra	2210, 2320
Elm, rock	Ulmus thomasii	2110, 2210
Elm, September	Ulmus serotina	2320
Elm, slippery	Ulmus rubra	2210, (2320)
Elm, water-	Planera aquatica	2310, 2320
Elm, winged	Ulmus alata	2210, 2310, 2320
Eriogonum	Eriogonum tomentosum	2310
Eriogonum, annual	Eriogonum annuum	2520, 2530
Eryngium, fragrant	Eryngium aromaticum	4110
Euonymus, trailing	Euonymus obovatus	2210
Eupatorium	Eupatorium spp.	2310
Eupatorium	Eupatorium album	2310
Eupatorium, semaphore	Eupatorium mikanioides	4110
Eupatorium, villous	Eupatorium villosum	4110
Euphorbia	Euphorbia polygonifolia	2320
Euphorbia, ipecac	Euphorbia ipecacuanhae	2320
Everlasting, pearly	Anaphalis margaritacea	2110, 2210
Falsecypress	Chamaecyparis thyoides	2310, 2320
Farkleberry	Vaccinium arboreum	2310, 2320
Ferns:		
Beech fern	Dryopteris phegopteris	2110
Beech fern, broad	Dryopteris hexagonoptera	2210
Boston fern	Nephrolepis exaltata	4110
Bracken fern	Pteridium aquilinum	2110, 2210, 2310
Bracken fern	Pteridium aquilinum var. caudatum	4110
Chain fern	Woodwardia spp.	2310
Chain fern, netted	Woodwardia areolata	2310
Chain fern, Virginia	Woodwardia virginica	2310, 2320

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Ferns (Continued):		
Christmas fern	Polystichum acrostichoides	2210, 2310, 2320
Cinnamon fern	Osmunda cinnamomea	2110, 2210, 2310, 2320
Climbing fern	Lygodium palmatum	2210
Goldie's fern	Dryopterus goldiana	2210
Hay-scented fern	Dennstaedtia punctilobula	2110, 2210, 2320
Interrupted fern	Osmunda claytoniana	2110, 2210, 2320
Lady-fern	Athyrium filix-femina	2210, 2310
Leather fern	Acrostichum danaeaefolium	4110
Maidenhair fern	Adiantum pedatum	2110, 2210, 2310, 2320
Marsh fern	Dryopteris thelypteris	2310
Marsh fern, southern	Thelypteris palustris var. haleana	4110
Mid-sorus fern, toothed	Blechnum serrulatum	4110
Oak-fern	Dryopterus disjuncta	2110
Ostrich fern	Pteretis pensylvanica	2110, 2210
Rattlesnake fern	Botrychium virginianum	2110, 2210, 2310
Resurrection fern	Polypodium polypodioides	2310
Royal fern	Osmunda regalis	2110, 2210, 2310, 2320, 4110
Sensitive fern	Onoclea sensibilis	2110, 2210, 2310
Sweet-fern	Comptonia peregrina	2110, 2210
Sword fern, giant	Nephrolepis biserrata	4110
Wood fern	Dryopteris spinulosa	2110, 2210
Wood fern, crested	Dryopteris cristata	2110
Fescue, meadow-	Festuca elatior	2110, 2210
Fescue, six-weeks	Festuca octoflora	2530
Fetter-bush lyonia	Lyonia lucida	2310, 2320, 4110
Fiddlewood	Citharexylum fruticosum	4110
Fig, strangler	Ficus aurea	4110
Figwort, Maryland	Scrophularia marilandica	2310
Fir, balsam	Abies balsamea	2110
Fireweed	Epilobium angustifolium	2110
Fireweed	Erechtites hieracifolia	2210
Flatsedge	Cyperus spp.	2310, 4110
Flatsedge	Cyperus ligularis	4110
Flatsedge	Cyperus planifolius	4110
Flaveria	Flaveria latifolia	4110
Flaveria	Flaveria linearis	4110
Flax	Linum carteri	4110
Fleabane	Erigeron spp.	2530
Fleabane, daisy-	Erigeron annuus	2110
Fleabane, early whitetop	Erigeron vernus	2320
Fleabane, marsh	Pluchea rosea	4110
Fleabane, southern	Erigeron quercifolius	4110
Fogfruit	Lippia stoechadifolia	4110
Foxglove, false	Agalinus fasciculata	4110
Foxtail	Setaria spp.	2210, 4110
Frostweed	Helianthemum nashii	4110
Fringe-tree	Chionanthus virginicus	2210, 2320
Fumitory	Fumaria officinalis	2320
Garlic, field	Allium vineale	2320
Garlic-mustard	Alliaria officinalis	2210
Gay-feather, dotted	Liatris punctata	(2210), 2510, 2530
Gay-feather, pinkscale	Liatris tenuifolia	2310
Gay-feather, tall	Liatris scariosa	2310
Geiger tree	Cordia sebestina	4110
Gentian	Gentiana villosa	2310
Geranium, wild	Geranium maculatum	2210
Gerardia	Gerardia fasciculata	2310
Gerardia	Gerardia flava	2310
Gerardia	Gerarida linifolia	2310

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Ginger, arum wild	Asarum arifolium	2320
Ginger, wild	Asarum canadense	2110, 2210
Ginseng	Panax quinquefolium	2210
Glasswort, annual	Salicornea bigelovii	4110
Globe mallow	Sphaeralcea spp.	2510
Goat's-beard, false	Astilbe biternata	2210
Goldaster	Chrysopsis scabrella	4110
Goldaster, Maryland	Chrysopsis mariana	2310
Golden-glow	Rudbeckia laciniata	2210
Goldenrod	Solidago spp.	2110, 2210, 2530
Goldenrod	Solidago microcephala	4110
Goldenrod	Solidago petiolaris	2310
Goldenrod	Solidago salicina	2320
Goldenrod	Solidago sempervirens	4110
Goldenrod, fragrant	Solidago odora	2310
Goldenrod, Missouri	Solidago missouriensis	2530
Goldenrod, oldfield	Solidago nemoralis	2320
Goldenrod, pine barren	Solidago fistulosa	2320
Goldenrod, silver	Solidago bicolor	2320
Goldenrod, zigzag	Solidago flexicaulis	2310
Goldenstar	Chrysogonum virginianum	2310, 2320
Goldthread	Coptis groenlandica	2110
Gooseberry	Ribes spp.	2210, 2510
Gooseberry, Florida	Ribes echinellum	2320
Gooseberry, pasture	Ribes cynosbati	2110, 2210
Gopher apple	Licania michauxii	4110
Grama, black	Bouteloua eriopoda	2530
Grama, blue	Bouteloua gracilis	2520, 2530
Grama, hairy	Bouteloua hirsuta	2520
Grama, side-oats	Bouteloua curtipendula	2520, 2530
Grama, Texas	Bouteloua rigidiseta	2520
Grape	Vitis spp.	2210, 2310, 2510
Grape, fox	Vitis labrusca	2210
Grape, muscadine	Vitis rotundifolia	2320, 4110
Grape, Oregon-	Mahonia trifolioata	2520
Grape, possum-	Cissus sicyoides	4110
Grape, river-bank	Vitis riparia	2210
Grape, wild	Vitis vulpina	2510
Grasses:		
Barnyard grass	Echinochloa crusgalli	2510, 2520, 2530
Beardgrass	Andropogon spp.	4110
Beardgrass	Andropogon cabanisii	4110
Beardgrass, bushy	Androgogon glomeratus	4110
Bentgrass, upland	Agrostis perennans	2210
Bermuda grass	Cynodon dactylon	2320
Blowout-grass	Redfieldia flexuosa	2530
Blue-eyed grass	Sisyrinchium spp.	2210, 2320
Blue-joint grass	Calamagrostis canadensis	2210
Bluegrass	Poa spp.	2530
Bluegrass, Canada	Poa compressa	2110, 2530
Bluegrass, Kentucky	Poa pratensis	2110, 2210
Bristlegrass, green	Setaria viridis	2510, 2530
Bristlegrass, yellow	Setaria lutescens	2530
Bromegrass	See "Brome"	
Buffalo grass	Buchloe dactyloides	2520, 2530
Canary-grass	Phalaris arundinacea	2210
Cheatgrass	See "Cheat"	
Cordgrass	Spartina bakeri	4110
Cordgrass, gulf	Spartina spartinae	2510
Cordgrass, marsh-hay	Spartina patens	2320
Cordgrass, prairie	Spartina pectinata	(2210), 2510, 2530
Cordgrass, smooth	Spartina alterniflora	2510
Cotton-grass	Eriophorum spp.	2110
Crabgrass, hairy	Digitaria sanguinalis	2320, 2530
Cutgrass, rice	Leersia oryzoides	2510
Dallis-grass	Paspalum dilatatum	2320
Fingergrass	Chloris glauca	4110
Gamagrass, eastern	Tripsacum dactyloides	2510, 2530
Gamagrass, Florida	Tripsacum floridanum	4110

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Grasses (Continued):		
Grama grass	See "Grama"	
Indian-grass	Sorghastrum nutans	2510, 2520, 2530
Key grass	Monanthochloe littoralis	4110
Lovegrass	Eragrostis spp.	2510
Lovegrass, gummy	Eragrostis curtipedicellata	2530
Lovegrass, sand	Eragrostis trichodes	2530
Lovegrass, tumble	Eragrostis sessilispica	2510, 2530
Marsh-grass	Spartina pectinata	2210, (2510), (2530)
Meadowgrass, fowl-	Glyceria striata	2210
Meadowgrass, salt	Puccinellia nuttalliana	2530
Needlegrass, Texas	Stipa leucotricha	2510, 2520
Nutgrass, yellow	Cyperus esculentus	2510
Panic-grass	Panicum spp.	2110, 2210, 2310, 2510, 4110
Plume grass, sugarcane	Erianthus giganteus	4110
Porcupine-grass	Stipa spartea	2530
Poverty-grass	Danthonia spicata	2110, 2210
Reedgrass	Calamagrostis inexpansa	2110, 2530
Rice-grass, Indian	Oryzopsis hymenoides	2530
Rice-grass, upland	Oryzopsis asperifolia	2110, 2210
Saltgrass	Distichlis spicata	4110
Saltgrass, inland	Distichlis stricta	2530
Sawgrass	Cladium jamaicense	4110
Sawgrass, Jamaica	Mariscus jamaicensis	2310
Silk grass	Chrysopsis graminifolia	4110
Star-grass	Aletris aurea	2320
Star-grass, golden	Hypoxis micrantha	2320
Star-grass, whitetube	Aletris farinosa	2320
Switchgrass	Panicum virgatum	2320, 2510, 2520, 2530, 4110
Tooth-ache grass	Ctenium aromaticum	2320
Tumblegrass	Schedonnardus paniculatus	2520
Umbrella grass, Florida	Dichromena floridensis	4110
Umbrella grass, white-topped	Dichromena colorata	4110
Wheatgrass, slender	Agropyron trachycaulum	2530
Wheatgrass, western	Agropyron smithii	2530
Wind-mill grass	Chloris verticillata	2530
Witchgrass, common	Panicum capillare	2530
Yellow-eyed grass	Xyris elliottii	4110
Green dragon	Arisaema dracontium	2210, 2310
Greenbrier	Smilax spp.	2320, 2510
Greenbrier	Smilax auriculata	4110
Greenbrier	Smilax glauca	2210, 2310
Greenbrier	Smilax havanensis	4110
Greenbrier, bristly	Smilax hispida	2210, 2510
Greenbrier, herbaceous	Smilax herbacea	2210, (2320)
Greenbrier, laurel-leaved	Smilax laurifolia	2310, 2320, 4110
Greenbrier, redbead	Smilax walteri	2310
Greenbrier, saw	Smilax bona-nox	2310, 2510
Ground-cedar	Lycopodium complanatum	2110
Ground-cherry	Physalis spp.	2310
Ground-cherry, field	Physalis viscosa	2510
Ground-pine	Lycopodium obscurum	2110
Groundsel	Baccharis halimifolia	4110
Gum, black	Nyssa sylvatica	2210, 2310, 2320
Hackberry, common	Celtis occidentalis	2210, 2310, 2320, 2510, 2530
Hackberry, sugar	Celtis laevigata	2310, 2320
Hardhack	Spiraea tomentosa	2110, 2210
Hat pin	Eriocaulon decangulare	4110

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Hawkweed	Hieraceum spp.	2110
Hawthorn	Crataegus spp.	2110, 2210, 2310, 2510
Hawthorn	Crataegus consanguinea	2310
Hawthorn	Crataegus elliptica	2320
Hawthorn	Crataegus robur	2310
Hawthorn, May	Crataegus aestivalis	2310
Hawthorn, one-flower	Crataegus uniflora	2320
Hazelnut, beaked	Corylus cornuta	2110, 2210, 2320
Hazelnut, common	Corylus americana	2110, 2210, 2310, 2320, 2510
Heliotrope	Heliotropium indicum	2310
Heliotrope, pineland	Heliotropium polyphyllum	4110
Hellebore, false	Veratrum viride	2210
Hemlock	Tsuga canadensis	2110, 2210
Hemp, button	Boehmeria cylindrica	4110
Hemp, Indian	Apocynum cannabinum	2320
Hempweed, climbing	Mikania scandens	4110
Hepatica	Hepatica spp.	2110
Hepatica, acute-lobed	Hepatica acutiloba	2210
Hepatica, round-lobed	Hepatica americana	2310
Hercules'-club	Aralia spinosa	2210, 2310
Hickory, bitternut	Carya cordiformis	2210, 2310, 2320
Hickory, Carolina	Carya carolinae-septentrionalis	2320
Hickory, mockernut	Carya tomentosa	2210, 2310, 2320
Hickory, pignut	Carya glabra	2210, 2310, 2320, 2510
Hickory, red	Carya ovalis	2320
Hickory, sand	Carya pallida	2320
Hickory, shagbark	Carya ovata	2210, 2310, 2320, 2510, 2530
Hickory, shellbark	Carya laciniosa	2210
Hickory, Texas	Carya texana	2210, 2510
Hickory, water	Carya aquatica	2310, 2320
Hippocratea	Hippocratea volubilis	4110
Hobblebush	Viburnum alnifolium	2110
Hog-peanut	Amphicarpa bracteata	2110, 2210
Holly	Ilex coriacea	2320
Holly, American	Ilex opaca	2210, 2310, 2320
Holly, deciduous	Ilex decidua	2110, 2210, (2320)
Holly, mountain	Nemopanthus mucronatus	2110, 2210
Holly, tawnyberry	Ilex krugiana	4110
Honewort	Cryptotaenia canadensis	2210
Honeysuckle	Lonicera spp.	2210
Honeysuckle, bush	Diervilla lonicera	2110, 2210
Honeysuckle, fly-	Lonicera canadensis	2110, 2210
Honeysuckle, hairy	Lonicera hirsuta	2110, 2210
Honeysuckle, Japanese	Lonicera japonica	2320
Honeysuckle, swamp-fly-	Lonicera oblongifolia	2110
Honeysuckle, tartarian	Lonicera tartarica	2110
Hop-hornbeam	Ostrya virginiana	2110, 2210, 2310, 2320
Horse-gentian, common	Triosteum perfoliatum	2320
Horsetail	Equisetum spp.	2110, 2210
Horsetail, common	Equisetum arvense	2210
Horseweed	Conyza canadensis	2510, 2530
Huckleberry	Gaylussacia baccata	2110, 2210, 2320
Huckleberry, dwarf	Gaylussacia dumosa	2310, 2320
Hydrangea, wild	Hydrangea arborescens	2210, 2320
Hypericum	Hypericum spp.	2310
Hyssop, water	Bacopa monnieri	4110
Indigo-berry, white	Randia aculeata	4110
Indigo, wild	Baptisia lanceolata	2310
Indigo, wild	Baptisia tinctoria	2210
Indigo, Atlantic wild	Baptisia leucantha	2530
Indigo, blue wild	Baptisia minor	2510, 2530
Indigo, plains wild	Baptisia leucophaea	2510
Indigobush	Amorpha fruticusa	2510
Inkberry	Ilex glabra	2310, 2320, 4110
Inkwood	Exothea paniculata	4110
Iris, bay	Iris tridentata	2320
Iris, vernal	Iris verna	2320
Ironweed	Vernonia blodgettii	4110
Ironwood, black	Krugiodendron ferreum	4110
Jack-in-the-pulpit	Arisaema atrorubens	2210, 2310
Jack-in-the-pulpit, small	Arisaema triphyllum	2110, 2210, 2310, 2320
Jacob's-ladder	Polemonium van-bruntiae	2210
Jessamine, Carolina	Gelsemium sempervirens	2310, 2320
Jewelweed	Impatiens capensis	2110, 2210, 2310, 2320
Joe-Pye-weed, spotted	Eupatorium maculatum	2210
John's-cabbage	Hydrophyllum virginianum	2110, 2210
Jointweed	Polygonella polygama	2320, 4110
Juneberry	Amelanchier spp.	(2110), 2210
Juneberry	Amelanchier canadensis	2210
Juniper, common	Juniperus communis	2210
Kalmia, sandhill	Kalmia hirsuta	2310
Knotweed	Polygonum spp.	2110, 2210
Kochia	Kochia scoparia	2530
Kudzu	Pueraria lobata	2320
Labrador-tea	Ledum groenlandicum	2110
Ladies'-tresses	Spiranthes vernalis	4110
Ladies'-tresses, southern	Spiranthes praecox	2310
Lady's-slipper	Cypripedium spp.	2110
Lady's-slipper, common	Cypripedium acaule	2210
Lady's-slipper, yellow	Cypripedium calceolus	2210
Lamb's-quarters	Chenopodium album	2530
Larkspar, dwarf	Delphinium tricorne	2210
Larkspar, rock	Delphinium carolinianum	2210
Laurel, bog-	Kalmia polifolia	2110
Laurel, mountain-	Kalmia latifolia	2110, 2210, 2320
Leadplant	Amorpha spp.	2530
Leadplant	Amorpha canescens.	2310, 2510, 2530
Leafcup	Polymnia canadensis	2210
Leather-leaf	Chamaedaphne calyculata	2110, 2320
Leatherwood	Dirca palustris	2110, 2210
Leek, wild	Allium tricoccum	2110, 2210
Lespedeza	Lespedeza spp.	(2210), 2510
Lespedeza, Chinese	Lespedeza cuneata	2320
Lespedeza, common	Lespedeza striata	2310
Lespedeza, hairy	Lespedeza hirta	2310
Lespedeza, Korean	Lespedeza stipulacea	2510
Leucothoe, coast	Leucothoe axillaris	2320
Leucothoe, sweetbells	Leucothoe racemosa	2310, 2320
Licorice, wild	Galium lanceolatum	2210
Lily, corn-	Clintonia borealis	2110
Lily-of-the-valley, wild	Maianthemum canadense	2110, 2210
Lily, rain	Zephyranthes simpsonii	4110
Lily, spider	Hymenocallis latifolia	4110
Lily, trout-	Erythronium americanum	2110, 2210, (2320)
Lily, white water	Nymphaea odorata	4110
Limbo, gumbo	Bursera simaruba	4110
Lime, wild	Zanthoxylum fagara	4110
Lion's-foot	Prenanthes serpentaria	2110
Lizard's-tail	Saururus cernuus	2210, 2320

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Lobelia	Lobelia glandulosa	2310
Lobelia, pale-spike-	Lobelia siphilitica	2320
Loblolly bay	Gordonia lasianthus	2320
Locust, black	Robinia pseudo-acacia	2210, 2310, 2320, 2510
Locust, honey-	Gleditsia triacanthos	2210, 2310, 2320, 2510
Locust, little	Robinia nana	2320
Locust, water-	Gleditsia aquatica	2310
Locustberry	Byrsonima cuneata	4110
Loosestrife	Lythrum flagellare	4110
Loosestrife, whorled	Lysimachia quadrifolia	2210
Lopseed	Phryma leptostachya	2110, 2210
Love vine	Cassytha filiformis	4110
Lupine	Lupinus villosus	2310
Lupine, gully	Lupinus diffusus	2320
Lupine, sundial	Lupinus perennis	2310
Lycopodium	Lycopodium obscurum	2110
Magnolia	Magnolia spp.	2210
Magnolia, bigleaf	Magnolia macrophylla	2310, 2320
Magnolia, southern	Magnolia grandiflora	2310
Magnolia, sweet bay	Magnolia virginiana	2310, 2320, 4110
Magnolia, umbrella	Magnolia tripetala	2310, 2320
Mahoe, seaside	Thespea populnea	4110
Mahogany, West Indian	Swietiana mahogani	4110
Maiden-cane	Panicum hemitomon	2310
Maleberry	Lyonia ligustrina	2210, 2320
Mallow, salt marsh	Kosteletzkya virginica	4110
Manchineel	Hippomane manicinella	4110
Mandarin, nodding	Disporum maculatum	2210
Mangrove, black	Avicennia germinans	4110
Mangrove, red	Rhizophora mangle	4110
Mangrove, white	Laguncularia racemosa	4110
Maple, Florida	Acer floridanum	2310, 2320
Maple, mountain	Acer spicatum	2110, 2210
Maple, red	Acer rubrum	2110, 2210, 2310, 2320, 4110
Maple, silver	Acer saccharinum	2110, 2210, 2310, 2320
Maple, striped	Acer pensylvanicum	2110, 2210
Maple, sugar	Acer saccharum	2110, 2210, 2310, 2320
Marigold, marsh-	Caltha palustris	2110, 2210
Marlberry	Ardisia escallonoides	4110
Marsh-pink	Sabatia grandiflora	4110
Mastic, wild	Mastichodendron foetidissimum	4110
May-apple	Podophyllum peltatum	2210, 2320
Mayflower, Canada	Maianthemum canadense	2110, (2210)
Meadow-beauty	Rhexia alifanus	2320, 4110
Meadow-beauty	Rhexia mariana	2310
Meadow-rue	Thalictrum revolutum	2320
Meadow-rue, early	Thalictrum dioicum	2210, 2310
Meadow-sweet	Spiraea latifolia	2110, (2210)
Mermaid weed	Proserpinaca pectinata	4110
Mesquite	Prosopis juliflora	2520, 2530
Mesquite, vine-	Panicum obtusum	2520
Milfoil, water-	Myriophyllum exalbescens	2110
Milk bark	Drypetes diversifolia	4110
Milk-vetch, groundplum	Astragalus caryocarpus	2510
Milkpea	Galactia spp.	2320
Milkpea	Galactia regularis	4110
Milkweed	Asclepias spp.	2210, 2520
Milkweed, swamp-	Asclepias incarnata	2210, 4110
Milkweed, West Coast	Asclepias phytolaccoides	2310
Milkweed, whorled	Asclepias verticillata	2310
Mint, mountain-	Pycnanthemum flexuosum	2210
Mint, Atlantic mountain-	Pycnanthemum incanum	2320

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Mint, musky	Hyptis alata	4110
Mistflower	Eupatorium coelestinum	2310, 4110
Mistletoe, Christmas American-	Phoradendron flavescens	2310
Miterwort	Cynoctonum mitreola	4110
Miterwort, false	Tiarella cordifolia	2110, 2210
Moonseed	Menispermum canadense	2210
Moss, haircap	Polytrichum spp.	2110
Muhly	Muhlenbergia spp.	2310
Muhly	Muhlenbergia capillaris	4110
Muhly, sandhill	Muhlenbergia pungens	2530
Mulberry, Indian	Morinda royoc	4110
Mulberry, red	Morus rubra	2210, 2310, 2320, 2510
Mullein, common	Verbascum thapsus	2320, 2510
Mustard, garlic-	Alliaria officinalis	2210
Myrsine	Myrsine guianensis	4110
Myrtle-of-the-river	Calyptranthes zuzygium	4110
Nannyberry	Viburnum lentago	2110, 2210
Necklace pod	Sophora tomentosa	4110
Needle-and-thread	Stipa comata	2530
Nettle	Urtica spp.	2110
Nettle, stinging	Urtica dioica	2210
Nettle, tall	Urtica procera	2110, 2210
Nettle, wood-	Laportea canadensis	2210, 2320
New Jersey tea	Ceanothus americanus	2110, 2210, 2310, 2320
Nicker, gray	Caesalpinia crista	4110
Nightshade, bittersweet	Solanum dulcamara	2210
Nightshade, enchanter's	Circaea canadensis	2110
Nightshade, enchanter's	Circaea lutetiana	2210
Ninebark	Physocarpus capitatus	2210
Ninebark	Physocarpus opulifolius	2210
Nuisache	Acacia farnesiana	2520
Oak, bear	Quercus ilicifolia	2210
Oak, black	Quercus velutina	2210, 2310, 2320
Oak, blackjack	Quercus marilandica	2210, 2310, 2320, 2510, 2530
Oak, bluejack	Quercus cinerea	2310
Oak, bluejack	Quercus incana	2320
Oak, bur	Quercus macrocarpa	2210, 2510, 2530
Oak, Chapman's	Quercus chapmanii	4110
Oak, cherrybark	Quercus falcata var. pagodaefolia	2310, 2320
Oak, chestnut	Quercus prinus	2210, 2310, 2320
Oak, chinquapin	Quercus prinoides	2210
Oak, dwarf	Quercus pumila	2310, 2320, 4110
Oak, dwarf post	Quercus margaretta	2310, 2320
Oak, jack	Quercus ellipsoidalis	2210, 2510
Oak, live	Quercus virginiana	2310, 2320, 2510, 2520, 4110
Oak, laurel-leaved	Quercus laurifolia	2210, 2310, 2320
Oak, myrtle	Quercus myrtifolia	2310, 4110
Oak, northern red	Quercus borealis	2110, 2210, 2510
Oak, over-cup	Quercus lyrata	2210, 2310, 2320
Oak, pin	Quercus palustris	2210, 2310
Oak, post	Quercus stellata	2210, 2310, 2320, 2510, 2530
Oak, red	Quercus borealis var. maxima	2310
Oak, red	Quercus rubra	2210, 2320
Oak, sand live	Quercus virginiana var. geminata	2310
Oak, scarlet	Quercus coccinea	2210, 2320
Oak, shingle	Quercus imbricaria	2210, 2310
Oak, shinnery	Quercus mohriana	2530
Oak, Shumard's red	Quercus shumardii	2210, 2310, 2320
Oak, Spanish	Quercus falcata	2210, 2310, 2320

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Oak, swamp-white	Quercus bicolor	2210, 2320
Oak, Texas	Quercus texana	2310
Oak, turkey	Quercus laevis	2310, 2320
Oak, water	Quercus nigra	2310, 2320
Oak, white	Quercus alba	2210, 2310, 2320, 2510
Oak, willow	Quercus phellos	2210, 2320
Oak, yellow	Quercus muhlenbergii	2210, 2310, 2510
Oilnut	Pyrularia pubera	2210
Olive, black	Bucida buceras	4110
Orchis, round-leaved	Habenaria orbiculata	2110
Osmanthus, devilwood	Osmanthus americanus	2310, 2320
Osmunda	Osmunda spp.	2310
Ox-eye, sea	Borrichia arborescens	4110
Ox-eye, sea	Borrichia frutescens	4110
Palafoxia	Palafoxia feayi	4110
Palm, Everglades	Acoelorrhaphe wrightii	4110
Palm, royal	Roystonea elata	4110
Palm, silver	Coccothrinax argentea	4110
Palmetto, cabbage	Sabal palmetto	2320, 4110
Palmetto, dwarf	Sabal minor	2310
Palmetto, saw	Serenoa repens	2310, 4110
Panicum, beaked	Panicum anceps	2510
Panicum, bitter	Panicum amarum	2320
Panicum, torpedo	Panicum repens	2310
Papaya	Papaya carica	4110
Paradise tree	Simaruba glauca	4110
Paronychia	Paronychia americana	4110
Parrot's-feather, farewell	Myriophyllum heterophyllum	2320
Parsnip, water	Sium suave	2110
Partridge-berry	Mitchella repens	2110, 2210, 2310, 2320
Partridge-pea	Cassia spp.	2520
Partridge-pea	Cassia bahamensis	4110
Partridge-pea	Cassia derringianus	4110
Partridge-pea, showy	Chamaecrista fasciculata	2310
Paspalum	Paspalum spp.	2510, 2520
Paspalum	Paspalum monostachyum	4110
Paspalum	Paspalum setaceum	4110
Paspalum, fringeleaf	Paspalum ciliatifolium	2510
Paspalum, sand	Paspalum stramineum	2530
Passion-flower	Passiflora lutea	2210, 2320
Pawpaw	Asimina reticulata	4110
Pawpaw	Asimina triloba	2210, 2310, 2320
Pawpaw, smallflower	Asimina parviflora	2310, 2320
Pawpaw, sprawling	Asimina pygmaea	2310
Pecan	Carya illinoensis	2210, 2510
Pedicularis, early	Pedicularis canadensis	2320
Pencil-flower	Stylosanthes biflora	2210
Pennyroyal	Satureja rigida	4110
Pennywort, largeleaf	Hydrocotyle bonariensis	2310
Penstemon	Penstemon australis	2320
Penstemon, smooth	Penstemon laevigatus	2310
Pepper tree, Brazilian	Schinus terebinthifolius	4110
Pepper-vine	Ampelopsis arborea	2310, 2510, 4110
Persimmon, common	Diospyros virginiana	2210, 2310, 2320, 2510
Phlox, blue	Phlox divaricata	2210, 2310
Phlox, downy	Phlox pilosa	2310
Phlox, trailing	Phlox nivalis	2320
Pickerlweed	Pontederia lanceolata	4110
Pigweed, rough	Amaranthus retroflexus	2530
Pimpernel, water	Samolus ebracteatus	4110
Pinckneya	Pinckneya pubens	2310
Pine, Australian-	Casuarina equisetifolia	4110
Pine, jack	Pinus banksiana	2110
Pine, loblolly	Pinus taeda	2310, 2320
Pine, longleaf	Pinus palustris	2310, 2320

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Pine, pitch	Pinus rigida	2210
Pine, pond	Pinus serotina	2310, 2320
Pine, red	Pinus resinosa	2110
Pine, sand	Pinus clausa	2310, 4110
Pine, shortleaf	Pinus echinata	2210, 2310, 2320
Pine, slash	Pinus elliottii	2310
Pine, south Florida slash	Pinus elliottii var. densa	4110
Pine, spruce	Pinus glabra	2310
Pine, table-mountain	Pinus pungens	2210
Pine, Virginia	Pinus virginiana	2210, 2320
Pine, white	Pinus strobus	2110, 2210
Pinxter-flower	Rhododendron nudiflorum	2210, 2310, 2320
Pipsissewa, common	Chimaphila umbellata	2320
Pitcher-plant	Sarracenia purpurea	2110, 2320
Pitcher-plant, hooded	Sarracenia minor	2310
Pitcher-plant, trumpet	Sarracenia flava	2310, 2320
Plantain, rattlesnake	Goodyera pubescens	2320
Plum	Prunus spp.	2510
Plum, American	Prunus americana	(2210), (2320), 2510, 2530
Plum, Canada	Prunus nigra	2110
Plum, chicksaw	Prunus angustifolia	2320, 2530
Plum, coco	Chrysobalanus icaco	4110
Plum, darling	Reynosia septentrionalis	4110
Plum, Guiana	Drypetes lateriflora	4110
Plum, Mexican	Prunus mexicana	2510
Plum, wild	Prunus americana	2210, 2320, (2510), (2530)
Pogonia, rose	Pogonia ophioglossoides	2320
Poison ivy	Rhus radicans	2210, 2310, 2320, 4110
Poison oak	Rhus toxicodendron	2320
Poison sumac	Rhus vernix	2210, 2310, 2320
Poisonwood	Metopium toxiferum	4110
Pokeweed	Phytolacca americana	2210, 2510
Polygala	Polygala boykinii	4110
Polygala	Polygala cymosa	2310
Polygala	Polygala grandiflora	4110
Polygala	Polygala nana	4110
Polygala, blood	Polygala sanguinea	2310
Polygala, fringed	Polygala paucifolia	2110, 2210
Polygala, orange	Polygala lutea	2320
Polypody, golden	Polypodium aureum	4110
Poplar, balsam-	Populus balsamifera	2110
Poplar, swamp	Populus heterophylla	2320
Possum-haw	Ilex decidua	(2110), (2210), 2320
Potato tree	Solanum erianthum	4110
Prairie clover	Petalostemum spp.	2530
Prairie clover	Petalostemum carneum	4110
Prairie clover, purple	Petalostemum purpureum	2530
Prairie clover, silky	Petalostemum villosum	2530
Prickly-ash	Zanthoxylum americanum	2210
Prickly-ash, Hercules'-club	Zanthoxylum clava-herculis	2310
Prickly pear	Opuntia compressa	4110
Primrose, common evening-	Oenothera biennis	2320
Privet, pineland	Forestiera pinetorum	4110
Privet, swamp-	Forestiera acuminata	2210, 2310
Puccoon	Lithospermum canescens	2210
Purslane, marsh	Ludwigia repens	4110
Purslane, water-	Ludwigia palustris	2210
Pussy's-toes	Antennaria spp.	2110, 2210
Pyrola, one-flowered	Pyrola secunda	2110
Quinine, wild	Parthenium integrifolium	2320

continued

General Appendix A (continued)

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Ragweed	Ambrosia spp.	2510, 2520
Ragweed, common	Ambrosia artemisiifolia	2320, 2510, 2530, 4110
Ragweed, giant	Ambrosia trifida	2210, 2320, 2510, 2530
Ragweed, western	Ambrosia psilostachya	2510, 2520, 2530
Raisin, wild-	Viburnum cassinoides	2110, 2210
Raspberry, black	Rubus occidentalis	2210
Raspberry, dwarf	Rubus pubescens	2110
Raspberry, red	Rubus idaeus	2110, 2210
Rattan vine	Berchemia scandens	(2310), (2320), 4110
Rattlesnake-master	Eryngium yuccifolium	2210
Rattlesnake-root	Prenanthes alba	2110
Red bay	Persea borbonia	2310, 2320, 4110
Red-root	Lachnanthes caroliniana	4110
Redbud	Cercis canadensis	2210, 2310, 2320
Redcedar, eastern	Juniperus virginiana	2210, 2310, 2320, 2530
Redtop	Agrostis alba	2110, 2510, 2530
Reed	Phragmites communis	2110, 2310
Rhododendron	Rhododendron spp.	2310
Rhododendron	Rhododendron maximum	2110, 2210
Rice, wild	Zizania aquatica	2110
Rice, southern wild	Zizaniopsis miliacea	2320, 2510
Rose, Carolina	Rosa carolina	2310, 2320
Rose mallow, scarlet	Hibiscus lasiocarpus	2310
Rose, wild	Rosa spp.	2210, 2510, 2530
Rose, wild	Rosa acicularis	2110
Rosemary, bog-	Andromeda glaucophylla	2110
Rosinweed	Silphium spp.	2510
Rubber vine	Rhabdadenia biflora	4110
Rue, goat's-	Tephrosia virginiana	2210, 2310
Rush	Juncus spp.	2210, 2310, 2320
Rush	Juncus marginatus	4110
Rush, beak	Rhynchospora corniculata	4110
Rush, beak	Rhynchospora grayii	4110
Rush, beak	Rhynchospora megalocarpa	4110
Rush, needlegrass	Juncus roemerianus	2320, 4110
Rye, Canada wild	Elymus canadensis	2510, 2530
Sagebrush, sand	Artemisia filifolia	2530
St. Andrew's cross	Ascyrum hypericoides	2210
St. John's-wort	Hypericum fasciculatum	4110
St. John's-wort	Hypericum hypericoides	2320
St. John's-wort	Hypericum myrtifolium	4110
St. John's-wort	Hypericum petiolatum	2310
St. John's-wort, marsh-	Hypericum virginicum	2110, 2210, 2310
St. Peter's-wort	Ascyrum stans	2210
Sagewort, Louisiana	Artemisia ludoviciana	2530
Samson, black	Echinacea angustifolia	2530
Sand-myrtle, box	Leiophyllum buxifolium	2310, 2320
Sandbur	Cenchrus incertus	4110
Sandbur	Cenchrus pauciflorus	2530
Sandbur, dune	Cenchrus tribuloides	2310
Sandheath	Ceratiola ericoides	2310, 4110
Sandreed, prairie	Calamovilfa longifolia	2530
Sandwort, Carolina	Arenaria caroliniana	2320
Sandwort, grove-	Arenaria lateriflora	2210
Sapodilla	Manilkara zapoda	4110
Sarsaparilla, wild	Aralia nudicaulis	2110, 2210
Sassafras, white	Sassafras albidum	2210, 2310, 2320
Satin leaf	Chrysophyllum oliviforme	4110
Scorpion-weed	Phacelia bipinnatifida	2210
Scouring-rush	Equisetum hyemale	2310
Scurf pea, lemon	Psoralea lanceolata	2530
Scurf pea, manyflower	Psoralea floribunda	2530
Scurf pea, silverleaf	Psoralea argophylla	2530
Scurf pea, slimflower	Psoralea tenuiflora	2530

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Sea blite	Suaeda linearis	4110
Sea-grape	Coccoloba uvifera	4110
Sea-oats	Uniola paniculata	2320
Sea-rocket	Cakile spp.	2320
Sea-rocket, American	Cakile edentula	2310
Sedge	Carex spp.	2110, 2210, 2320, 2510
Sedge	Carex grayii	2210
Sedge	Carex intumescens	2210
Sedge	Carex stricta	2210
Sedge, vernal	Carex pensylvanica	2210
Seedbox	Ludwigia spp.	2320
Seedbox	Ludwigia alternifolia	2310
Seedbox	Ludwigia pilosa	2310
Selfheal, common	Prunella vulgaris	2320
Sensitive plant, wild	Cassia nictitans	2210
Serviceberry	Amelanchier spp.	2110, (2210)
Serviceberry	Amelanchier arborea	2210, 2320
Sesuvitum	Sesuvium maritinum	2320
Silverbell	Halesia monticola	2210
Silverbell, Carolina	Halesia carolina	2310, 2320
Silverbell, two-wing	Halesia diptera	2310
Skullcap	Scutellaria spp.	2210
Skullcap, hyssop	Scutellaria integrifolia	2310
Smartweed	Polygonum spp.	2110, 2210
Smartweed	Polygonum pensylvanicum	2210
Smartweed, water	Polygonum punctatum	4110
Smilacina, three-leaved	Smilacina trifolia	2110
Snakeroot, black	Sanicula gregaria	2210, 2310
Snakeroot, button	Eryngium yuccifolium var. synchaetum	4110
Snakeroot, Sampson's	Psoralea psoralioides	2210
Snakeroot, white	Eupatorium rugosum	2110, 2210, 2320
Snakeweed, broom	Gutierrezia sarothrae	2520
Sneezeweed	Helenium tenuifolium	2210
Snowbell, bigleaf	Styrax grandifolia	2320
Snowberry	Symphoricarpos albus	2210
Snowberry, creeping	Gaultheria hispidula	2110
Snowberry, western	Symphoricarpos orbiculatus	(2210), 2510, (2530)
Soapberry, southern	Sapindus saponaria	4110
Soapweed, small	Yucca glauca	2530
Solomon's-seal	Polygonatum biflorum	2210, 2310, 2320
Solomon's-seal, false	Smilacina racemosa	2110, 2210, 2320
Solomon's-seal, hairy	Polygonatum pubescens	2110, 2210
Sorrel, sheep-	Rumex acetosella	2110, 2210
Sorrel, wood-	Oxalis montana	2110
Sourwood	Oxydendrum arboreum	2210, 2310, 2320
Sphagnum	Sphagnum spp.	2110
Spicebush	Lindera benzoin	2210, 2320
Spiderwort	Tradescantia virginiana	2210
Spikenard	Aralia racemosa	2110, 2210
Spiraea, meadow	Spiraea latifolia	2110, 2210
Spleenwort	Asplenium spp.	2210
Spleenwort	Athyrium spp.	2210
Spleenwort	Athyrium thelypteroides	2110, 2310, 2320
Spleenwort, narrowleaf	Athyrium pycnocarpon	2310
Spring-beauty	Claytonia virginica	2210, 2320
Spruce, black	Picea mariana	2110
Spruce, red	Picea rubrens	2110
Spruce, white	Picea glauca	2110
Spurge	Euphorbia spp.	2510
Spurge	Euphorbia polyphylla	4110
Spurge, Allegheny-	Pachysandra procumbens	2210, 2310
Spurge, flowering	Euphorbia corollata	2310, 2320, 2530
Squaw-root	Conopholis americana	2310, 2320
Squirrel-corn	Dicentra canadensis	2110, 2210
Stagger-bush	Lyonia fruticosa	4110

continued

General Appendix A (continued)

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Stagger-bush	Lyonia mariana	2320
Star-flower	Trientalis borealis	2110
Stewartia, Virginia	Stewartia malacodendron	2310
Stickseed	Hakelia virginiana	2510
Stillingia	Stillingia aquatica	4110
Stipulicida	Stipulicida setacea	4110
Stonecrop, wild	Sedum ternatum	2210
Stopper, Spanish	Eugenia myrtoides	4110
Stopper, white	Eugenia axillaris	4110
Strawberry, barren	Waldsteinia fragarioides	2110
Strawberry-bush	Euonymus americanus	2210, 2310, 2320
Strawberry, wild	Fragaria virginiana	2110, 2210, 2320
Sumac	Rhus spp.	2110
Sumac, fragrant	Rhus aromatica	2210
Sumac, poison	Rhus vernix	2210, 2310, 2320
Sumac, shining	Rhus copallina	2310, 2320
Sumac, smooth	Rhus glabra	2210, 2320, 2510
Sumac, staghorn	Rhus typhina	2210
Sumpweed	Iva imbricata	2320
Sundew	Drosera brevifolia	2310
Sundew	Drosera rotundifolia	2110, 2320
Sunflower	Helianthus spp.	2110, 2210, 2510, 2520, 2530
Sunflower	Helianthus angustifolius	2210
Sunflower	Helianthus radula	2310
Sunflower, ashy	Helianthus mollis	2510
Sunflower common	Helianthus annuus	2510, 2520, 2530
Sunflower, plains	Helianthus petiolaris	2510, 2530
Sunflower, sawtooth	Helianthus grosseserratus	2530
Sunflower, stiff	Helianthus rigidus	2530
Sunnybell, white	Schoenolirion elliottii	4110
Supplejack, Alabama	Berchemia scandens	2310, 2320, (4110)
Sweet gale	Myrica gale	2110
Sweet shrub, common	Calycanthus floridus	2320
Sweet-spire	Itea virginica	2210, 2310, 2320
Sweetflag	Acorus calamus	2110
Sweetgum	Liquidambar styraciflua	2210, 2310, 2320
Sweetleaf, common	Symplocos tinctoria	2310
Sycamore	Platanus occidentalis	2210, 2310, 2320, 2510
Synandra	Synandra hispidula	2210
Tallowwood	Ximenia americana	4110
Tamarack	Larix laricina	2110
Tamarind, wild	Lysiloma latisiliqua	4110
Tarflower	Befaria racemosa	4110
Teaberry	Gaultheria procumbens	2110, 2210
Tearthumb, arrow-leaved	Polygonum sagittatum	2210
Tetrazygia	Tetrazygia bicolor	4110
Thatch, brittle	Thrinax microcarpa	4110
Thatch palm, Florida	Thrinax parviflora	4110
Thimbleberry	Rubus parviflorus	2110
Thistle, purple	Cirsium horridulum	4110
Thistle, Russian	Salsola iberica	2530
Thistle, Russian	Salsola kali	2320
Three-awn, arrowfeather	Aristida purpurascens	2310
Three-awn, bottlebrush	Aristida spiciformis	2310
Three-awn, pineland	Aristida stricta	2320
Three-awn, prairie	Aristida oligantha	2320, 2510
Thoroughwort	Eupatorium perfoliatum	2210
Tickclover	Desmodium rigidum	2310
Tickseed	Coreopsis lewtonii	4110
Tie-tongue	Coccoloba diversifolia	4110
Tillandsia, treebeard	Tillandsia usneoides	2310
Titi	Cyrilla racemiflora	2310, 2320
Toadflax	Linaria spp.	2310
Toadshade	Trillium sessile	2210
Toothwort	Dentaria spp.	2310

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Toothwort	Dentaria laciniata	2210
Torchwood, balsam	Amyris balsamifera	4110
Tread-softly, risky	Cnidoscolus stimulosus	2320
Trefoil, tick-	Desmodium spp.	2210, 2310, 2320
Trefoil, tick-	Desmodium grandiflorum	2210
Trefoil, tick-	Desmodium rotundifolium	2210
Trema	Trema micrantha	4110
Tridens, hairy	Tridens pilosus	2530
Trillium	Trillium spp.	2110, 2210, 2310
Trillium	Trillium lanceolatum	2310
Trillium, Huger's	Trillium hugeri	2310
Trillium, large-flowered	Trillium grandiflorum	2110, 2210
Trillium, nodding	Trillium cernuum	2210
Trumpet-creeper	Campsis radicans	2210, 2320
Tulip-poplar	Liriodendron tulipifera	2210, 2310, 2320
Tupelo, swamp black	Nyssa sylvatica var. biflora	2310, 2320
Tupelo, water	Nyssa aquatica	2310, 2320
Twinflower	Linnaea borealis	2110
Twinleaf	Jeffersonia diphylla	2210
Twisted-stalk	Streptopus roseus	2110
Varnish tree	Dodonea viscosa	4110
Velvetseed	Guettarda scabra	4110
Venus-fly-trap	Dionaea muscipula	2320
Venus's looking-glass, clasping	Specularia perfoliata	2310
Verbena, woolly	Verbena stricta	2510
Viburnum, black-haw	Viburnum prunifolium	2110, 2320
Viburnum, maple-leaved	Viburnum acerifolium	2110, 2210, 2320
Viburnum, possum-haw	Viburnum nudum	2320
Viburnum, rusty black-haw	Viburnum rufidulum	2310, 2320
Violet	Viola spp.	2110, 2210, 2310, 2320
Violet, birdfoot-	Viola pedata	2210
Violet, dog's-tooth-	Erythronium americanum	2110, (2210), 2320
Violet, downy yellow	Viola pubescens	2210
Violet, pale	Viola pallens	2110
Violet, primrose	Viola primulifolia	2320
Violet, swamp white	Viola incognita	2110
Virginia creeper	Parthenocissus quinquefolia	2210, 2210, 2310, 2320, 2510, 4110
Virgin's-bower	Clematis virginiana	2110
Wahoo	Euonymus atropurpureus	2210, 2320
Walnut, black	Juglans nigra	2210, 2310, 2320, 2510
Waterleaf	Hydrophyllum spp.	2210
Wax-myrtle, southern	Myrica cerifera	2310, 2320, 4110
Whitewood	Schoepfia schreberi	4110
Willow	Salix spp.	2110, 2210, 2310, 2510
Willow, black	Salix nigra	2210, 2310, 2320
Willow, coastal plain	Salix caroliniana	4110
Willow, prairie	Salix humilis	2210
Willow, shrubby	Salix spp.	2110, 2210
Winterberry	Ilex decidua	2110, (2210), (2320)
Winterberry	Ilex verticillata	2210, 2320
Winterberry, mountain	Ilex montana	2210
Wintergreen, spotted	Chimaphila maculata	2110, 2320
Witch-hazel	Hamamelis virginiana	2210, 2310, 2320
Wood-poppy	Stylophorum diphyllum	2210
Woodbine	Lonicera sempervirens	2210, 2310, 2320
Woodbine	Parthenocissus inserta	2210
Woodrush	Luzula spp.	2110
Woodvine	Lonicera canadensis	2110, (2210)

continued

Common name	Scientific name	Province(s)[a]
	Eastern United States (Continued)	
Yam	Dioscorea hirticaulis	2210
Yarrow	Achillea millefolium	2110, 2210
Yaupon	Ilex vomitoria	2310, 2320
Yellowroot	Xanthorhiza simplicissima	2320
Yellowwood	Cladrastis lutea	2210
Yellowwood	Zanthoxylum flavum	4110
Yew	Taxus canadensis	2110
Yucca	Yucca spp.	2320
Yucca, Adam's needle	Yucca filamentosa	2310
Yucca, moundlily	Yucca gloriosa	2310
Zenobia, green	Zenobia pulverulenta	2320
* *		
	Western United States	
Abrojo, grayleaf	Condalia lycioides	3140, 3210, 3220, M3120
Abrojo, spiny	Condalia spathulata	3140, 3210, 3220
Acacia	Acacia spp.	3210
Acacia	Acacia vernicosa	3140, 3210
Acacia, mescat	Acacia constricta	3140, 3210, 3220, M3120
Agave, desert	Agave deserti	3140, 3210, 3220
Agave, Palmer	Agave palmeri	3140, 3210, 3220, M3120
Agave, Parry	Agave parryi	3140, 3210, 3220, M3120
Agave, rough	Agave asperrima	3210
Agave, Shott	Agave shottii	3140, 3210, 3220
Agoseris, annual	Agoseris heterophylla	3130
Agoseris, false	Microseris troximoides	3120, 3130
Agoseris, pale	Agoseris glauca	M3110
Alder, Arizona	Alnus oblongifolia	3140, 3210, M3120
Alder, mountain	Alnus tenuifolia	M3120, P3130
Alder, red	Alnus rubra	2410, M3110
Alder, thinleaf	Alnus tenuifolia	M3120, P3130
Alder, white	Alnus rhombifolia	3130, M2410, M2620
Algaroba	Prosopis glandulosa	3210
Algodoncillo	Gossypium thurberi	3140, 3210, 3220
Allthorn	Castela texana	3210
Alumroot, small-leaf	Heuchera micrantha	M2410
Amargoso, chaparro	Castela texana	3210
Amole	Agave shottii	3140, 3210, 3220
Anacahuite	Cordia boisieria	3210
Anemone, Lyall	Anemone lyallii	M2410
Anemone, Oregon	Anemone oregana	M2410
Anemone, Piper	Anemone piperi	M2410
Anemone, threeleaf	Anemone deltoidea	2410, M2410
Angelica, shining	Angelica arguta	M2410
Antelope brush	Purshia tridentata	(3130), 3210, 3220, (M2110), M2610, M2620, (M3110), M3120, P3130, (A3140)
Arnica, broadleaf	Arnica latifolia	M2110, M2410
Arnica, heartleaf	Arnica cordifolia	3130, M2110, M2410, M3110
Arnica, orange	Arnica fulgens	3130
Arnica, small-flowered	Arnica discoidea	M2410
Arrow-weed	Tessaria sericea	3210, 3220, M3120
Arrowhead	Sagittaria spp.	M2410
Ash	Fraxinus spp.	3220
Ash, Oregon	Fraxinus latifolia	2410
Ash, sitka mountain-	Sorbus sitchensis	M2410
Ash, velvet	Fraxinus velutina	3140, 3210, M3120
Aspen, golden	Populus tremuloides	(3110), (3130), 3140, 3210, 3220, (M2110), (M3110), M3120, P3130

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Aspen, quaking	Populus tremuloides	3110, 3130, 3140, (3210), 3220, M2110, M3110, M3120, P3130
Aspen, trembling	Populus tremuloides	(3110), (3130), 3140, 3210, (3220), (M2110), (M3110), M3120, (P3130)
Aster	Aster spp.	3130, 3140, M3110, P3130
Aster, Chilian	Aster chilensis	2410, M2410
Aster, crag	Aster scopulorum	3130
Aster, desert	Aster abatus	3220
Aster, heath	Aster ericoides	3110
Aster, hoary	Machaeranthera canescens	3130
Aster, leafy	Aster foliaceus	M2110
Aster, Majave	Aster abatus	3220
Aster, roughleaf	Aster radulinus	2410
Aster, shasta	Machaeranthera shastensis	M2410
Avens	Geum spp.	3130
Avens, largeleaf	Geum macrophyllum	3130
Avens, three-flowered	Geum triflorum	3120
Azalea, western	Rhododendron occidentale	M2410
Baccharis	Baccharis spp.	3140, 3210, 3220, M3120
Baccharis, Emory	Baccharis emoryi	M3120
Bahia, plains	Bahia oppositifolia	3140
Balsam, white	Abies lasiocarpa	(3130), (M2110), (M2410), M3120, P3130
Balsamroot, arrowleaf	Balsamorhiza sagittata	3120, 3130, M2110, P3130
Balsamroot, Carey's	Balsamorhiza careyana	3120, 3130
Balsamroot, deltoid	Balsamorhiza deltoidea	2410, M2410
Balsamroot, Hooker	Balsamorhiza hookeri	3130
Balsamroot, serrated	Balsamorhiza serrata	3130
Balsamscale, woolspike	Elyonurus barbiculmus	3140, 3210, 3220, M3120
Baneberry	Actaea rubra	M2110, M2410
Barberry	Berberis haematocarpa	3140, 3210, 3220, M3120
Barberry	Berberis fremontii	3210, 3220, M3120, P3130
Barley, foxtail	Hordeum jubatum	M3120, P3130
Barley, meadow	Hordeum brachyantherium	2410
Bassia, five-hook	Bassia hyssopifolia	3130, P3130
Beadlily	Clintonia uniflora	M2110, M2410
Beadlily, red	Clintonia andrewsiana	M2410
Beakrush	Rhynchospora albus	2410
Bearberry	Arctostaphylos uva-ursi	(2410), (3130), (M2110), M2410, (M3110), M3120, P3130
Beard tongue	Penstemon spp.	(3110), (3130), M3110
Beavertail	Opuntia basilaris	3210, 3220, M3120, P3130
Bedstraw	Galium spp.	2410, M3110
Bedstraw, Cleaver's	Galium aparine	2410, M2110, M2410
Bedstraw, northern	Galium boreale	3130, M2110
Bedstraw, obscure	Galium ambiguum	M2410
Bedstraw, shrubby	Galium multiflorum	M2410
Bedstraw, sweet-scented	Galium triflorum	2410, M2110, M2410
Bee-brush, common	Aloysia gratissima	3210
Beebalm	Monarda spp.	M3120, P3130
Beeplant, Rocky Mountain	Cleome serrulata	3140, P3130

continued

General Appendix A (continued)

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Bellflower, Scouler	Campanula scouleri	M2410
Besseya, red	Besseya rubra	3120
Bilberry, dwarf	Vaccinium myrtillus	M2110
Birch, bog	Betula glandulosa	M3110
Birch, paper	Betula papyrifera	M2110
Birch, river	Betula occidentalis	M3110
Bird's-beak, slender	Cordylanthus viscidus	M2410
Bisbirinda	Castela texana	3210
Biscuit root	Lomatium spp.	3130, P3130
Bistort, American	Polygonum bistortoides	M2410
Bitterbrush	Purshia tridentata	3130, 3210, 3220, M2110, (M2610), (M2620), M3110, M3120, P3130, A3140
Blackberry, strawberry-leaf	Rubus pedatus	M2410
Blackberry, trailing	Rubus ursinus	2410, M2410
Blackbrush	Acacia rigidula	3210
Blackbrush	Coleogyne ramosissima	3130, 3220, P3130
Blackbrush	Flourensis cernua	3140, 3210
Bladder-nut, Bolander's	Staphylea bolanderi	M2610
Bladderpod	Isomeris arborea	M2620
Bladderpod	Lesquerella spp.	3110
Bladderpod, Oregon double	Physaria oregana	3130
Bladderwort, common	Utricularia vulgaris	3130
Blazing-star	Liatris punctata	(3110), 3140, P3130
Blazing-star	Mentzelia spp.	3140, 3220, M3120, P3130
Blazing-star	Mentzelia laevicaulis	3130
Blazing-star	Mentzelia nitens	3220
Blazing-star, Venus	Mentzelia nitens	3220
Bleeding-heart	Dicentra formosa	M2410
Blennosperma, common	Blennosperma nanum	2610
Blepharipappus	Blepharipappus scaber	M2410, M2610
Blow-wives	Achyrachaena mollis	2610
Bluebell	Campanula rotundifolia	3130, (M3110), P3130
Bluebells	Mertensia spp.	M3110
Blueberry	Vaccinium oreophyllum	M3120, P3130
Blueberry, Alaska	Vaccinium alaskaense	M2410
Blueberry, delicious	Vaccinium deliciosum	M2410
Blueberry, evergreen	Vaccinium ovatum	M2410
Bluejoint turkeyfoot	Andropogon gerardii	(3110), 3140, P3130
Bluestem, big	Andropogon gerardii	3110, 3140, P3130
Bluestem, cane	Andropogon barbinodis	3140, 3210, 3220, M3120
Bluestem, little	Andropogon scoparius	3110, 3140, 3210, P3130
Bluestem, sand	Andropogon hallii	3110
Bluestem, silver	Andropogon saccharoides	3210
Bolandra, Sierra	Bolandra californica	M2610
Box-elder	Acer negundo	3140, 3210, M3120, A3140
Box thorn	Lycium cooperi	3130, P3130
Boxleaf, myrtle	Pachystima myrsinites	3130, 3140, 3210, 3220, (M2110), (M2410), (M2610), M3120, P3130
Boxwood, Oregon	Pachystima myrsinites	(3130), 3140, 3210, 3220, M2110, M2410, M2610, M3120, P3130
Boykinia, large-flowered	Boykinia major	M2410
Boykinia, slender	Boykinia elata	M2410
Bracken	See "Ferns"	
Bramble, dwarf	Rubus lasiococcus	M2410
Brickellia, California	Brickellia californica	3140, 3210, 3220, M3120
Brittle bush	Encelia farinosa	3140, 3220, M3120
Brodiaea, Douglas'	Brodiaea douglasii	3120, 3130
Brodiaea, purplehead	Brodiaea pulchella	M2410
Brome	Bromus spp.	M2410, M3110, M3120, P3130

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Brome, California	Bromus carinatus	3130, M2110, M2410, M3120, P3130
Brome, Columbia	Bromus vulgaris	2410, M2110, M2410, M3110
Brome, downy	Bromus tectorum	3110, (3120), (3130), (M2110), P3130, A3140
Brome, Japanese	Bromus japonicus	2410, 3110, 3120
Brome, mountain	Bromus carinatus	(3130), (M2110), M3120, P3130
Brome, mountain	Bromus marginatus	3130, 3220, M3120, P3130
Brome, red	Bromus rubens	3220, M3120
Brome, rescue	Bromus carinatus	(3130), (M2110), M3120, P3130
Broom, Scotch	Cystisus scoparius	2410
Buckbrush	Ceanothus fendleri	3130, 3140, 3210, 3220, M3120, P3130
Buckbrush, common	Ceanothus cuneatus	M2410
Buckthorn	Rhamnus crocea	3140, 3210, 3220, (M2410), M3120
Buckthorn, birchleaf	Rhamnus betulaefolia	3210, 3220, M3120
Buckthorn, California	Rhamnus californica	3140, 3210, 3220, (M2410), (M2620), M3120
Buckthorn, hollyleaf	Rhamnus crocea	3140, 3210, 3220, M2410, M3120
Buckthorn, red berry	Rhamnus crocea	3140, 3210, 3220, (M2410), M3120
Buckwheat, barestem	Eriogonum nudum	M2410
Buckwheat, cushion	Eriogonum ovalifolium	3130, P3130
Buckwheat, deer	Eriogonum wrightii	3140, 3220, M3120
Buckwheat, desert	Eriogonum deserticola	3220
Buckwheat, desert	Eriogonum heracleoides	3120, 3130
Buckwheat, desert	Eriogonum strictum	3130
Buckwheat, Douglas	Eriogonum douglasii	3130
Buckwheat, mat	Eriogonum caespitosum	3130
Buckwheat, northern	Eriogonum compositum	3130
Buckwheat, rock	Eriogonum sphaerocephalum	3130
Buckwheat, slender	Eriogonum microthecum	3130
Buckwheat, sulfur	Eriogonum umbellatum	3110, 3130, M2410, M3110
Buckwheat, thyme	Eriogonum thymoides	3130
Buckwheat, wild	Eriogonum spp.	3110, 3130, P3130
Buckwheat, wild	Eriogonum deserticola	3220
Buckwheat, wild	Eriogonum fasciculatum	M2620
Budsage	Artemisia spinescens	(3130), P3130
Budsagebrush	Artemisia spinescens	(3130), P3130
Buffalo-gourd	Cucurbita foetidissima	3210
Buffaloberry	Shepherdia spp.	P3130
Buffaloberry	Shepherdia canadensis	M2110, M3110
Bugbane, false	Trautvetteria carolinensis	M2610
Bullnettle	Solanum elaeagifolium	3140, 3210, 3220
Bulrush	Scirpus spp.	3140, 3210, 3220, M2410, M3120
Bulrush	Scirpus pallidus	3210
Bulrush, alkalai	Scirpus olneyi	3130
Bulrush, American great	Scirpus validus	3130
Bulrush, salt-marsh	Scirpus paludosus	3130, 3140, 3220, M3120
Bulrush, three-square	Scirpus americanus	M3120
Bur-reed	Sparganium spp.	M2410
Bur sage	Ambrosia deltoidea	3140, 3220, M3120
Bur sage, skeletonleaf	Franseria discolor	3140, P3130
Bur sage, triangle	Ambrosia deltoidea	3140, 3220, M3120
Bur sage, white	Ambrosia dumosa	3220
Bur sage, woolly	Ambrosia eriocentra	3220
Burroweed	Haplopappus tenuisectus	3140, 3210, 3220
Bursera, elephant	Bursera microphylla	3220
Buttercup	Ranunculus spp.	M3120, P3130

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Buttercup, California	Ranunculus californicus	M2410
Buttercup, western	Ranunculus occidentalis	2410
Buttonsage	Artemisia spinescens	(3130), P3130
Buttonweed, rough	Diodia teres	M3110
Cabbage, skunk	Lysichitum americanum	2410, M2410
Cacanapo	Opuntia lindheimeri	3210
Cactus, barbed-wire	Cereus pentagonus	3210
Cactus, barrel	Ferocactus wislizenii	3140, 3210, 3220, M3120
Cactus, cream	Mammillaria gummifera	3140, 3210, 3220, M3210
Cactus, desert Christmas	Opuntia leptocaulis	3140, 3210, 3220, M3210
Cactus, fish-hook	Mammillaria spp.	3140, 3210
Cactus, fish-hook	Mammillaria microcarpa	3140, 3220, M3120
Cactus, giant	Cereus giganteus	3140, 3220, M3120
Cactus, hedgehog	Echinocereus spp.	3140, 3220, M3120, P3130
Cactus, hedgehog	Echinocereus enneacanthus	3210
Cactus, organpipe	Cereus thurberi	3140, 3220, M3120
Cactus, pancake pear	Opuntia chlorotica	3140, 3210, 3220
Cactus, pincushion	Coryphantha vivipara	3140, 3210
Cactus, pincushion	Mammillaria spp.	3140, 3210
Cactus, rainbow	Echinocereus pectinatus	3140, 3210, 3220, M3120
California tea	Psoralea physodes	M2410
Calliandra, hairy-leaved	Calliandra eriophylla	3140, 3210, 3220
Calypso	Calypso bulbosa	2410, M2110
Camas, common	Camassia quamash	2410
Camino	Leucophyllum frutescens	3210
Camote-de-raton	Hoffmanseggia spp.	3140, 3210, 3220
Camphor-weed	Pluchea camphorata	3210, 3220
Canatilla	Ephedra trifurca	3140, 3210, 3220
Candlewood	Fouquieria splendens	3140, 3210, 3220, M3120
Cane, Georgia	Arundo donax	3210
Caraway, mountain	Aletes acaulis	M3110
Carpenteria	Carpenteria californica	M2610
Carrizo	Arundo donax	3210
Cascara	Rhamnus purshiana	2410, M2410
Cat-claw	Acacia greggii	3140, 3210, 3220, M3120
Cat-claw	Mimosa spp.	3210
Cat-claw	Mimosa biuncifera	3140, 3210, 3220, M3120
Cat-tail	Typha spp.	3140, 3210, 3220, M3120
Cat-tail, common	Typha latifolia	3130, M2410
Cat-tail, narrow-leaved	Typha angustifolia	3130, 3220
Catalpa, desert	Chilopsis linearis	3140, 3210, 3220, (M2610), M3120
Catsear, spotted	Hypochaeris radicata	M2410
Ceanothus	Ceanothus spp.	M2620, M3110
Ceanothus, blue-blossum	Ceanothus thyrsiflorus	M2410
Ceanothus, desert	Ceanothus greggii	3140, 3210, 3220, M3120
Ceanothus, dwarf	Ceanothus prostratus	M2410
Cedar, incense-	Libocedrus decurrens	2410, M2410, M2610, M2620
Cedar, Port-Orford	Chamaecyparis lawsoniana	M2410
Celery, wild	Apiastrum angustifolium	M2610
Cenizo	Leucophyllum frutescens	3210
Century plant, mescal	Agave palmeri	3140, 3210, 3220, M3120

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Chamise, common	Adenostoma fasciculatum	M2610, M2620
Chamiso	Atriplex canescens	(3130), 3140, 3220, P3130, (A3140)
Chaparral broom	Baccharis consanguinea	2610
Chapparo prieto	Acacia rigidula	3210
Cheat	Bromus tectorum	(3110), 3120, 3130, M2110, P3130, A3140
Checkermallow, meadow	Sidalcea campestris	2410
Checkermallow, rose	Sidalcea virgata	M2410
Cherioni	Sapindus drummondi	3140, 3210, 3220, M3120
Cherry, bitter	Prunus emarginata	M2410, M2610, M3110, M3120, P3130
Cherry, mazzard	Prunus avium	2410
Cherry, western choke-	Prunus virginiana	3110, 3130, M2110, M2410, P3130
Cherry, wild	Prunus spp.	3140, M3120
Cherry, wild	Prunus emarginata	(M2410), (M2610), (M3110), M3120, P3130
Chess, downy	Bromus tectorum	(3110), (3120), (3130), (M2110), P3130, (A3140)
Chicalote	Argemone intermedia	3140, P3130
Chickweed, common	Cerastium vulgatum	M2410
Chickweed, common	Stellaria media	M2410
Chickweed, field	Cerastium arvense	M2110
Chickweed, jagged	Holosteum umbellatum	3120, 3130
Chickweed, shining	Stellaria nitens	3120, M2110
Chilicote	Erythrina flabelliformis	3140, 3210, 3220, M3120
China-tree, wild	Sapindus drummondi	3140, 3210, 3220, M3120
Chinquapin, giant	Castanopsis chrysophylla	M2410, M2620
Chinquapin, Sierra	Castanopsis sempervirens	M2610, M2620
Chittanwood	Bumelia lycoides	3210
Cholla	Opuntia spp.	(3130), 3220, P3130
Cholla	Opuntia leptocaulis	3140, 3210, 3220, M3120
Cholla, cane	Opuntia imbricata	3140, 3210, 3220
Cholla, cane	Opuntia spinosior	3140, 3210, 3220, M3120
Cholla, devil	Opuntia stanlyi	3140, 3210
Cholla, jumping	Opuntia fulgida	3140, 3220, M3120
Cholla, Stanly	Opuntia stanlyi	3140, 3210
Cholla, tree	Opuntia imbricata	3140, 3210, 3220
Cholla, Whipple	Opuntia whipplei	3210, 3220, P3130
Chopo	Populus arizonica	3210
Christmas berry	Heteromeles arbutifolia	M2410, M2620
Cinquefoil	Potentilla spp.	3130, M3110, M3120, P3130
Cinquefoil, beauty	Potentilla gracilis	3120, 3130, M2110
Cinquefoil, bush	Potentilla fruticosa	M3120, P3130
Cinquefoil, Norwegian	Potentilla norvegica	M2110
Cinquefoil, shrubby	Potentilla fruticosa	M3120, P3130
Circaea, Alpine	Circaea alpina	2410, 3130, M2410
Clapweed	Ephedra antisyphilitica	3140, 3210, 3220
Clematis, Columbia	Clematis columbiana	M2110
Cliff-brake, Oregon	Cryptogramma densa	M2410
Cliffbush	Jamesia americana	3140, 3220, M2610, M3110, M3120, P3130
Cliffrose	Cowania mexicana	3130, 3140, 3210, 3220, M3120, P3130
Clover	Trifolium gymnocarpon	3130, A3140
Clover, big-headed	Trifolium macrocephalum	3130
Clover, long-stalked	Trifolium longipes	3130
Clover, mountain	Trifolium fendleri	M3120, P3130

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Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Douglas-fir	Pseudotsuga menziesii	2410, 3130, 3140, 3210, 3220, M2110, M2410, M2610, M3110, M3120, P3130
Douglas-fir, big cone	Pseudotsuga macrocarpa	M2610
Dove weed	Croton spp.	3140, 3210, 3220
Dove weed	Croton texensis	(3110), 3140, 3210, 3220
Draba, vernal	Draba verna	3120, 3130
Dropseed	Sporobolus spp.	3140, 3210, 3220
Dropseed, black	Sporobolus interruptus	3220, M3120, P3130
Dropseed, hairy	Blepharoneuron tricholepis	3140, 3210, 3220, M3120, P3130
Dropseed, pine	Blepharoneuron tricholepis	3140, 3210, 3220, M3120, P3130
Dropseed, sand	Sporobolus cryptandrus	3110, 3130, 3210, 3220, M3120, P3130
Durango root	Datisca glomerata	M2620
Eastwoodia	Eastwoodia elegans	M2620
Elder, Arizona	Sambucus mexicana	3210
Elder, Canadian	Sambucus cerulea	3130, 3220, (M2410), (M2620), M3120, P3130
Elder, Mexican	Sambucus mexicana	3210
Elderberry	Sambucus spp.	3130, 3140, M3120, P3130
Elderberry, blue	Sambucus cerulea	(3130), (3220), M2410 M2620, (M3120), (P3130)
Elderberry, red	Sambucus racemosa	3130, M2410, M3110, M3120, P3130
Elephant-tree	Bursera microphylla	3220
Ephedra, vine	Ephedra antisyphilitica	3140, 3210, 3220
Eriogonum, annual	Erogonum annuum	3110
Eriogonum, slenderbush	Eriogonum microthecum	3130, 3140, P3130
Eriogonum, snowy	Eriogonum niveum	3130
Everlasting, pearly	Anaphalis margaritacea	3130, M2410
Everlasting, pinewoods	Antennaria geyeri	3130
Everlasting, woodrush	Antennaria luzuloides	3130
Fairy duster	Calliandra eriophylla	3140, 3210, 3220
Fairybells, Hooker's	Disporum hookeri	M2410
Fairybells, Smith's	Disporum smithii	M2410
Fairybells, wartberry	Disporum trachycarpum	M2110
False-caraway, mountain	Perideridia bolanderi	M2410
Felt-thorn, bald-leaved	Tetradymia glabrata	3130, P3130
Felt-thorn, white	Tetradymia comosa	3130, P3130
Fendlerella	Fendlerella utahensis	3220, M3120, P3130
Ferns: Bracken fern	Pteridium aquilinum	2410, 3140, 3210, M2410, M3120, P3130
Brittle fern	Cystopteris fragilis	M2110, M3110

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Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Ferns (Continued): Chain fern	Woodwardia fimbriata	M2410, M2610, M2620
Deer fern	Blechnum spicant	2410, M2410, M2620
Lady-fern	Athyrium filix-femina	2410, M2110, M2410
Maidenhair fern	Adiantum pedatum	M2410
Oak-fern	Gymnocarpium dryopteris	M2110, M2410
Shield-fern, coastal	Dryopteris arguta	2410
Sword fern	Polystichum munitum	2410, M2410
Sword fern, rock	Polystichum scopulinum	M2410
Wood fern, mountain	Dryopteris austriaca	M2410
Fernbush	Chamaebatiaria millefolium	3210, 3220, M2610, M3120, P3130
Fescue	Festuca spp.	M3110, M3120, P3130
Fescue, Arizona	Festuca arizonica	3140, 3210, 3220, M3120, P3130
Fescue, California	Festuca californica	2410
Fescue, eight-flowered	Festuca octoflora	2410, (3110), 3120, 3130
Fescue, Idaho	Festuca idahoensis	2410, 3110, 3120, 3130, M2110, M2410, M3110, P3130
Fescue, meadow	Festuca pratensis	2410
Fescue, Nuttall's	Festuca microstachys	3120, 3130
Fescue, red	Festuca rubra	2410, M3120, P3130
Fescue, rough	Festuca scabrella	M2110
Fescue, sheep	Festuca ovina	M2410
Fescue, six-weeks	Festuca octoflora	(2410), 3110, (3120), (3130)
Fescue, spike	Hesperochloa kingii	3130, M2110
Fescue, Thurber	Festuca thurberi	M3120, P3130
Fescue, western	Festuca occidentalis	2410, 3130, M2410, M3110
Filaree	Erodium cicutarium	3130, 3140, 3210, 3220, M3120
Fir, balsam	Abies concolor	(3110), 3140, (3210), 3220, (M2110), (M2410), (M3110), M3120, P3130
Fir, corkbark	Abies lasiocarpa	(3130), (M2110), (M2410), M3120, P3130
Fir, grand	Abies grandis	2410, 3130, M2110, M2410, M3110
Fir, noble	Abies procera	M2410
Fir, Pacific silver	Abies amabilis	M2410
Fir, shasta red	Abies magnifica	M2410, M2610
Fir, subalpine	Abies lasiocarpa	3130, M2110, M2410, M3120, P3130
Fir, white	Abies concolor	3130, 3140, 3210, 3220, M2410, M2610, M3110, M3120, P3130
Fir, white	Abies lasiocarpa	(3130), (M2110), (M2410), M3120, P3130
Fire-cracker flower	Brodiaea Ida-Maia	M2410
Fireweed	Epilobium angustifolium	3130, M2410
Flag	Iris missouriensis	(3120), (3130), M3120, P3130
Flag, blue	Iris missouriensis	(3120), (3130), M3120, P3130
Flannel bush	Fremontia californica	3140, 3210, 3220, M3120
Flax, wild blue	Linum perenne	M2410
Fleabane	Erigeron spp.	3130, M3120, P3130
Fleabane	Erigeron divergens	3140, 3210, 3220, M3120, P3130
Fleabane	Erigeron flagellaris	3220, M3120, P3130
Fleabane, Alice	Erigeron aliceae	M2410
Fleabane, annual	Erigeron annuus	M2410
Fleabane, Bloomer	Erigeron bloomeri	M2410

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Common name	Scientific name	Province(s)[a]
Western United States (Continued)		
Fleabane, dwarf mountain	Erigeron compositus	M2110
Fleabane, lineleaf	Erigeron linearis	3130
Fleabane, longleaf	Erigeron corymbosus	3120, 3130
Fleabane, salt-marsh	Pluchea camphorata	3210, 3220
Fleabane, showy	Erigeron speciosus	M2110
Fleabane, threadleaf	Erigeron filifolius	3130
Fleabane, threadleaf	Erigeron foliosus	M2410
Foam bush	Holodiscus dumosus	(3130), 3140, 3210, 3220, (M2410), (M3110), M3120, P3130
Foamflower, coolwort	Tiarella unifoliata	M2410
Foxglove	Digitalis purpurea	M2410
Foxtail, marsh	Alopecurus geniculatus	2410
Fremont, California	Fremontia californica	3140, 3210, 3220, M2610, M2620, M3120
Fringe, purple	Phacelia spp.	M3110
Fringecup, Alaska	Tellima grandiflora	2410, M2410
Fringecup, slender	Lithophragma bulbifera	3120, 3130
Fringecup, small-flowered	Lithophragma parviflora	3120, M2110
Galleta, big	Hilaria rigida	3220
Galrezia, showy	Galrezia speciosa	M2620
Gay-feather	Liatris spp.	3110
Gay-feather, dotted	Liatris punctata	3110, 3140, P3130
Gayophytum, Nuttall's	Gayophytum nuttallii	3130
Geranium	Geranium spp.	3130, M3110, P3130
Geranium, cranesbill	Geranium richardsonii	M2110, M3120, P3130
Geranium, cut-leaved	Geranium dissectum	2410
Geranium, sticky	Geranium viscosissimum	3120, 3130
Gilia, globe	Gilia capitala	M2410
Gilia, granite	Leptodactylon pungens	P3130, (3130)
Gilia, small-flowered	Gilia minutiflora	3130
Ginger, wild	Asarum candatum	M2410
Globe mallow	Sphaeralcea spp.	3210, 3220, P3130
Globe mallow	Sphaeralcea ambigua	3130, P3130
Globe mallow	Sphaeralcea fendleri	M3120, P3130
Globe mallow	Sphaeralcea grossalarirefolia	3130, P3130
Globe mallow, scarlet	Sphaeralcea coccinea	3110
Globeflower, American	Trollius laxus	M2110
Goatnut	Simmondsia chinensis	3140, 3220, M3120 (M2620)
Goat's-beard	Aruncus sylvester	M2410
Goldaster	Chrysopsis villosa var. bolanderi	M2410
Goldaster, hairy	Chrysopsis villosa	3130, 3140, P3130
Golden banner	Thermopsis divaricarpa	M3110
Golden stars, common	Bloomeria crocea	M2620
Goldenhead	Acamptopappus sphaerocephalus	3220
Goldenrod	Solidago spp.	M3110, M3120, P3130
Goldenrod, Canada	Solidago canadensis	M2110
Goldenrod, coastal	Solidago spathulata	M2410
Goldenweed	Haplopappus lanceolatus	3130, P3130
Goldenweed	Haplopappus racemosa	M2410
Goldthread, cutleaf	Coptis laciniata	M2410
Goldthread, western	Coptis occidentalis	M2110
Gooseberry	Ribes spp.	3130, M3120, P3130
Gooseberry	Ribes californicum	M2410
Gooseberry	Ribes inebrians	3110
Gooseberry	Ribes velutinum	3130, P3130
Gooseberry, canyon	Ribes menziesii	M2410
Gooseberry, hupa	Ribes marshallii	M2410
Gooseberry, orange	Ribes pinetorum	3140, 3210
Gooseberry, pioneer	Ribes lobbii	M2410
Gooseberry, siskiyou	Ribes binominatum	M2410
Gooseberry, swamp	Ribes lacustre	M2110, M2410
Goosefoot	Chenopodium album	3140, P3130
Goosefoot, slimleaf	Chenopodium leptophyllum	3140, P3130
Grama	Bouteloria spp.	A3140
Grama, black	Bouteloua eriopoda	3140, 3210, 3220, M3120, P3130
Grama, blue	Bouteloua gracilis	3110, 3130, 3140, 3210, 3220, M3120, P3130
Grama, Chino	Bouteloua breviseta	3210
Grama, hairy	Bouteloua hirsuta	3140, 3210, 3220, P3130
Grama, red	Bouteloua trifida	3210
Grama, Rothrock	Bouteloua rothrockii	3140, 3210, 3220, M3120
Grama, side-oats	Bouteloua curtipendula	3110, 3140, 3210, 3220, M3120, P3130
Grama, six-weeks	Bouteloua barbata	3210
Grama, slender	Bouteloua filiformis	3140, 3210, 3220
Grama, sprucetop	Bouteloua chondrosioides	3140, 3210, 3220
Grape, canyon	Vitis arizonica	3140, 3210, 3220, M3120
Grape, Oregon-	Berberis nervosa	2410, M2410, M3110
Grape, Oregon-	Berberis repens	3130, 3220, M2110, M3110, M3120, P3130
Grasses:		
Arrowgrass	Triglochin spp.	3130
Barnyard grass	Echinochloa crusgalli	3110
Bear grass	Nolina microcarpa	3210, 3220
Bear grass	Nolina texana	3140, 3210, 3220
Bear grass	Xerophyllum tenax	M2110, M2410, M2620
Beardgrass, cane	Andropogon barbinodis	3140, 3210, 3220, M3120
Bentgrass	Agrostis spp.	2410, (M3120), (P3130)
Bentgrass, Hall's	Agrostis hallii	2410
Bentgrass, Idaho	Agrostis idahoensis	2410
Bentgrass, winter	Agrostis scabra	M2110
Bermuda grass	Cynodon dactylon	3140, 3210, 3220, M3120
Blue-eyed grass	Sisyrinchium bellum	M2410
Blue-eyed grass, golden	Sisyrinchium californicum	M2410
Blue-eyed grass, Idaho	Sisyrinchium angustifolium	2410
Bluegrass	Poa spp.	3130, M3120, P3130
Bluegrass, Canada	Poa compressa	3130
Bluegrass, Cusick	Poa cusickii	3130
Bluegrass, Fendler	Poa fendleriana	3130, 3220, M3120, P3130, A3140
Bluegrass, fowl	Poa palustris	M2410
Bluegrass, Kentucky	Poa pratensis	2410, 3130, M3110, M3120, P3130
Bluegrass, Merrill's	Poa ampla	3120, 3130, M2110
Bluegrass, Nevada	Poa nevadensis	3130, P3130
Bluegrass, pine	Poa scabrella	2410, M2110
Bluegrass, plains	Poa arida	3140, P3130
Bluegrass, Sandberg	Poa sandbergii	3120, 3130, M2410, P3130
Bluegrass, Sandberg	Poa secunda	3130
Bluegrass, wheeler	Poa nervosa	3130, M3110
Bristlegrass, green	Setaria viridis	3110
Bristlegrass, yellow	Setaria lutescens	3110
Bromegrass	See "Brome"	
Buffalo grass	Buchloe dactyloides	3110, 3140, 3210, P3130
Bullgrass	Muhlenbergia emersleyi	3140, 3210, 3220, M3120
Canary-grass, reed	Phalaris arundinacea	3130
Cheatgrass	See "Cheat"	
Colusa grass	Anthochloa colusana	2610
Crabgrass	Digitaria sanguinalis	3110
Deergrass	Muhlenbergia rigens	3140, 3220, M3120, P3130

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Common name	Scientific name	Province(s)[a]
Western United States (Continued)		
Grasses (Continued):		
Fluffgrass	Tridens puchellus	3140, 3210, 3220, M3120
Galleta grass	Hilaria jamesii	3130, 3140, P3130
Gama grass, eastern	Tripsacum dactyloides	3110
Grama grass	See "Grama"	
Hairgrass, slender	Deschampsia elongata	3130, M2110, M2410
Hairgrass, tufted	Deschampsia caespitosa	2410, M3120, P3130
Indian-grass	Sorghastrum nutans	3110, 3140, P3130
Junegrass, mountain	Koeleria cristata	(3110), (3120), (3130) 3140, 3210, 3220, (M3110), M3120, P3130, (A3140)
Junegrass, prairie	Koeleria cristata	3110, 3120, 3130, 3140, 3210, 3220, M3110, M3120, P3130, A3140
Lovegrass, gummy	Eragrostis curtipedicellata	3110
Lovegrass, Lehmann	Eragrostis lehmanniana	3140, 3210, 3220
Lovegrass, plains	Eragrostis intermedia	3140, 3210, 3220, M3120, P3130
Manna grass	Glyceria spp.	M2410
Muttongrass	Poa fendleriana	(3130), 3220, M3120, P3130, (A3140)
Needlegrass	Stipa spp.	3210, 3220, M3120, P3130, A3140
Needlegrass, Columbian	Stipa columbiana	3130, M3120, P3130
Needlegrass, green	Stipa viridula	3110
Needlegrass, Lemmon	Stipa lemmonii	2410, M2410
Needlegrass, Letterman	Stipa lettermani	3130, M3120, P3130
Needlegrass, subalpine	Stipa columbiana	(3130), M3120, P3130
Needlegrass, Thurber	Stipa thurberiana	3130
Needlegrass, western	Stipa occidentalis	2410, 3120, 3130, M2410, M3110
Oat grass	Danthonia spp.	M3120, P3130
Oat grass, few-flowered wild	Danthonia unispicata	3130
Oniongrass	Melica bulbosa	M3120, P3130
Oniongrass, Alaska	Melica subulata	2410
Oniongrass, showy	Melica spectabilis	M2410
Orchardgrass	Dactylis glomerata	2410
Peppergrass, yellow-flowered	Lepidium perfoliatum	3130
Pinegrass	Calamagrostis rubescens	3130, M2110, M2410, M3110
Podgrass, shore	Triglochin maritimum	M2410
Reedgrass, bluejoint	Calamagrostis canadensis	3130, M2110
Reedgrass, Pacific	Calamagrostis nutkaensis	M2410
Reedgrass, plains	Calamagrostis montanensis	3130
Rice-grass, Indian	Oryzopsis hymenoides	3110, 3130, 3140, 3210, 3220, M3120 P3130, A3140
Rice-grass, pinyon	Piptochaetium fimbriatum	3210, 3220, P3130
Rice-grass, roughleaf	Oryzopsis asperifolia	M2110
Ring grass	Muhlenbergia torreyi	3210, 3220, M3120, P3130
Saltgrass	Distichlis spicata	3140, 3210, 3220, M2410, M3120
Saltgrass, desert	Distichlis stricta	3130, P3130
Schismus grass	Schismus barbatus	M3120
Slough grass	Bechmannia syzigachne	2410

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Common name	Scientific name	Province(s)[a]
Western United States (Continued)		
Grasses (Continued):		
Switchgrass	Panicum virgatum	3110, 3140, P3130
Sword-grass	Scirpus americans	M3120
Ticklegrass	Agrostis spp.	(2410), M3120, P3130
Tobosa-grass	Hilaria mutica	3140, 3210, 3220
Vanilla grass	Hierochloe occidentalis	M2410
Velvet grass	Holcus lanatus	2410, M2410
Vernal grass, sweet	Anthoxanthum odoratum	M2410
Wheatgrass	Agropyron spp.	M3110, M3120, P3130
Wheatgrass, bearded	Agropyron caninum	2410
Wheatgrass, bluebunch	Agropyron spicatum	3110, 3120, 3130, M2110, M2410, M3110, P3130
Wheatgrass, slender	Agropyron trachycaulum	M3120, P3130, A3140
Wheatgrass, thickspike	Agropyron dasystachyum	3130, P3130
Wheatgrass, western	Agropyron smithii	3110, 3130, 3140, P3130, A3140
Widgeon-grass	Ruppia maritima	3130
Gray-thorn	Condalia lycioides	3140, 3210, 3220, M3120
Greasewood	Larrea divaricata	3140, 3210, 3220, M3120
Greasewood	Sarcobatus vermiculatus	3130, P3130, A3140
Greenbrier, California	Smilax californica	M2610
Gromwell, western	Lithospermum ruderale	3120, 3130
Ground-cedar	Juniperus comunis	(3130), (M2110), (M2110), M3120, P3130
Ground-cone	Boschniakia hookeri	M2410
Groundsel	Senecio spp.	3140, 3210, P3130
Groundsel	Senecio serra	3130, M3120, P3130
Groundsel, arrowleaf	Senecia triangularis	M2110
Groundsel, Bolander's	Senecio bolanderi	M2410
Groundsel, cleftleaf	Senecio streptanthifolius	M2110
Groundsel, common	Senecio vulgaris	M2410
Groundsel, western	Senecio integerrimus	3120, 3130, M2110 M2410
Groundsmoke, hairstem	Gayophytum ramosissimum	3130
Grouseberry	Vaccinium scoparium	M2110, M2410, M3110
Guajillo	Acacia berlandieri	3210
Guazacan	Porlieria angustifolia	3210
Gumdrop tree	Zizyphus obtusifolia	3210
Gumweed	Grindelia hirsutula	M2410
Gumweed, curlycup	Grindelia squarrosa	3140, P3130
Gutterweed	Senecio serra	(3130), M3120, P3130
Hackberry, common	Celtis occidentalis	3110
Hackberry, desert	Celtis pallida	3140, 3210, 3220, M3120
Hackberry, netleaf	Celtis reticulata	3110, 3130, 3140, 3210, 3220, M3120, P3130
Hackberry, spiny	Celtis pallida	3140, 3210, 3220, M3120
Hackberry, western	Celtis reticulata	(3110), (3130), 3140, 3210, 3220, M3120, (P3130)
Halogeton	Halogeton glomeratus	3130, P3130
Haplopappus, Bloomer's	Haplopappus bloomeri	M2410
Haplopappus, narrow-leaved	Haplopappus stenophyllus	3130
Haplopappus, palouse	Haplopappus liatriformis	3120
Harebell	Campanula rotundifolia	(3130), M3110, P3130

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Harebell, California	Campanula prenanthoides	M2410
Hawksbeard	Crepis acuminata	3130, P3130
Hawksbeard, slender	Crepis atrabarba	3130
Hawkweed, houndstongue	Hieracium cynoglossoides	3130, M2410
Hawkweed, slender	Hieracium gracile	M2110
Hawkweed, western	Hieracium albertinum	3120, M3110
Hawkweed, white	Hieracium albiflorum	2410, M2410, M3110
Hawthorn	Crataegus spp.	3130
Hawthorn, Columbia	Crataegus columbiana	3130, M2110
Hawthorn, Douglas	Crataegus douglasii	2410, 3110, 3130, M2110
Hazelnut, California	Corylus cornuta	2410, M2110, M2410
Heather, red mountain	Phyllodoce empetriformis	M2110
Hedge-nettle, great	Stachys mexicana	M2410
Hedge-parsley, field	Torilis arvensis	2410
Heliotrope, turnsole	Heliotropium confertifolium	3210
Hellebore, American false	Veratrum viride	M2110, M2410
Hellebore, California false	Veratrum californicum	M2410
Helleborine, giant	Epipactis gigantea	M2410
Hemitomes	Hemitomes congestum	M2620
Hemlock, mountain	Tsuga mertensiana	M2110, M2410
Hemlock, western	Tsuga heterophylla	2410, M2110, M2410
Hermidium	Hermidium alipes	3130, P3130
Heron-bill	Erodium circutarium	(3130), 3140, 3210, 3220, M3120
Hidden flower	Cryptantha spp.	3140, P3130
Himalaya-berry	Rubus procerus	M2410
Hojase	Flourensia cernua	3140, 3210
Holacantha	Holacantha emoryi	3140, 3220, M3120
Hollisteria	Hollisteria lanata	2610, M2620
Hollygrape	Berberis fremontii	3210, 3220, M3120, P3130
Hollyhock, desert-	Sphaeralcea ambigua	(3130), P3130
Holozonia	Holozonia filipes	M2610, M2620
Honeysuckle	Lonicera spp.	M3110
Honeysuckle	Lonicera hispidula	M2410
Honeysuckle, black-fruited	Lonicera involucrata	M2410, M3120, P3130
Hop-sage, spiny	Atriplex spinosa	3130
Hop-sage, spiny	Grayia spinosa	3130, 3220, P3130
Hop-tree	Ptelea trifoliata	3130, P3130
Hopbush	Dodonaea viscosa	3140, 3220, M3120
Hornwort, common	Ceratophyllum demersum	3130
Horse bean, littleleaf	Cercidium microphyllum	3140, 3220, M3120
Horse chestnut	Aesculus californica	2610, M2410, M2620
Horsebrush, gray	Tetradymia canescens	3130
Horsemint	Monarda spp.	M3120, P3130
Horsenettle, silver	Solanum elaeagifolium	3140, 3210, 3220
Horsenettle, white	Solanum elaeagifolium	3140, 3210, 3220
Horsetail	Equisetum spp.	M2410
Horsetail, common	Equisetum arvense	M2110
Horseweed	Conyza canadensis	3110
Houndstongue, great	Cynoglossum grande	M2410
Huajillo	Calliandra eriophylla	3140, 3210, 3220
Huckleberry, big	Vaccinium membranaceum	2410, M2410
Huckleberry, big	Vaccinium uliginosum	3130
Huckleberry, dwarf	Vaccinium caespitosum	M2110
Huckleberry, globe	Vaccinum globulare	M2110
Huckleberry, ovalleaf	Vaccinium ovalifolium	2410, M2410
Huckleberry, red	Vaccinium parvifolium	2410, M2410
Hutchinsia	Hutchinsia procumbens	3130, P3130
Hyssop, nettleleaf giant	Agastache urticifolia	M2410
Incienso	Encelia farinosa	3140, 3220, M3120
Indian bean	Erythrina flabelliformis	3140, 3210, 3220, M3120

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Indian root	Lomatium spp.	(3130), P3130
Indigobush	Dalea mollis	3220, M3120
Indigobush	Dalea spinosa	3220
Indigobush	Psorothamnus polydenius	3130, P3130
Inkweed	Suaeda torreyana	3140, 3210, 3220, M3120
Inside-out flower, white	Vancouveria hexandra	M2410
Iodine weed	Suaeda torreyana	3140, 3210, 3220, M3120
Iodinebush	Allenrolfea occidentalis	2610, (3130), 3140, 3210, 3220, M3120
Iris, Rocky Mountain	Iris missouriensis	(3120), (3130), M3120, P3130
Iris, siskiyou	Iris bracteata	M2410
Iris, slender-tubed	Iris chrysophylla	M2410
Iris, western	Iris missouriensis	3120, 3130, (M3120), (P3130)
Iris, wild	Iris douglasiana	M2410
Ironwood	Olneya tesota	3140, 3220, M3120
Jaboncillo	Sapindus drummondi	3140, 3210, 3220, M3120
Jacamilla	Jatropha cathartica	3210
Janusia	Janusia gracilis	3210, 3220, M3120
Javelina bush	Condalia ericoides	3140, 3210, 3220
Jepsonia, coast	Jepsonia parryi	M2620
Jerusalem-thorn	Parkinsonia aculcata	3210
Joint-fir	Ephedra antisyphilitica	3140, 3210, 3220
Joint-fir	Ephedra torreyana	3130, P3130
Joint-fir, longleaf	Ephedra trifurca	3140, 3210, 3220
Jojoba	Simmondsia chinensis	3140, 3220, M2620, M3120
Joshua tree	Yucca brevifolia	3220
Juniper	Juniperus spp.	3110, P3130
Juniper, alligator	Juniperus deppeana	3140, 3210, 3220, M3120, P3130
Juniper, common	Juniperus communis	(3130), M2110, M2410, (M3110), (M3120), (P3130)
Juniper, creeping	Juniperus horizontalis	M2110
Juniper, dwarf	Juniperus communis	3130, (M2110), M3110, M3120, P3130
Juniper, one-seeded	Juniperus monosperma	3140, 3210, 3220, M3120, P3130
Juniper, Rocky Mountain	Juniperus scopulorum	3130, 3210, 3220, M2110, M3110, M3120, P3130, A3140
Juniper, Utah	Juniperus osteosperma	3130, 3210, 3220, M3120, P3130
Juniper, western	Juniperus occidentalis	3130, M2610, M3110
Juniper, western	Juniperus osteosperma	(3130), 3210, 3220, M3120, P3130
Juniper, western	Juniperus scopulorum	(3130), 3210, 3220, (M2110), (M3110), M3120, P3130, (A3140)
Kelloggia	Kelloggia gallioides	M2610, M2620
Kidneywood	Eysenhardtia polystachya	3140, 3210, 3220
Kidneywood	Eysenhardtia texana	3210
Kinnikkinnik	Arctostaphylos uva-ursi	2410, 3130, M2110, M3110, M3120, P3130
Knotweed	Polygonum aviculare	3110
Knotweed, wing	Polygonum majus	M2410
Kochia	Kochia scoparia	3110
Labrador-tea	Ledum glandulosum	M2110
Labrador-tea, bog	Ledum groenlandicum	2410, M2110, M2410
Ladies'-tresses	Spiranthes spp.	M3110

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Lady's-slipper	Cypripedium fasciculatum	M2410
Lady's-slipper, mountain	Cypripedium montanum	M2110
Lady's-slipper, yellow	Cypripedium calceolus	M2110
Lamb's-quarters	Chenopodium album	3140, P3130
Larch, subalpine	Larix lyallii	M2110, M3110
Larch, western	Larix occidentalis	3130, M2110, M2410, M3110
Larkspur	Delphinium spp.	M3120, P3130
Larkspur	Delphinium andersoni	3130, P3130
Larkspur	Delphinium occidentale	3130
Larkspur, plains	Delphinium virescens	3110
Laurel, California-	Umbellularia californica	M2410, M2610, M2620
Laurel, mountain-	Rhus ovata	3140, 3210, 3220, (M2610), M3120
Laurel, pale	Kalmia polifolia	2410, M2410
Lavender, desert	Hyptis emoryi	3220
Leatherwood, western	Dirca occidentalis	M2620
Legenere	Legenere limosa	2610
Lenscale	Atriplex lentiformis	(3130), 3220, M3120, P3130
Lettuce, Indian	Montia sibirica	M2410
Lettuce, miner's	Montia perfoliata	M2410
Lettuce, miner's	Montia spathulata	M2410
Lettuce, prickly	Lactuca serriola	3120, 3130
Lettuce, wall	Lactuca muralis	M2410
Leucothoe, western	Leucothoe davisiae	M2610
Licoriceroot, parsleyleaf	Ligusticum apiifolium	2410, M2410
Lignum vitae	Porlieria angustifolia	3210
Lilac, California	Ceanothus greggii	3140, 3210, 3220, M3120
Lily, chocolate	Fritillaria atropurpurea	M2410
Lily, Columbia	Lilium columbianum	M2410
Lily, Indian pond	Nuphar polysepalum	M2110, M2410
Lily, lamb's-tongue fawn	Erythronium grandiflorum	M2110
Lily, mariposa	See "Mariposa lily"	
Lily-of-the-valley, false	Maianthemum dilatatum	M2410
Lily, sego	Calochortus nuttallii	(3130), P3130
Lily, white-flowered rush	Schoenolirion album	M2410, M2610
Linanthus, thread-stemmed	Linanthus pharnaceoides	3130
Lippia, Wright	Lippia wrighti	3140, 3210
Listera, northwest	Listera cordata	M2410
Loco, specklepod	Astragalus lentiginosus	3130
Loco, white	Oxytropis spp.	3140, P3130
Locoweed	Oxytropis lamberti	3220, M3120, P3130
Locoweed, white	Astragalus bisulcatus	3140, P3130
Locust, honey-	Prosopis glandulosa	3210
Locust, mock	Amorpha californica	3140, 3210, 3220, M3120
Locust, New Mexican	Robinia neomexicana	3130, 3140, 3210, 3220, M3120, P3130
Loeflingia, California	Loeflingia squarrosa	2610, M2620
Lomatium, barestem	Lomatium nudicaule	M2410
Lomatium, bigseed	Lomatium macrocarpum	3120, 3130, M2110, M2410
Lomatium, lace-leaved	Lomatium dissectum	3120, 3130, M2110
Lomatium MacDougal	Lomatium macdougalii	3130
Lomatium, nineleaf	Lomatium triternatum	3120, 3130, M2410
Lotebush	Condalia spp.	3210
Lotebush	Condalia lycioides	3140, 3210, 3220, M3120
Lotebush	Zizyphus obtusifolia	3210
Lotus, Torrey's	Lotus oblongifolius	M2410
Lousewort, leafy	Pedicularis racemosa	M2410

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Lovage, Gray's	Ligusticum grayi	M2410
Luetkea	Luetkea pectinata	M2610
Luina, silverback	Luina hypoleuca	M2410
Lungwort, broad-leaved	Mertensia ciliata	M2410
Lupine	Lupinus spp.	3130, 3140, 3210, M3120, P3130
Lupine	Lupinus argenteus	M3110
Lupine	Lupinus formosus	M2410
Lupine, broadleaf	Lupinus latifolius	M2410, M3110
Lupine, rock	Lupinus saxosus	3130
Lupine, silky	Lupinus sericeus	3120, 3130, M2110
Lupine, tailcup	Lupinus caudatus	3130, M3110, P3130
Lupine, tree	Lupinus arboreus	M2410
Lupine, velvet	Lupinus leucophyllus	3130, M2410
Lycium, Anderson	Lycium andersonii	3220
Lycium, Cooper's	Lycium cooperi	(3130), P3130
Lycium, pale	Lycium pallidum	3210, 3220
Lyre-pod, Coulter's	Lyrocarpa coulteri	M2620
Madrone	Arbutus menziesii	2410, M2410, M2610, M2620
Madrone, Arizona	Arbutus arizonica	3140, 3210, 3220, M3120
Madrono	Arbutus arizonica	3140, 3210, 3220, M3120
Maguey cenizo	Agave asperrima	3210
Mahonia, red	Berberis haematocarpa	3140, 3210, 3220, M3120
Mammillaria	Mammillaria spp.	3140, 3210
Manzanita	Arctostaphylos pringlei	3140, 3210, 3220, M3120
Manzanita	Arctostaphylos uva-ursi	(2410), (3130), (M2110), (M3110), M3120, P3130
Manzanita, big-berry	Arctostaphylos glauca	M2620
Manzanita, common	Arctostaphylos manzanita	M2620
Manzanita, eastwood	Arctostaphylos glandulosa	M2620
Manzanita, gray	Arctostaphylos cinerea	M2410
Manzanita, greenleaf	Arctostaphylos patula	3130, 3220, M2410, M2620, M3120, P3130
Manzanita, hairy	Arctostaphylos columbiana	M2410
Manzanita, mariposa	Arctostaphylos mariposa	M2610
Manzanita, pine-mat	Arctostaphylos nevadensis	3130, M2410, M2610
Manzanita, pointleaf	Arctostaphylos pungens	3140, 3210, 3220, M3120
Manzanita, white-leaved	Arctostaphylos viscida	M2410, M2620
Maple, bigleaf	Acer macrophyllum	2410, M2410, M2620
Maple, bigtooth	Acer grandidentatum	3130, 3140, 3210, M3120, P3130
Maple, Rocky Mountain	Acer glabrum	3130, 3140, M2110, M3120, P3130
Maple, vine	Acer circinatum	2410, M2410
Mariola	Parthenium incanum	3140, 3210
Mariposa lily	Calochortus luteus	M2410
Mariposa lily	Calochortus nuttallii	3130, P3130
Mariposa lily, big-pod	Calochartus nitidus	3130
Mariposa lily, elegant	Calochortus elegans	M2410
Mariposa lily, green-banded	Calochortus macrocarpus	3120, 3130
Mariposa lily, Tolmie's	Calochortus tolmiei	M2410
Matchweed, yellow-green	Gutierrezia lucida	3140, 3210, 3220
Mats, yellow	Sanicula arctopoides	M2410

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Meadow-rue	Thalictrum fendleri	3130, 3220, M3120, P3130
Meadow-rue, western	Thalictrum occidentale	M2110, M2410
Melic, false	Schizachne purpurascens	M2110
Menodora, spiny	Menodora spinescens	3220
Mescal	Agave parryi	3140, 3210, 3220, M3120
Mescal bean	Sophora spp.	3140, 3210, 3220
Mesquite	Prosopis juliflora	3140, 3210, 3220, M3120
Mesquite, curly	Hilaria belangeri	3140, 3210, 3220
Mesquite, false	Calliandra eriophylla	3140, 3210, 3220
Mesquite, honey	Prosopis glandulosa	3210
Mesquite, honey	Prosopis juliflora	3140, 3210, 3220, M3120
Mesquite, screwbean	Prosopis pubescens	3210, 3220, M3120
Mesquite, velvet	Prosopis juliflora	3140, 3210, 3220, M3120
Mesquite, vine	Panicum obtusum	3140, 3210, 3220
Mexican tea	Ephedra spp.	P3130
Mexican tea	Ephedra trifurea	3140, 3210, 3220
Microcala, American	Microcala quadrangularis	M2610, M2620
Microsteris, pink	Microsteris gracilis	3120, 3130
Milfoil	Achillea spp.	(3130), M3110, P3130
Milk-vetch	Astragalus spp.	3110, 3130, M3110, P3130
Milk-vetch	Astragalus bisulcatus	3140, P3130
Milk-vetch	Astragalus humistratus	3140, 3210
Milk-vetch, balloon	Astragalus whitneyi	M2410
Milk-vetch, narrowleaf	Astragalus stenophyllus	3130
Milk-vetch, Pursh's	Astragalus purshii	3130
Milk-vetch, Spalding's	Astragalus spaldingii	3120, 3130
Milk-vetch, starved	Astragalus miser	3130
Milk-vetch, threadstalk	Astragalus filipes	3130
Milkweed, climbing	Sarcostemma spp.	3140, 3210, 3220, M3120
Milkwort	Polygala spp.	3140, P3130
Milkwort, California	Polygala californica	M2410
Mimosa	Mimosa spp.	3210
Mimosa, velvet pod	Mimosa dysocarpa	3210, 3220
Mistletoe, American dwarf	Arceuthobium americanum	M2110
Misteltoe, Douglas dwarf	Arceuthobium douglasii	M2110
Miterwort	Mitella spp.	M2410
Miterwort, cross-shaped	Mitella stauropetala	M2110, M2410
Mock orange	Philadelphus microphyllus	3220, M3120
Mock orange, Lewis	Philadelphus lewisii	2410, 3130, M2110, M2410
Monardella	Monardella odoratissima	M2410
Monkey-flower, bush	Mimulus aurantiacus	M2410, M2620
Monkey-flower, yellow	Mimulus guttatus	M2410
Montia, narrow-leaved	Montia linearis	2410, 3120
Monument plant	Frasera speciosa	3130, M3110
Mormon tea	Ephedra spp.	P3130
Mormon tea	Ephedra nevadensis	P3130
Mormon tea	Ehpedra trifurca	3140, 3210, 3220
Mormon tea	Ephedra viridis	3130, 3210, 3220, M3120, P3130
Mortonia, scurfy	Mortonia scabrella	3140, 3210
Mountain-lover	Pachystima myrsinites	(3130), 3140, 3210, 3220, (M2110), (M2410), (M2610), M3120, P3130
Mountain-mahogany	Cercocarpus montanus	3130, P3130
Mountain-mahogany, birchleaf	Cercocarpus betuloides	3140, 3210, 3220, M2620, M3120

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Mountain-mahogany, curlleaf	Cercocarpus ledifolius	3130, 3220, M2410, M2620, M3110, M3120, P3130
Mountain-mahogany, hairy	Cercocarpus breviflorus	3140, 3210, 3220, M3120, P3130
Mountain-mahogany, Wright	Cercocarpus breviflorus	3140, (3210), 3220, M3120, P3130
Mountain misery	Chamaebatia foliolosa	M2610
Mountain spray	Holodiscus dumosus	(3130), 3140, 3210, 3220, (M2410), (M3110), M3120, P3130
Mousetail, bristly	Myosurus aristatus	3130
Muhly	Muhlenbergia spp.	3140, 3210, 3220, P3130
Muhly, bush	Muhlenbergia porteri	3140, 3210, 3220, M3120
Muhly, mountain	Muhlenbergia montana	3140, 3210, 3220, M3120, P3130
Muhly, pullup	Muhlenbergia filiformis	3130
Muhly, ring	Muhlenbergia torreyi	3210, 3220, M3120, P3130
Muhly, sandhill	Muhlenbergia pungens	3110
Muhly, screwleaf	Muhlenbergia virescens	3140, 3210, M3120, P3130
Muhly, spike	Muhlenbergia wrightii	3220, M3120, P3130
Mulberry, Texas	Morus microphylla	3140, 3210, M3120
Mullein, great	Verbascum thapsus	M3120, P3130
Mullein, turkey	Eremocarpus setigerus	2610
Mustard	Cruciferae spp.	3140, 3210, 3220, M3120
Mustard, pinnate tansy	Descurainia pinnata	3130
Mustard, tower	Arabis glabra	M2110
Navarretia, short-stemmed	Navarretia divaricata	M2410
Needle-and-thread	Stipa comata	3110, 3130, M2110, P3130
Nemacladus	Nemacladus glanduliferus	3220, M3120
Nettle, bigsting	Urtica dioica	3130
Nettle, western	Hesperocnide tenella	M2610
Nightshade	Solanum elaeagifolium	3140, 3210, 3220
Ninebark	Physocarpus capitatus	M2410, M3110
Ninebark	Physocarpus monogynus	3220, M3120
Ninebark, mallow	Physocarpus malvaceus	M2110, M2410
Nolina, Bigelow	Nolina bigelovii	3220
Nolina, tree	Nolina bigelovii	3220
Nutmeg, California	Torreya californica	M2610, M2620
Oak, Arizona white	Quercus arizonica	3140, 3210, 3220, M3120, P3130
Oak, blue	Quercus douglasii	2610, M2620
Oak, bur	Quercus macrocarpa	3110
Oak, California black	Quercus kelloggii	M2410, M2610
Oak, California scrub	Quercus dumosa	M2620
Oak, California scrub	Quercus turbinella	3140, 3210, 3220, M3120, P3130
Oak, canyon live	Quercus chrysolepis	M2410, M2610, M2620
Oak, coastal live	Quercus agrifolia	M2410, M2620
Oak, Emory	Quercus emoryi	3140, 3210, 3220, M3120
Oak, evergreen white	Quercus engelmannii	M2620
Oak, Gambel	Quercus gambelii	3110, 3130, 3140, 3210, 3220, M3110, M3120, P3130

continued

Common name	Scientific name	Province(s)[a]
Western United States (Continued)		
Oak, gray	Quercus grisea	3140, 3210, 3220, M3120
Oak, Havard	Quercus havardii	3140, P3130
Oak, interior live	Quercus wislizenii	M2610, M2620
Oak, Mexican blue	Quercus oblongifolia	3140, 3210, 3220, M3120
Oak, netleaf	Quercus reticulata	3140, 3210, 3220, M3120
Oak, Oregon white	Quercus garryana	2410, M2410
Oak, Palmer	Quercus palmeri	3140, M3120
Oak, scrub	Quercus turbinella	3140, 3210, 3220, M3120, P3130
Oak, shinnery	Quercus havardii	3140, P3130
Oak, shrub live	Quercus turbinella	3140, 3210, 3220, M3120, P3130
Oak, silverleaf	Quercus hypoleucoides	3140, 3210, 3220, M3120
Oak, tanbark-	Lithocarpus densiflora	M2410, M2610, M2620
Oak, turbinella	Quercus turbinella	3140, 3210, 3220, M3120, P3130
Oak, valley	Quercus lobata	2610
Oak, whiteleaf	Quercus hypoleucoides	3140, (3210), 3220 M3120
Ocean spray	Holodiscus discolor	2410, 3130, M2110, M2410
Ocean spray	Holodiscus dumosus	3130, 3140, 3210, 3220, M2410, M3110, M3120, P3130
Ocotillo	Fouquieria splendens	3140, 3210, 3220, M3120
Odontostomum, Hartweg's	Odontostomum hartwegi	M2610
Olive, desert	Forestiera angustifolia	3210
Onion	Allium acuminatum	3130, P3130
Orchid, Alaska rein	Habenaria unalascensis	M2410
Orchid, bog	Habenaria spp.	M3110
Orchid, canyon bog	Habenaria sparsiflora	M2410
Oso berry	Osmaronia cerasiformis	2410, M2610, M2620
Owlclover, mountain	Orthocarpus imbricatus	M2410
Oxalis, Oregon	Oxalis oregana	M2410
Paintbrush	Castilleja chromosa	3130, P3130
Paintbrush, Indian	Castilleja spp.	3140, 3210, M3120, P3130
Paintbrush, scarlet	Castilleja miniata	3130, M2410
Paintbrush, yellow	Castilleja lutescens	3120
Painted-cup, seaside	Castilleja latifolia	M2410
Palm, California fan	Washingtonia filifera	3220, M3120
Palma	Yucca torreyi	3140, 3210, 3220
Palmilla	Yucca spp.	(3110), (3140), 3210
Palmilla	Yucca elata	3140, 3210, 3220
Palo amarillo	Aloysia gratissima	3210
Palo-de-hierro	Olneya tesota	3140, 3220, M3120
Paloblanco	Celtis reticulata	(3110), (3130), 3140, 3210, 3220, M3120, P3130
Paloverde	Cercidium texanum	3210
Paloverde, blue	Cercidium floridum	3140, 3210, 3220, M3120
Paloverde, border	Cercidium floridum	3140, 3210, 3220, M3120
Paloverde, foothill	Cercidium microphyllum	3140, 3220, M3120
Paloverde, littleleaf	Cercidium microphyllum	3140, 3220, M3120
Paloverde, yellow	Cercidium microphyllum	3140, 3220, M3120
Panalero	Forestiera angustifolia	3210
Paper-bag bush	Salazaria mexicana	3220
Parsley, Howell's desert	Lomatium howellii	M2410
Parsley, water	Oenanthe sarmentosa	M2410
Parsley, wiskbroom	Harbounia trachypleura	M3110
Parsnip, cow	Heracleum lanatum	3130, M2410
Parsnip, water-	Berula erecta	3130

continued

Common name	Scientific name	Province(s)[a]
Western United States (Continued)		
Paspalum, sand	Paspalum stramineum	3110
Pea-bush	Dalea mollis	3220, M3120
Peavine	Lathyrus graminifolius	3140, 3210
Peavine	Lathyrus leucanthus	M3120, P3130
Peavine, aspen	Lathyrus leucanthus	M3120, P3130
Peavine, few-flowered	Lathyrus pauciflorus	M2410
Peavine, Nevada	Lathyrus nevadensis	M2110, M2410
Pennycress	Thlaspi arvense	3130
Penstemon	Penstemon spp.	3110, 3130, (M3110)
Penstemon, bush	Penstemon microphyllus	3220
Penstemon, Cusick's	Penstemon cusickii	3130
Penstemon, gay	Penstemon laetus	M2410
Penstemon, matroot	Penstemon radicosus	3130
Penstemon, scabland	Penstemon deustus	3130
Penstemon, stiffleaf	Penstemon aridus	3130
Peony, western	Paeonia brownii	3130, M2620
Pepperweed, prairie	Lepidium densiflorum	3140, P3130
Phacelia, varileaf	Phacelia heterophylla	3130, M2410
Phlox	Phlox spp.	3130, P3130
Phlox	Phlox caespitosa	M3120, P3130
Phlox, Hood's	Phlox hoodii	3130, P3130
Phlox, longleaf	Phlox longifolia	3120, 3130, P3130
Phlox, periwinkle	Phlox adsurgens	M2410
Phlox, showy	Phlox speciosa	M2410
Phlox, shrubby	Leptodactylon pungens	3130, P3130
Phlox, spreading	Phlox diffusa	3130, M2410
Phlox, tufted	Phlox douglasii	M3110
Pickleweed	Salicornia spp.	M2410
Pickelweed	Allenrolfea occidentalis	(2610), 3130, 3140, 3210, 3220, M3120
Pine, Apache	Pinus latifolia	3140, 3210, 3220, M3120
Pine, Arizona	Pinus latifolia	(3140), 3210, (3220), (M3120)
Pine, bishop	Pinus muricata	M2410
Pine, bristle-cone	Pinus aristata	3130, M3120, P3130
Pine, Chihuahua	Pinus leiophylla	3140, 3210, 3220, M3120
Pine, Coulter	Pinus coulteri	M2610
Pine, digger	Pinus sabiniana	M2410, M2610, M2620
Pine, foxtail	Pinus aristata	(3130), M3120, P3130
Pine, Jeffrey	Pinus jeffreyi	M2410, M2610
Pine, knobcone	Pinus attenuata	M2410, M2620
Pine, limber	Pinus flexilis	3130, 3220, M2110, M3110, M3120, P3130, A3140
Pine, lodgepole	Pinus contorta	3130, M2110, M2410, M3110
Pine, Monterey	Pinus radiata	M2410
Pine, pinyon	See "Pinyon"	
Pine, ponderosa	Pinus ponderosa	3110, 3130, 3140, 3210, 3220, M2110, M2410, M2610, M3110, M3120, P3130, A3140
Pine, Rocky Mountain white	Pinus flexilis	(3130), 3220, (M2110), (M3110), M3120, P3130, (A3140)
Pine, sugar	Pinus lambertiana	M2410, M2610
Pine, white	Pinus monticola	M2110, M2410, M2610
Pine, white	Pinus reflexa	3140, 3210
Pine, whitebark	Pinus albicaulis	3130, M2110, M3110, A3140
Pinesap	Hypopitys monotropa	M2410
Pinesap, fringed	Pleuricospora fimbriolata	M2610, M2620
Pingwing	Hymenoxys quinquesquemata	3140, 3210
Pingwing	Hymenoxys richardsonii	3130, P3130
Pinque	Hymenoxys quinquesquemata	3140, 3210

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Pinque	Hymenoxys richardsonii	(3130), P3130
Pinyon, Colorado	Pinus edulis	3130, 3210, 3220, M3120, P3130
Pinyon, Mexican	Pinus cembroides	3140, 3210, 3220, M3120
Pinyon pine	Pinus edulis	(3130), 3210, (3220), M3120, (P3130)
Pinyon, Rocky Mountain	Pinus edulis	(3130), 3210, 3220, M3120, P3130
Pinyon, singleleaf	Pinus monophylla	3130, 3220, M3120, P3130
Pipe-vine, California	Aristolochia californica	M2610, M2620
Pitahaya	Cereus thurberi	3140, 3220, M3210
Pitcher-plant, California	Darlingtonia californica	M2410, M2610
Plantain, rattlesnake	Goodyera oblongifolia	2410, M2110, M2410
Plantain, fringed water-	Machaerocarpus californicus	2610
Plum, chickasaw	Prunus angustifolia	3110
Plume, Apache	Fallugia paradoxa	3140, 3210, 3220, M3120, P3130
Poison ivy	Rhus radicans	3140
Poison oak	Rhus diversiloba	2410, M2410, M2620
Poison vetch, narrowleaf	Astragalus pectinatus	3140, P3130
Poison vetch, timber	Astragalus convallarius	3130
Polemonium, skunkleaf	Polemonium pulcherrimum	M2410
Pondweed	Potamogeton spp.	3130, 3220
Poplar, trembling	Populus tremuloides	(3110), (3130), 3140, 3210, 3220, (M2110), (M3110), M3120, P3130
Popote	Ephedra antisyphilitica	3140, 3210, 3220
Popotilla	Ephedra trifurca	3140, 3210, 3220
Poppy, matilija	Romneya coulteri	M2620
Poppy, prickle	Argemone intermedia	3140, P3130
Poppy, tree	Dendromecon rigida	M2610
Poppy, wind	Stylomecon heterophylla	2610
Porterella	Porterella carnosula	M2610
Potato, rat	Hoffmanseggia spp.	3140, 3210, 3220
Poverty weed	Iva axillaris	3130, P3130
Prairie clover	Petalostemum spp.	3140, P3130
Prairie clover, purple	Petalostemum purpureum	3110
Prairie clover, silky	Petalostemum villosum	3110
Prickly pear	Opuntia spp.	3130, 3220, P3130
Prickly pear	Opuntia phaeacantha	3140, 3210, 3220, M3120
Prickly pear, brittle	Opuntia fragilis	(3140), 3210, (3220), (M3120), (P3130)
Prickly pear, dollarjoint	Opuntia chlorotica	3140, 3210, 3220
Prickly pear, little	Opuntia fragilis	3140, 3210, 3220, M3120, P3130
Prickly pear, nopal	Opuntia lindheimeri	3210
Prickly pear, plains	Opuntia polycantha	3110, 3140, 3210, 3220,P3130
Prickly pear, purple	Opuntia violacea	3140, 3210
Prickly pear, Santa Rita	Opuntia chlorotica	3140, 3210, 3220
Prickly pear, Texas	Opuntia lindheimeri	3210
Primrose	Primula spp.	3130, 3220, P3130
Primrose, evening-	Oenothera spp.	M3110, M3120
Primrose, evening-	Oenothera multijuga	3220, M3120
Primrose, pale evening-	Oenothera pallida	3140, P3130

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Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Prince's-pine, little	Chimaphila menziesii	M2410
Prince's-pine, western	Chimaphila umbellata	3130, M2110, M2410
Prince's plume	Stanleya pinnatifida	3220
Pterostegia	Pterostegia drymaroides	2610
Puccoon	Lithospermum multiflorum	M3110
Pussy's-toes	Antennaria spp.	3130, M3110
Pussy's-toes, flattop	Antennaria corymbosa	3130
Pussy's-toes, littleleaf	Antennaria parvifolia	3130
Pussy's-toes, low	Antennaria dimorpha	3130, M2110
Pussy's-toes, narrowleaf	Antennaria stenophylla	M3110
Pussy's-toes, rosy	Antennaria rosea	3130, M2110, M3110
Pussy's-toes, tall	Antennaria anaphaloides	M2110
Pyrola, large	Pyrola asarifolia	M2110, M2410
Pyrola, toothed	Pyrola dentata	M2410
Pyrola, whitevein	Pyrola picta	3130, M2110, M2410
Quailbrush	Atriplex lentiformis	(3130), 3220, M3120, P3130
Rabbit brush	Chrysothamnus depressus	3210, 3220, M3120, P3130
Rabbit brush	Chrysothamnus nauseosus	3110, 3130, 3210, 3220, M2410, M3120, P3130, A3140
Rabbit brush	Chrysothamnus viscidiflorus	3130, P3130
Rabbit brush, Parry	Chrysothamnus parryi	3220, M3120, P3130
Rabbit brush, whitestem gray	Chrysothamnus nauseosus var. albicaulis	3120, 3130
Ragger, Texas	Leucophyllum frutescens	3210
Ragweed	Ambrosia psilostachya	3110, 3220, P3130
Ragweed, canyon	Ambrosia ambrosioides	3220, M3120
Raspberry	Rubus spp.	3140, M3120
Raspberry	Rubus strigosa	3220, M3120, P3130
Raspberry, black	Rubus leucodermis	M2110, (M2410)
Raspberry, boulder	Rubus deliciousus	M3110
Raspberry, red	Rubus idaeus	M2110
Raspberry, western	Rubus leucodermis	(M2110), M2410
Ratany	Krameria parvifolia	3140, 3210, 3220, M3120
Ratany, white	Krameria grayi	3140, 3220, M3120
Redbud, western	Cercis occidentalis	M2610, M2620
Redcedar, western	Thuja plicata	2410, M2110, M2410
Redtop, spike	Agrostis spp.	(2410), M3120, P3130
Redwood	Sequoia sempervirens	M2410
Reed	Phragmites communis	3130, 3210, 3220, M3120
Reed, giant	Arundo donax	3210
Retama	Parkinsonia aculeata	3210
Rhododendron, Pacific	Rhododendron macrophyllum	M2410
Rhododendron, white	Rhododendron albiflorum	M2410
Rigiopappus	Rigiopappus leptocladus	M2610
Rockcress, bristly-leaved	Arabis rectissima	3130
Rockcress, hoary	Arabis puberula	M2110
Rockcress, Holboell	Arabis holboellii	3130
Rose, Arizona	Rosa arizonica	3140, 3210
Rose, baldhip	Rosa gymnocarpa	2410, M2110, M2410
Rose mallow	Hibiscus spp.	3210, M3120
Rose, Nootka	Rosa nutkana	2410, 3120, M2110
Rose, sweetbriar	Rosa eglanteria	2410
Rose, wild	Rosa spp.	3110, 3130, M3110, P3130
Rose, Woods'	Rosa woodsii	3120, M2410

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Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Rush	Juncus spp.	2410, 3130, 3140, 3210, 3220, M3110, M3120, P3130
Rush	Juncus torreyi	3220
Rush, common	Juncus effusus	M2410
Rusty leaf	Menziesia ferruginea	2410, M2110
Rye, blue wild	Elymus glaucus	2410, 3130, M2110, M2410
Rye, Canada wild	Elymus canadensis	3110
Rye, creeping wild	Elymus triticoides	3130
Rye, wild	Elymus spp.	3130, P3130
Rye, wild	Elymus cinereus	3130, P3130
Rye, yellow wild	Elymus flavescens	3130
Sacahuista	Nolina microcarpa	3210, 3220
Sacahuista	Nolina texana	3140, 3210, 3220
Sacahuiste	Nolina microcarpa	3210, 3220
Sacahuiste	Nolina texana	3140, 3210, 3220
Sacaton	Sporobolus wrightii	3140, 3210, 3220
Sacaton, alkalai	Sporobolus airoides	3130, P3130
Sage, black	Salvia mellifera	M2620
Sage, bladder	Salazaria mexicana	3220
Sage, coastal	Artemisia californica	2610
Sage, Mojave	Salvia mohavensis	3220
Sage, pasture	Artemisia frigida	3110, M2110, M3110
Sage, prairie	Artemisia gnaphaloides	3110
Sage, purple	Leucophyllum frutescens	3210
Sage, white	Salvia apiana	M2620
Sagebrush	Artemisia spp.	3130, 3220, P3130
Sagebrush	Artemisia ludoviciana	3220, M3120, P3130
Sagebrush	Artemisia spinescens	3130, P3130
Sagebrush, big	Artemisia tridentata	3130, 3210, 3220, M2110, M3110, M3120, P3130, A3140
Sagebrush, black	Artemisia nova	3210, 3220, M3120, P3130
Sagebrush, low	Artemisia arbuscula	3130
Sagebrush, Pacific	Artemisia campestris	M2110
Sagebrush, sand	Artemisia filifolia	3110, 3140, 3210, 3220, P3130
Sagebrush, stiff	Artemisia rigida	3130
Sagebrush, three-tip	Artemisia tripartita	3120, 3130
Saguaro	Cereus giganteus	3140, 3220, M3120
St. John's-wort, common	Hypericum perforatum	2410, M2410
Salal	Gaultheria shallon	2410, M2410
Salsify, yellow	Tragopogon dubius	3120
Saltbush, big	Atriplex lentiformis	3130, 3220, M3120 P3130
Saltbush, desert	Atriplex polycarpa	3220, M3120
Saltbush, four-wing	Atriplex canescens	3130, 3140, 3220, P3130, A3140
Saltbush, gardner	Atriplex nuttallii	3130, P3130
Saltbush, mat	Atriplex spp.	A3140
Saltbush, spiny	Atriplex confertifolia	(3130), 3220, P3130
Saltcedar	Tamarix pentandra	3140, 3210, 3220, M3120
Samphire	Salicornia rubra	3130
Samphire, Utah	Salicornia utahensis	3130
Samson, black	Echinacea angustifolia	3110
Sandberry	Arctostaphylos uva-ursi	(2410), (3130), (M2110), (M3110), M3120, P3130
Sandbur	Cenchrus pauciflorus	3110
Sandcorn	Zigadenus paniculatus	(3130), P3130
Sandpaper bush	Mortonia scabrella	3140, 3210
Sandreed, big	Calamovilfa gigantea	3110
Sandreed, prairie	Calamovilfa longifolia	3110
Sandwort	Arenaria spp.	A3140
Sandwort, bigleaf	Arenaria macrophylla	M2110, M2410
Sandwort, dense-flowered	Arenaria congesta	3130
Sanicle, purple	Sanicula bipinnatifida	2410

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Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Sarsaparilla, wild	Aralia nudicaulis	M2110
Saxifraga, northwestern	Saxifraga integrifolia	2410
Scouring-rush	Equisetum hyemale	M2110, M2410
Scurf pea, lemon	Psoralea lanceolata	3110, 3130
Scurf pea, silverleaf	Psoralea argophylla	3110
Scurf pea, slender	Psoralea tenuiflora	(3110), 3140, P3130
Scurf pea, slimflower	Psoralea tenuiflora	3110, 3140, P3130
Sea blite	Suaeda nigra	3130, P3130
Sea blite, Torrey	Suaeda torreyana	3140, 3210, 3220, M3120
Sedge	Carex spp.	2410, 3130, 3140, 3210, 3220, M2410, M3110, M3120, P3130
Sedge	Carex filifolia	(3110), (3120), A3140
Sedge, Dewey	Carex deweyana	M2410
Sedge, elk	Carex geyeri	3130, M2110, M2410, M3110
Sedge, Hood	Carex hoodii	M2110
Sedge, long-stoloned	Carex pensylvanica	2410, M2410
Sedge, needleleaf	Carex eleocharis	3110
Sedge, northwestern	Carex concinnoides	M2410
Sedge, Ross	Carex rossii	3130, M3110
Sedge, slough	Carex obnupta	M2410
Sedge, threadleaf	Carex filifolia	3110, 3120, (A3140)
Sedge, upland	Carex heliophila	3110
Seepweed	Suaeda spp.	3130
Seepwillow	Baccharis glutinosa	3140, 3210, 3220, M3120
Selaginella, Wallace's	Selaginella wallacei	M2110
Selfheal, common	Prunella vulgaris	M2410
Senna, shrubby	Cassia wislizeni	3140, 3210
Sequoia, giant	Sequoia gigantea	M2610
Serviceberry	Amelanchier spp.	A3140
Serviceberry	Amelanchier alnifolia	2410, 3110, 3130, 3210, M2110, M2410, M3110, M3120, P3130
Serviceberry, Utah	Amelanchier utahensis	3130, 3220, P3130
Shadscale	Atriplex confertifolia	3130, 3220, P3130
Shadscale	Atriplex lentiformis	(3130), 3220, M3120, P3130
Shadscale	Atriplex nutallii	(3130), P3130
Shield-pod, California	Dithyrea californica	M2620
Shoestring, devil's	Polygonum viviparum	A3140
Shooting star, broad-leaved	Dodecatheon hendersonii	2410
Silene, Douglas	Silene douglasii	3130
Silk-tassel	Garrya elliptica	M2410, M2620
Silk-tassel	Garrya flavescens	3140, 3210, 3220, M3120
Silk-tassel	Garrya wrightii	3140, 3210, 3220, M3120
Silk-tassel, Fremont	Garrya fremontii	M2410, M2620
Silver-leaf, big bend	Leucophyllum minus	3210
Skeletonplant, rush	Lygodesmia juncea	3140, P3130
Smartweed	Polygonum spp.	M2410
Smoke tree	Dalea spinosa	3220
Smokethorn	Dalea spinosa	3220
Snakeroot, Peck's	Sanicula peckiana	M2410
Snakeroot, Sierra	Sanicula graveolens	M2110, M2410
Snakeroot, western	Sanicula crassicaulis	2410
Snakeweed	Gutierrezia spp.	3140, P3130
Snakeweed	Gutierrezia lucida	3140, 3210, 3220
Snakeweed	Gutierrezia sarothrae	(3110), (3130), 3140, 3210, 3220, M3120, P3130
Snakeweed, broom	Gutierrezia sarothrae	3110, 3130, 3140, 3210, 3220, M3120, P3130

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Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Snakewood	Colubrina texensis	3210
Sneezeweed	Helenium hoopesii	M3120, P3130
Sneezeweed, Bigelow's	Helenium bigelovii	M2410
Snowberry	Symphoricarpos spp.	3130, M2410, P3130, A3140
Snowberry	Symphoricarpos mollis	M2410
Snowberry	Symphoricarpos oreophilus	3130, 3140, 3210, 3220, M3120, P3130
Snowberry, common	Symphoricarpos albus	2410, 3110, 3120, 3130, M2110, M2410, M3110
Snowberry, round-leaved	Symphoricarpos rotundifolius	3130
Snowberry, western	Symphoricarpos occidentalis	3110, M2110
Snowqueen	Synthyris reniformis	2410
Soapberry, western	Sapindus drummondi	3140, 3210, 3220, M3120
Soapbush	Porlieria angustifolia	3210
Soapweed, small	Yucca glauca	3140, P3130
Solomon plume, starry	Smilacina stellata	M2110, M2410, M3110
Solomon's-seal, false	Smilacina racemosa	M2110, M2410, M3110
Sophora	Sophora spp.	3140, 3210, 3220
Sorrel, wood-	Oxalis spp.	3140, 3210, 3220, M3120
Spanish bayonet	Yucca torreyi	3140, 3210, 3220
Spanish dagger	Yucca baccata	3140, 3210, 3220, M3120, P3130
Spanish dagger	Yucca schidigera	3220
Spanish dagger	Yucca torreyi	3140, 3210, 3220
Speedwell, purslane	Veronica peregrina	2410
Spiderflower, bee	Cleome serrulata	(3140), P3130
Spikerush	Eleocharis spp.	3140, 3210, 3220, M3120
Spikerush	Eleocharis rostellata	3130
Spikerush, needle	Eleocharis acicularis	2410
Spinach, cattle	Atriplex polycarpa	3220, M3120
Spiraea, Douglas	Spiraea douglasii	2410, M2410, M3110
Spiraea, shinyleaf	Spiraea betulifolia	3130, M2110, M2410
Spring gold	Crocidium multicaule	M2610
Spruce, blue	Picea pungens	M3110, M3120, P3130
Spruce, Colorado	Picea pungens	(M3110), M3120, P3130
Spruce, Engelmann	Picea engelmannii	3130, M2110, M2410, M3110, M3120, P3130
Spruce, silver	Picea pungens	(M3110), M3120, P3130
Spruce, Sitka	Picea sitchensis	M2410
Spruce, weeping	Picea breweriana	M2410
Spruce, white	Picea glauca	M2110
Spurge	Euphorbia spp.	3110
Squawbush	Condalia spathulata	3140, 3210, (3220)
Squawbush	Rhus trilobata	3110, 3130, 3140, 3210, 3220, M2410, M3120, P3130
Squirreltail	Sitanion hystrix	(2410), (3110), (3130), 3140, 3210, 3220, (M2410), (M3110), M3120, P3130
Squirreltail, big	Sitanion jubatum	2410
Squirreltail, bottlebrush	Sitanion hystrix	2410, 3110, 3130, 3140, (3210), 3220, M2410, M3110, M3120, (P3130)
Star-flower	Trientalis latifolia	M2410

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Starwort, crisped	Stellaria crispa	M2410
Starwort, northern	Stellaria calycantha	M2110
Stickleaf	Mentzelia spp.	3140, 3220, M3120, P3130
Stickseed, western	Lappula redowskii	3130
Stickseed, Jessica	Hackelia jessicae	M2410
Stingaree-bush	Pickeringia montana	M2610
Stonecrop	Sedum lanceolatum	M3110
Stonecrop, wormleaf	Sedum stenopetalum	3130
Stonewort, creamy	Sedum oregonense	M2410
Strawberry	Fragaria ovalis	M3110, M3120, P3130
Strawberry	Fragaria vesca	2410, M2410, M3110
Strawberry, sand	Fragaria chiloensis	2410, 3130, M2110, M2410
Strawberry, Virginia	Fragaria virginiana	3130, M3110
Sugar bush	Rhus ovata	3140, 3210, 3220, M2620, M3120
Sugarstick	Allotropa virgata	M2410
Sumac	Rhus spp.	3210
Sumac, desert	Rhus microphylla	3210
Sumac, fragrant	Rhus aromatica	3110
Sumac, laurel	Rhus laurina	M2620
Sumac, mahogany	Rhus integrifolia	M2620
Sumac, Mearns	Rhus choriophylla	3140, 3210, 3220
Sumac, prairie	Rhus lanceolata	3140
Sumac, scarlet	Rhus glabra	(3130), 3140, 3210, M3120
Sumac, smooth	Rhus glabra	3130, 3140, 3210, M3120
Sumac, sugar	Rhus ovata	3140, 3210, 3220, (M2620), M3120
Sun-drops	Oenothera spp.	(M3110), M3120
Sun-drops	Oenothera multijuga	3220, M3120
Sunflower	Helianthus spp.	3110
Sunflower	Helianthus annuus	3110, 3220, M3120
Sunflower, common woolly	Eriophyllum lanatum	2410, 3130, M2410
Sunflower, desert-	Garea canescens	M3120
Sunflower, false	Helianthella quinquenervis	M3120, P3130
Sunflower, false	Helianthella uniflora	3120
Sunflower, prairie	Helianthus petiolaris	3110, 3140, P3130
Sweet-scented shrub, western	Calycanthus occidentalis	M2610
Sweetroot	Osmorhiza spp.	M2110
Sweetroot, mountain	Osmorhiza chilensis	2410, M2110, M2410
Sweetroot, purple	Osmorhiza purpurea	M3110
Sycamore, Arizona	Platanus wrightii	3140, M3120
Sycamore, California	Platanus racemosa	M2620
Tamarisk	Tamarix pentandra	3140, 3210, 3220, M3120
Tanglehead	Heteropogon contortus	3140, 3210, 3220
Tansybush	Chamaebatiaria millefolium	3210, (3220), (M2610) (M3120), P3130
Tapiro	Sambucus mexicana	3210
Tarbush	Flourensia cernua	3140, 3210
Tarweed, least	Madia minima	3130
Tarweed, stinking	Madia glomerata	3130
Tarweed, woodland	Madia madioides	2410
Tauschia, glaucous	Tauschia glauca	M2410
Tauschia, Kellogg's	Tauschia kelloggii	M2410
Teasel, common	Dipsacus sylvestris	3130
Teposote	Ephedra trifurca	3140, 3210, 3220
Tesajo	Opuntia leptocaulis	3140, 3210, 3220, M3120
Tesota palo fierro	Olneya tesota	3140, 3220, M3120
Thelypody	Thelypodium sagittatum	3130, P3130
Thimbleberry	Rubus parviflorus	2410, M2110, M2410
Thistle, Collin's	Salsola collina	3110
Thistle, common	Cirsium arvense	M2410
Thistle, common	Cirsium vulgare	3130

continued

Common name	Scientific name	Province(s)[a]
	Western United States (Continued)	
Thistle, Russian	Salsola spp.	3140, P3130
Thistle, Russian	Salsola iberica	3110
Thistle, Russian	Salsola kali	3130, P3130
Thornbush, Anderson	Lycium andersonii	3220
Three-awn	Aristida spp.	3140, 3210, 3220
Three-awn	Aristida longiseta	(3110), (3130), 3140, 3210, 3220, M3120, P3130
Three-awn, red	Aristida longiseta	3110, 3130, 3140, 3210, 3220, M3120, P3130
Three-awn, purple	Aristida purpurea	3140, 3210
Thrift	Armeria maritima	2410
Thurberia	Gossypium thurberi	3140, 3210, 3220
Timothy, alpine	Phleum alpinum	M2410, M3120, P3130
Timothy, mountain	Phleum alpinum	(M2410), M3120, P3130
Timothy, Texas-	Lycurus phleoides	3140, 3210, 3220, M3120, P3130
Tobacco brush	Ceanothus velutinus	3130, M2410, M3110, P3130
Tobacco, tree	Nicotiana glauca	M2620
Tofieldia	Tofieldia glutinosa	M2410
Toothwort	Dentaria californica	M2410
Toothwort, slender	Cardamine pulcherrima	2410
Tornillo	Prosopis pubescens	3210, 3220, M3120
Torote	Bursera microphylla	3220
Trail plant	Adenocaulon bicolor	2410, M2110, M2410
Trillium, purple	Trillium petiolatum	M2110
Trillium, white	Trillium ovatum	M2410
Trisetum, nodding	Trisetum cernuum	M2410
Trisetum, spike	Trisetum spicatum	M3120, P3130
Trisetum, tall	Trisetum canescens	M2410
Trompillo	Solanum elaeagifolium	3140, 3210, 3220
Tumbleweed	Salsola iberica	M2610
Turpentine-brush	Haplopappus laricifolius	3140, 3210, 3220, M3120
Twayblade, northern	Listera borealis	M2410
Twayblade, western	Listera caurina	M2410
Twinflower	Linnaea borealis	M2110, M2410
Twisted-stalk, clasping-leaved	Streptopus amplexifolius	M2110, M2410
Twisted-stalk, purple	Streptopus roseus	M2410
Umbrella plant	Peltiphyllum peltatum	M2610
Una de gato	Acacia greggii	3140, 3210, 3220, M3120
Valerian, Sitka	Valeriana sitchensis	M2110, M2410
Varadulce	Eysenhardtia texana	3210
Varadulce	Eysenhardtia polystachya	3140, 3210, 3220
Verbena, hairy sand	Abronia villosa	3220
Verbena, large-bracted	Verbena bracteata	3110
Verbena, sand	Abronia latifolia	M2410
Vervain	Verbena spp.	3210
Vetch, American	Vicia americana	2410, 3220, M2110, M2410, M3120, P3130
Violet	Viola spp.	3130, M3120, P3130
Violet, Beckwith's	Viola beckwithii	3130, P3130
Violet, Canada	Viola canadensis	3140, 3210, M2110
Violet, evergreen	Viola sempervirens	M2410
Violet, marsh	Viola palustris	M2110
Violet, pine	Viola lobata	M2410
Violet, purple-tinged	Viola purpurea	3130
Violet, round-leaved	Viola orbiculata	M2110
Violet, upland yellow	Viola nuttallii	2410, M2110
Violet, western long-spurred	Viola adunca	2410, M2110
Violet, wood	Viola glabella	M2110, M2410
Virginia creeper	Parthenocissus inserta	3140, M3120
Virgin's-lower, climbing purple	Clematis pseudoalpina	M2110
Virgin's-lower, matted purple	Clematis tenuiloba	M2110
Wait-a-bit	Mimosa biuncifera	3140, 3210, 3220, M3120
Wait-a-minute bush	Mimosa biuncifera	3140, 3210, 3220, M3120
Wallflower, rough	Erysimum asperum	M2410
Walnut, Arizona	Juglans major	3140, M3120
Water nymph, holly-leaved	Najas marina	3130
Watercress	Rorippa spp.	3140, 3210, 3220, M3120
Waterleaf, baldhead	Hydrophyllum capitatum	M2110
Waterleaf, Fendler	Hydrophyllum fendleri	3130
Myrtle, wax-	Myrica californica	M2410
Wheat, Indian	Plantago patagonica	3120, 3130
Whispering bells	Emmenanthe penduliflora	M2610, M2620
White brush	Aloysia gratissima	3210
White brush	Lyspia wrighti	3140, 3210
White bush	Aloysia gratissima	3210
White-thorn	Acacia constricta	3140, 3210, 3220, M3120
White-thorn	Acacia vernicosa	3140, 3210
White-thorn, mountain	Ceanothus cordulatus	M2610
Whortleberry	Vaccinium oreophyllum	M3120, P3130
Willow	Salix spp.	2410, 3130, 3140, 3210, M2410, M3110, M3120, A3140
Willow	Salix amygdaloides	M3110
Willow, arroyo	Salix lasiolepis	3220
Willow, Bebb	Salix bebbiana	M2110
Willow, black	Salix scouleriana	(2410), M3120, P3130
Willow, Bonpland	Salix bonplandiana	3220, M3120
Willow, coast	Salix hookeriana	M2410
Willow, Columbia River	Salix fluviatilis	2410, M2110
Willow, desert-	Chilopsis linearis	3140, 3210, 3220, M2620, M3120
Willow, fire	Salix scouleriana	(2410), M3120, P3130
Willow, Goodding	Salix gooddingii	3140, 3210, 3220, M3120
Willow, mountain	Salix scouleriana	(2410), M3120, P3130
Willow, Pacific	Salix lasiandra	2410, M2110, M2410
Willow, rigid	Salix rigida	2410
Willow, Scouler's	Salix scouleriana	2410, M3120, P3130
Willow, soft-leaved	Salix sessilifolia	2410
Willow, stinking	Amorpha californica	3140, 3210, 3220, M3120
Willow, yellow	Salix taxifolia	3140
Willowweed, autumn	Epilobium paniculatum	3120, 3130, M2110
Willowweed, small-flowered	Epilobium minutum	3130, M2410
Wind flower	Pulsatilla patens	M3110
Wingscale	Atriplex canescens	(3130), 3140, 3220, P3130, (A3140)
Winter-fat	Eurotia lanata	3130, 3140, 3220, P3130
Wintergreen	Gaultheria ovatifolia	M2410
Wintergreen, one-sided	Pyrola secunda	M2110, M2410, M3110
Wolfberry	Lycium spp.	3140, 3210, 3220, M3120
Wolfberry	Lycium berlandieri	3210
Wolftail	Lycurus phleoides	3140, 3210, 3220, M3120, P3130
Woodnymph	Pyrola uniflora	M2110
Woodrush	Luzula hitchcockii	M2110

continued

General Appendix A (continued)

Common name	Scientific name	Province(s)[a]
Western United States (Continued)		
Woodrush, spreading	Luzula divaricata	M2410
Wormwood	Artemisia spp.	(3130), 3220, P3130
Wormwood	Artemisia spinescens	(3130), P3130
Wormwood, linearleaf	Artemisia dracunculus	M3110
Wyethia, mulesears	Wyethia amplexicaulis	3130, P3130
Yampah, Gairdner	Perideridia gairdneri	M2110
Yarrow	Achillea spp.	3130, (M3110), P3130
Yarrow	Achillea lanulosa	3140, 3210, M3120 P3130
Yarrow, false	Chaenactis douglasii	3130
Yarrow, western	Achillea millefolium	2410, 3120, 3130, M2110, M2410, M3110
Yellow cups	Oenothera brevipes	3220
Yerba buena	Satureja douglasii	2410
Yerba DeSelva	Whipplea modesta	M2410, M2620
Yerba mansa	Anemopsis californica	2610, M2620
Yerba santa	Eriodictyon angustifolium	3140, 3210, 3220, M3120
Yerba santa	Eriodictyon californicum	2610, M2620
Yew, western	Taxus brevifolia	2410, M2110, M2410 M2610, M2620
Yucca	Yucca spp.	3110, 3140, 3210
Yucca, Mojave	Yucca schidigera	3220
Yucca, soaptree	Yucca spp.	(3110), (3140), 3210
Yucca, soaptree	Yucca elata	3140, 3210, 3220
Yucca, tree	Yucca brevifolia	3220
Zinnia, desert	Zinnia grandiflora	3140, 3210, 3220
Zinnia, desert	Zinnia pumila	3140, 3210, 3220

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Common name	Scientific name	Province(s)[a]
Alaska		
Aconite	Aconitum delphinifolium	1220
Alder, green	Alnus crispa	1310, 1320, M1310
Androsace	Androsace ochotensis	1220
Anemone, narcissus-flowered	Anemone narcissiflora	M1310
Ash, green mountain-	Sorbus scopulina	M1310
Aspen, quaking	Populus tremuloides	1310, 1320, M1210, M1310
Avens	Geum rotundifolium	M1310
Avens, Drummond mountain-	Dryas drummondii	M1310
Avens, entire-leaf mountain-	Dryas octapetala	1210, M1310
Avens, white mountain-	Dryas integrifolia	1210, M1310
Azalea, Alpine	Loiseleuria procumbens	M1210, M1310
Bearberry	Arctostaphylos uva-ursi	1220, M1210, M1310
Bearberry, Alpine	Arctostaphylos alpina	1220, M1210, M1310
Bearberry, red-fruited	Arctostaphylos rubra	1310, 1320, M1310
Birch, Alaska bog	Salix fuscescens	1220, M1210
Birch, dwarf Arctic	Betula nana	1210, 1220, M1210, M1310
Birch, paper	Betula papyrifera	1310, 1320, M1210, M1310
Birch, resin	Betula glandulosa	1210, 1220, 1310, 1320, M1210, M1310

continued

Common name	Scientific name	Province(s)[a]
Alaska (Continued)		
Bistort	Polygonum bistortordes	1310, 1320
Bistort, Alpine	Polygonum viviparum	1210, M1310
Bistort, mountain meadow	Polygonum bistorta	1210
Blueberry, bog	Vaccinum uliginosum	1220, 1310, 1320, M1210, M1310
Blueberry, early	Vaccinium ovalifolium	1220
Buffaloberry	Shepherdia canadensis	1310, 1320, M1210, M1310
Cinquefoil, villous	Potentilla villosa	M1310
Cloud berry	Rubus chamaemorus	M1310
Coltsfoot, Arctic sweet	Petasites frigidus	1220
Cranberry, bog	Vaccinium oxycoccos	1220, M1310
Cranberry, highbush-	Viburnum edule	1220, 1310, 1320
Cranberry, mountain	Vaccinium vitis-idaea	1210, 1220, 1310, 1320, M1210, M1310
Crowberry	Empetrum nigrum	1310, 1320, M1310
Currant, American red	Ribes triste	1310, 1320
Daisy	Erigerson spp.	M1310
Elderberry, Pacific red	Sambucus callicarpa	1220
Ferns:		
Fragile fern	Cystopteris fragilis	M1310
Licorice-fern	Polypodium vulgare	M1310
Fescue	Festuca brachyphylla	1220, M1210
Fireweed	Epilobium angustifolium	1210, M1210, M1310
Fireweed	Epilobium latifolium	1210
Gale, sweet	Myrica gale	1220
Geranium, northern	Geranium erianthum	M1310
Goldenrod	Solidago spp.	M1310
Grasses:		
Bluegrass	Poa spp.	1210, M1310
Cottongrass	Eriophorum augustifolium	1220
Cottongrass	Eriophorum vaginatum	1220
Grass	Frisetum spp.	1210
Hairgrass	Deschampsia spp.	1210
Hairgrass	Deschampsia caespitora	1220
Hollygrass, Alpine	Hierochloe alpina	M1310
Oatgrass, downy	Trisetum subspicatum	M1310
Reedgrass, bluejoint	Calamagrostis langsdorffii	M1310
Ryegrass, beach	Elymus mollis	M1310
Heath, blue mountain	Phyllodoce coerula	1220
Heather, club-moss mountain	Cassiope lycopodioides	M1310
Heather, four-angled mountain	Cassiope tetragona	1220, M1210, M1310
Horsetail	Equisetum spp.	1310, 1320
Juniper, common	Juniperus communis	M1210, M1310
Kobresia	Kobresia myosuriodes	1210
Labrador-tea	Ledum groenlandicum	1310, 1320
Labrador-tea	Ledum palustre	M1310
Labrador-tea	Ledum procumbens	1220
Labrador-tea, narrowleaf	Ledum decumbens	1210, 1220, M1210, M1310

continued

General Appendix A (continued)

Common name	Scientific name	Province(s)[a]
	Alaska (Continued)	
Leather-leaf	Chamaedaphne calyculata	M1310
Lichen	Peltigera scabrosa	1220
Lichen, hair	Alectoria pubescens	1220
Lichen, Iceland	Cetravia hepatizon	1220
Lichen, reindeer	Cladonia spp.	1210
Lousewort	Pedicularis spp.	1210
Lousewort	Pedicularis pennellii	1220
Lupine, Arctic	Lupinus arcticus	1220
Meadow-rue	Thalictrum kemense	M1310
Mosses:		
Campion moss	Silene acaulis	1220
Haircap moss	Polytrichium spp.	1220
Peat moss	Sphagnum spp.	1210
Woolly moss	Rhacomitrium lanuginosum	1210
Oxytrope, blackish	Oxytropis nigrescens	1220
Parsnip, cow	Heracleum lanatum	M1310
Pea, beach	Lathyrus maritima	M1310
Poppy, Arctic	Papaver radicatum	1210
Poplar, balsam-	Populus balsamifera	1310, 1320, M1310
Poplar, black	Populus trichocarpa	1310, 1320
Primrose, northern	Primula borealis	1220
Rose, prickly	Rosa acicularis	1310, 1320, M1210
Rosebay, Lapland	Rhododendron lapponicum	M1210, M1310
Rosemary, bog	Andromeda polifolia	1210
Rush	Eleocharis spp.	1210
Rush, two-flowered	Juncus biglumis	1220
Sagebrush, Alaskan	Artemisia alaskana	1310, 1320
Sandwort, Arctic	Avenaria arctica	1220
Sandwort, long-podded	Avenaria macrocarpa	1220
Sandwort, sea-beach	Honkenya peploides	M1310
Saxifrage	Saxifraga spp.	1210, 1220
Sedge	Carex spp.	1210, M1310
Sedge	Carex microchaeta	1220
Sedge	Eriophorum spp.	1210
Sedge, aquatic	Carex aquatilis	1220
Senecio	Senecio pseudoarnica	M1310
Silverweed, Pacific	Potentilla egedii	1220
Spruce, black	Picea mariana	1310, 1320, M1210, M1310
Spruce, white	Picea glauca	1310, 1320, M1210, M1310
Tamarack	Larix laricina	1310, 1320
Vetch	Vicia spp.	1310, 1320
Willow	Salix spp.	1210, 1220
Willow	Salix arbutifolius	1220
Willow	Salix brachycarpa	1220, M1210
Willow	Salix candida	1210, M1310
Willow	Salix chamissanis	M1210
Willow	Salix lanata	1210
Willow	Salix pulchra	1220
Willow, Arctic	Salix arctica	1220
Willow, Barclay	Salix barclayi	M1310
Willow, barren-ground	Salix brachycarpa	M1310
Willow, Bebb	Salix bebbiana	1310, 1320
Willow, diamondleaf	Salix planifolia	1210, 1220
Willow, feltleaf	Salix alexensis	1210, 1310, 1320, M1210, M1310
Willow, littleleaf	Salix arbusculoides	1210, 1310, 1320, M1310
Willow, ovalleaf	Salix ovalifolia	1210, 1220
Willow, netleaf	Salix reticulata	1210, 1220, M1210
Willow, Scouler	Salix scouleriana	1310, 1320
Willow, undergreen	Salix commutata	M1310
Wood-rush, alpine	Luzula arcuata	M1310
Wood-rush, northern	Luzula confusa	1220
Wood-rush, snow	Luzula nivalis	1220
Wormwood	Artemisia alaschcensis	M1310
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	Hawaii	
Aalii	Dodonaea eriocarpa	M4210
Aalii	Dodonaea sandwicensis	M4210
Abutilon, hoary	Abutilon grandifolium	M4210
Ae	Polypodium pellucidum	M4210
Ae	Zanthoxylum spp.	M4210
Ahakea	Bobea elatior	M4210
Ahakea	Bobea mannii	M4210
Ahakea	Bobea sandwicensis	M4210
Aheahea	Chenopodium oahuense	M4210
Aiea	Nothocestrum latifolium	M4210
Akala	Rubus hawaiiensis	M4210
Akia	Wikstroemia spp.	M4210
Akoko	Euphorbia spp.	M4210
Akoko	Euphorbia celastroides	M4210
Alaa	Planchonella spathulata	M4210
Alaa	Planchonella spp.	M4210
Alaalawainui	Peperomia spp.	M4210
Alahee	Canthium odoratum	M4210
Albizia, molucca	Albizia falcata	M4210
Amau	Sadleria spp.	M4210
Ardisia, shoebutton	Ardisia humilis	M4210
Andropogon	Andropogon spp.	M4210
Ash, tropical	Fraxinus uhdei	M4210
Asplenium	Asplenium spp.	M4210
Athyrium	Athyrium spp.	M4210
Bagras	Eucalyptus deglupta	M4210
Bamboo, common	Bambusa vulgaris	M4210
Banana	Musa spp.	M4210
Blackberry	Rubus penetrans	M4210
Blechnum	Blechnum occidentale	M4210
Bluegum	Eucalyptus globulus	M4210
Bluegum, Sydney	Eucalyptus saligna	M4210
Breadfruit	Artocarpus altilis	M4210
Castorbean	Ricinus communis	M4210
Christmas berry	Schinus terebinthifolius	M4210
Club-moss	Lycopodium spp.	M4210
Coconut palm	Cocos nucifera	M4210
Cook-pine	Araucaria columnaris	M4210
Cypress, Monterey	Cupressus macrophylla	M4210
Deschampsia	Deschampsia australis	M4210
Dropseed, African	Sporobulus capensis	M4210
Dropseed, West Indian	Sporobulus indicus	M4210
Dryopteris	Dryopteris spp.	M4210
Ekaha	Elaphoglossum spp.	M4210

continued

continued

General Appendix A (continued)

Common name	Scientific name	Province(s)[a]
	Hawaii (Continued)	
Ferns:		
Filmy fern	Trichomanes spp.	M4210
Golden fern	Pityogramma chrysophylla	M4210
Sword fern	Nephrolepis spp.	M4210
Fire tree	Myrica faya	M4210
Fireweed	Erechtites heiracifolia	M4210
Foxtail, bristly	Setaria verticillata	M4210
Ginger, white	Hedychium coronarium	M4210
Ginger, yellow	Hedychium flavescens	M4210
Gosmore	Hypochaeris radicata	M4210
Grasses:		
Buffel grass	Cenchrus ciliaris	M4210
Fingergrass, feather	Chloris virgata	M4210
Glenwood grass	Sacciolepis indica	M4210
Guinea grass	Panicum maximum	M4210
Kikuyu grass	Pennisetum clandestinum	M4210
Lovegrass, lar Hawaiian	Eragrostis grandis	M4210
Mollasses grass	Melinis minutiflora	M4210
Napier grass	Pennisetum purpurea	M4210
Orchardgrass	Dactylis glomerata	M4210
Pangolagrass	Digitaria decumbens	M4210
Paragrass	Panicum purpurascens	M4210
Pili grass	Heteropogon contortus	M4210
Plush grass	Chloris radiata	M4210
Quakgrass	Panicum repens	M4210
Velvet grass	Holcus lanatus	M4210
Guava	Psidium guajava	M4210
Gum, Red River	Eucalyptus camaldulenis	M4210
Haha	Clermontia spp.	M4210
Hahanui	Cyanea spp.	M4210
Hala	Pandanus spp.	M4210
Halapepe	Pleomele aurea	M4210
Hamakua pamakani	Eupatorium riparium	M4210
Hao	Rauvolfia spp.	M4210
Hapuu	Cibotium spp.	M4210
Hau	Hibiscus tiliaceus	M4210
Hoi	Dioscorea bulbifera	M4210
Ieie	Freycinetia arborea	M4210
Iliahi	Santalum spp.	M4210
Iliahi	Santalum ellipticum	M4210
Ilima	Sida spp.	M4210
Indian pluchea	Pluchea indica	M4210
Ironwood	Casuarina equisetifolia	M4210
Jacaranda	Jacaranda mimosifolia	M4210
Java plum	Eugenia cumini	M4210
Kalamoho	Pellaea ternifolia	M4210
Kamakahala	Labordia spp.	M4210
Kanawao	Brousaissia arguta	M4210
Kawau	Ilex anomala	M4210
Keahi	Nesoluma chrysophylla	M4210
Kepau, papala	Pisonia umbellifera	M4210
Kiawe	Prosopis pallida	M4210
Kilau	Pteridium aquilinum	M4210
Koa	Acacia koa	M4210
Koa haole	Leucaena leucocephala	M4210
Kolea	Myrsine lessertiana	M4210
Kolea laulii	Myrsine sandwicensis	M4210
Kolomona	Cassia floribunda	M4210
Kookoolau	Bidens spp.	M4210
Kopiko	Psychotria spp.	M4210
Koster's curse	Clidemia hirta	M4210
Kukui	Aleurites moluccana	M4210
Kului	Nototrichium sandwicense	M4210

continued

Common name	Scientific name	Province(s)[a]
	Hawaii (Continued)	
Kupaoa	Raillardia spp.	M4210
Lama	Diospyros ferrea	M4210
Lantana	Lantana camara	M4210
Lemon gum	Eucalyptus citriodora	M4210
Loulu	Pritchardia spp.	M4210
Mahogony, swamp	Eucalyptus robusta	M4210
Maile	Alyxia olivaeformis	M4210
Makole	Nertera granadensis	M4210
Maia pilo	Capparis sandwichiana	M4210
Mamaki	Pipturus spp.	M4210
Mamani	Sophora chrysophlla	M4210
Manele	Sapindus saponaria	M4210
Mango	Mangifera indica	M4210
Manono	Gouldia terminalis	M4210
Mao	Abutilon incanum	M4210
Mao	Gossypium sandwicense	M4210
Mapele	Cyrtandra spp.	M4210
Maple, Queensland	Flindersia brayleyana	M4210
Maua	Xylosma hawaiiense	M4210
Mehame	Antidesma platyphyllum	M4210
Mehamehame	Drypetes phyllanthoides	M4210
Melastome, Malabar	Melastoma malabathricum	M4210
Melochia	Melochia indica	M4210
Moa	Psilotum nudum	M4210
Monkeypod	Pithecellobium saman	M4210
Mountain apple	Eugenia malaccensis	M4210
Myrtle, downy	Rhodomyrtus tomentosa	M4210
Naenae	Dubautia spp.	M4210
Naio	Myoporum sandwicense	M4210
Naupaka	Scaevola spp.	M4210
Nehe	Lipochaeta spp.	M4210
Neneleau	Rhus sandwicensis	M4210
Ohelo	Vaccinium spp.	M4210
Ohe makai	Reynoldsia spp.	M4210
Oheohe	Tetraplasandra spp.	M4210
Ohia	Metrosideros collina	M4210
Ohia ha	Eugenia sandwicensis	M4210
Olapa	Cheirodendron spp.	M4210
Olomea	Perrottetia sandwicensis	M4210
Olopua	Osmanthus sandwicensis	M4210
Ophioglossum	Ophioglossum spp.	M4210
Opiuma	Pithecellobium dulce	M4210
Opuhe	Urera spp.	M4210
Painiu	Astelia spp.	M4210
Pala	Marattia douglasii	M4210
Palaa	Sphenomeris chusana	M4210
Palapalai	Microlepia setosa	M4210
Pamakani, Maui	Eupatorium odoratum	M4210
Panini	Opuntia spp.	M4210
Papala	Charpentiera spp.	M4210
Paperbark	Melaleuca leucadendra	M4210
Paspalum	Paspalum spp.	M4210
Pennywort, marsh	Hydrocotyle subthorpioides	M4210
Pepper tree	Schinus molle	M4210
Phyllostegia	Phyllostegia spp.	M4210
Piia	Dioscorea pentaphylla	M4210
Pilo	Coprosma spp.	M4210
Pine	Pinus spp.	M4210
Pine, Norfolk Island	Araucaria heterophylla	M4210
Polypodium	Polypodium spp.	M4210
Poola	Claoxylon sandwicense	M4210
Pride of India	Melia azedarach	M4210
Puakala	Argemone glauca	M4210
Pukiawe	Styphelia tameiameia	M4210

continued

General Appendix A (concluded)

Common name	Scientific name	Province(s)[a]
	Hawaii (Continued)	
Rattlebox	Crotolaria incana	M4210
Redtop	Rhynchelytrum repens	M4210
Redwood, coast	Sequoia sempervirens	M4210
Rose apple	Eugenia jambos	M4210
Sedge	Cyperus cyperoides	M4210
Selaginella	Selaginella spp.	M4210
Selfheal	Prunella vulgaris	M4210
Silk-oak	Grevillea robusta	M4210
Stenogyne	Stenogyne spp.	M4210
Sugi	Cryptomeria japonica	M4210
Thimbleberry	Rubus rosaefolius	M4210
Toon, Australian	Toona ciliata	M4210
Tulip, African	Spathodea campanulata	M4210
Uki	Cladium leptostachyum	M4210
Uki	Gahnia beechyi	M4210
Uki	Machaerina gahniformis	M4210
Ukiuki	Dianella sandwicensis	M4210
Uluhe	Dicranopteris spp.	M4210
Uluhe, giant	Hilcriopteris pinnata	M4210
Umbrella plant	Cyperus alternifolius	M4210
Uulei	Osteomeles anthylidifolia	M4210
Waiowi	Psidium cattleianum	M4210
Wattle, black	Acacia decurrens	M4210
Wiliwili	Erythrina sandwicensis	M4210

[a]A province number in parenthesis indicates that the plant is listed in that province with a different common name only.

GENERAL APPENDIX B

List of Selected Wildlife

Common name	Scientific name	Key[a]
	Mammals	
Aplo dontia	See "Beaver, mountain"	
Badger	Taxidea taxus	EW*
Bat, big-eared	Plecotus rafinesquii	S-ET
Bat, eastern big-eared	Plecotus rafinesquii	S-ET
Bat, Townsend's big-eared	Plecotus townsendii	S-ET
Bat, western big-eared	Plecotus townsendii	S-ET
Bat, evening	Nycticeius humeralis	S-ET
Bat, gray	Myotis grisescens	E*
Bat, Hawaiian	See "Bat, Hawaiian hoary"	
Bat, Hawaiian hoary	Lasiurus cinereus semotus	W*
Bat, Indiana	Myotis sodalis	E*
Bat, Keen's	Myotis keenii	S-ET
Bat, southeastern	Myotis austroriparius	S-ET
Bear, black	Ursus americanus	EW*
Bear, Florida black	Ursus americanus floridanus	S-ET
Bear, northern black	Ursus americanus americanus	S-ET
Bear, grizzly	Ursus arctos	W*
Bear, polar	Thalarctos maritimus	W-NC
Beaver	Castor canadensis	EW
Beaver, mountain	Aplodontia rufa	W-NC
Bison	Bison bison	W
Boar, wild	See "Pig, feral"	
Bobcat	Lynx rufus	EW*
Buffalo, American	See "Bison"	
Burro, feral	Equus asinus	W
Cane-cutter	See "Rabbit, swamp"	
Caribou	Rangifer tarandus	W*
Cat, ringtail	See "Ringtail"	
Chickaree	Tamiasciurus douglasi	W-NC
Chipmunk, eastern	Tamias striatus	T
Chipmunk, least	Eutamias quadriuittatus	T
Chipmunk, Townsend	Eutamias townsendii	T
Civet	See "Ringtail"	
Coati	Nasua nasua	W
Coatimundi	See "Coati"	
Cougar	See "Lion, mountain"	
Cougar, eastern	Felis concolor cougar	S-ET
Coyote	Canis latrans	EW*
Deer, axis	Axis axis	W
Deer, black-tailed	See "Deer, mule"	
Deer, mule	Odocoileus hemionus	EW
Deer, Virginia	See "Deer, white-tailed"	
Deer, white-tailed	Odocoileus virginianus	EW
Deer, Columbian white-tailed	Odocoileus virginianus leucurus	S-ET
Elk	Cervus elaphus	EW
Elk, Rocky Mountain	Cervus elaphus nelsoni	Ssp. of elk
Elk, Roosevelt	Cervus elaphus roosevelti	
Elk, tule	Cervus elaphus nannodes	
Ermine	See "Weasel, shorttail"	
Ferret, black-footed	Mustela nigripes	EW*
Fisher	Martes pennanti	EW-NC
Fox, arctic	Alopex lagopus	W
Fox, gray	Urocyon cinereoargenteus	EW
Fox, island	Urocyon littoralis	S-ET
Fox, kit	Vulpes macrotis	W*
Fox, San Joaquin kit	Vulpes macrotis mutica	S-ET
Fox, red	Vulpes vulpes	EW
Fox, swift	Vulpes velox	EW*
Fox, northern swift	Vulpes velox hebes	S-ET

continued

Common name	Scientific name	Key[a]
	Mammals (Continued)	
Glutton	See "Wolverine"	
Goat, feral	Capra hircus	W
Goat, mountain	Oreamnos americanus	W
Gophers:		
Pocket, eastern	Geomys spp.	E
Pocket, western	Thomomys spp.	W
Colonial pocket	Geomys colonus	S-ET
Plains pocket	Geomys bursarius	S-ET
Sherman's pocket	Geomys fontenalus	S-ET
Groundhog	See "Woodchuck"	
Hare, snowshoe	Lepus americanus	EW
Hare, varying	See "Hare, snowshoe"	
Hog, wild	See "Pig, feral"	
Horse, feral	Equus caballus	W
Jackrabbit, black-tailed	Lepus californicus	EW*
Jackrabbit, white-sided	Lepus callotis gaillardi	S-ET
Jackrabbit, white-tailed	Lepus townsendii	EW*
Jaguar	Felis onca	W*
Javelina	See "Peccary"	
Lemming, southern bog	Synaptomys cooperi	S-ET
Lion, mountain	Felis concolor	EW*
Lion, Yuma mountain	Felis concolor browni	S-ET
Lynx	Lynx lynx	EW*
Manatee	See "Manatee, West Indian"	
Manatee, Florida	Trichechus manatus	E*
Manatee, West Indian	Trichechus manatus	S-ET
Margay	Felis wiedii	S-ET
Marmot	See "Woodchuck"	
Marmots, western	Marmota spp.	W
Marten	Martes americana	EW-NC*
Marten, pine	Martes americana	S-ET
Mink	Mustela vison	EW
Mole, star-nosed	Condylura cristata	S-ET
Moose	Alces alces	EW
Mouflon	Ovis musimon	W
Mouse, Alabama Gulf Beach	Peromyscus polionotus ammobates	S-ET
Mouse, big-eared	Peromyscus truei	T
Mouse, cotton	Peromyscus gossypinus	T
Mouse, deer	Peromyscus maniculatus	T
Mouse, Cloudland deer	Peromyscus maniculatus nubiterrae	S-ET
Mouse, dusky-footed	Peromyscus boylei	T
Mouse, golden	Ochrotomys nuttalli	S-ET
Mouse, grasshopper	Onychomys leucogaster	S-ET
Mouse, plains harvest	Reithrodontomys montanus	S-ET
Mouse, salt marsh harvest	Reithrodontomys raviventris	W*
Mouse, western harvest	Reithrodontomys megalotis	S-ET
Mouse, house	Mus musculus	T
Mouse, jumping	Zapus sp.	T
Mouse, meadow jumping	Zapus hudsonius	T
Mouse, woodland jumping	Napeozapus insignis	S-ET
Mouse, Perdido Bay Beach	Peromyscus polionotus trissyllepsis	S-ET
Mouse, pocket	Perognathus sp.	T
Mouse, plains pocket	Peroganathus flavescens	S-ET
Mouse, Kentucky red-backed	Clethrionomys gapperi maurus	S-ET
Mouse, white-footed	Peromyscus leucopus	T
Musk ox	Ovibos moschatus	W
Muskrat	Ondatra zibethicus	EW
Myotis, gray	Myotis grisescens	S-ET
Myotis, Indiana	Myotis sodalis	S-ET
Myotis, Keene's	Myotis keenii	S-ET

continued

General Appendix B (continued)

Common name	Scientific name	Key[a]
	Mammals (Continued)	
Myotis, small-footed	Myotis leibii	S-ET
Myotis, southeastern	Myotis austroriparius	S-ET
Nutria	Myocastor coypus	EW
Ocelot	Felis pardalis	W*
Opossum	Didelphis virginiana	EW
Otter, river	Lutra canadensis	EW*
Otter, sea	Enhydra lutris	S-ET
Panther	See "Lion, mountain"	
Panther, Florida	Felis concolor coryi	S-ET
Peccary	Tayassu tajacu	W
Phenacomys, tree	Phenacomys spp.	W-NC
Pig, feral	Sus scrofa	EW-NC
Porcupine	Erethizon dorsatum	EW-NC*
Prairie dog, black-tailed	Cynomys Audouicianus	EW
Prairie dog, Utah	Cynomys parvidens	EW*
Prairie dog, white-tailed	Cynomys leucurus	EW
Pronghorn	Antilocapra americana	EW
Pronghorn, Mexican	Antilocapra americana mexicana	S-ET
Pronghorn, Sonoran	Antilocapra americana sonoriensis	S-ET
Puma	See "Lion, mountain"	
Rabbit, brush	Sylvilagus bachmani	W
Rabbit, Audubon cottontail	See "Rabbit, desert cottontail"	
Rabbit, desert cottontail	Sylvilagus audubonii	W
Rabbit, eastern cottontail	Sylvilagus floridanus	EW
Rabbit, mountain cottontail	See "Rabbit, Nuttall cottontail"	
Rabbit, New England cottontail	Sylvilagus transitionalis	E
Rabbit, Nuttall's cottontail	Sylvilagus nuttallii	W
Rabbit, marsh	Sylvilagus palustris	E
Rabbit, Pygmy	Sylvilagus idahoensis	W
Rabbit, swamp	Sylvilagus aquaticus	E*
Raccoon	Procyon lotor	EW
Rat, cotton	Sigmodon sp.	T
Rat, Hispid cotton	Sigmodon hispidus	S-ET
Rat, house	See "Rat, Norway"	T
Rat, Fresno kangaroo	Dipodomys nitratoides exilis	S-ET
Rat, Morro Bay kangaroo	Dipodomys heermanni morroensis	W*
Rat, Ord's kangaroo	Dipodomys ordii	W
Rat, Stephen's kangaroo	Dipodomys stephensi	S-ET
Rat, Norway	Rattus norvegicus	T
Rat, rice	Oryzomus palustris	S-ET
Rat, wood	Neotoma floridana magister	S-ET
Rat, eastern wood	Neotoma floridana	S-ET
Ringtail	Bassariscus astutus	W
Seal, Guadalupe fur	Arctocephalus townsendi	S-ET
Seal, Hawaiian	Monachus schauinslandi	S-ET
Sheep, bighorn	Ovis canadensis	W*
Sheep, California bighorn	Ovis canadensis californiana	S-ET
Sheep, peninsular bighorn	Ovis canadensis cremnabates	S-ET
Sheep, desert	Ovis canadensis mexicana	S-ET
Sheep, Dall	Ovis dalli	
Sheep, feral	Ovis aries	W
Sheep, white	See Sheep, Dall	W
Shrew, Bachman's	Sorex longirostris	S-ET
Shrew, common	Sorex cinereus	S-ET
Shrew, least	Cryptotis parva	S-ET
Shrew, masked	Sorex cinereus	T
Shrew, shorttail	Blarina brevicauda	T
Shrew, smoky	Sorex fumeus	T
Shrew, southeastern	Sorex longirostris	S-ET
Shrew, Trowbridge	Sorex trowbridgei	T
Skunk, hog-nosed	Conepatus leuconotus	EW

continued

Common name	Scientific name	Key[a]
	Mammals (Continued)	
Skunk, hooded	Mephitis macroura	EW
Skunk, spotted	Spilogale putorius	EW*
Skunk, striped	Mephitis mephitis	EW
Squirrel, Abert's	See "Squirrel, tassel-eared"	
Squirrel, Douglas	See "Chickaree"	
Squirrel, northern flying	Glaucomys sabrinus	EW-NC
Squirrel, southern flying	Glaucomys volans	EW-NC*
Squirrel, Apache fox	Sciurus apache	W
Squirrel, Delvarva Peninsula fox	Sciurus niger cinereus	S-ET
Squirrel, eastern fox	Sciurus niger	EW
Squirrel, Arizona gray	See "Squirrel, western gray"	
Squirrel, eastern gray	Scuirus carolinensis	EW-NC
Squirrel, western gray	Sciurus griseus	W-NC
Squirrel, Franklin's ground	Spermophilus franklini	S-ET
Squirrel, golden-mantled ground	Callosphermophilus sp.	T
Squirrel, Mohave ground	Spermophilus mohavensis	S-ET
Squirrel, kaibab	See "Squirrel, tassel-eared"	
Squirrel, red	Tamiasciurus hudsonicus	EW-NC
Squirrel, spruce	See "Squirrel, red"	
Squirrel, tassel-eared	Scivrus aberti	W-NC
Vole, meadow	Microtus pennsylvanicus	T
Vole, Oregon	Microtus oregoni	T
Vole, prairie	Microtus ochrogaster ochrogaster	S-ET
Vole, pine	Microtus pinetorum	S-ET
Vole, red-backed	Clethrionomys gapperi	S-ET
Vole, boreal redback	Clethrionomys gapperi	T
Vole, Richardson	Microtus richardsoni	T
Vole, woodland	Microtus pinetorum	S-ET
Wapiti	See "Elk"	
Weasel, least	Mustela nivalis	EW*
Weasel, long-tailed	Mustela frenata	EW*
Weasel, shorttail	Mustela erminea	EW
Whales	All Federally listed species	S-ET
Wolf	See "Wolf, gray"	
Wolf, gray	Canis lupus	EW*
Wolf, red	Canis rufus	E*
Wolf, northern Rocky Mountain	Canis lupus irremotus	S-ET
Wolf, eastern timber	See "Wolf, gray"	
Wolverine	Gulo gulo (gulo luscus)	W-NC*
Woodchuck	Marmota monax	E
* *		
	Birds	
Aeo	See "Stilt, Hawaiian"	
Akakane	See "Akepa"	
Akepa	Loxops coccinea	W
Akepa, Hawaii	Loxops maculata coccinea	S-ET
Akepa, Maui	Loxops maculata ochracea	S-ET
Akepeuie	See "Akepa"	
Akialoa, Kauai	Hemignathus procerus	W*
Akiapolaau	Hemignathus wilsoni	W*
Alae	See "Gallinule, Hawaiian"	
Alae keo keo	See "Coot, Hawaiian"	
Alae ula	See "Gallinule, Hawaiian"	
Albatross, short-tailed	Diomedea albatrus	W*
Amakihi, Maui	Loxops vicens wilsoni	S-ET
Amaui	See "Thrush, large Kauai and Thrush, Malokai"	
Ani, smooth-billed	Crotophaga ani	N-ST
Ao	See "Shearwater, Newell's"	
Avocet, American	Recurvirostra americana	N-WSm

continued

General Appendix B (continued)

Common name	Scientific name	Key[a]
	Birds (Continued)	
Baldpate	See "Wigeon, American"	
Becard, rose-throated	Platyparis aglaiae richmondi	S-ET
Bittern, American	Botaurus lentiginosus	S-ET
Bittern, least	Ixobrychus exilis	S-ET
Blackbird, Brewer's	Euphagus cyanocephalus	N-LT*
Blackbird, red-winged	Agelaius phoeniceus	N-WFm
Blackbird, rusty	Euphagus carolinus	N-ST
Blackbird, tri-colored	Agelaius tricolor	N-WFm
Blackbird, yellow-headed	Xanthocephalus xanthocephalus	N-WFm*
Bluebird, eastern	Sialia sialia	N-CT
Bluebird, mountain	Sialia currucoides	N-CT
Bluebird, western	Sialia mexicana	N-CT
Bluethroat	Luscinia svecica	N-GL
Bobolink	Dolichonyx oryzivorous	N-GF*
Bufflehead	Bucephala albeola	N-DC
Bunting, indigo	Passerina cyanea	N-ST
Bunting, lark	Calamospiza melanocorys	N-GF*
Bunting, lazuli	Passerina amoena	N-ST
Bunting, McKay's	Plectrophenax hyperboreus	N-GF
Bunting, painted	Passerina ciris	N-ST*
Bunting, snow	Plectrophenax nivalis	N-GF
Bunting, varied	Passerina versicolor	N-ST
Bushtit	Psaltriparus minimus	N-ST
Buzzard	See "Vulture, turkey"	
Canvasback	Aythya valisineria	N-DG
Caracara	Caracara cheriway audubonii	S-ET
Cardinal	Cardinalis cardinalis	N-ST
Catbird, gray	Dumetella carolinensis	N-ST
Chachalaca	Ortalis vetula	E
Chat, yellow-breasted	Icteria virens	N-ST
Chickadee, black-capped	Parus atricapillus	N-CT
Chickadee, boreal	Parus hudsonicus	N-CT
Chickadee, Carolina	Parus carolinensis	N-CT
Chickadee, chestnut-backed	Parus rufescens	N-CT
Chickadee, gray-headed	Parus cinctus	N-CT
Chickadee, Mexican	Parus sclateri	N-CT
Chickadee, mountain	Parus gambeli	N-CT
Chickenhawk	See "Vulture, turkey"	
Chuck-will's-widow	Caprimulgus carolinensis	N-GW
Condor, California	Gymnogyps californianus	W*
Coot, American	Fulica americana	N-WFm
Coot, Hawaiian	Fulica americana alai	W*
Cormorant, double-crested	Phalacrocorax auritus	S-ET
Cowbird, bronzed	Molothrus aeneus	N-LT
Cowbird, brown-headed	Molothrus ater	N-ST
Crane, sandhill	Grus canadensis	N-WSm*
Crane, greater sandhill	Grus canadensis tabida	S-ET
Crane, Mississippi sandhill	Grus canadensis pulla	E*
Crane, whooping	Grus americana	EW*
Creeper	Loxops maculata	W
Creeper, brown	Certhia familiaris	N-LT*
Creeper, Hawaii	Loxops maculata mana	S-ET
Creeper, Molokai	Loxops maculata flammea	S-ET
Creeper, Oahu	Loxops maculata maculata	S-ET
Crossbill, red	Loxia curvirostra	N-LT
Crossbill, white-winged	Loxia leucoptera	N-LT
Crow, common	Corvus brachyrhynchos	N-LT
Crow, fish	Corvus ossifragus	N-LT*
Crow, Hawaiian	Corvus tropicus	W*
Crow, northwestern	Corvus caurinus	N-LT
Cuckoo, black-billed	Coccyzus erythropthalmus	N-ST
Cuckoo, yellow-billed	Coccyzus americanus	N-ST
Cuckoo, California yellow-billed	Coccyzus americanus occidentalis	S-ET
Curlew, Eskimo	Numenius borealis	EW*
Curlew, long-billed	Numenius americanus	N-GF
Dickcissel	Spiza americana	N-GF
Dipper	Cinclus mexicanus	N-WFr
Dove, ground	Columbina passerina	N-ST
Dove, mourning	Zenaida macroura	EW
Dove, turtle	See "Dove, mourning"	
Dove, white-fronted	Leptotila verreauxi	N-ST
Dove, white-winged	Zenaida asiatica	EW, N-ST
Duck, black	Anas rubripes	N-SG
Duck, harlequin	Histrionicus histrionicus	N-DG
Duck, Hawaiian	Anas wyvilliana	W*
Duck, laysan	See "Teal, Laysan"	
Duck, Mexican	Anas platyrhynchos diazi	W*
Duck, mottled	Anas fulvigula	N-SG*
Duck, ring-necked	Aythya collaris	N-DG
Duck, ruddy	Oxyura jamaicensis	N-DG
Duck, black-bellied whistling	Dendrocygna autumnalis	N-TD*
Duck, fulvous whistling	Dendrocygna bicolor	N-TD
Duck, wood	Aix sponsa	N-SC
Eagle, bald	Haliaeetus leucocephalus	S-ET
Eagle, northern bald	Haliaeetus leucocephalus alascanus	EW*
Eagle, southern bald	Haliaeetus leucocephalus leucocephalus	EW*
Eagle, golden	Aquila chrysaetos	EW*
Egret, cattle	Bubulcus ibis	T
Egret, common	Casmerodius albus	T
Egret, great	Casmerodius albus egretta	S-ET
Egret, reddish	Dichromanassa rufescens	S-ET
Egret, snowy	Egretta thula brewsteri	S-ET
Falcon, aplomado	Falco femoralis septentrionalis	S-ET
Falcon, peregrine	Falco peregrinus	EW*
Falcon, American peregrine	Falco peregrinus anatum	S-ET
Falcon, Arctic peregrine	Falco peregrinus tundrius	S-ET
Falcon, prairie	Falco mexicanus	W
Finch, Cassin's	Carpodacus cassinii	N-LT
Finch, house	Carpodacus mexicanus	N-ST
Finch, Laysan	Psittirostra cantans cantans	W*
Finch, Nihoa	Psittirostra cantans ultima	W*
Finch, purple	Carpodacus purpureus	N-LT
Flicker, common	Colaptes auratus	N-CT
Flicker, gilded	See "Flicker, common"	
Flicker, yellow-shafted	See "Flicker, common"	
Flycatcher, Acadian	Empidonax virescens	N-LT
Flycatcher, alder	Empidonax alnorum	N-ST
Flycatcher, ash-throated	Myiarchus cinerascens	N-CT
Flycatcher, beardless	Camptostoma imberbe	T
Flycatcher, buff-breasted	Empidonax fulvifrons pygmaeus	S-ET
Flycatcher, Wied's crested	Myiarchus tyrannulus	N-CT
Flycatcher, dusky	Empidonax oberholseri	N-ST
Flycatcher, gray	Empidonax wrightii	N-ST
Flycatcher, great-crested	Myiarchus crinitus	N-CT
Flycatcher, least	Empidonax minimus	N-ST
Flycatcher, olive-sided	Nuttallornis borealis	N-LT
Flycatcher, scissor-tailed	Muscivora forficata	N-LT
Flycatcher, sulphur-bellied	Myiodynastos luteiventris swarthi	S-ET
Flycatcher, Traill's	See "Flycatcher, Alder"	
Flycatcher, vermillion	Pyrocephalus rubinus	N-LT
Flycatcher, willow	Empidonax traillii	N-ST
Flycatcher, yellow-bellied	Empidonax flaviventris	N-GW
Gadwall	Anas strepera	N-SG
Gallinule, common	Gallinula chloropus	N-WFm*
Gallinule, Hawaiian	Gallinula chloropus sandvicensis	W*
Gallinule, purple	Porphyrula martinica	N-WFm*
Gnatcatcher, black-tailed	Polioptila melanura	N-ST
Gnatcatcher, blue-gray	Polioptila caerulea	N-LT

continued

continued

General Appendix B (continued)

Common name	Scientific name	Key[a]
Birds (Continued)		
Godwit, marbled	Limosa fedoa	N-WFm
Goldeneye, Barrow's	Bucephala islandica	N-DC
Goldeneye, common	Bucephala clangula	N-DC
Goldfinch, American	Carduelis tristis	N-ST
Goldfinch, green-backed	See "Goldfinch, lesser"	
Goldfinch, Lawrence's	Carduelis lawrencei	N-ST
Goldfinch, lesser	Carduelis psaltria	T
Goose, Canada	Branta canadensis	EW
Goose, Aleutian Canada	Branta canadensis leucopareia	W*
Goose, Hawaiian	Branta sandvicensis	W*
Goose, snow	Chen hyperborea	T
Goshawk	Accipiter gentilis	W
Grackle, boat-tailed	Cassidix major	N-WSm, N-WFm
Grackle, common	Quiscalus quiscalus	T
Grackle, great-tailed	Cassidix mexicanus	N-WSm, N-WFm
Grebe, eared	Podiceps caspicus	S-ET
Grosbeak, black-headed	Pheucticus melanocephalus	N-ST
Grosbeak, blue	Guiraca caerulea	N-ST
Grosbeak, evening	Hesperiphona vespertina	N-LT
Grosbeak, pine	Pinicola enucleator	N-LT
Grosbeak, rose-breasted	Pheucticus ludovicianus	N-LT
Grouse, blue	Dendragapus obscurus	W
Grouse, Frankin's	See "Grouse, spruce"	
Grouse, Richardson's	See "Grouse, blue"	
Grouse, ruffed	Bonasa umbellus	EW*
Grouse, sage	Centrocercus urophaisanus	W*
Grouse, sharp-tailed	Pedioecetes phasianellus	EW*
Grouse, prairie sharp-tailed	Pediocetes phasianellus jamesii	S-ET
Grouse, spruce	Canachites canadensis	EW
Harrier, northern	Circus cyaneus	T
Hawk, black	Buteogallus a. anthracinus	S-ET
Hawk, broad-winged	Buteo platypterus	EW*
Hawk, Cooper's	Accipiter cooperii	EW*
Hawk, duck	See Falcon, peregrine	S-ET
Hawk, ferruginous	Buteo regalis	EW
Hawk, gray	Buteo mitidus	S-ET
Hawk, Hawaiian	Buteo solitarius	W*
Hawk, marsh	Circus cyaneus	S-ET
Hawk, pigeon	See "Merlin"	
Hawk, red-shouldered	Buteo lineatus	EW*
Hawk, red-tailed	Buteo jamaicensis	EW
Hawk, rough-legged	Buteo lagopus	EW
Hawk, sharp-shinned	Accipiter striatus	EW*
Hawk, sparrow	See "Kestrel, American"	
Hawk, zone-tailed	Buteo albonotatus	S-ET
Hawk, Swainson's	Buteo swainsoni	EW*
Heron, great blue	Ardea herodias	T
Heron, green	Butorides virescens	T
Heron, little blue	Florida caerulea	S-ET
Heron, Lousiana	Hydranassa tricolor	T
Heron, black-crowned night	Nycticorax nycticorax hoactli	S-ET
Heron, yellow-crowned night	Nyctanassa violacea	S-ET
Honeycreeper, crested	Palmeria dolei	W*
Hummingbird, Allen's	Selasphorus sasin	N-ST
Hummingbird, Anna's	Calypte anna	N-ST
Hummingbird, black-chinned	Archilochus alexandri	N-ST
Hummingbird, blue-throated	Lampornis clemenciae	N-ST
Hummingbird, broad-billed	Cynanthus latirostris	N-ST
Hummingbird, broad-tailed	Selasphorus platycercus	N-ST
Hummingbird, buff-bellied	Amazilia yucatanensis	N-ST
Hummingbird, calliope	Stellula calliope	N-ST
Hummingbird, Costa's	Calypte costae	N-ST
Hummingbird, Lucifer	Calothorax lucifer	N-ST
Hummingbird, Rivoli's	Eugenes fulgens	N-ST
Hummingbird, ruby-throated	Archilochus colubris	N-ST
Hummingbird, rufous	Selasphorus rufus	N-ST
Hummingbird, violet-crowned	Amazilia verticalis	N-ST
Hummingbird, white-eared	Hylocharis leucotis	N-ST

continued

Common name	Scientific name	Key[a]
Birds (Continued)		
I'iwi	Vestiaria coccinea	S-ET
Io	See "Hawk, Hawaiian"	
Jay, blue	Cyanocitta cristata	N-LT
Jay, Canada	See "Jay, gray"	
Jay, gray	Perisoreus canadensis	N-LT
Jay, green	Cyanocorax yncas	N-ST
Jay, Mexican	Aphelocoma ultramarina	N-LT
Jay, pinyon	Gymnorhinus cyanocepnalus	N-LT
Jay, scrub	Aphelocoma coerulescens	N-ST
Jay, Stellar's	Cyanocitta stelleri	N-LT
Junco, dark-eyed	Junco hyemalis	N-GW, N-ST
Junco, gray-headed	Junco caniceps	N-GW
Junco, Mexican	See "Junco, yellow-eyed"	
Junco, Oregon	See "Junco, dark-eyed"	
Junco, slate-colored	See "Junco, dark-eyed"	
Junco, white-winged	See "Junco, dark-eyed"	
Junco, yellow-eyed	Junco phaeonotus	N-GW
Kamao	See "Thrush, large Kauai"	
Kamau	See "Thrush, large Kauai"	
Kestrel, American	Falco sparverius	EW
Kildeer	Charadrius vociferus	N-GF
Kingbird, Cassin's	Tyrannus vociferans	N-LT
Kingbird, eastern	Tyrannus tyrannus	N-LT
Kingbird, thick-billed	Tyrannus crassirostris	N-LT
Kingbird, western	Tyrannus verticalis	N-LT*
Kingfisher, belted	Megaceryle alcyon	N-LT
Kingfisher, green	Chloroceryle americana	N-CE
Kinglet, golden-crowned	Regulus satrapa	N-LT
Kinglet, ruby-crowned	Regulus calendula	N-LT
Kite, Florida Everglade	Rostrhamus sociabilis plumbeus	E
Kite, Mississippi	Ictinia mississippiensis	E*
Kite, swallow-tailed	Elanoides forficatus	E
Kite, white-tailed	Elanus leucurus	EW
Koki	See "Gallinule, Hawaiian"	
Koloa	See "Duck, Hawaiian"	
Koloa Maoli	See "Duck, Hawaiian"	
Kukuluaeo	See "Stilt, Hawaiian"	
Lark, horned	Eremophila alpestris	N-GF
Longspur, chestnut-collared	Calcarius ornatus	N-GF
Longspur, Lapland	Calcarius lapponicus	N-GF
Longspur, McCown's	Rhynchophanes mccownii	N-GF
Longspur, Smith's	Calcarius pictus	N-GF
Magpie, black-billed	Pica pica	N-ST
Magpie, yellow-billed	Pica nuttalli	N-ST
Mallard	Anas platyrhynchos	N-SG
Martin, purple	Progne subis	T
Meadowlark, eastern	Sturnella magna	N-GF
Meadowlark, western	Sturnella neglecta	N-GF
Merganser, American	See "Merganser, common"	
Merganser, common	Mergus merganser	N-DC
Merganser, hooded	Lophodytes cucullatus	N-DC
Merganser, red-breasted	Mergus serrator	N-DG
Merlin	Falco columbarius	EW*
Millerbird, Nihoa	Acrocephalus familiaris kingi	W*
Mockingbird	Mimus polyglottos	N-ST
Nene	See "Goose, Hawaiian"	
Nighthawk, common	Chordeiles minor	N-GF
Nighthawk, lesser	Chordeiles acutipennis	N-GF
Nukupuu, Kauai	Hemignathus lucidus hanapepe	W*
Nukupuu, Maui	Hemignathus lucidus affinis	W*
Nutcracker, Clark's	Nucifraga columbiana	N-LT
Nuthatch, brown-headed	Sitta pusilla	N-CT

continued

General Appendix B (continued)

Common name	Scientific name	Key[a]
	Birds (Continued)	
Nuthatch, pygmy	Sitta pygmaea	N-CT
Nuthatch, red-breasted	Sitta canadensis	N-CT
Nuthatch, white-breasted	Sitta carolinensis	N-CT
Olomau	See "Thrush, large Kauai and Thrush, Molokai"	
Oo, Kauai	Moho braccatus	W*
Oriole, Baltimore	See "Oriole, northern"	N-LT
Oriole, black-headed	Icterus graduacauda	N-LT
Oriole, Bullock's	See "Oriole, northern"	
Oriole, hooded	Icterus cucullatus	N-GL, N-GW
Oriole, northern	Icterus galbula	
Oriole, orchard	Icterus spurius	N-LT
Oriole, Scott's	Icterus parisorum	N-ST
Osprey	Pandion haliaetus	EW*
Ou	Psittirostra psittacea	W*
Ouzel, water	See "Dipper"	
Ovenbird	Seiurus aurocapillus	N-GW
Owl, barn	Tyto alba	E*
Owl, barred	Strix varia	S-ET
Owl, burrowing	Athene cunicularia	EW*
Owl, great horned	Bubo virginianus	EW
Owl, Hawaiian	Asio flammeus sandwichensis	S-ET
Owl, long-eared	Asio otus	E*
Owl, short-eared	Asio flammeus	E*
Owl, northern spotted	Strix occidentalis caurina	S-ET
Palila	Psittirostra bailleui	W*
Parrot, thick-billed	Rhynchopsitta pachyrhyncha	W
Parrotbill, Maui	Pseudonestor xanthophrys	W*
Partridge, chukar	Alectoris chukar	W
Partridge, European	See "Partridge, Gray"	
Partridge, gray	Perdix perdix	
Partridge, Hungarian	See "Partridge, Gray"	EW
Parula, northern	Parula americana	N-LT
Pauraque	Nyctidromus albicollis	N-GL
Pelican, brown	Pelecanus occidentalis	EW*
Pelican, California brown	Pelecanus occidentalis	S-ET
Pelican, eastern brown	Pelecanus occidentalis carolinensis	S-ET
Pelican, white	Pelecanus erythrorhunchos	S-ET
Petrel, Hawaiian dark-rumped	Pterodroma phaeopygia sandwichensis	W*
Petrel, Hawaiian storm	Oceanodroma castro cryptoleucuro	S-ET
Pewee, eastern wood	Contopus virens	N-LT
Pewee, western wood	Contopus sordidulus	N-LT
Phainopepla	Phainopepla nitens	N-LT
Phalarope, northern	Lobipes lobatus	N-WSm, N-WFm
Phalarope, Wilson's	Steganopus tricolor	N-WFm*
Pheasant, ring-necked	Phasianus colchicus	EW
Phoebe, eastern	Sayornis phoebe	T
Phoebe, Say's	Sayornis saya	S-ET
Pigeon, band-tailed	Columba fasciata	W
Pintail	Anas acuta	N-SG
Pipit, Sprague's	Anthus spragueii	N-GF
Pipit, water	Anthus spinoletta	N-GF
Plover, mountain	Charadrius montanus	S-ET
Plover, piping	Charadrius melodus	S-ET
Plover, snowy	Charadrius alexandrinus	S-ET
Plover, western snowy	Charadrius alexandrinus nivosus	S-ET
Plover, upland	Bartramia longicauda	S-ET
Poor-will	Phalaenoptilus nuttallii	N-GL
Poo-uli	Melamprosops phaeosoma	W*
Prairie chicken, greater	Tympanuchus cupido	EW*
Prairie chicken, Attwater's greater	Tympanuchus cupido attwateri	E*
Prairie chicken, lesser	Tympanuchus pallidicinctus	W*

continued

Common name	Scientific name	Key[a]
	Birds (Continued)	
Ptarmigan, white-tailed	Lagopus leucurus	W*
Puaiohi	See "Thrush, small Kauai"	
Pyrrhuloxia	Cardinalis sinuata	N-ST
Quail, bobwhite	Colinus virginianus	EW*
Quail, masked bobwhite	Colinus virginianus ridgwayi	W
Quail, California	Lophortyx californicus	W
Quail, Gambel's	Lophortyx gambelii	W
Quail, Montezuma	Cyrtonyx montezumae	W
Quail, mountain	Oreortyx pictus	W
Quail, scaled	Callipepla squamata	W
Rail, black	Laterallus jamaicensis	N-WSm*
Rail, California black	Laterallus jamaicensis coturnicolus	S-ET
Rail, California clapper	Rallus longirostris obsoletus	W*
Rail, light-footed clapper	Rallus longirostris levipes	W*
Rail, Yuma clapper	Rallus longirostris yumanensis	W*
Rail, king	Rallus elegans	N-WFm*
Rail, sora	See "Sora"	
Rail, Virginia	Rallus limicola	N-WFm
Rail, yellow	Coturnicops noveboracensis	S-ET
Raven	See "Raven, common"	
Raven, common	Corvus corax	N-LT*
Raven, white-necked	Corvus cryptoleucus	N-LT
Redpoll, common	Carduelis flammea	N-ST
Redpoll, hoary	Carduelis hornemanni	T
Redstart, American	Setophaga ruticilla	N-LT
Redstart, painted	Myioborus pictus	N-GW
Robin, American	Turdus migratorius	N-LT
Sandpiper, buff-breasted	Tryngites subruficollis	T
Sandpiper, least	Calidris minutilla	N-WSm, N-WFm
Sandpiper, solitary	Tringa solitaria	N-WSm, N-WFm
Sandpiper, spotted	Actitis macularia	N-GF
Sandpiper, upland	Bartramia longicauda	N-GF*
Sandpiper, western	Calidris mauri	N-WSm, N-WFm
Sapsucker, red-breasted	See Sapsucker, yellow-bellied	N-CT
Sapsucker, Williamson's	Sphyrapicus thyroideus	N-CT
Sapsucker, yellow-bellied	Sphyrapicus varius	N-CT
Scaup, lesser	Aythya affinis	N-DG
Scoter, surf	Melanitta perspicillata	N-DG
Scoter, white-winged	Melanitta deglandi	N-DG
Seedeater, white-collared	Sporophila torqueola	N-ST
Shearwater, Newell's	Puffinus puffinus newelli	W*
Shoveler, northern	Anas clypeata	N-SG
Shrike, loggerhead	Lanius ludovicianus	N-ST*
Siskin, pine	Carduelis pinus	N-LT
Skylark	Alauda arvensis	N-GF
Snipe, common	Capella gallinago	EW
Snipe, Wilson's	See "Snipe, common"	
Solitaire, Townsend's	Myadestes townsendi	N-CE
Sora	Porzana carolina	N-WFm
Sparrow, Bachman's	Aimophila aestivalis	S-ET
Sparrow, Baird's	Ammodramus bairdii	N-GF
Sparrow, black-chinned	Spizella atrogularis	N-ST
Sparrow, black-throated	Amphispiza bilineata	N-ST
Sparrow, Botteri's	Aimophila botterii	N-GL
Sparrow, Brewer's	Spizella breweri	N-GL
Sparrow, Cape Sable	Ammospiza maritima mirabilis	E
Sparrow, Cassin's	Aimophila cassinii	N-GL
Sparrow, chipping	Spizella passerina	N-ST, N-LT
Sparrow, clay-colored	Spizella pallida	N-GL, N-ST
Sparrow, field	Spizella pusilla	N-GF, N-GL, N-ST

continued

General Appendix B (continued)

Common name	Scientific name	Key[a]
Birds (Continued)		
Sparrow, fox	Passerella iliaca	N-GL, N-ST
Sparrow, golden-crowned	Zonotrichia atricapilla	N-GL, N-ST
Sparrow, grasshopper	Ammodramus savannarum	N-GF*
Sparrow, Harris'	Zonotrichia querula	T
Sparrow, Henslow's	Ammodramus henslowii	N-GF*
Sparrow, Ipswich	Passerculus princeps	S-ET
Sparrow, lark	Chondestes grammacus	N-GF
Sparrow, LeConte's	Ammospiza leconteii	N-GF
Sparrow, Lincoln's	Melospiza lincolnii	N-WFm
Sparrow, olive	Arremonops rufivirgata	N-ST
Sparrow, rufous-crowned	Aimophila ruficeps	N-GL
Sparrow, rufus-winged	Aimophila carpalis	N-ST
Sparrow, sage	Amphispiza belli	N-ST
Sparrow, savannah	Passerculus sandwichensis	N-GF
Sparrow, Beldings savannah	Passerculus sandwichensis	S-ET
Sparrow, seaside	Ammospiza maritima	N-WSm
Sparrow, dusky seaside	Ammospiza maritima nigrescens	E
Sparrow, sharp-tailed	Ammospiza caudacuta	N-WFm
Sparrow, song	Melospiza melodia	N-GL, N-GW, N-ST
Sparrow, Santa Barbara song	Melospiza melodia graminea	W
Sparrow, swamp	Melospiza georgiana	N-WFm
Sparrow, tree	Spizella arborea	T
Sparrow, vesper	Pooecetes gramineus	N-GF*
Sparrow, white-crowned	Zonotrichia leucophyrys	N-GL, N-ST
Sparrow, white-throated	Zonotrichia albicollis	N-GW, N-ST
Starling	Sturnus vulgaris	N-CT
Stilt, black-necked	Himantopus mexicanus	N-WFm
Stilt, Hawaiian	Himantopus himantopus knudseni	W*
Swallow, bank	Riparia riparia	N-CE
Swallow, cave	Petrochelidon fulva	N-CE
Swallow, cliff	Petrochelidon pyrrhonata	S-ET
Swallow, rough-winged	Stelgidopteryx ruficollis	N-CE
Swallow, tree	Iridoprocne bicolor	N-CT
Swallow, violet-green	Tachycineta thalassina	N-CT
Swift, Vaux's	Chaetura vauxi	N-CT
Tanager, hepatic	Piranga flava	N-LT
Tanager, scarlet	Piranga olivacea	N-LT
Tanager, summer	Piranga rubra	N-LT
Tanager, western	Piranga ludoviciana	N-LT
Teal, blue-winged	Anas discors	N-SG
Teal, cinnamon	Anas cyanoptera	N-SG
Teal, green-winged	Anas crecca	N-SG
Teal, Laysan	Anas laysanensis	W*
Tern, black	Chidonias niger	N-WFm*
Tern, common	Sterna hirundo hirundo	S-ET
Tern, Forster's	Sterna forsteri	S-ET
Tern, least	Sterna albifrons	S-ET
Tern, California least	Sterna albifrons browni	W*
Tern, interior least	Sterna albifrons athalassos	S-ET
Tern, roseate	Sterna dougallii	S-ET
Tern, white	Gygis alba	S-ET
Thrasher, Bendire's	Toxostoma bendirei	N-ST
Thrasher, brown	Toxostoma rufum	N-GL, N-ST
Thrasher, California	Toxostoma redivivum	N-ST
Thrasher, crissal	Toxostoma dorsale	N-ST
Thrasher, curve-billed	Toxostoma curvirostre	N-ST
Thrasher, LeConte's	Toxostoma lecontei	N-ST
Thrasher, long-billed	Toxostoma longirostre	N-ST
Thrasher, sage	Oreoscoptes montanus	N-ST
Thrush, gray-cheeked	Catharus minimus	N-LT
Thrush, hermit	Catharus guttatus	N-GW
Thrush, large Kauai	Phaeornis obscurus myadestina	W*
Thrush, small Kauai	Phaeornis palmeri	W*
Thrush, Molokai	Phaeornis obscurus rutha	W*
Thrush, Swainson's	Catharus ustulatus	N-ST
Thrush, varied	Ixoreus naevius	N-ST
Thrush, wood	Hylocichla mustelina	N-LT
Timberdoodle	See "Woodcock"	
Titmouse, black-crested	See "Titmouse, tufted"	
Titmouse, bridled	See "Titmouse, tufted"	
Titmouse, plain	Parus inornatus	N-CT
Titmouse, tufted	Parus bicolor	N-CT
Towhee, Abert's	Pipilo aberti	N-ST
Towhee, brown	Pipilo fuscus	N-ST
Towhee, green-tailed	Pipilo chlorurus	N-ST
Towhee, rufus-sided	Pipilo erythrophthalmus	N-ST
Towhee, spotted	See "Towhee, rufus-sided"	
Trogon, coppery-tailed	Trogon elegans canescens	S-ET
Turkey, wild	Meleagris gallopavo	EW
Uau	See "Petrel, Hawaiian dark-rumped"	
Uuau	See "Petrel, Hawaiian dark-rumped"	
Uwau	See "Petrel, Hawaiian dark-rumped"	
Veery	Catharus fuscescens	N-ST*
Verdin	Auriparus flaviceps	N-CT
Vireo, Bell's	Vireo bellii	N-ST
Vireo, black-capped	Vireo atricapilla	N-ST
Vireo, Hutton's	Vireo huttoni	N-ST
Vireo, Philadelphia	Vireo philadelphicus	N-LT
Vireo, red-eyed	Vireo olivaceus	N-LT
Vireo, solitary	Vireo solitarius	N-LT
Vireo, warbling	Vireo gilvus	N-LT
Vireo, white-eyed	Vireo griseus	N-ST
Vireo, yellow-green	Vireo flavoviridis	N-LT
Vireo, yellow-throated	Vireo flavifrons	N-LT
Vulture, black	Coragyps atratus	S-ET
Vulture, turkey	Cathartes aura	EW
Wagtail, yellow	Motacilla flava	N-GL
Warbler, Arctic	Phylloscopus borealis	N-GL
Warbler, Bachman's	Vermivora bachmanii	E*
Warbler, bay-breasted	Dendroica castanea	N-LT
Warbler, black-and-white	Mniotilta varia	N-GW
Warbler, Blackburnian	Dendroica fusca	N-LT
Warbler, blackpoll	Dendroica striata	N-LT
Warbler, black-throated blue	Dendroica caerulescens	N-ST
Warbler, black-throated gray	Dendroica nigrescens	N-ST, N-LT
Warbler, black-throated green	Dendroica virens	N-LT
Warbler, blue-winged	Vermivora pinus	N-GL*
Warbler, Calaveras	See "Warbler, Nashville"	
Warbler, Canada	Wilsonia canadensis	N-GW
Warbler, Cape May	Dendroica tigrina	N-LT
Warbler, cerulean	Dendroica cerulea	N-LT
Warbler, chestnut-sided	Dendroica pensylvanica	N-ST
Warbler, Colima	Vermivora crissalis	N-GW
Warbler, Connecticut	Oporornis agilis	N-WFm
Warbler, golden-cheeked	Dendroica chrysoparia	N-LT
Warbler, golden-winged	Vermivora chrysoptera	N-GL
Warbler, Grace's	Dendroica graciae	N-LT
Warbler, hermit	Dendroica occidentalis	N-LT
Warbler, hooded	Wilsonia citrina	N-ST
Warbler, Kentucky	Oporornis formosus	N-GW, N-ST
Warbler, Kirtland's	Dendroica kirtlandii	E*
Warbler, Lucy's	Vermivora luciae	N-CT
Warbler, MacGillivray's	Oporornis tolmiei	N-GL
Warbler, magnolia	Dendroica magnolia	N-ST
Warbler, mourning	Oporornis philadelphia	N-GL
Warbler, myrtle	Dendroica coronata	T
Warbler, Nashville	Vermivora ruficapilla	N-GW

continued

continued

General Appendix B (continued)

Common name	Scientific name	Key[a]
Birds (Continued)		
Warbler, olive	Peucedramus taeniatus	N-LT
Warbler, olive-backed	See "Warbler, tropical parula"	
Warbler, orange-crowned	Vermivora celata	N-GL, N-ST
Warbler, palm	Dendroica palmarum	N-ST, N-WFm
Warbler, pine	Dendroica pinus	N-LT
Warbler, prairie	Dendroica discolor	N-ST
Warbler, prothonotary	Protonotaria citrea	N-CT
Warbler, red-faced	Cardellina rubifrons	N-GW
Warbler, Swainson's	Lymnothlypis swainsonii	N-ST*
Warbler, Tennessee	Vermivora peregrina	N-WFm
Warbler, tropical parula	Parula pitiayumi	N-GW
Warbler, Virginia's	Vermivora virginiae	N-GL
Warbler, Wilson's	Wilsonia pusilla	N-WFm
Warbler, worm-eating	Helmitheros vermivorus	N-GW
Warbler, yellow	Dendroica petechia	N-ST
Warbler, yellow-rumped	Dendroica coronata	N-LT
Warbler, yellow-throated	Dendroica dominica	N-LT
Waterthrush, Louisiana	Seiurus motacilla	N-CE
Waterthrush, Northern	Seiurus noveboracensis	N-WEm
Waxwing, Bohemian	Bombycilla garrula	N-LT
Waxwing, cedar	Bombycilla cedrorum	N-ST
Whip poor-will	Caprimulgus vociferus	N-GW
Wigeon, American	Anas americana	N-SG
Woodcock, American	Philohela minor	E
Woodpecker, acorn	Melanerpes formicivorus	N-CT
Woodpecker, Arizona	Picoides arizonae	N-CT
Woodpecker, downy	Picoides pubescens	N-CT
Woodpecker, Gila	Melanerpes uropygialis	N-CT
Woodpecker, golden-fronted	Melanerpes aurifrons	N-CT
Woodpecker, hairy	Picoides villosus	N-CT
Woodpecker, ivory-billed	Campephilus principalis	S-ET
Woodpecker, ladder-backed	Picoides scalaris	N-CT
Woodpecker, Lewis'	Melanerpes lewis	N-CT
Woodpecker, Nuttall's	Picoides nuttallii	N-CT
Woodpecker, pileated	Dryocopus pileatus	EW
Woodpecker, red-bellied	Melanerpes carolinus	N-CT
Woodpecker, red-cockaded	Picoides borealis	E*
Woodpecker, red-headed	Melanerpes erythrocephalus	N-CT*
Woodpecker, black-backed three-toed	Picoides arcticus	N-CT
Woodpecker, white-headed	Picoides albolarvatus	N-CT
Wren, Bewick's	Thryomanes bewickii	N-CT*
Wren, brown-throated	Troglodytes brunneicollis	N-CT
Wren, cactus	Campylorhynchus brunneicapillus	N-ST
Wren, canyon	Catherpes mexicanus	N-CE
Wren, Carolina	Thryothorus ludovicianus	N-CT
Wren, house	Troglodytes aedon	N-CT
Wren, long-billed marsh	Cistothorus palustris	N-WSm, N-WFm
Wren, rock	Salpinctes obsoletus	N-CE
Wren, short-billed marsh	Cistothorus platensis	N-WFm*
Wren, winter	Troglodytes troglodytes	N-CT
Wrentit	Chamaea fasciata	N-ST
Yellowlegs, greater	Tringa melanoleucus	N-WSm, N-WFm
Yellowlegs, lesser	Tringa flavipes	N-WSm, N-WFm
Yellowthroat, common	Geothlypis trichas	N-ST, N-WSm, N-WFm
* *		
Amphibians and reptiles		
Alligator, American	Alligator mississippiensis	E*

continued

Common name	Scientific name	Key[a]
Amphibians and reptiles (Continued)		
Boa, southern rubber	Charina bottae umbrieata	S-ET
Copperbelly, northern	Natrix erythrogaster neglecta	S-ET
Copperhead, northern	Agkistrodon contortix	T
Crocodile, American	Crocodylus acutus	E
Frog, Strecker's chorus	Pseudacris streckeri	S-ET
Frog, Illinois chorus	Pseudacris streckeri illinoensis	S-ET
Frog, cricket	Acris crepitans	S-ET
Frog, dusky gopher	Rana areolata sevosa	S-ET
Frog, western spotted	Rana pretiosa	S-ET
Frog, western bird-voiced tree	Hyla avivoca avivoca	S-ET
Frog, green tree	Hyla cinerea	S-ET
Frog, Pine Barrens tree	Hyla andersoni	S-ET
Frog, wood	Rana sylvatica	S-ET
Gila monster	Heloderma suspectum	S-ET
Hellbender	Cryptobranchus alleganiensis	S-ET
Kingsnake, speckled	Lampropeltis getulus	S-ET
Lizard, slender glass	Ophisaurus attenuatus	S-ET
Lizard, western slender glass	Ophisaurus attenuatus	S-ET
Lizard, blunt-nosed leopard	Crotaphytus silus	W*
Massasauga	Sistrurus catenatus	S-ET
Newt, central	Notophthalmus viridescens	S-ET
Peeper, spring	Hyla crucifer	S-ET
Racer, Alameda striped	Masticophis lateralis euryxanthus	S-ET
Rattlesnake, canebrake	Crotalus horridus atricaudatus	S-ET
Rattlesnake, prairie	Crotalus viridis	S-ET
Rattlesnake, western pygmy	Sistrurus meliarius streckeri	S-ET
Rattlesnake, ridge-nosed	Crotalus willardi silus	S-ET
Rattlesnake, timber	Crotalus horridus	S-ET
Salamander, Texas blind	Typhlomolge rathbuni	E*
Salamander, blue-spotted	Ambystoma laterale	S-ET
Salamander, cave	Eurycea lucifuga	S-ET
Salamander, Tennessee cave	Gyrenophilus palleucus	S-ET
Salamander, Cascade Cavern	Eurycea latitans	S-ET
Salamander, dwarf	Manculus quadridigitatus	S-ET
Salamander, dusky	Desmognathus fuscus	S-ET
Salamander, Fern Bank	Eurycea pterophila	S-ET
Salamander, flatwoods	Ambystoma cingulatum	S-ET
Salamander, four-toed	Hemidactylium scutatum	S-ET
Salamander, green	Aneides aeneus	S-ET
Salamander, Jefferson	Ambystoma jeffersonianum	S-ET
Salamander, triploid Jefferson's	Ambystoma platineum	S-ET
Salamander, limestone	Hydromantes brunus	S-ET
Salamander, Santa Cruz long-toed	Ambystoma macrodactylum croceum	W*
Salamander, marbled	Ambystoma opacum	S-ET

continued

General Appendix B (continued)

Common name	Scientific name	Key[a]
	Amphibians and reptiles (Continued)	
Salamander, Oklahoma	Eurycea tynerensis	S-ET
Salamander, northern red	Pseudotriton ruber ruber	S-ET
Salamander, Red Hills	Phaeognathus hubrichii	S-ET
Salamander, San Marcos	Eurycea nana	S-ET
Salamander, shasta	Hydromantes shastae	S-ET
Salamander, silvery	Ambystoma platineum	S-ET
Salamander, Siskiyou Mountain	Plethodon stormi	S-ET
Salamander, desert slender	Batrachoseps aridus	W*
Salamander, Kern Canyon slender	Batrachoseps simatus	S-ET
Salamander, Tehachapi slender	Batrachoseps stebbinsi	S-ET
Salamander, small-mouthed	Ambystoma texanum	S-ET
Salamander, three-toed	Amphiuma means	S-ET
Salamander, eastern tiger	Ambystoma tirginum tirginum	S-ET
Salamander, Wehrle's	Plethodon wehrlei	S-ET
Salamander, zig-zag	Plethodon dorsalis	S-ET
Siren, western lesser	Siren intermedia	S-ET
Skink, blue-tailed	Eumeces fasciatus	S-ET
Skink, coal	Eumeces anthracinus anthracinus	S-ET
Skink, southern coal	Eumeces anthracinus pluvialis	S-ET
Skink, five-lined	Eumeces fasciatus	S-ET
Skink, Great Plains	Eumeces obsoletus	S-ET
Slider	Pseudemys floridana x concinna	S-ET
Snake, brown	Storeria dekayi	S-ET
Snake, corn	Elaphe guttata	S-ET
Snake, southeastern crowned	Tantilla coronata coronata	S-ET
Snake, eastern earth	Haldea valeriae valeriae	S-ET
Snake, mountain earth	Haldea valeriae pulchra	S-ET
Snake, western earth	Haldea valeriae elegans	S-ET
Snake, Butler's garter	Thamnophis butleri	S-ET
Snake, eastern plains garter	Thamnophis radix radix	S-ET
Snake, giant garter	Thamnophis couchi gigas	S-ET
Snake, San Francisco garter	Thamnophis sirtalis tetrataenia	W*
Snake, smooth green	Opheodrys vernalis blanchardi	S-ET
Snake, eastern hognose	Heterodon platyrhinos	S-ET
Snake, southern hognose	Heterodon simus	S-ET
Snake, western hognose	Heterodon nasicus	S-ET
Snake, eastern indigo	Drymarchon corais couperi	S-ET
Snake, prairie king	Lampropeltis calligaster	S-ET
Snake, lined	Tropidoclonion lineatum	S-ET
Snake, western mud	Farancia abacura reinwardti	S-ET
Snake, black pine	Pituophis melanoleucus lodingi	S-ET
Snake, Florida pine	Pituophis melanoleucus mugitus	S-ET
Snake, northern pine	Pituophis melanoleucus melanoleucus	S-ET
Snake, green	Natrix septemvittata	S-ET
Snake, rainbow	Farancia erytrogramma erytrogramma	S-ET
Snake, black rat	Elaphe obsoleta	S-ET
Snake, Great Plains rat	Elaphe guttata	S-ET
Snake, northern red-bellied	Storeria occipitomaculata	S-ET
Snake, eastern ribbon	Thamnophis sauritus	S-ET
Snake, western ribbon	Thamnophis proximus	S-ET
Snake, scarlet	Cemophora coccinea copei	S-ET
Snake, broad-banded water	Nerodia fasciata	S-ET
Snake, diamondback water	Natrix rhombifera	S-ET
Snake, Graham's water	Natrix grahami	S-ET
Snake, green water	Natrix cyclopion	S-ET
Snake, Kirtland's water	Natrix kirtlandi	S-ET
Snake, yellow-bellied water	Natrix erythrogaster	S-ET
Snake, whip	Masticophis flagellum	S-ET
Spadefoot, western	Scaphiopus bombifrons	S-ET
Stinkpot	Sternotherus odoratus	S-ET
Toad, Houston	Bufo houstonensis	E*

continued

Common name	Scientific name	Key[a]
	Amphibians and reptiles (Continued)	
Toad, eastern narrow-mouthed	Gastrophryne carolinensis	S-ET
Tortoise, desert	Gopherus agassizi	S-ET
Tortoise, gopher	Gopherus polyphemus	S-ET
Turtle, Blanding's	Emydoidea blandingi	S-ET
Turtle, bog	Clemmys muhlenbergi	S-ET
Turtle, eastern bog	Terrapene carolina carolina	S-ET
Turtle, ornate box	Terrapene ornata	S-ET
Turtle, Atlantic green	Chelonia mydas mydas	S-ET
Turtle, Atlantic hawksbill	Eretmochelys imbricata imbricata	S-ET
Turtle, hieroglyphic	Pseudemys concinna hieroglyphica	S-ET
Turtle, Atlantic leatherback	Dermochelys coreacea coreacea	S-ET
Turtle, Atlantic loggerhead	Caretta caretta	S-ET
Turtle, false map	Graptemys pseudogeographica	S-ET
Turtle, eastern mud	Kinosternon subrubrum subrubrum	S-ET
Turtle, Illinois mud	Kinosternon flavescens spooneri	S-ET
Turtle, Sonoran mud	Kinosternon sonoriense	T
Turtle, flattened musk	Sternotherus minor depressus	S-ET
Turtle, Alabama red-bellied	Pseudemys alabamensis	S-ET
Turtle, red-eared	Chrysemys scripta	S-ET
Turtle, Atlantic Ridley	Lepidochelys kempi	S-ET
Turtle, black-knobbed sawback	Graptemys nigrinoda	S-ET
Turtle, ringed sawback	Graptemys oculifera	S-ET
Turtle, yellow-blotched sawback	Graptemys flavimaculata	S-ET
Turtle, alligator snapping	Macroclemys temminckii	S-ET
Turtle, spiny softshell	Trionyx spiniferus	S-ET
Turtle, spotted	Clemmys guttata	S-ET
Turtle, wood	Clemmys insculpta	S-ET
Whip, coach	Masticophis flagellum	S-ET
* *		
	Fish	
Bloater	Coregonus hoyi	S-ET
Boneytail, pahranagat	Gila robusta	US-ET*
Bullhead, brown	Ictalurus nebulosus	S-ET
Burbot	Lota lota	S-ET
Cavefish, Alabama	Speoplatyrhinos poulsoni	S-ET
Cavefish, northern	Amblyopsis spelaea	S-ET
Cavefish, Ozark	Amblyopsis rosae	S-ET
Cavefish, southern	Typhlichthys subterraneous	S-ET
Cavefish, spring	Chologaster agassizi	S-ET
Chub, bigeye	Hybopsis amblops	S-ET
Chub, bonytail	Gila elegans	S-ET
Chub, gila	Gila intermedia	S-ET
Chub, gravel	Hybopsis x punctata	S-ET
Chub, humpback	Gila cypha	US-ET*
Chub, lake	Couesius plumbeus	S-ET
Chub, Mohave	Gila mohavensis	US-ET*
Club, Owens tui	Gila bicolor	S-ET
Chub, sicklefin	Hybopsis meeki	S-ET
Chub, silver	Hybopsis storeriana	S-ET
Chub, slender	Hybopsis cahni	S-ET
Chub, Arkansas River speckled	Hybopsis aestivalis tetranemus	S-ET
Chub, spotfin	Hybopsis monacha	S-ET
Chub, sturgeon	Hybopsis gilida	S-ET
Chub, thicktail	Gila crassicauda	S-ET
Chubsucker, lake	Erimyzon sucetta	S-ET
Cisco	Coregonus artedii	S-ET
Cisco, blackfin	Coregonus nigripinnis	S-ET

continued

General Appendix B (continued)

Common name	Scientific name	Key[a]
Fish (Continued)		
Cisco, deepwater	Coregonus johannae	S-ET
Cisco, longjaw	Coregonus alpenae	US-ET*
Cisco, shortjaw	Coregonus zenithicus	S-ET
Cisco, shortnose	Coregonus reighardi	S-ET
Cui-ui	Chasmistes cujus	US-ET*
Cutthroat, Colorado River	Salmo clarki pleuriticus	S-ET
Cutthroat, greenback	Salmo clarki stomias	S-ET
Cutthroat, Rio Grande	Salmo clarki virginalis	S-ET
Dace, finescale	Phoxinus neogaeus	S-ET
Dace, Kendall Warm Springs	Rhinichthys osculus	US-ET
Dace, Moapa	Moapa coriacea	US-ET
Dace, pearl	Semotilus margarita	S-ET
Dace, northern redbelly	Phoxinus eos	S-ET
Dace, southern red-bellied	Chrosomus erythrogaster	S-ET
Dace, redside	Clinostomus elongatus	S-ET
Dace, rosyside	Clinostomus funduloides	S-ET
Darter, amber	Percina sp.	S-ET
Darter, Arkansas	Etheostoma cragini	S-ET
Darter, bayou	Etheostoma rubrum	US-ET*
Darter, bluebreast	Etheostoma camurum	S-ET
Darter, bluestripe	Percina cymatotaenia	S-ET
Darter, bluntnose	Etheostoma chlorosomum	S-ET
Darter, central johnny	Etheostoma nigrum nigrum	S-ET
Darter, channel	Percina copelandi	S-ET
Darter, coldwater	Etheostoma ditrema	S-ET
Darter, coppercheek	Etheostoma sp.	S-ET
Darter, crystal	Ammocrypta asprella	S-ET
Darter, duskytail	Etheostoma sp.	S-ET
Darter, fountain	Etheostoma fonticola	US-ET*
Darter, freckled	Percina lenticula	S-ET
Darter, gilt	Percina evides	S-ET
Darter, goldline	Percina aurolineata	S-ET
Darter, goldstripe	Etheostoma parvipinne	S-ET
Darter, harlequin	Etheostoma histrio	S-ET
Darter, Iowa	Etheostoma exile	S-ET
Darter, least	Etheostoma microperca	S-ET
Darter, longhead	Percina macrocephala	S-ET
Darter, longnose	Percina nasuta	S-ET
Darter, Maryland	Etheostoma sellare	US-ET
Darter, mud	Etheostoma asprigene	S-ET
Darter, niangua	Etheostoma nianguae	S-ET
Darter, Okaloosa	Etheostoma okaloosae	US-ET
Darter, orangethroat	Etheostoma spectabile	S-ET
Darter, Plains orangethroat	Etheostoma spectabile pulchellum	S-ET
Darter, river	Percina shumardi	S-ET
Darter, eastern sand	Ammocrypta pellucida	S-ET
Darter, western sand	Ammocrypta clara	S-ET
Darter, slackwater	Etheostoma boschungi	S-ET
Darter, slenderhead	Percina phoxocephala	S-ET
Darter, snail	Percina tanasi	US-ET*
Darter, spottail	Etheostoma squamiceps	S-ET
Darter, spotted	Etheostoma maculatum	S-ET
Darter, stargazing	Percina uranidea	S-ET
Darter, swamp	Etheostoma swaini	S-ET
Darter, Tippecanoe	Etheostoma tippecanoe	S-ET
Darter, trispot	Etheostoma trisella	S-ET
Darter, Tuscumbia	Etheostoma tuscumbia	S-ET
Darter, variegated	Etheostoma variatum	S-ET
Darter, warrior muscadine	Percina sp. ssp.	S-ET
Darter, watercress	Etheostoma nuchale	US-ET*
Eel, American	Anguilla rostrata	S-ET
Gambusia, amistad	Gambusia amistadensis	S-ET
Gambusia, Big Bend	Gambusia gaigei	US-ET*
Gambusia, Clear Creek	Gambusia heterochir	US-ET*
Gambusia, Pecos	Gambusia nobilis	US-ET*
Gambusia, San Marcos	Gambusia georgei	S-ET
Gar, alligator	Lepisosteus spatula	S-ET
Gar, shortnose	Lepisosteus platostomus	S-ET
Gar, spotted	Lepisosteus oculatus	S-ET
Herring, lake	Coregonus artedii	S-ET
Herring, skipjack	Alosa chrysochloris	S-ET
Killifish, banded	Fundulus diaphanus	S-ET
Killifish, Pahrump	Empetrichythys latos	US-ET*
Killifish, plains	Fundulus kansae	S-ET
Kiyi	Coregonus kiyi	S-ET
Lamprey, Allegheny brook	Ichthyomyzon greeleyi	S-ET
Lamprey, American brook	Lampetra lamottei	S-ET
Lamprey, northern brook	Ichthyomyzon fossor	S-ET
Lamprey, southern brook	Ichthyomyzon gagei	S-ET
Lamprey, chestnut	Ichthyomyzon castaneus	S-ET
Lamprey, Ohio	Ichthyomyzon bdellium	S-ET
Lamprey, silver	Ichthyomyzon unicuspis	S-ET
Longperch, reticulate	Percina sp.	S-ET
Madtom	Notorus sp.	S-ET
Madtom, frecklebelly	Notorus munitus	S-ET
Madtom, mountain	Notorus eleutherus	S-ET
Madtom, neosho	Notorus placidus	S-ET
Madtom, northern	Notorus stigmosus	S-ET
Madtom, Scioto	Notorus trautmani	US-ET*
Madtom, yellowfin	Notorus flavipinnis	S-ET
Minnow, brassy	Hybognathus hankinsoni	S-ET
Minnow, loach	Tiaroga cobitus	S-ET
Minnow, Ozark	Dionda nubila	S-ET
Minnow, pugnose	Opsopoeodus emiliae	S-ET
Minnow, silverjaw	Ericymba buccata	S-ET
Minnow, tonguetied	Exoglossum laurae	S-ET
Minnow, eastern slim	Pimephales tenellus parviceps	S-ET
Mooneye	Hiodon tergisus	S-ET
Mudminnow, central	Umbra limi	S-ET
Muskellunge, Great Lakes	Esox masquinongy masquinongy	S-ET
Muskellunge, Ohio River	Esox masquinongy ohioensis	S-ET
Paddlefish	Polydon spathula	S-ET
Perch, trout	Percopsis omiscomaycus	S-ET
Pickeral, grass	Esox americanus vermiculatus	S-ET
Pike, blue	Stizostedion vitreum glaucum	US-ET*
Pirateperch	Aphredoderus sayanus	S-ET
Pumpkinseed	Lepomis gibbosus	S-ET
Pupfish, Comanche Springs	Cyprinodon elegans	US-ET*
Pupfish, Cottonball Marsh	Cyprinodon milleri	S-ET
Pupfish, Devil's Hole	Cyprinodon diabolis	US-ET*
Pupfish, Leon Springs	Cyprinodon bovinus	S-ET
Pupfish, Owens River	Cyprinodon radiosus	US-ET*
Pupfish, Tecopa	Cyprinodon nevandensis calidae	US-ET*
Pupfish, Warm Springs	Cyprinodon nevandensis pectoralis	US-ET
Redhorse, black	Moxostoma duquesnei	S-ET
Redhorse, greater	Moxostoma valenciennesi	S-ET
Redhorse, river	Moxostoma carinatum	S-ET
Sculpin, rough	Cottus asperrimus	S-ET
Sculpin, pygmy	Cottus pygmaeus	S-ET
Shad, Alabama	Alosa alabamae	S-ET
Shiner, beautiful	Notropis formosus	S-ET
Shiner, bigeye	Notropis boops	S-ET
Shiner, bigmouth	Notropis dorsalis	S-ET
Shiner, blacknose	Notropis heterolepis	S-ET
Shiner, bluehead	Notropis sp.	S-ET
Shiner, bluntnose	Notropis simus	S-ET
Shiner, Cahaba	Notropis sp.	S-ET
Shiner, ghost	Notropis buchanani	S-ET
Shiner, popeye	Notropis ariommus	S-ET

continued

continued

General Appendix B (concluded)

Common name	Scientific name	Key[a]
Fish (Continued)		
Shiner, proserpine	Notropis proserpinus	S-ET
Shiner, pugnose	Notropis anogenus	S-ET
Shiner, ribbon	Notropis fumeus	S-ET
Shiner, rosefin	Notropis ardens	S-ET
Shiner, sabine	Notropis sabinae	S-ET
Shiner, silver	Notropis photogenis	S-ET
Shiner, silverband	Notropis shumardi	S-ET
Shiner, Topeka	Notropis topeka	S-ET
Shiner, weed	Notropis texanus	S-ET
Silverside, Mississippi	Menidia audens	S-ET
Squawfish, Colorado River	Ptychocheilus lucius	US-ET*
Stickleback, brook	Culaea inconstans	S-ET
Stickleback, unarmored three-spined	Gasterosterus aculeatus williamsoni	US-ET*
Stoneroller, Mexican	Campostoma ornatum pricei	S-ET
Sturgeon	Scaphirhyncus sp.	S-ET
Sturgeon, Atlantic	Acipenser oxyrhynchus	S-ET
Sturgeon, lake	Acipenser fulvescens	S-ET
Sturgeon, pallid	Scaphirhynchus albus	S-ET
Sturgeon, shortnose	Acipenser brevirostrum	US-ET*
Sturgeon, shovelnose	Scaphirhyncus platorynchus	S-ET
Sucker, blue	Cycleptus elongatus	S-ET
Sucker, humpback	Xyrauchen texanus	S-ET
Sucker, longnose	Catostomus catostomus	S-ET
Sucker, Lost River	Catostomus luxatus	S-ET
Sucker, Modoc	Catostomus microps	S-ET
Sucker, razorback	Xyrauchen texanus	S-ET
Sucker, shortnose	Chasmistes brevirostris	S-ET
Sunfish, bantam	Lepomis symmetricus	S-ET
Sunfish, longear	Lepomis megalotis	S-ET
Sunfish, pygmy	Elassoma sp.	S-ET
Tomcod, Atlantic	Microgadus tomcod	S-ET
Topminnow, Barren's	Fundulus sp.	S-ET
Topminnow, Gila	Poeciliopsis occidentalis	US-ET*
Topminnow, plains	Fundulus sciadicus	S-ET
Topminnow, starhead	Fundulus notti	S-ET
Topminnow, Yaqui	Poeciliopsis occidentalis sonoriensis	S-ET
Trout, Arizona	Salmo apache	US-ET*
Trout, Gila	Salmo gilae	US-ET*
Trout, greenback cutthroat	Salmo clarki stomias	US-ET
Trout, Lahontan cutthroat	Salmo clarki henshawi	US-ET
Trout, Paiute cutthroat	Salmo clarki seleniris	US-ET
Trout, Utah cutthroat	Salmo clarki utah	S-ET
Whitefish, lake	Coregonus clupeaformis	S-ET
Woundfin	Plagopterus argentissimus	US-ET*

[a]The following key letters indicate where information concerning the wildlife species can be located.

- E - Eastern United States. See Figures 6.1, 6.2, and 6.3 for provinces and page numbers.
- W - Western United States. See Figures 6.1, 6.2, and 6.3 for provinces and page numbers.
- EW - Eastern and Western United States. See Figures 6.1, 6.2, and 6.3 for provinces and page numbers.
- E-NC - Eastern United States--probably not compatible with ROWs. See Figure 6.1A for provinces and status.
- W-NC - Western United States--probably not compatible with ROWs. See Figure 6.1A for provinces and status.
- EW-NC - Eastern and Western United States--probably not compatible with ROWs. See Figure 6.1A for provinces and status.
- US-ET - U.S. endangered/threatened fish. See Table 6.4 for range.
- S-ET - State endangered/threatened fish and wildlife. See Table 6.5 for States and status.
- T - Species is referred to in the text only.
- (N) - See Table 6.2N for the range and nesting habitat indicated by the following:
- N-GF - Ground nesting birds/fields, grasslands, pastures, tundra
- N-GL - Ground nesting birds/late succession types
- N-GW - Ground nesting birds/woodland edge
- N-ST - Shrub, small tree nesting birds
- N-LT - Large tree nesting birds
- N-CE - Cavity nesting birds/earth burrows
- N-CT - Cavity nesting birds/tree cavities
- N-WSm - Wetland nesting birds/saltwater - marsh, bay, tundra
- N-WFm - Wetland nesting birds/freshwater - marsh, bog, lake, pond
- N-WFr - Wetland nesting birds/freshwater - rivers, streams, creeks
- N-DC - Diving ducks - cavity nesters
- N-DG - Diving ducks - ground nesters
- N-SC - Surface (puddle) ducks - cavity nesters
- N-SG - Surface (puddle) ducks - ground nesters
- N-TD - Tree (whistling-) ducks
- (*) - An asterisk following key letters indicates that the species is also on a State endangered/threatened fish and wildlife list.

NOTE: The lists of State endangered/threatened species were used almost verbatim as received from the States. No attempt was made to reconcile all of the nomenclatural discrepancies present in these lists.

GENERAL APPENDIX C

Approximate Equivalents[a] of Decimals to Fractions and English to Metric Measurements and Temperatures[b]

Measurements						Temperatures	
English[c]	Metric	English	Metric	English	Metric	°F	°C
.02 (1/50) in	.5 mm	1 in	2.5 cm	25 ft	7.6 m	12	-11.1
.03 (1/32) in	.8 mm	2 in	5.1 cm	30 ft	9.1 m	16	-8.9
.04 (1/25) in	1.0 mm	3 in	7.6 cm	35 ft	10.7 m	20	-6.7
.05 (1/20) in	1.3 mm	4 in	10.2 cm	40 ft	12.2 m	24	-4.4
.06 (1/16) in	1.5 mm	5 in	12.7 cm	45 ft	13.7 m	28	-2.2
.07 (1/15) in	1.7 mm	6 in	15.2 cm	50 ft	15.2 m	32	0.0
.08 (1/12) in	2.1 mm	7 in	17.8 cm	55 ft	16.8 m	36	2.2
.09 (3/32) in	2.3 mm	8 in	20.3 cm	60 ft	18.3 m	40	4.4
.1 (1/10) in	2.5 mm	9 in	22.9 cm	65 ft	19.8 m	44	6.7
.13 (1/8) in	3.2 mm	10 in	25.4 cm	70 ft	21.3 m	48	8.9
.17 (1/6) in	4.3 mm	11 in	27.9 cm	75 ft	22.9 m	52	11.1
.2 (1/5) in	5.1 mm	1 ft	.3 m	80 ft	24.4 m	56	13.3
.25 (1/4) in	6.4 mm	2 ft	.6 m	85 ft	25.9 m	60	15.6
.28 (7/25) in	7.1 mm	3 ft	.9 m	90 ft	27.4 m	64	17.8
.33 (1/3) in	8.4 mm	4 ft	1.2 m	95 ft	29.0 m	68	20.0
.38 (3/8) in	9.6 mm	5 ft	1.5 m	100 ft	30.5 m	72	22.2
.4 (2/5) in	10.2 mm	6 ft	1.8 m	110 ft	33.5 m	76	24.4
.5 (1/2) in	12.7 mm	7 ft	2.1 m	120 ft	36.6 m	80	26.7
.6 (3/5) in	15.2 mm	8 ft	2.4 m	130 ft	39.6 m	84	28.9
.63 (5/8) in	15.9 mm	9 ft	2.7 m	140 ft	42.7 m	88	31.1
.67 (2/3) in	16.9 mm	10 ft	3.0 m	150 ft	45.7 m	92	33.3
.75 (3/4) in	19.1 mm	15 ft	4.6 m	175 ft	53.3 m	96	35.6
.8 (4/5) in	20.3 mm	20 ft	6.1 m	200 ft	61.0 m	100	37.8

[a]Exact equivalents can be found by using the following equations:

Decimals from fractions--Divide the upper numeral by the lower numeral. (Example: 3/8 = 3 ÷ 8 = .375)

Centimeters or millimeters from inches--(1 in = 2.54 cm or 25.4 mm). Multiply the number of inches by 2.54 for centimeters or 25.4 for millimeters. (Examples: 3 in = 3 x 2.54 = 7.62 cm; 3/5 in = .6 x 25.4 = 15.24 mm)

Meters or centimeters from feet--(1 ft = .3048 m or 30.48 cm). Multiply the number of feet by .3048 for meters or 30.48 for centimeters. (Examples: 30 ft = 30 x .3048 = 9.144 m; 2 ft = 2 x 30.48 = 60.96 cm)

Degrees Celsius from degrees Fahrenheit--(°C = (°F - 32) x 5/9). Subtract 32 from the degrees Fahrenheit and multiply by 5/9. (Example: 72°F - 32 x 5 ÷ 9 = 22.2222222°C) To find the equivalent of a number of degrees difference or change in temperature in Fahrenheit to the number of degrees difference in Celsius, multiply the Fahrenheit number by 5/9. Example: A temperature rise of 5°F = a rise of about 2.8°C--5 x 5 ÷ 9 = 2.7777777)

[b]Abbreviations used in this table are:

in--inch(es)
ft--foot (feet)
mm--millimeter(s)
cm--centimeter(s)
m--meter(s)
°F--degrees Fahrenheit
°C--degrees Celsius

[c]Fractional equivalents of decimals are shown in parenthesis with inches and the metric equivalent of that fraction of an inch, since most decimals were used with inches in the text.

Glossary

achene A one-seeded, dry, indehiscent fruit with seed attached to fruit wall at one point only, derived from a superior ovary.

acorn The fruit of the oak; a nut in a hardened scaly cup.

aggregate fruit A group of separate fruits developed from one flower.

allelopathic inhibition The influence of one living plant upon another due to secretion of toxic substances.

alluvial soil A soil, recently deposited by running water, showing practically no horizon development (save A1 formation) or other modification.

alternating current (AC) A current that reverses direction in regular cycles.

altricial Referring to those birds that after hatching are helpless and require parental care for a period of time.

annual Living one year.

anthesis The time when the flower expands and opens or the process of expansion and opening.

anthocarp Structure in which fruit is united with perianth or receptacle.

apical dominance The upward growth of terminal shoot meristems that inhibits the growth of underlying lateral buds.

awn A bristle-shaped appendage at the end or on the back or edge of an organ.

axil The angle formed between a plant axis and any organ developing from it (e.g., a leaf axil).

barrier effect The inhibition of the movement or reproductive behavior of an endangered species when its habitat is fragmented by a ROW.

basal leaves With branches from ground level.

bench Level or gently sloping land surrounded by steeper slopes above and below it.

berry Fleshy fruit.

biennial Living two years; usually flowering the second year.

bifid Forked; that is, having two equal parts.

bipinnate A leaf two times pinnately compounded.

blowdown An area where wind has blown over all tall-growing vegetation.

bog An extremely wet, poorly drained area characterized by a floating, spongy mat of vegetation, composed of sphagnum, sedges, and heaths.

bract Modified leaf found in the inflorescence.

browse Leaves, stems, twigs, bark, and wood of woody plants consumed by animals.

bulb A short, erect, underground stem surrounded by fleshy leaves.

bur Any rough or prickly involucre or pericarp.

cabling A vegetation maintenance technique in which a 150 foot to 200 foot 1.5 inch cable is dragged between two tractors to break off or uproot plants.

caespitose See "cespitose."

calcareous soils Of soils made alkaline by calcium carbonate or calcium magnesium bicarbonate.

callus Wound tissue. Generally, soft parenchymatous tissue that develops after the wounding of a plant, tending to cover the wound. Specifically, a caplike mass of callose that covers the sieve plates of nonfunctioning sieve tubes.

calyx The outermost layer of modified leaves, sepals.

canopy A network of the uppermost branches of a forest which partially or fully cover the understory.

capsule A dry, dehiscent fruit derived from a two or more carpelled ovary.

carpellate Plant with female or pistillate flowers.

caryopsis A one-seeded, dry, indehiscent fruit with the seed coat attached to the fruit wall.

cauline Leaves more or less distributed evenly on a stem.

cespitose Short, much-branched; a plant forming a cushion.

chaining A vegetation maintenance technique in which a heavy anchor chain is dragged between two tractors to break off or uproot plants.

chipping A process of slash disposal in which a machine is used to grind up large pieces of wood into small chips.

circuit, double Referring to a transmission line that has two separate circuits (each with three phases).

circuit, single Referring to a transmission line that has only one electrical circuit consisting of three phases.

clear cut Removal of all trees in an area in one cutting operation.

coalesce To grow together or into one body.

coalescent The union of similar parts (e.g., the petals of a flower).

coma A tuft of hairs especially at the tips of seeds.

community An assemblage of animal and plant populations that live together in a prescribed area or habitat.

compaction Firm, concentrated soil caused by pressure on top layers (e.g., bulldozing).

composites Members of the plant family Compositae (Asteraceae).

conductor A substance, body, or device that readily conducts heat, electricity, sound, etc.

cone The reproductive structure of pine, fir, and other conifers, consisting of an axis to which are attached many woody, overlapping scales which bear seeds.

conifer (coniferous) Cone-bearing.

continental Having large annual and daily ranges in temperature.

cordate Of a conventional heart shape.

corm The enlarged, solid, fleshy base of a stem with scales; an upright underground storage stem.

corolla The whorl of petals above the sepals.

corymb A flat-topped or convex indeterminate cluster of flowers.

cover Plants or objects used by wildlife for protection from predators and adverse weather and for rearing their young.

cover type The dominant plant type covering an area (e.g., aspen cover type).

culm A stem of a grass (e.g., bamboo); sometimes a sedge that is typically hollow between nodes.

culvert A drainage device designed to prevent erosion near roads.

cuneate Obitriangular; inversely triangular.

danger tree Any tree adjacent to a transmission line right-of-way that could fall into or otherwise endanger the line.

dieback A diseased condition of the peripheral, aboveground structures of woody plants caused by parasites or other agents (e.g., winter injury).

deciduous Of any plant organ or group of organs that is shed naturally — leaf-losing. Of perennial plants that are normally leafless for some time during the year.

decumbent Reclining or lying on the ground with the tips ascending.

deer yard An area of heavy cover where deer congregate in winter for food and shelter.

dehiscent Opening regularly by valves, slits, etc., as a capsule or anther.

deltoid Triangular in shape.

dentate Toothed; referring to margins of leaves.

den tree A tree, either hollow or having holes, that is utilized by various animals for cover and nesting.
digitate Several members arising from the summit of support. Said especially of spikes from the summit of a stalk of clustered flowers.
dioecious Unisexual flowers; having the staminate and pistillate on different plants. Also refers to gymnosperms with pollen and seed cones on different individuals.
direct current (DC) Electric current with no change in the direction of electron flow and with only slightly varied magnitude.
disking A vegetation maintenance technique that cuts, lifts, and inverts vegetation while scarifying the soil.
diurnal Active during the day.
drupe (druplet) A fleshy fruit with a stony endocarp. A druplet is a small drupe.

ecological characteristics The basic information about a species, including distribution, habitat, reproduction, growth characteristics and needs, and responses to habitat changes.
ecosystem The interaction of a community of living organisms with their nonliving surroundings.
ecotone The transition zone between two or more biotic communities (e.g., the ecotone between forest and prairie).
edge The transition zone between two or more vegetation types (i.e., the edge between a field and a forest).
ellipsoid Solidly-shaped, with an elliptical outline.
elliptic With widest axis at midpoint of structure and with margins symmetrically curved.
endangered species A species whose chances for survival are in immediate danger.
Endangered Species Act of 1973—PL93-205; 87 Stat. 884 A law providing a means to protect and conserve endangered or threatened species and their habitats.
endemic Native to a particular region.
epiphyte A plant growing on, but not nourished by, another plant.
epicormic Growing from a dormant bud exposed to light and air.
exotic species A species not native to a geographical area in which it is found.

fascicle A bundle or cluster of flowers.
feral Having reverted to a wild state after being domesticated at one time (e.g., feral hogs).
filter strip A protective area of absorbent, undisturbed soil between access roads and streams, preventing runoff.
flashover A sudden electrical surge between two conductors that causes an arc.
flats Level tracts of land with little or no relief.
follicle A dry, dehiscent fruit derived from one carpel that splits along a suture.
forage All plants available to wildlife or livestock for feeding.
fronds Leaves of a fern.
fuelbreak A cleared strip in a wooded area that serves as a line of fire defense.
furbearer A mammal commonly harvested for its hide.
fusiform In spindle shape; that is, widest at the middle and tapering gradually to each pointed end, the body being circular in cross-section.

gestation The length of time from conception to birth.
girdling The act of encircling a tree with cuts through the cambium layer to kill the tree.
glabrous Smooth; not hairy.
glacial drift A deposit of soils and minerals transported by a glacier.
glacial till A clay subsoil originally transported and deposited by a glacier.
glandular hairs Hair-bearing glands or glandlike appendages.
globose Spherical, globular.
glumes Bracts, usually occurring in pairs, at the base of a grass spikelet.
grading A restoration method to return soil to its original contour on construction sites that will no longer be used.
habit Characteristic mode of growth or occurrence in plants.
habitat An area where an organism and all its life requirements can be found; the natural environment of a plant or animal.
halophyte A plant that is more or less restricted to saline soil or to sites that are influenced by salt water.
heath layer A layer of vegetation consisting of members of the Ericaceae.
hinge-cutting The act of cutting through a tree trunk enough to fell it but leave a strip of wood and bark attached.
home range The area within which an animal commonly travels to find all its life requirements.
hummock A round, conical hollock or knoll; a slight rise in ground-level.
indehiscent Not opening by valves, or any other means; persistently closed.
inflorescence The flowering part of a plant, and especially the mode of its movement.
insectivorous Adapted to feeding on insects.
insulator A material of such low conductivity that the flow of current through it can usually be neglected.
interspersion The actual mixing of habitat types at an edge.
involute Having edges rolled inward over upper surface.
kilovolt (kV) A unit of electromotive force equal to 1000 volts.
lanceolate Lance-shaped; about 4 times as long as wide and broadest below or about the middle.
lacustrine Relating to or formed in lakes.
leaflet A distinct and separate segment of a leaf.
legume A usually dry, dehiscent fruit derived from one carpel that splits along two sutures.
lemmas Outer scales subtending a grass floret.
lenticular Lens-shaped; biconvex.
ligulate Having a tonguelike outgrowth at the base of blade or top of sheath.
loam A soil consisting of an easily crumbled mixture of clay, sand, and silt.
locule Compartment of an anther; ovary cavity.
loess A loam mixture, ranging from clay to fine sand with calcareous elements, that is extensively prevalent in the Continental U.S.
marsh A low, treeless, wet area, characterized by sedges, rushes, and cattails.
mericarp A portion of fruit that seemingly matured as a separate fruit.
metamorphic Changing mineral constitution; compact, highly crystalline.
moraines A deposit of glacial drift at the foot or sides or along the bottom of a glacier; typically ridges of irregular form, save for the ground moraine which is gently rolling or hummocky, and composed largely of till.
muck farm A cultivated area of wet, fertile soil marked by the presence of decaying plant matter.
muskegs A tract of partly forested peatland supporting mosses (typically sphagnum), shrubby plants, and scattered spruce and larch.
nocturnal Active at night.
oblanceolate Lanceolate with the broadest part toward the apex.
obovate Inversely ovate.
obovoid Having the form of an egg with the broad end apical.
omnivore An animal that eats both plant and animal matter.
oolitic Consisting of calcareous, granular limestone; sometimes containing silica or iron oxide.
orbicular Circular.
outwash Soils and minerals transported down slopes by rainwater to settle on adjacent lower land.
ovate With widest axis below middle and with margins symmetrically curved; egg-shaped.
ovoid fruit Fruit having an oval or ovate body.

palatability The degree of desirability of a plant as food to an animal.
palmately compound Leaflets arising from one point at end of a petiole.
panicle Branched inflorescence with clusters of flowers.
papilla A minute, nipple-shaped projection.
pappus Bristly or scaly calyx in composites.
parasitic Growing on and deriving nourishment from another organism.
perennial Living more than two years.
perianth In angiosperms, the floral envelope generally differentiated into a calyx (an outer layer of sepals) and a corolla (an inner ring of petals).
pericarp Fruit wall.
perigynium Fused scales, a sac, around the pistil or ovary.
petiolate With a petiole or leaf stalk.
phloem The tissues of the inner bark, characterized by the presence of sieve tubes and serving for the transport of foodstuffs.
pinnate Leaflets arranged along a common axis, the rachis.
pneumatophores Submerged or exposed roots that have a respiratory function.
pocosin An upland swamp of the southeast coastal plain.
pod A dry, dehiscent fruit.
Podzolic Refers to soils that are matted at the surface; developed in a moist climate with coniferous and other vegetative influences.
pome A fleshy fruit derived from an inferior compound ovary and receptacle.
precocial Referring to those birds that are active and able to move about at an early age.
prescribed burn Intentional burning of an area under selected fuel, moisture, and wind conditions to be able to contain the fire to a desired area and intensity.
prickles Sharp-pointed projections from the epidermis or cortex of any organ.
prostrate Trailing or lying flat, not rooting at the nodes.
puberulent Covered with soft, minute hairs.
pubescent Covered with dense or scattered hairs.
pyriform Pear-shaped.
raceme Unbranched, indeterminate inflorescence with clusters of flowers.
rachis The elongated axis of an inflorescence.
rating The operating limit of a conductor, expressed in voltage frequency.
reniform Kidney-shaped.
resistance That property of a conductor in virtue of which the passage of a current is opposed, causing electric energy to be transformed into heat.
reticulate With veins forming a network.
revolute With the margins or the tip rolled backward.
rhizome (rhizomatous) A stem, generally modified (particularly for storing food materials), that grows below the ground surface and produces adventitious roots, scale leaves, and suckers irregularly along its length, not just at nodes.
riparian Relating to or bordering a natural waterway.
roller chopping A maintenance method creating minimum slash and disturbance by flattening and cutting smaller vegetation with a blade mounted on metal drums.
root revetment An underground network of roots that sustains a stream embankment, preventing erosion.
root sucker A shoot arising horizontally from a root below ground level.
rootstock A root-bearing plant or plant part, generally a stem or root, onto which another plant part is grafted; or, the collective roots in a stand, capable of sprouting.
rosulate Leaves from a cluster (rosette) developed in a crowded crown of circles or spirals.
samara A winged, dry fruit.
savanna Essentially lowland, tropical and subtropical grassland, with a scattering of trees and shrubs.
scabrous Covered with rough projections, harsh to touch.
scalping A maintenance method that uses a heavy blade to scrape the plants and topsoil layer off a site.
scapes Naked, or lightly scaled, flowering stems arising from the ground.
scarify To break or loosen hard ground.
scarious Thin and dry, appearing shriveled.
scat Animal fecal matter.
schizocarp A dry fruit with the carpels separating at maturity.
selective cut Removal of trees with certain specific qualities such as those of a given species or size.
semimarine Referring to a climate controlled by oceanic winds and air masses with a relatively limited range in temperature and high humidity.
sepal One of the flower parts of an outer series forming a calyx.
serrate Saw-toothed; teeth sharp and ascending, with a 1/16 to 1/8 inch distance to midrib or midvein.
sessile Without a petiole or leaf stalk.
shelterbelt A strip of tall-growing plants planted or left standing in prairie areas to help reduce wind erosion of topsoil.
silicle A dry, dehiscent fruit derived from two or more carpels that dehisce along two sutures and which has a persistent partition after dehiscence and is as broad or broader than long.
silique A silicle-type fruit that is longer than broad.
slash Woody material left after a cutting operation.
snag A standing dead tree from which most of the branches have fallen.
spadix Unbranched, indeterminate inflorescence with flowers embedded in the rachis.
spathe A sheathing leaf subtending or enclosing an inflorescence.
spathulate Oblong or obovate apically with a long attenuate base.
species A group of individuals reproductively isolated from other groups of individuals under natural conditions.
spicate Arranged in or resembling a spike.
spikelets Small spikes; the basic inflorescence unit in grasses and sedges.
sporangium Spore sac; a structure containing spores.
spore A reproductive body, characteristic of the lower plants, consisting of one or a few cells and never containing an embryo.
staghead The leafless or dead uppermost branches of a tree.
static or ground wire A lead from an electrical apparatus to the ground or to a grounded connnection.
stellate Star-shaped.
stipules Paired scales, spines, glands, or bladelike structures at the base of a petiole.
stolon (stoloniferous) A stem or branch from a base plant that grows along or down to the ground surface, taking root at its nodes.
strobilus Stem with short internodes and spore-bearing appendages.
subherbaceous Slightly having the characteristics of an herb, somewhat leaflike in color and texture.
subsidence Flattened soil caused by pressure on top layers (e.g., bulldozing).
succulent Juicy, fresh.
sunscald Injury of woody plants caused by intense summer heat and light, characterized by local tissue death and occasionally, cankers.
swamp A wet area that usually has standing trees.
tableland A broad, elevated plain; plateau; mesa.
threatened species Likely to become endangered in the near future.
trifoliate Three leaflets, pinnately compounded with terminal leaflets longer than lateral; palmately compounded with leaflets equal in length.
trigonous Three-angled.
trilocular Having three loculi chambers or cells.
tripinnate Referring to a leaf compounded three times.

tubercle A small tuber or tuberlike body, often due to symbiotic relation of organisms.

tufted Formed into a tuft or cluster of short-stalked flowers, leaves, or other vegetation, growing from a common point.

tuberoid roots Fleshy, thickened roots, resembling a tuber.

umbels Flat-topped or convex inflorescence with the flower stalks arising from a common point.

understory Foilage consisting of seedlings, shrubs, or herbs that lies beneath and is shaded by canopy or taller plants.

ungulate A hoofed mammal.

utricle A small, bladdery or inflated, one-seeded, dry fruit.

villous Having long and soft (not interwoven) hairs.

voltage Electromotive force, expressed in volts (v).

wetland Any area where the water table is near or above the surface of the land during a significant part of the year.

whorl A group of leaves or other structures at a single node.

wildlife All nondomesticated animals living in a natural environment.

windthrow Uprooting and inversion of trees by strong winds.

wolf tree A tree of dominant size and position that usurps light and space from smaller understory, preventing its growth.

xeric Low or deficient in moisture for the support of plant life.

xerophyte A plant with the adapted structures for survival in a xeric or highly acid or saline environment (e.g., epidermal thickening, dense pubescence, resinous coating).

Subject Index, by Section Number, for Volume 1

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