FIRE MANAGEMENT PLAN

LEE METCALF NATIONAL WILDLIFE REFUGE
U.S. FISH AND WILDLIFE SERVICE

Stevensville, Montana

September 17, 2001

Prepared by: _____
Assistant Refuge Manager, Date
Lee Metcalf National Wildlife Refuge

Recommended by: _____
Project Leader, Date
Lee Metcalf National Wildlife Refuge

Reviewed by: _____
Prescribed Fire Specialist, Date
Mountain-Prairie Region

Concurred by: _____
Regional Fire Management Coordinator, Date
Mountain-Prairie Region

Concurred by: _____
Geographical Associate Regional Director, Date
Northern Ecosystems

Approved by: _____
Regional Director, Date
Mountain-Prairie Region

Table of Contents

I. INTRODUCTION

A. Description of Lee Metcalf National Wildlife Refuge 1
B. Climate 4
C. Soils 4
D. Vegetation 4
E. Wildlife 6
F. Threatened and Endangered Species 8
G. Cultural Resources and Improvements 8
H. Socio-Political and Economic Resources 10
I. Wilderness 10
J. Air Quality/Smoke Management 10
K. History and Effects of Fire 11

II. POLICY COMPLIANCE - GOALS AND OBJECTIVES

A. Compliance with Service Policy 14
B. NEPA Compliance 14
C. Authorities for Implementation 14
D. Other Regulatory Concerns 15
E. Enabling Legislation and Purpose 15
F. Overview of Planning Documents 15
G. Land Management Goals and Objectives 17

III. REFUGE FIRE MANAGEMENT OBJECTIVE 18

IV. FIRE MANAGEMENT STRATEGIES

A. Wildfire Prevention 19
B. Wildfire Suppression 20

V. FIRE MANAGEMENT RESPONSIBILITIES

A. Refuge Staff Responsibilities 25
B. Cooperator Involvement 26

VI. FIRE SEASON

A. Refuge Wildfire Frequency 28
B. Refuge Fire Season 28

VII. EQUIPMENT AND STAFFING NEEDS

A. Normal Unit Strength 29

VIII. PREPAREDNESS

A. Training and Qualifications 32
B. Annual Refuge Fire Management Activities 33
C. Impacts of Drought and Other Impacts on Station Activities 34
D. Severity and Emergency Presuppression Funding 35

IX. WILDFIRE PROGRAM 36

A. Special Safety Concerns 36
B. Prevention Program 36
C. Detection 37
D. Suppression 38
E. Minimum Impact Strategies and Limits of Suppression Activities 40
F. Extended Attack 41
G. Mop Up Standards and Emergency Stabilization and Rehabilitation 41
H. Refuge Specific Rehabilitation Guidelines 42

X. PRESCRIBED FIRE PROGRAM 42

XI. FIRE MANAGEMENT UNITS

A. Description of Fire Management Units 43
B. Fuels and Expected Behavior 44
C. Special Conditions and Trigger Points 44
D. Effects of Fire on Vegetation 45
E. Special Concerns 45

XII. ADDITIONAL OPERATIONAL ELEMENTS

A. Public Safety 46
B. Public Education and Information 46
C. Fire Critique and Annual Fire Plan Review 47

XIII. AIR QUALITY AND SMOKE MANAGEMENT GUIDELINES 48

XIV. FIRE RESEARCH NEEDS 49

XV. CONSULTATION AND COORDINATION 50

XVI. LITERATURE CITED 51

APPENDICES

Appendix A	Lee Metcalf National Wildlife Refuge Background and Operating Statements
Appendix B	Letter from Montana Department of Natural Resources and Conservation and Statewide Annual Operating Plan
Appendix C	Real Property Inventory
Appendix D	Plant species mentioned in the Fire Management Plan.
Appendix E	Lee Metcalf National Wildlife Refuge Wildlife List
Appendix F	Montana Smoke Management Memorandum of Understanding
Appendix G	Southwest Montana Area Fire Restriction and Closure Plan
Appendix H	Current Fire Staff and Employee Contact List
Appendix I	Physical Fitness Standards and PAR-Q Health Screening Questionnaire
Appendix J	Step-Up Plan
Appendix K	Communication Plan
Appendix L	Wildland Fire Situation Analysis (WFSA)
Appendix M	BEHAVE Computerized Fire Prediction Model Description
Appendix N	Fire Effects on Predominant Plant Species at Lee Metcalf National Wildlife Refuge

LIST OF FIGURES

Figure 1:	Area and vicinity map of Lee Metcalf National Wildlife Refuge.	2
Figure 2:	Fire management units on Lee Metcalf National Wildlife Refuge.	9
Figure 3:	Initial reporting and dispatching procedures for responding to a wildfire on Lee Metcalf National Wildlife Refuge.	22
Figure 4:	Roads and buildings on Lee Metcalf National Wildlife Refuge.	23

LIST OF TABLES

Table 1	General habitat types, fuel models, and their acreage on Lee Metcalf National Wildlife Refuge.
Table 2	Prescribed fire history on Lee Metcalf National Wildlife Refuge (1987-2001).
Table 3	Land management goals identified in the Lee Metcalf National Wildlife Refuge Operating Statement.
Table 4	Wildfire prevention measures to be implemented on Lee Metcalf National Wildlife Refuge.
Table 5	Responsibilities of fire management team members at Lee Metcalf National Wildlife Refuge.
Table 6	Recommended Fire Management Staffing Levels
Table 7	Fire-fighting equipment at Lee Metcalf National Wildlife Refuge.
Table 8	Other equipment available for fire suppression or prescribed fire operations.
Table 9	Annual Refuge fire management activities by month.
Table 10	Appropriate management response to wildfires on Lee Metcalf National Wildlife Refuge.
Table 11	Fire Management units by acreage and fuel model.
Table 12	Criteria for fire restrictions and closures under the southwest Montana area fire restriction and closure plan (Appendix G).

I. INTRODUCTION

This plan was written to help achieve resource management objectives for Lee Metcalf National Wildlife Refuge (Refuge) as defined in the Refuge Operating Statement (**Appendix A**) and other established operational plans. This plan replaces a fire management plan drafted and approved in 1985. The U.S. Fish and Wildlife Service (Service) requires a fire management plan be in place for all of its management units with burnable vegetation. This plan meets the requirements of this Service mandate.

The Refuge was established in December 1963, under authority of the Migratory Bird Conservation Act (16 USC 661-667e), with State of Montana approval under provisions of PL 87-383 (75 Stat. 813) for use as an inviolate sanctuary, or for any other management purpose, for migratory birds. Purposes defined under the Refuge Recreation Act (16 USC 460k-1) also include: 1) incidental fish and wildlife-oriented recreational development, 2) the protection of natural resources, and 3) the conservation of endangered and threatened species.

Under an agreement with the Montana Department of Natural Resources and Conservation (**Appendix B**), the state assumes suppression responsibility for wildfires that occur on the Refuge. In return, the Service agrees to protect state lands and inholding as specified in the vicinity of Charles M. Russell National Wildlife Refuge.

A. Description of the Refuge

The Refuge is a 2,797-acre parcel in the heart of the Bitterroot Valley of western Montana at an elevation of 3,250 feet MSL (**Figure 1**). Topography is flat to gently sloping. The Bitterroot River borders the Refuge on the west. To the east, the Refuge is bordered by residential and agricultural properties, and the Montana Rail Link right-of-way. There is an 80-acre inholding managed as a privately owned golf course.

The Refuge was established in 1963. At that time, most of the properties acquired to create the Refuge were dairy farms and farm lands. Prior to Service acquisition, vegetation had been heavily grazed and converted from ponderosa parklands, riparian areas, and cool-season bunchgrasses to tame grass pastures. Following acquisition, the area underwent extensive excavation to create a series of impoundments for migratory bird habitat. Habitat types can be broken into five major categories and three fuel types (**Table 1**): forest, uplands, cropland, semi-permanent wetland, and floodplain/wet-meadow.

Figure 1. Area and Vicinity Map

Table 1. General habitat types, fuel models, and their acreage on Lee Metcalf National Wildlife Refuge.

Habitat Type	Fire Behavior Fuel Model (Anderson 1982)	NFDRS Fuel Model (Anderson 1982)	Acres
Forest	2 - Timber	C - Open Pine w/ Grass	1,255
Upland (Sparse Cover)	1 - Short Grass	A - Annuals L - Perennials	202
Upland (Heavy Cover)	3 - Tall Grass	N- Sawgrass	100
Cropland	1 - Short Grass	A - Annuals L - Perennials	240
Semi-permanent Wetland	N/A Open Water		500
Semi-permanent Wetland (Cattails)	3 - Tall Grass	N - Sawgrass	100
Wet Meadow/Floodplain	1 - Short Grass	A - Annuals P - Perennials	400
Total			2,797

The Bitterroot Valley contains a human population between 35,000 and 40,000 and the adjacent Missoula area is home to an additional 75,000. Suburban sprawl has surrounded the Refuge in recent years, so that risks to private property from fires originating on the Refuge have increased tremendously. This suburban interface also increases the potential for fires starting on private land (e.g. barbeques, leaf burning, etc.) to spread to the Refuge and threaten wildlife habitat and recreational resources. The black cottonwood, ponderosa pine association along the Bitterroot River, like most western riparian areas, is an important resource area for many species of migratory birds and resident wildlife. The advanced age of the cottonwoods in most of these areas makes the riparian area susceptible to destruction by fire (Hansen et al. 1995). Protection of large trees on the Refuge is a priority, since they provide nesting habitat bald eagles and a variety of migratory birds, including osprey, several neotropical migrant species, and a number of cavity-nesting species. The Refuge contains the historic Whaley Homestead (circa 1877) and its associated structures, which must be protected from fire. Other structures that require fire protection include the white barn, shop building complex and house trailer, Refuge residential quarters, pole barn, environmental education pavilion, fishing deck, signs, kiosks, outhouses, and related public use facilities. The Refuge's inventory (**Appendix C**) lists all structures and other real property, including those that could be destroyed by fire.

B. Climate

The Bitterroot Valley's climate is typical of the northern Rocky Mountains. The average monthly temperature is 44.6 ^{o}F. Winters are often milder than east of the continental divide; the season is generally marked by repeated freezing and thawing. Influences from Pacific weather systems maintain cloud cover during much of the winter. Annual precipitation is a scarce 12.5 inches, about half of which falls as snow. However, evaporation is relatively low, and the Bitterroot Valley is watered by numerous tributaries and hundreds of miles of irrigation ditches.

C. Soils

Approximately 50% of the Refuge soils are excessively drained. These soils tend to be shallow and are over a gravel substrate (chamokane and loamy-sand). Thirty percent of the Refuge contains shallow soils of flood plains (chamokane complex). About 10% of the area's soils are moderately well-drained (slocum loam and slocum snady loam). The final 10% of the soils are imperfectly drained or poorly drained soils found in marshy areas (USDA Soil Conservation Service 1951).

D. Vegetation

Habitats represented on the Refuge include 1,255 acres of black cottonwood riparian forest and ponderosa pine forest, 600 acres of semi-permanent wetlands, 240 acres of croplands, 302 acres of arid cool-season grasslands and uplands, and 400 acres of wet meadow and floodplain. Semi-permanent wetland and wet meadows provide extensive fire breaks throughout the Refuge. However, fuel loading in some areas of the riparian zone is heavy due to the advanced age of the cottonwood stands, and the quantity of dead and down timber. Heavy understories of reed canary grass and smooth brome in many parts of the riparian area makes fire danger extreme during late summer and fall. Plant species mentioned in the plan are listed in **Appendix D**.

1. Forested Areas

Forested areas on the Refuge are best described as a *Populus trichocarpa*/Herbaceous Community Type (Hansen et al. 1995). On the Refuge, this type is dominated by black cottonwoods in mid- to late-seral stages. Mid-seral stages occur along the Bitterroot River and are characterized by mature black cottonwoods, herbaceous understory of introduced grasses and forbs, and some shrubs (primarily *Rosa woodsii*). The riparian understory was heavily grazed until the late 1970s. As a result, some native understory plants such as red-osier dogwood and hawthorne have been replaced by more grazing tolerant forms such as rose and snowberry. Late seral stages characterize old oxbows, forested areas further from the Bitterroot River, and the borders of semipermanent wetlands such as Pond 8 and Pond 10. In this stage, mature and dying cottonwoods are being or have been replaced by ponderosa pine and an mostly herbaceous understory. Primary succession toward the ponderosa pine forest will continue unless flooding creates new sediments suitable for cottonwood seedlings.

2. Uplands

Native cool-season grasslands were converted to introduced pasture grasses such as Kentucky bluegrass and smooth brome prior to Service acquisition. Most upland tracts contain widespread infestations of noxious weeds and invasive plants such as spotted knapweed, musk thistle, bull thistle, oxeye daisy and cheatgrass. Infestations of leafy spurge, houndstongue, Canada thistle, sulphur cinquefoil, and St. Johnswort occur in some areas. Much of the upland acreage contains sparse herbaceous cover over gravelly streambed deposits. These areas are rarely capable of sustaining a fire. Some upland areas, particularly those adjacent to irrigation ditches and wetlands, contain patches or even large areas of fuel models 3 and 1 that can rapidly carry a fire when cured and dry.

Effects of Fire on Uplands: Invasive and noxious weeds are a severe threat to wildlife habitat in western Montana. Much of the Refuge has extensive seed banks of noxious weeds such a spotted knapweed, bull thistle, Canada thistle, hound's tongue, and tansy. Experience has shown that burning during the "safe" prescribed burn period (March & April) tends to invigorate these weeds to the detriment of the existing cool-season grass species.

3. Croplands

Croplands are managed in a five year rotation so that each field is planted to a tame grass/forb mixture for four years and then planted to small grain crop the fifth year. These areas are not likely to carry a fire as they are irrigated prior to July 15 and are generally cut or harvested before high fire danger periods in late summer and fall.

4. Semi-Permanent Wetlands

These areas contain open water areas that serve as a fire break throughout the Refuge, but also contain cattails (fuel model 3) which are extremely flammable except when green or wet. In many areas of the Refuge, the cattails are interspersed with forested areas that are extremely flammable during high fire danger periods in late summer and fall.

5. Wet Meadow/Floodplain

These areas consist mainly of sedge meadows (fuel model 1) that are wet for several months of the year. During the early part of the growing season, these areas are unlikely to burn. However, in dry years, they cure out by late summer and are flammable during high fire danger in later summer and fall.

E. Wildlife

1. Birds

A total of 235 bird species have been recorded on the Refuge (**Appendix E**). The Refuge supports up to 106 species of breeding birds, including a pair of nesting bald eagles (a threatened species). Peregrine falcons use the Refuge sporadically spring and fall, mostly as a hunting area. Ten to 20 pair of breeding osprey use the Refuge from April through September. The Refuge provides important riparian habitat for breeding and migrating birds, including neotropical migrants and many cavity nesters, and provides important feeding and resting sites for migrating and wintering waterfowl.

2. Mammals

The Refuge wildlife list (**Appendix E**) contains documented and theoretically present mammals. The Refuge provides habitat for 100-300 white-tailed deer, occasional moose, black bear, bobcat, and puma, as well as many small mammal species common to the area. Native mammals historically present in the but now absent include elk (except occasionally

in winter), grizzly bears, wolves, wolverine, and badger.

3. Fish, Reptiles & Amphibians

The Refuge hosts several native and exotic fish species, including breeding populations of large-mouth bass and pumpkinseeds. Five reptile species have been confirmed on the Refuge, as well as three native and one exotic amphibian species (**Appendix E**).

4. Invertebrates

Refuge wetlands contain healthy populations of aquatic invertebrates. More information is needed on terrestrial insect populations. The Refuge hosts at least 40 species of butterflies including a small population of bronze coppers (*Lycaena hyllus*). While this species is not listed as federally threatened or endangered and does not appear on any sensitive species list in Montana, it is unusual and its host plants (*Rumex spp.*) should be protected. The southern portion of the Refuge hosts two species of introduced biological control insects that are the subject of ongoing research by Montana State University Western Agricultural Research Center. The research areas should not be subjected to perturbations such as prescribed burns and should be protected from wildfire.

5. Effects of Fire on Wildlife

Effects of fire on wildlife vary widely depending on species habitat requirements. In general, species that require riparian forest for all or part of their life cycle will be negatively impacted by a catastrophic, stand-replacing fire. This category includes many neotropical and short-distance migrant passerine birds that breed in the riparian forests on the Refuge and several orders of cavity-nesting birds.

Species that rely solely on open water, grasslands, wetlands or use the Refuge only as a migratory stopover would not be significantly impacted or would be impacted only in the short-term. Habitat generalists will also be impacted only in the short-term. However, burning uplands and wetlands during the breeding season of ground and wetland-nesting birds should be avoided whenever possible. Historically, most natural fires probably took place August through October, after most birds have completed their breeding cycle.

The seasonality of fire is an important determining factor for some species. Long-toed salamander populations could be devastated by a stand-replacing fire in spring or summer when they inhabit logs, but probably would not be impacted during late fall or winter when

salamanders have moved underground.

F. Threatened and Endangered Species

The Refuge contains the only successful bald eagle nest in the Bitterroot Valley. The nest has been active since 1990, and has occupied three different trees in the vicinity of Pond 10. In order to protect this important resource, the nesting area should be protected from wildfire and should not be subjected to prescribed fire. During the sensitive nesting period between February 1 and August 15 (USDI Bureau of Reclamation, 1994), the dike road north of Pond 10 (MacDonald Pond) should not be used to access a wildfire unless absolutely necessary.

G. Cultural Resources and Improvements

The Refuge contains a number of service buildings, historic buildings, two residences, fences, bridges, signs, outhouses, kiosks, hunting blinds, a pavilion, and an accessible fishing deck that could be damaged or destroyed by fire (**Appendix C**). The total cost of all real property that could be damaged or destroyed by fire is $3,345,260 (2001 projections).

Effects of Fire on Improvements and Cultural Resources

Structures and improvements can obviously be damaged or destroyed by fire. Primary locations of these resources are identified as Fire Management Units (FMU) on **Figure 2**. Wildfires suppression will be emphasized in areas where these resources occur.

Figure 2. Fire management units.

H. Socio-Political and Economic Resources

The Refuge receives approximately 150,000 visitors a year. These include students and teachers participating in environmental education activities, local and out of state hunters and fishermen, bird-watchers, photographers, and other recreationalists. The ever-increasing number of visitors has a positive impact on the local economy because visitors also patronize local businesses.

The intrinsic scenic value of the Refuge also increases property values for adjacent private landowners. These properties command premium prices for the privilege of neighboring a parcel that is both scenic and protected from development.

Extensive damage to forested areas of the Refuge resources would decrease these values because important wildlife habitat would be lost for many years. However, short-term visitation would probably increase slightly immediately following such a fire. Fire events in areas of the Refuge dominated by herbaceous vegetation will have less effect, as vegetation can recover within one growing season.

I. Wilderness

There are no designated wilderness areas located within the Refuge.

J. Air Quality/Smoke Management

Due to air quality concerns, burning in western Montana is by permit only except for the period March 1 - August 31. Because of the close proximity of the Refuge to two state/federal highways and many residential areas, burning should only take place if weather conditions allow quick dispersal of smoke.

The Service is part of a number of agencies and organizations that form the Montana State Airshed Group. This group strives to minimize or prevent the accumulation of smoke from prescribed burns by coordinating burning operations on all forest and range lands in the state through the Montana Smoke Management Memorandum of Understanding (MOU)(**Appendix F)**. Each member is granted an annual air quality permit**.**

K. History and Effects of Fire

1. History of Wildfire

Like all areas of the Northern Rocky Mountains, fire helped shape the Bitterroot Valley. However, the influences of extensive logging, grazing, farming, mining, roading, fire suppression (Habeck 1987), and the introduction of exotic pests have created present-day plant communities that are very different from those maintained by fire prior to 1900. Wildfires have probably been suppressed since white settlement of the area beginning in the 1840s. Low elevations in this area (3,000 - 5,000 ft/ 900-1,500m) historically supported stands of old-grown ponderosa pine and western larch (Habeck 1990). Low-intensity fires occurred at 10 - 30 year intervals, maintaining open, park like stands carpeted by native bunchgrasses (Habeck and Mutch 1973; Lunan and Habeck 1973; Arno 1976, 1980, 1988; Freedmand and Habeck 1985; Habeck 1985, 1987). Large, stand-replacing fires were probably uncommon (Arno 1980). Lightning or Native American caused fires probably occurred most often during the driest portion of the year: August through October (Habeck 1990). The wetter areas immediately adjacent to the Bitterroot River itself probably burned much less frequently than the Bitterroot River terraces and upland areas. When fires did occur in the wetter areas, however, it was probably a stand-replacing fire. Today, open stands of ponderosa pine still exist, but contain a heavier layer of underbrush, litter, and dead and down timber. The native bunchgrasses are mostly gone, replaced by introduced herbaceous plants such as Kentucky bluegrass, smooth brome, and a variety of invasive forbs and noxious weeds, or by plantings dominated by tall or western wheatgrass. Riparian areas where ponderosa pine is mixed with black cottonwood have very heavy accumulations of dead and downed timber with understories of willow, red-osier dogwood, snowberry, rose, and reed canary grass.

Historic fire frequencies in the upland areas were 15-30 years. Little information is available on the frequency of fires in the black cottonwood riparian areas, but durations between fires were probably much longer than in the upland areas. Due to the age and location of the cottonwood stands, it is unlikely that the many of the forested areas on the Refuge could regenerate in our lifetimes following a fire. Cottonwoods germinate on a scoured moist substrate only created along the Bitterroot River following a flood event. Many of these wooded areas are located along historic oxbows, and are no longer flooded during a typical runoff year.

2. History of Prescribed Fire

The Refuge was established in 1963. Since that time, wildfires have been suppressed and the use of prescribed fire has been sporadic and mostly constrained to wetlands, ditches, and agricultural fields (**Table 2**). In the past, prescribed fire has been used primarily to provide goose grazing areas and to open rank cattail stands for early spring flooding. Water supply ditches were burned in spring to removed dead vegetation that would otherwise block the channels. In the past, agricultural stubble was burned to make it easier for farmers to till the fields. The window for safe prescribed burning on the Refuge is generally in March, April, and May. With current staff and equipment and close proximity to private lands, it is not feasible to mimic historic dry-season burns without endangering private property, riparian forest, and old cottonwood stands.

Table 2. Documented fire history on Lee Metcalf National Wildlife Refuge (1987-2001).

Month & Year	Fire Type	Acres Burned	Description
April 1987	Prescribed	7.0	Pond 5 - goose grazing
April 1987	Prescribed	1.5	Pond 8 - goose grazing
April 1987	Prescribed	6.0	Pond 8 - goose grazing
April 1987	Prescribed	44.0	Stubble field
April 1987	Prescribed	2.3	Ditch maintenance
May 1987	Prescribed	5.0	Pond 1 - cattail control
May 1987	Prescribed	5.0	Pond 6 - cattail control
October 1987	Wildfire	0.1	Lightning strike - snag
April 1988	Prescribed	3.0	Ditch maintenance
April 1988	Prescribed	15.0	Preparation for DNC planting
August 1988	Wildfire	1.0	Lightning strike - snag
April 1989	Prescribed	3.0	Ditch maintenance
April 1989	Prescribed	5.0	Pond 4 - cattail control
April 1989	Prescribed	3.0	North Pole Barn - grass/sedge
April 1989	Prescribed	30.0	Grass
March 1990	Prescribed	unknown	Cattails and grass - goose grazing
March 1990	Prescribed	30.0	Pond 10 - goose grazing
March 1990	Prescribed	20.0	North of barn - goose grazing

March 1990	Prescribed	1.0	Goose grazing
April 1990	Prescribed	3.0	Ditch maintenance
April 1991	Prescribed	6.0	Ditch maintenance
April 1991	Prescribed	8.0	Pond 8 - goose grazing
April 1991	Prescribed	5.0	Seeder Field North - goose grazing
April 1991	Prescribed	8.0	Bass Creek North - goose grazing
April 1991	Prescribed	3.0	Quarters South - goose grazing
April 1991	Prescribed	16.0	Blind 6 South - goose grazing
April 1991	Prescribed	6.0	Otter Pond SE - goose grazing
April 1992	Prescribed	6.0	Ditch maintenance
April 1992	Prescribed	50.0	Stubble fields (4 burns)
April 1993	Prescribed	70.0	Stubble fields
April 1993	Prescribed	10.0	Pond 6 - cattail control
April 1993	Prescribed	3.0	Ditch maintenance
May 1993	Prescribed	3.0	Ditch maintenance
March 1995	Prescribed	6.0	Ditch maintenance
May 1995	Wildfire	2.0	Illegal campfire
April 1996	Prescribed	3.0	Ditch maintenance
June 1996	Wildfire	0.1	Lightning strike - snag
April 1997	Prescribed	3.0	Ditch maintenance
April 1998	Prescribed	3.0	Ditch maintenance
April 1999	Prescribed	3.0	Ditch maintenance
April 2000	Prescribed	3.0	Ditch maintenance
April 2001	Prescribed	2.0	Ditch maintenance
April 2001	Prescribed	2.0	Weed control - pre-herbicide

II. POLICY COMPLIANCE - GOALS AND OBJECTIVES

A. Compliance with Service Policy

U.S. Fish and Wildlife Service policy requires that an approved Fire Management Plan must be in place for all of Service lands with burnable vegetation. Service Fire Management Plans must be consistent with firefighter and public safety, protection values, and land, natural, and cultural resource management plans, and must address public health issues. Fire Management Plans must also address all potential wildland fire occurrences and may include the full range of appropriate management responses. The responsible agency administrator must coordinate, review, and approve Fire Management Plans to ensure consistency with approved land management plans.

Service policy allows for a wildland fire management program that offers a full range of activities and functions necessary for planning, preparedness, emergency suppression operations, emergency rehabilitation, and prescribed fire operations, including non-activity fuels management to reduce risks to public safety and to restore and sustain ecosystem health. This plan provides fire management guidelines for the Refuge.

B. NEPA Compliance

This plan is in compliance with National Environmental Protection Act (NEPA). Regulations published in the Federal Register (62 FR 2375) January 16, 1997, categorically exclude wildfire suppressions actions. This guidance is outlined in 516 DM2.

C. Authorities for Implementation

1. **Protection Act of September 20, 1922 (42 Stat. 857; 16 USC 594).** Authorizes the Secretary of the Interior to protect from fire, lands under the jurisdiction of the Department directly or in cooperation with other Federal agencies, states, or owners of timber.

2. **Reciprocal Fire Protection Act of May 27, 1955 (69 Stat. 66, 67; 42 u.s.c. 1856,1856a and b).** Authorizes reciprocal fire protection agreements with any fire organization for mutual aid with or without reimbursement and allows for emergency or major disaster by direction of the President.

3. **National Wildlife Refuge System Administration Act of 1966 (80 Stat. 927; 16 USC 1601) 668dd-668ee).**. Defines the National Wildlife Refuge System as including wildlife refuges, areas for the protection and

conservation of fish and wildlife which are threatened with extinction, wildlife ranges, game ranges, wildlife management areas, and waterfowl production areas.

4. **Federal Fire Prevention and Control Act of October 29, 1974 (88 Stat. 1535; 15 USC 2201).** Provides for reimbursement to state or local fire services for costs of firefighting on federal property.

5. **Departmental Manual, Part 620 DM-1, Wildland Fire Management (April 10, 2000).** Defines Department of Interior Fire Wildfire Suppression and Management Policies.

6. **U.S. Fish and Wildlife Service Manual, 621 FW 1-3 (February 7, 2000).** Defines Fish and Wildlife policies based on Departmental Manual 910 DM.

7. **U.S. Fish and Wildlife Service Fire Management Handbook (December 2, 2000**) Provides general planning and operational guidance for fire management programs in the Service.

D. Other Regulatory Concerns

Fire management activities within the Complex will be implemented in accordance with the regulations and directions governing the protection of cultural resources as outlined in **Departmental Manual Part 519 (519M)**, **Code of Federal Regulations (36 CFR 800)**, the **Archaeological Resources Protection Act of 1979**, and the **Archaeology and Historic Preservation Act of 1974**. **National Historic Preservation Act of 1966 Section 106** clearance will be followed for any fire management activity that may affect historic structures or archaeological resources. **Endangered Species Act** of 1973, as amended, dictates that managers will take appropriate action to identify and protect from adverse effects any rare, threatened, or endangered species located within the Complex. Service policy requires that state threatened and endangered species and federal candidate species will be incorporated into any planning activities.

E. Enabling Legislation and Purpose

The Refuge was established in December, 1963 under authority of the Migratory Bird Conservation Act (16 USC 661-667e), with State of Montana approval under provisions of PL 87-383 (75 Stat. 813) for use as an inviolate sanctuary, or for any other management purpose, for migratory birds. Purposes defined under the Refuge Recreation Act (16 USC 460k-1) also include: 1) incidental fish and wildlife-oriented recreational development, 2) the protection of

natural resources, and 3) the conservation of endangered and threatened species.

F. Overview of Planning Documents

The Refuge Background and Operating Statement (**Appendix A**) is the only comprehensive management document currently in place. The Refuge lacks a Comprehensive Conservation Plan, Master Plan, and major land use planning documents. Refuge planning documents include a hunting plan, wildlife inventory plan, cropland management plan, and station safety plan. Of these, the station safety plan is the only one that applies directly to the fire management plan.

Station Safety Plan: Objectives of the safety plan include the following:

X Provide safe working conditions for employees
X Provide safe environments for the visiting public
X Provide emergency information and sources of assistance
X Protect the safety of Service-owned equipment
X Identify equipment location and availability
X Identify employee responsibilities
X Promote a positive safety attitude in the workplace

G. Land Management Goals and Objectives

Three land management goals and objectives are included in the Refuge Operating Statement (**Table 3, Appendix A**).

Table 3. Land management goals identified in the Lee Metcalf National Wildlife Refuge Operating Statement.

Land Management Goals	Objectives
Provide optimal habitat for federally listed endangered and threatened animal and plant species.	Monitor occurrence of endangered and threatened animal and plant species on and adjacent to the Refuge.
	Provide seasonal sanctuary areas within the Refuge for bald eagles.
	Identify, protect and monitor the occurrence of endangered and threatened plant species and other species of special concern within the Refuge.
Identify and protect nationally designated cultural and natural areas within the Refuge which are unique to the Bitterroot Valley.	Identify, preserve, and protect all cultural resource values in accordance with public law.
Provide maximum habitat for the life requirements for migratory birds that utilize the Bitterroot Valley.	Provide high quality habitat with emphasis on seasonal food, nesting, and cover requirements. Priorities will include maintenance of riparian and wetland communities and noxious weed control.
	Provide high quality nesting and feeding habitat for osprey and other pisciverous bird species.

III. REFUGE FIRE MANAGEMENT GOALS AND OBJECTIVES

The goal of wildland fire management is to plan and make decisions that help accomplish the mission of the National Wildlife Refuge System. That mission is to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans. Fire management objectives (standards) are used in the planning process to guide management to determine what fire management responses and activities are necessary to achieve land management goals and objectives.

The primary goal is to provide for firefighter and public safety, property, and natural resource values. Service policy and the Wildland Fire Policy and Program Review direct an agency administrator to use the appropriate management response concept when selecting specific actions to implement protection and fire use objectives. The resulting Appropriate Management Response are specific actions taken in response to a wildland fire to implement protection and fire use objectives. With an approved Fire Management Plan, the Refuge staff may use wildland fire in accordance with local and State ordinances and laws to achieve resource management objectives (habitat improvement).

The goal of this fire management plan is to identify ways to protect important migratory bird habitats, research areas, cultural resources, recreational areas, and educational facilities from destruction by wildfire. The current objectives of the plan is to prevent and properly manage wildfires to prevent damage to resources and other values at risk.

The Refuge staff recognizes that wildland fire can play an important role in habitat management. In the near future, Refuge staff plans to draft land use planning documents and implement a habitat management program that includes prescribed fire. Future funding through Refuge Operating Needs System (RONS) packages and other partnerships will allow fire management goals to be expanded.

IV. FIRE MANAGEMENT STRATEGIES

A. Wildfire Prevention

Preventing wildfires is the primary objective of the fire management plan. This objective will be accomplished through several measures (**Table 4**).

Sources of possible ignition include cooking fires in the Bitterroot River Recreation Area (BRRA), improper disposal of cigarettes in the BRRA and along roadways, vehicles and other power equipment, and lightning. Although three out of the four wildfires recorded on the Refuge were lightning-caused, human caused ignition is equally, if not more, likely. Education and regulation of visitors and staff will be the focus of the Refuge fire prevention program. These strategies will be combined with interagency restrictions and closures during high fire danger when these are warranted.

Permitted fires on the Refuge are limited to cooking fires in barbeque pits in the BRRA. Signs at the BRRA entrance indicate that no other open fires are allowed. Law enforcement officers and the outdoor recreation planner will have the primary responsibility for monitoring and enforcing and monitoring compliance.

Vehicles can start fires when driven or parked in fine, dry fuels. Off-road driving by visitors is prohibited year-round. A formal prohibition on off-road driving for staff, volunteers, and other associates will help prevent wildfires. The Refuge contains an extensive network of roads, so that driving off-road is rarely necessary. Special dispensation for off-road driving may be provided by the refuge manager when absolutely necessary to meet the needs of special permits or projects that support the goals and objectives of the Refuge. However, special dispensation will not be given during periods of intergency fire restrictions or closures that specifically prohibit off-road driving. Mowing Refuge roads prior to the onset of high fire danger in mid to late summer will reduce the likelihood of accidental ignition from staff, volunteers, and permittees parking alongside the road during the normal course of their duties. Mowing is the responsibility of the maintenance worker.

During periods of high fire danger, Refuge staff will post high fire danger signs at the BRRA and all other areas open to the public. When the Zone FMO notifies the Refuge of interagency restrictions and closures (**Appendix G**), Refuge staff will also post these restrictions. Interagency restrictions are advertised through the local media by U.S. Forest Service officials. These responsibilities will lie with the assistant refuge manager and outdoor recreation planner.

Table 4. Wildfire prevention measures to be implemented on Lee Metcalf National Wildlife Refuge.

Season	Prevention Measure	Responsibility
All Year	Employee training and awareness.	Refuge Manager All Staff
All Year	Restriction of recreational fires to enclosed barbecue pits in the Bitterroot River Recreation Area.	LE Officers Outdoor Recreation Planner
All Year	Prohibition on off-road driving unless by special dispensation from refuge manager.	All Staff, Volunteers, and Visitors
All Year	Enforcement of regulations and prosecution of violators.	Refuge Manager LE Officers
Mid- to Late Summer	Mowing of Refuge roads.	Maintenance Worker
Summer - Fall	Public contacts through press releases and verbal contacts.	Refuge Manager Outdoor Rec. Planner
Summer - Fall	Posting of high fire danger in Bitterroot River Recreation Area.	Assistant Refuge Manager Outdoor Recreation Planner

Summer - Fall	Compliance, posting, and advertising interagency restrictions and closures during periods of severe fire danger (**Appendix G**).	Zone FMO Assistant Refuge Manager Refuge Manager Outdoor Recreation Planner
Summer - Fall	Monitoring for smokes following a thunder storm.	Refuge Manager (on-site staff)

B. Wildfire Suppression

As previously stated, the primary goal is to provide for firefighter and public safety, public and private property, and cultural and natural resource values. Service policy and the Wildland Fire Policy and Program Review direct an agency administrator to use the appropriate management response concept when selecting specific actions to implement protection and fire use objectives. The resulting Appropriate Management Response are specific actions taken in response to a wildland fire to implement protection and fire use objectives. With an approved Fire Management Plan that addresses prescribed fire and less restrictive wildland fire management strategies, the Refuge staff may use wildland fire in accordance with local and State ordinances and laws to achieve resource management objectives (habitat improvement).

Under this plan, the Refuge's primary strategy is to use the appropriate management response concept to promptly take suppression action on all wildfires detected on the Refuge in order to prevent a catastrophic wildfire that could lead to the destruction of wildlife habitat and recreational facilities.

The Service will rely on an agreement with the Montana Department of Natural Resources and Conservation (MDNRC) to achieve this goal (**Appendix B**), as the Refuge is not staffed to suppress wildfires. Under the agreement, MDNRC has agreed to provide wildfire protection for 23,364 acres of Service lands in western Montana that include 2,797 acres on the Refuge. In exchange for this protection, the Service has agreed to protect 36,870 acres of state trust land within the administrative boundaries of the Charles M. Russell National Wildlife Refuge.

1. Station Procedures for Responding to a Wildfire

When a wildfire is detected on the Refuge, Refuge staff will implement the initial reporting and dispatching procedures outlined in **Figure 3**. The purpose of the procedures is to get qualified suppression personnel to safely respond to the fire in the least amount of time. Although quick response is essential, careful coordination and reporting are required so that Refuge staff can meet and direct suppression forces to

and through appropriate access points. Maps detailing access gates, interior roads and refill stations (**Figure 4**) will be distributed to local fire departments in advance, so that crews can be familiar with the Refuge layout prior to an emergency. Once fire crews have been called to the scene of a wildfire, the refuge manager or his/her designee will meet the crew to open gates and direct crews to the appropriate routes and refill stations.

Figure 3. Initial reporting and dispatching procedures for responding to a wildfire on Lee Metcalf National Wildlife Refuge.

Figure 4. Roads and buildings on Lee Metcalf National Wildlife Refuge.

2. Critical Protection Areas

The goal of the fire management plan is to protect the entire Refuge from wildfire. Because some resources are deemed more critical to the Refuge mission than others, the Refuge is divided into five Fire Management Units categories (**Figure 2**) to help prioritize protection in the event of a extreme fire event. These are discussed in detail in **Section XI** of this plan, but will be protected in the following order of most to least critical: fire prevention unit, fire protection unit, fire control unit, fire management unit, and fire maintenance unit. Protection of life and property will receive top priority, followed by endangered species habitat, and forested riparian areas.

3. Rehabilitation Following a Wildfire

In order to restore wildlife habitat and prevent large infestations of noxious and invasive plant species, it is important to rehabilitate all sites affected by wildfire. In the case of riparian forested areas, this will require seeding of native grasses and forbs and replanting of black cottonwood, willow, and other native shrub species. Open upland areas will be seeded to native grasses and forbs.

4. The Urban Interface

Urban encroachment on the Refuge increases with each passing month. Ravalli County sustained a 44% population growth rate from 1991-2000 yet still has no county growth plan. The result of this has been an unplanned mixture of commercial, industrial, and residential development that now surrounds the Refuge. Fire protection is still limited to volunteer rural services. The variety and scope of activities that take place along Refuge boundaries vastly increases the potential for fire to spread onto the Refuge from accidental ignition. Conversely, wildfires originating on the Refuge have the potential to quickly affect hundreds if not thousands of lives and hundreds of millions of dollars worth of property.

V. FIRE MANAGEMENT RESPONSIBILITIES

A. Refuge Staff Responsibilities

Primary members of the fire management team are the refuge manager and the assistant refuge manager. Additional staff augment the team as collateral duty firefighters. Only qualified employees meeting the fitness and training requirements of assigned positions will be dispatched to fires at the discretion of the refuge manager. Employees not meeting requirements may assist in support or administrative capacities, but are not permitted on the fire line. The Service Fire Management Handbook and Regional Policy Directives can be referred to for specific policy guidance. Responsibilities of fire management team members are outlined below (**Table 5**).

Table 5. Responsibilities of fire management team members at Lee Metcalf National Wildlife Refuge.

Title	Responsibilities
Refuge Manager	S Responsible for overall management of the Refuge. S Insures that Department, Service, and Refuge policies are followed and maintained. S Serves on the fire management team. S Approves prescribed fire plans. S Reviews fire reports (DI-1202) for accuracy. S Dispatches qualified staff to fire response.

Assistant Refuge Manager	S Responsible for the fire program; maintains fire records. S During the absence of the refuge manager, delegated the responsibility for managing the fire program. S Serves as prescribed burn boss, as qualified. S Serves on the fire management team. S Insure that Department, Service, and Refuge policies are followed and maintained. S Prepares annual FIREBASE budget requests, approves and tracks use of FIREBASE accounts. S Writes and updates prescribed burn plans for the Refuge. S Responsible for Refuge fire cache inventory, maintenance, and operation. S Responsible for planning, coordinating and directing preparedness activities including: a. Fire Training a. Physical testing and Interagency Fire Qualification System (IFQS) data entry. b. Fire cache and equipment inventory accountability, maintenance, and operation. c. Cooperation with cooperative agencies. Revises cooperative agreements as necessary. d. Insures Step-Up plan is followed. S Reviews all proposed units to be burned to ensure Refuge objectives are being met, and sensitive resources are not being negatively impacted.
Collateral Duty Firefighters	S Maintain assigned fire equipment in ready state and use required personal protective equipment (PPE). S Responsible for assigned PPE and physical conditioning. S Qualify annually with the work capacity test by April 15.
Fire Cooperators	S Provide assistance in suppression of wildfires as defined in cooperative agreements and Memorandums of Understanding. S Assist as needed in the investigation of suspicious fires.

B. Cooperator Involvement

The Refuge operates under an agreement with the Montana Department of Natural Resources and Conservation (**Appendix B**). Under this agreement, a call to 911 causes rural volunteer departments to respond to a wildfire on the Refuge.

Along with other land management agencies, the Service has adopted the National Interagency Incident Management System (NIIMS) Wildland and Prescribed Fire Qualification Subsystem Guide, PMS 310-1 to identify minimum qualification standards for interagency wildland and prescribed fire operations. PMS 310-1 recognizes the ability of cooperating agencies at the local level to jointly define certification and qualification standards for wildland fire suppression. Under that authority, local wildland fire suppression forces will meet the standards established for their agency or department. All personnel participating in prescribed fire management activities must meet Service fitness and training standards.

VI. FIRE SEASON

A. Refuge Wildfire Frequency

Refuge files contain documentation of fire history since 1987 (**Table 2**). Since that time, there have been four reported wildfires. Three were caused by lightning strikes to trees, and one was ignited by an illegal campfire. Prescribed fires have been used annually since 1987, with the exception of 1994.

B. Refuge Fire Season

The maximum wildfire season in dry year runs from July through mid-November. A more typical fire year will extend from late July through early October.

VII. EQUIPMENT AND STAFFING NEEDS

A. Normal Unit Strength

1. Personnel

The safety of firefighters and the public is the first priority. Persons engaged in fire suppression activities are exposed to a high element of risk. The Refuge Manager and fireline supervisors must make every effort to reduce the exposure to risk and enhance performance. One way is

through formal and on-the-job training and improved physical fitness. The Service has adopted the training and fitness standards established in 310-1, and all firefighters must meet these and other standards established by the Service to participate in fire management activities.

Currently, the Refuge is not staffed to respond to wildfires, and due to standing agreements and the low fire occurrence, there is little need to do so[1]. In order to respond to a wildfire, at least three staff members would have to be qualified at the arduous level on the work capacity test and meet annual training and other fitness requirements. The Refuge has staff available to participate in ditch maintenance activities where fire is used to remove accumulated debris. Table 6 outlines the position needed to fully implement the present Fire Management program at the Refuge. **Appendix H** contains a listing of current firefighters and their fitness and qualification levels.

Table 6: Recommended Fire Management Staffing Levels

Position	**Number**
Incident Commander Type 5 (ICT5)	0
Prescribed Fire Burn Boss Type 3 (RXB3)	1
Engine Boss (ENGB)	1
Engine Operator (ENOP)	1
Fire Fighter Type 2 (FFT2)	2

Note: A firefighter can be qualified at more than one position, however there should be a minimum of three qualified individuals.

2. Engines, tools, and other equipment

The Refuge has firefighting equipment that has been used to support the prescribed fire program. The equipment would also be available for wildfire suppression if the Refuge is staffed for wildfire response in the future.

Firefighting and other pre-suppression and suppression equipment are

[1] Under an agreement with the Montana Department of Natural Resources and Conservation (**Appendix B**), the state assumes suppression responsibility for wildfires that occur on the Refuge. In return, the Service agrees to protect state lands and inholding as specified in the vicinity of Charles M. Russell National Wildlife Refuge.

listed in **Tables 6 and 7**. The light engine will be fully prepared during the fire season and stored in the Refuge shop. All other equipment will be stored at the Refuge shop and may be kept in the equipment storage building during the winter months.

Table 7. Fire-fighting equipment at Lee Metcalf National Wildlife Refuge.

Item	Description
Engine (primary)	$ 300-gallon slip-on unit with 200 feet of hose, with adjustable nozzles and foam capability. $ Mounted on a 1-ton, four-wheel drive utility pickup.
Slip-on Pumper	$ 250-gallon unit with 100 feet of hose and adjustable nozzles. $ Mounts, as needed, on a 1-ton, four-wheel drive flatbed pickup.
Slip-on Pumper	$ 200-gallon slip-on fire pumper with 200 feet of hose. $ Trailer-mounted.
Chainsaw	$ (1) Stihl 20" bar.
Portable Pump (1)	$ 0.5hp, 1000 feet 3/4-inch hose.

Table 8. Other equipment available for fire suppression or prescribed fire operations.

Item	Description
Mower(s)	$ (1) 24" push mower. $ (3) 36" garden tractors. $ (1) sickle bar unit. $ (1) 96" brush hog mower.
Heavy Equipment	$ John Deere 55 hp farm tractor. $ Huber 12' motor grader. $ Caterpillar backhoe. $ Case 2½ yard front-end loader. $ International 10-yard dump truck.
Other Vehicles	X In addition to the fire trucks, there are six other 4 x 4 vehicles for transporting equipment or people.

VIII. PREPAREDNESS

A. Training and Qualifications

Service policy sets training, qualification and fitness requirements for all wildland firefighters and prescribed fire positions. All personnel involved in fire management functions will be provided with the training required to meet Service qualification standards for the position they are expected to perform. The use of interagency training opportunities is encouraged.

1. Training Courses

The Regional Office may pay for all approved fire training if the following criteria are met:

a. Participant completes and submits to the Zone FMO a National Wildfire Coordinating Group Interagency Training Nomination form (NFES 2131), complete with supervisory approval and an estimated cost of training, travel and per diem prior to the commencement of training.

a. Except for certain national level courses, training is approved by the Zone FMO.

b. Upon completion of the training, a copy of the Certificate of Completion and a copy of the travel voucher are sent to the Zone FMO.

2. Annual Refresher Training

All personnel involved in Fire Management activities are required to participate in eight hours of fire management refresher training annually in order to be qualified for fire management activities in that calendar year. Refresher training will concentrate on local conditions and factors, the Standard Fire Orders, LCES, 18 Situations, and Common Dominators. NWCG courses Standards for Survival, Lessons Learned, Look Up, Look Down, Look Around, and others meet the firefighter safety requirement; but, efforts will be made to vary the training and use all or portions of other NWCG courses to cover the required topics. Fire shelter use and deployment under adverse conditions, if possible, must be included as part of the annual refresher.

3. Physical Fitness Standards

All personnel involved in fire management activities will meet the fitness

standards established by the Service and Region. At this point in time, firefighters participating in wildfire suppression must achieve and maintain an Arduous rating. Firefighters participating in Prescribed Burns must achieve and maintain a Moderate rating. Information found in **Appendix I** provides specific instructions to administer the tests, a health screening questionnaire to aid in assessing personal health and fitness of employees prior to taking the test, an informed consent form, and safety considerations. A trained and qualified American Red Cross First Responder (or equivalent) who can recognize symptoms of physical distress and appropriate first aid procedures must be on site during the test.

Wildland fire fitness tests shall not be administered to anyone who has obvious physical conditions or known heart problems that would place them at risk. All individuals are required to complete a pre-test physical activity readiness questionnaire prior to taking a physical fitness test. They must read and sign the Par-Q health screening questionnaire, an informed consent form (**Appendix I**). If an employee cannot answer NO to all the questions in the PAR-Q health screening questionnaire, or is over 40 years of age, unaccustomed to vigorous exercise, and testing to achieve a Moderate or Light rating, the test administrator will recommend a physical examination. As noted below, all individuals over 40 years of age must receive an annual physical prior to physical testing.

4. Physical Examinations

In keeping with Service Policy, a physical examination is required for all new permanent employees and all seasonal employees assigned to arduous duty as fire fighters prior to reporting for duty. A physical examination may be requested for a permanent employee by the supervisor if there is a question about the ability of an employee to safely complete one of the work capacity tests. All permanent employees over 40 years of age who take the Pack or Field Work Capacity Test to qualify for a wildland or prescribed fire position are required to have an annual physical examination before taking the test.

B. Annual Refuge Fire Management Activities

Refuge fire management activities are scheduled according to **Table 9**. Activities should be completed prior to the end of the month that is indicated.

Table 9. Annual Refuge fire management activities by month.

Activity	Month (January through December)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Update Interagency Fire Agreements	x											
Winterize Fire Management Equipment										x		
Inventory Fire Engine and Cache		x										
Complete Training Analysis	x											
Annual Refresher Training		x										
Annual Fitness Testing			x									
Pre-Season Engine Preparation			x									
Weigh Engines to verify GVW Compliance			x									
Prescribed Fire Plan Preparation												x
Review and Update Fire Management Plan											x	

C. Impacts of Drought and Other Impacts on Station Activities

As indicated previously, periods of drought can greatly impact fire behavior and resistance to control. An interagency team, headed by U.S. Forest Service staff in Missoula, monitors drought indices to determine when restrictions and closures are necessary to reduce chances of human-caused ignition. Restrictions and closures are implemented under the Southwest Montana Area Fire Restriction and Closure Plan (**Appendix G**). The Service Zone FMO contacts refuges in western Montana so that refuge managers can implemented these restrictions and closures. General criteria (trigger points) for closures are listed in **Table 12**. Other criteria are listed in **Appendix G**. When conditions indicated Level 1 or 2 restrictions, the Refuge Step-Up Plan (**Appendix J**) will be implemented.

Large scale fire suppression activities occurring in various parts of the country can have an impact on local fire management activities. For example, resources may be limited to implement prescribed fire activities because the closest available resources may be assigned to fire suppression duties or Refuge personnel may be involved as well. Regional drought conditions may also tie-up local resources that would normally be able to assist with Refuge fire management activities. It may be necessary to go out of Region to get the resources needed to staff Refuge engines during periods of extreme drought or high fire danger.

D. Severity and Emergency Presuppression Funding

Severity funding is different from Emergency Presuppression funding. Emergency Presuppression funds are used to fund activities during short-term weather events and increased human activity that increases the fire danger beyond what is normal. Severity funding is requested to prepare for abnormally extreme fire potential caused by unusual climate or a weather event such as extended drought. Severity funds and emergency presuppression funds may be used to rent or preposition additional initial attack equipment, augment existing fire suppression personnel, and meet other requirements of the Step-up Plan.

Emergency Presuppression and Severity funds will be requested in accordance with the guidance provided in the Service's Fire Management Planning Handbook. As a general guide, Severity funding will be requested if a severe drought is indicated by a Palmer Drought Index reading of -4.0 or less or a Keech-Byram Drought Index of 600 or greater and a long-range forecast calling for below average precipitation and/or above average temperatures. Drought Indices can be located at: http://www.boi.noaa.gov/fwxweb/fwoutlook.htm

IX. WILDFIRE PROGRAM

All wildfires will receive prompt suppression action in an effort to minimize acreage burned. The strategy selected will be based on firefighter safety and values at risk. The benefits to resources will not be a consideration when selecting the appropriate management response.

As previously indicated, the Refuge is not currently staffed to respond to wildfires. In order to suppress wildfires, the Refuge operates under an agreement with the Montana Department of Natural Resources and Conservation (**Appendix B**). Under this agreement, a call to 911 causes rural volunteer departments to respond to a wildfire on the Refuge.

Along with other land management agencies, the Service has adopted the National Interagency Incident Management System (NIIMS) Wildland and Prescribed Fire Qualification Subsystem Guide, PMS 310-1 to identify minimum qualification standards for interagency wildland and prescribed fire operations. PMS 310-1 recognizes the ability of cooperating agencies at the local level to jointly define certification and qualification standards for wildland fire suppression. Under that authority, local wildland fire suppression forces will meet the standards established for their agency or department. All personnel participating in debris disposal activities involving the use of fire must meet Service prescribed fire fitness and training standards.

A. Special Safety Concerns

Heavy fuel loading and adverse weather conditions can combine to produce conditions that are extremely hazardous. Firefighters must be alert to their surroundings and the weather to insure there is adequate time to access escape routes and safety zones. The large quantity of tall herbaceous vegetation (fuel model 3) and standing and downed timber in forested areas (fuel model 2) of the Refuge presents a significant danger to firefighters in the event of a wildfire. Many standing trees in forested areas are dead or partially dead. Firefighters must be alert to hazards from falling trees in both burned and unburned areas.

Smoke from wildfires is a recognized health concern for firefighters. Incident commanders should plan to minimize exposure to heavy smoke to one hour or less, at which time the firefighter should be rotated to a smoke-free area (Sharkey 1997).

B. Prevention Program

Wildfire prevention is the primary objective of the fire management plan. Strategies for prevention are discussed in detail in Section IV and are outlined in **Table 4**.

C. Detection

Patrols will be made by the refuge manager following a lightning storm whenever possible. If a fire is detected by the refuge manager or staff, the initial reporting and dispatching procedure outlined in **Figure 3** will be followed.

There may be occasions when unqualified personnel discover a wildland fire. When this occurs the employee should report the fire and request assistance before taking action to suppress or slow the spread of the fire. If the fire poses an imminent threat to human life, the employee may take appropriate action to protect that life before requesting assistance. The unqualified personnel will be relieved from direct on-line suppression duty or reassigned to non-fireline duty when qualified initial attack forces arrive.

Due to the Refuge's proximity to the private lands, fires on the Refuge are often detected by neighboring landowners. When this occurs, rural volunteer departments are sometimes dispatched before the Refuge staff is aware of the wildfire. For this reason, it is critical to discuss Refuge resources and distribute maps (**Figures 2 and 4**) to local fire departments in advance. Local fire officials should be made aware of the priority for protecting crucial Refuge resources. These priorities, discussed in detail in Section IX, will be protected in the following order of most to least critical: fire prevention unit, fire protection unit, fire control unit, fire management unit, and fire maintenance unit.

D. Suppression

1. Objectives of the Suppression Program

a. Provide for firefighter safety and safety of Refuge visitors, cooperators, and other personnel.

b. Utilize the appropriate management response (**Table 10**) to suppress all wildland fire occurring within the boundaries of the Refuge.

c. Minimize damage to Refuge resources from suppression efforts.

d. Prevent the fire from burning across Refuge boundaries onto neighboring lands.

e. Prevent damage to cultural resources, improvements, and threatened and endangered species.

2. Communications

Communication frequencies used by the refuge and the local firefighting community are listed in the Communication Plan (**Appendix K**).

3. Suppression Strategies and Tactics

A suppression oriented response will generally be the appropriate strategy for most of the Refuge. Minimum impact strategies and tactics will be used whenever possible. Direct attack can be used to suppress fires that are limited in size and intensity, such as a single tree on fire. The size of larger or faster-spreading fires will be limited by flanking and halting the fire at a fire break. The Refuge is dissected by a number of existing fuel breaks that include roads, railroad tracks, ponds, ditches, and the Bitterroot River. The use of natural or manmade barriers to contain the fire may also be appropriate when increased firefighter safety or reduced cost per acre over aggressive attack can be attained. However, it is possible that a larger fire in the forested area could require aerial retardant.

Tactics used to manage a wildland fire will be unique to each incident and are dependent on safety considerations, current and predicted weather conditions, current and predicted fire behavior, fuel conditions, cost of suppression, availability of resources, and location of the fire in proximity to structures and cultural resource sites. Guidance will be provided in this plan, but specific tactics will be determined by the Incident Commander on site.

The following table is intended to illustrate through the use of a matrix, *some of the various options* available to the Incident Commander.

Table 10: Appropriate Management Response

SITUATION	STRATEGY	TACTIC
1. Wildland fire on Refuge lands which does not threaten life, natural or cultural resources or property values.	Restrict the fire within defined boundaries established either prior to the fire or during the fire.	1. Holding at natural and man-made barriers. 2. Burning out. 3. Observe and patrol.
1. Wildland fire on Service property with low values to be protected. 2. Wildfire burning on to Service lands. 3. Escaped prescribed fire entering another unit to be burned.	Take suppression action, as needed, which can reasonably be expected to check the spread of the fire under prevailing conditions.	1. Direct and indirect line construction. 2. Use natural and man-made barriers. 3. Burning out 4. Patrol and mop-up of fire perimeter.
1. Wildland fire that threaten life, property or sensitive resources. 2. Wildland fire on Service property with high values to be protected. 3. Observed and/or forecasted extreme fire behavior.	Aggressively suppress the fire using direct or indirect attack methods, holding the fire to the fewest acres burned as possible.	1. Direct or indirect line construction 2. Engine and water use. 3. Aerial retardant 4. Burn out and back fire. 5. Mop-up all or part of the fire area.

4. Initial Attack

Initial attack will be implemented by rural volunteer departments under an agreement with MDNRC (**Appendix B**). The Incident Commander (IC) or lead firefighter will be responsible for all management aspects of the fire until the fire is declared out or he/she is relieved. If a qualified IC is not available, and time permits, one will be ordered through the Interagency Dispatch Center in Missoula. All resources will report to the IC (either in person or by radio) prior to deploying to the fire and upon arrival to the fire. The Incident Commander (IC) will be responsible for:

1. The safe and efficient suppression of the assigned fire.

D. Fulfill the duties described for the IC in the Field Operations Guidelines (IC-420-1).

E. Notifying dispatcher of all resource needs and providing situation updates, including the need for an extended attack.

F. Ensuring that personnel are qualified for the job they are performing, and briefing firefighters on expected weather, fire behavior, communications, escape routes, and safety zones, and posting fire lookouts.

G. Ensuring that fire behavior is monitored, data collected and recorded

H. Identifing and protecting sensitive areas

I. Utilizing minimum impact strategies whenever possible.

J. Ensuring that the fire site is fully rehabilitated or that the management of rehabilitation has been assigned.

The IC will receive general suppression strategy from the fire management plan, but appropriate tactics used to suppress the fire will be up to the IC to implement.

E. Minimum Impact Strategies and Limits of Suppression Activities

When heavy equipment is used for fireline construction, the refuge manager or his/her designated representative should assign a resource advisor to provide guidance to suppression forces. Suppression activities will be limited to existing roads whenever possible to minimize environmental damage and the spread of noxious and invasive plants. Fire lines constructed using heavy equipment should not be located off roadways unless the fire is an imminent threat to human life, Service buildings, threatened or endangered species, or is about to spread onto private land.

In order to protect nesting bald eagles, the dike road north of Pond 10 (MacDonald Pond) should not be used to access or control a wildfire without authorization from the refuge manager during the sensitive nesting period between February 1 and August 15 (USDI Bureau of Reclamation 1994).

Aerial Retardants and foams will not be used within 300 feet of any waterway as described in the Guidelines for Aerial Delivery of Retardant or Foam near Waterways.

F. Extended Attack

When a fire is likely to escape initial attack efforts, leave Service lands, or

when the fire complexity exceeds the capabilities of command or operations, the incident commander (IC) will take appropriate, proactive actions to ensure additional resources are ordered. The IC, through his/her dispatcher or other means, will notify the refuge manager of the situation. The Zone FMO should be contacted by the Refuge. He/she may be available to assist the refuge manager in completing a Wildland Fire Situation Analysis (WFSA) (**Appendix L**).

G. Mop up Standards and Emergency Stabilization and Rehabilitation

The IC will be responsible for mop-up and mitigation of suppression actions taken on Refuge fires. The mop-up standards established in the Fireline Handbook will be followed. Refuge fires will be patrolled or monitored until declared out.

Prior to releasing all firefighters from a wildland fire the following actions will be taken:

- All trash will be removed.
- Firelines will be refilled and waterbars added if needed.
- Hazardous trees and snags cut and the stumps cut flush
- Disked firelines should be compacted as soon as possible to preserve the living root stock of natives grasses.
- Overturned sod resulting from plowing must be rolled back with a grader or by hand and compacted to preserve native grass root stock.

Other emergency stabilization and emergency rehabilitation measures may be taken in accordance with Chapter 5 of the Fire Management Handbook. Briefly:

- **Emergency stabilization** is the use of appropriate emergency stabilization techniques in order to protect public safety and stabilize and prevent further degradation of cultural and natural resources in the perimeter of the burned area and downstream impact areas from erosion and invasion of undesirable species. The Incident Commander may initiate Emergency Stabilization actions before the fire is demobilized, as delegated by the Agency Administrator, but emergency stabilization activities may be completed after the fire is declared out.

- **Rehabilitation** is the use of appropriate rehabilitation techniques to improve natural resources as stipulated in approved refuge management plans and the repair or replacement of minor facilities damaged by the fire. Total "rehabilitation" of a burned area is not within the scope of the Emergency Rehabilitation funding. Emergency Rehabilitation funding can be used to begin the rehabilitation process if other funding is committed to continue the rehabilitation throughout the life of the project (beyond the initial 3 years of Emergency Rehabilitation funding). Major facilities are repaired or replaced through supplemental appropriations of other funding.

G Because of the emergency nature of the fire event, the emergency stabilization section of the Emergency Stabilization and Rehabilitation Plan (ESR Plan) must be developed expeditiously and is frequently developed by a local unit or designated burned area ESR team. The rehabilitation section of the ESR Plan is not considered an emergency, and is developed as other refuge land use plans. The refuge manager is responsible for preparing all ESR Plans. In order to be funded, ESR Plans must meet resource management objectives and be approved by the refuge manager and the Regional Director.

H. Refuge Specific Rehabilitation Guidelines

In order to restore wildlife habitat and prevent large infestations of noxious and invasive plant species, it is important to rehabilitate all sites affected by wildfire. In the case of riparian forested areas, this will require seeding of native grasses and forbs and replanting of black cottonwood, willow, and other native shrub species. Open upland areas will be seeded to native grasses and forbs.

X. PRESCRIBED FIRE PROGRAM

Prescribed fires have been used successfully on the Refuge at least since 1987 and are vital to maintaining a number of important biological resources on the Refuge. Other than an approved fire management plan, along with an Environmental Assessment and Findings of No Significant Interest (FONSI) date from 1985, the Refuge has no land use management plans that address the use of prescribed fire. The 1985 plan and NEPA documentation pre-date bald eagle nesting on the Refuge as well as important documentation and legislation for identifying and protecting cultural resources on the Refuge. Because the fire management plan is now outdated and prescribed fire is not covered in any other land use management plan, the use of prescribed fire on the Refuge will be suspended until it can be incorporated into either a land use plan or updated fire management plan and appropriate NEPA documentation can be completed.

Service guidelines (Fire Management Handbook - Section 2.2.5) permit the use of fire to support routine maintenance activities. A prescribed fire plan has been written and approved to facilitate maintenance of irrigation ditches supplying water to the Refuge. This action will continue using personnel who meet Service prescribed fire fitness and qualification standards .

XI. FIRE MANAGEMENT UNITS

A. Description of Fire Management Units

The Refuge is divided into five Fire Management Units (categories) (**Figure 2, Table 11**) to help prioritize protection of values at risk in the event of a extreme fire event. Fire management units (FMUs) are areas within or near the Refuge (**Figure 2**) that have common fire management strategies. Each FMU has been created so that it has similar resource values and requires similar efforts to effect fire protection. Because the Refuge is heavily roaded and bounded by the Bitterroot River on the west side, it is likely that wildfires could be contained in most FMUs within the Refuge. Where fuels are light (NFFL Fuel Model 1), direct attack will usually be the most effective control strategy, except during periods of drought and extremely high wind. In FMUs containing NFFL Fuel Models 2 and 3 containment may be the only option. For Fire Maintenance Units (ditches outside the Refuge boundary), continuous fuels are often present between the ditches and private property. Direct attack must be used to contain flare ups in order to prevent property damage. Suppression strategies for each FMU are discussed below.

1. Fire Prevention Unit

The protection of life and property are paramount concern in this FMU. The areas that make up this unit include buildings, structures, and public use facilities. Fires occurring in this unit will be aggressively attacked and completely suppressed. Heavy equipment, including dozers, may be used to protect values at risk. Vehicles and equipment will utilize existing roads or trails whenever possible. Foam and other fire retardants will not be used within 300 feet of wetlands but may otherwise be used to protect critical resources.

2. Fire Protection Unit

This FMU, composed of two separated areas near wetlands, contains riparian or heavily wooded areas (NFFL Fuel Model 2) that would be severely damaged by a fire. This unit may also include non-wooded areas where, once ignited, fire could easily spread into areas of private homes. During extended periods of drought and warm weather (July through October) fire danger can be extreme. An aggressive suppression response will be implemented in these areas.

3. Fire Control Unit

This FMU is composed of scattered areas covered by sparse to heavy herbaceous vegetation (NFFL Fuel Models 1 and 3). Fire

in these units is desirable only if conditions or other treatments are available to achieve the desired plant community following the fire (i.e. fire is followed by weed control or seeding of native plants). Relatively little resource or economic damage would result from a fire in these areas. Under most circumstances, a suppression strategy involving indirect attack would be appropriate for this unit.

4. Fire Management Unit

The resources in this FMU has been managed with prescribed fire in the past. Until appropriate management plans and NEPA documentation can be completed, the use of prescribed fire will be suspended in these areas. These areas include wetlands (NFFL Fuel Model 3) where it may be desirable to control cattails periodically using prescribed fire followed by flooding. These areas are wet most of the year, and are consequently fairly resistant to fire. To facilitate a prescribed burn, these areas will be dried the fall prior to a late winter or very early spring burn.

5. Fire Maintenance Unit

This FMUs includes water supply ditches (NFFL Fuel Models 1 or 3) or fence lines where vegetation must be removed using fire. These ditches have been managed using prescribed fire in the past. The fire provides no direct ecological benefit, but is used as a maintenance tool. Because many of these FMUs run through private property, special care must be taken to prevent the spread of fire outside the ditch.

Table 11. Fire Management units by acreage and fire behavior fuel model.

Fire Management Unit	Approximate Acreage	Percentage of Refuge Land	Predominant Fire Behavior Fuel Models*
Fire Prevention Unit	14	0.5	Structures
Fire Protection Unit	1678	60.0	2 - Timber 3 - Tall Grass
Fire Control Unit	811	29.0	1 - Short Grass 3 - Tall Grass
Fire Management Unit	280	10.0	3 - Tall Grass
Fire Maintenance Unit	14	0.5	1 - Short Grass 3 - Tall Grass
Totals	2797	100.0	

*Anderson 1982.

B. Fuels and Expected Behavior

Fuel types and acreage are described in **Tables 1 and 11**. Fire behavior is dependent on relative humidity, air temperature, fuel type, fuel moisture, windspeed, slope, aspect, time of day, and season. Prolonged drought and low fuel moistures can cause extreme behavior in any fuel type. The BEHAVE computerized fire prediction model (Andrews 1986 - **Appendix M**) can be used to approximate fire behaviors such as rate of spread, fireline intensity, heat per unit area, and flame length.

1. Fuel Model 1 - Short Grass

Approximately 842 acres of the Refuge can be classified under this model. Cured perennial and annual grasses are the primary fuels. Other fuels include perennial and annual forbs and a small percentage (usually less than 10%) of woody plants. Excessively drained gravelly soils in some areas support little vegetation and are only able to carry a fire under high wind conditions.

2. Fuel Model 3 - Tall Grass

Approximately 200 acres of the Refuge can be classified under this model. Perennial grasses and forbs, along with a woody component that rarely exceeds 15%, comprise this model on much of the Refuge. Cattail stands also fall under this model.

3. Fuel Model 2 - Timber

Approximately 1255 acres of the Refuge can be classified under this model. This fuel type is characterized by mature black cottonwood stands that include a ponderosa pine component. Some areas are predominantly ponderosa pine. The understory is predominantly herbaceous vegetation, but some areas exhibit a heavy shrub understory as well.

C. Special Conditions and Trigger Points

An interagency team, headed by U.S. Forest Service staff in Missoula, monitors drought indices to determine when restrictions and closures are necessary to reduce chances of human-caused ignition. Restrictions and closures are implemented under the Southwest Montana Area Fire Restriction and Closure Plan (**Appendix G**). The Service Zone FMO contacts refuges in western Montana so that refuge managers can implemented these restrictions and closures. General criteria (trigger points) for closures are listed in **Table 12**. Other criteria

are listed in **Appendix G**.

Table 12. Criteria for fire restrictions and closures under the southwest Montana area fire restriction and closure plan (Appendix G).

Weather Criteria	Stage I Restrictions	Stage II Restrictions	Closure
ERCs (3-day avg)	90-94th percentile	95-97th percentile	98+ percentile
Live Fuel Moisture	$\leq$ 100	$\leq$ 75	$\leq$ 50
1000-hour fuels	$\leq$ 14	$\leq$ 13	$\leq$ 12

D. Effects of Fire on Vegetation

Effects of fire on predominant Refuge plant species can be found in **Appendix N**. Addition information concerning effects of fire on vegetation and other biotic resources can be accessed through the Fire Effects Information System (FEIS - http://www.fs.fed.us/database/feis/). FEIS provides up-to-date information about fire effects on plants and animals. It was developed at the USDA Forest Service Rocky Mountain Research Station's Fire Sciences Laboratory in Missoula, Montana.

E. Special Concerns

Suppression activities will be limited to existing roads whenever possible to minimize environmental damage and the spread of noxious and invasive plants. Firelines constructed by heavy equipment should not be located off roadways unless the fire is an imminent threat to human life, Service buildings, threatened or endangered species, or is about to spread onto private land. In order to protect nesting bald eagles, the dike road north of Pond 10 (MacDonald Pond) should not be used to access or control a wildfire without authorization from the refuge manager during the sensitive nesting period between February 1 and August 15 (USDI Bureau of Reclamation 1994). Fire retardants and foam will not be discharged into wetlands, but may be used to protect critical resources.

XII. ADDITIONAL OPERATIONAL ELEMENTS

A. Public Safety

Firefighter and public safety will always take precedence over property and resource protection during any fire management activity. Firefighter safety was covered previously. This section will deal with public safety.

Fire fronts on hillsides move rapidly and are dangerous. However, the Refuge is relatively flat; therefore, entrapment by public users is not considered to be a threat. The local law enforcement agency having jurisdiction will maintain order at the scene and enforce evacuation orders. Service personnel may assist with the evacuation process in cooperation with the law enforcement officer in charge. Public use areas adjacent to a wildfire will be closed until mop-up operations are complete or until, in the opinion of the refuge manager, the fire scene no longer presents a hazard to the Refuge visitors.

Smoke from a wildfire or prescribed burn could impair visibility on roads and highways, and become a hazard. During wildfires, the IC is will insure that traffic hazards from smoke are being managed. Actions to manage smoke include: use of road signs, pilot cars, or uniformed officers to direct traffic. During wildfires, the local law enforcement agency having jurisdiction is responsible for managing traffic hazards from smoke.

Wildfires which might escape from Service lands and spread to private property are also a concern. The IC is responsible for informing the Ravalli County Sheriff's Office if he/she believes that warnings or evacuations will become necessary.

B. Public Information and Education

Informing the public is an important part of fire suppression, fire prevention, and the Service mission. During wildfires occurring on Service lands, the refuge manager is responsible for providing fire information to the press and the public. The refuge manager may delegate this task as needed.

The following actions may be used to inform the public as part of the Refuge fire prevention and suppression program:

- Press releases
- Interviews with local media
- Signs and interpretive materials
- Attendance at local volunteer fire department meetings

Personal contact with bystanders

C. Fire Critique and Annual Fire Plan Review

1. Fire Plan Review

The fire management plan will be reviewed and updated annually to ensure the fire program advances and evolves with the Service policy and the Refuge mission. The fire management plan will be reviewed upon completion of the Comprehensive Conservation Plan and other land use planning documents to insure that goals and objectives identified in this plan reflect the goals and objectives of higher order plans.

2. Wildfire Critique and Review

Wildfires will be critiqued by the IC and documented on the DI-1202. The Zone FMO and the Regional Fire Management Coordinator or his designee will conduct formal fire critiques in the event of:

Significant injury/accident/death
Significant property or resource damage
Significant safety concerns are raised

3. Records and Reports

The assistant refuge manager will be responsible for the completion of a DI-1202 Fire Report as well as Crew Time Reports for all personnel assigned to an incident and return these reports to the refuge manager. The assistant refuge manager should include a list of all expenses and items lost on the fire and a list of personnel assignments on the DI-1202. The refuge manager will provide these data to the Zone FMO within 10 days after the fire is out so that they can be recorded into the FMCS computer database. The refuge manager will also inform the timekeeper of all time and premium pay to be charged to the fire and ensure expended supplies are replaced.

XIII. AIR QUALITY AND SMOKE MANAGEMENT GUIDELINES

Refuge staff are dedicated to the preservation of air quality and will abide by the Cooperative Smoke Management Plan for Montana as agreed to in the Montana Smoke Management Memorandum of Understanding dated July 31, 1978 (**Appendix F**). The objectives of this Agreement are to minimize or prevent the accumulation of smoke in Montana when prescribed burning is necessary and to develop a smoke management plan for reporting and coordinating burning operations on all forest and range lands in the state.

Visibility and clean air are primary natural resource values. The protection of these resources must be given full consideration in fire management planning and operations. Additionally, smoke can have serious health and safety effects which must be considered during planning and approval processes.

In general, air quality of the area is good during the burning season but become poor during the winter months when inversions are prevalent. The State of Montana requires permits for all open burning during the period September 1 to February 28.

The management of smoke will be incorporated into the suppression of wildfires whenever possible.

XIV. FIRE RESEARCH NEEDS

The Refuge has identified the need for a comprehensive vegetation monitoring program that can track changes in species composition and densities of herbaceous vegetation, shrubs, and trees. Such a program would collect valuable baseline data and track future vegetative responses to a wide variety of habitat management programs (e.g. noxious weed control and prescribed fire) and natural phenomena (e.g. flooding and wildfire).

XV. CONSULTATION AND COORDINATION

All fire management program activities will be implemented in cooperation and coordination with the MDNRC and rural fire protection districts. Other agencies and organizations will be consulted as needed.

General program consultation and coordination will be sought from the Zone FMO, Regional Fire Management Coordinator, Regional Prescribed Fire Specialist, and the National Interagency Fire Center (NIFC).

The following Service staff were consulted during the development of this plan:

Carl Douhan, Wildland Fire Planner (Contractor)

Jim Kelton, Regional Fire Management Specialist

Bob Rebarchik, Montana Zone FMO

Lee Metcalf National Wildlife Refuge Staff

XVI. LITERATURE CITED

Anderson, H. 1982. Aids to determining fuel models for estimating fire behavior. USDA Forest Service. General Technical Report INT-122. 22pp.

Andrews, P. L. 1986. BEHAVE: Fire behavior prediction and fuel modeling system--BURN subsystem, Part 1. Gen. Tech. Rep. INT-194. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 130pp.

Arno, S. F. 1976. The historical role of fire on the Bitterroot National Forest. Research Paper INT-187. USDA Forest Service.

Arno, S. F. 1980. Forest fire history in the northern Rockies. J. Forestry 78:460-465.

Arno, S. F. 1988. Fire ecology and its management implications in ponderosa pine forests. Pages 133-139 in D. M. Baumgartner and J. E. Lotan, eds., Ponderosa pine: The species and its management, Symposium Proceedings. Pullman, Wash.: Washington State Univ. Coop. Ext. Serv.

Freedman, J. D., and J. R. Habeck. 1985. Fire, logging, and white-tailed deer inter-relationships in the Swan Valley, Northwestern Montana. Pages 23-35 in J.E. Lotan and J.K. Brown, compilers. Proc. Symposium: Fire's effects on wildlife habitat. Gen. Tech. Report INT-186. USDA Forest Service.

Habeck, J. R. 1985. Changes in stand structure related to fire history in ponderosa pine/douglas-fir forests in Pattee Canyon, Missoula County, western Montana. Contract Completion Report 27-C-3-INT-132 to the USDA Forest Service.

Habeck, J. R. 1987. Present-day vegetation in the northern Rocky Mountains. Natural Areas Jour. 8:202-211.

Habeck, J.R. 1990. Old-growth ponderosa pine - western larch forests in western Montana: ecology and management. The Northwest Environ. Jour. 6:271-292.

Habeck, J. R., and R. W. Mutch. 1973. Fire-dependent forests in the northern Rocky Mountains. J. Quaternary Research 3:408-424.

Hansen, P .L., R. D. Pfister, K. Boggs, B.J. Cook, J. Joy, and D. K. Hinckley.

Classification and management of Montana's riparian and wetland sites. 1995. Montana Forest and Conservation Experiment Station. School of Forestry, The University of Montana. Miscellaneous Pub. No. 54.

Lunan, J. S. and J. R. Habeck. 1973. The effects of fire exclusion on ponderosa pine communities in Glacier National Park, Montana. Can. J. For. Research 3:574-579.

USDA Forest Service. 1997. Health hazards of smoke: recommendations of the April 1997 Consensus Conference. Sharkey, B.ed. Tech. Rep 9751-2836-MTDC. Missoula Technology and Development Center. Missoula, Montana. 84pp.

USDA Soil Conservation Service. 1951. Soil Survey: Bitterroot Valley Area, Montana. Series 1951, No. 4. 128pp.

USDI Bureau of Reclamation. 1994. Montana bald eagle management plan. Billings, Montana. 104pp.

XVII. APPENDICES

Appendix D. Plant species mentioned in the fire management plan.

Common name	Latin Name
Ponderosa Pine	*Pinus ponderosa*
Western Larch	*Larix occidentalis*
Black Cottonwood	*Populus trichocarpa*
Sandbar Willow	*Salix exigua*
Bebb Willow	*Salix bebbiana*
Mackenzie Willow	*Salix rigida*
Whiplash Willow	*Salix lasiandra*
Geyer Willow	*Salix geyeriana*
Douglas Hawthorne	*Crataegus douglasii*
Wood's Rose	*Rosa woodsii*
Common Snowberry	*Symphoricarpos albus*
Red-osier Dogwood	*Cornus sericea*
Tansy	*Tanacetum vulgare*
Spotted Knapweed	*Centaurea maculosa*
Canada Thistle	*Cirsium arvense*
Musk Thistle	*Carduus nutans*
Sulphur Cinquefoil	*Pontentilla recta*
Hound's Tongue	*Cynoglossum officinale*
Intermediate Wheatgrass	*Agropyron intermedium*
Western Wheatgrass	*Agropyron smithii*
Smooth Brome	*Bromus inermis*
Kentucky Bluegrass	*Poa pratensis*
Reed Canary Grass	*Phalaris arundinacea*
Common Cattail	*Typha latifolia*

Appendix H. Current Fire Staff and Employee Contact List

Current Staff Available to Meet Position Needs (2001).

EMPLOYEE	PRESCRIBED FIRE	AVAILABILITY STATUS	WORK CAPACITY SCORE
Gillund, David	FFT2	**Available**	**ARDUOUS**
Browder, Sharon	**RXB3** **FFT2**	**Available**	**MODERATE**
Miwa-Vogan, Emily	**FFT2**	**Available**	**MODERATE**
McDonald, Sue	**FFT2**	**Medically Disqualified**	**ARDUOUS**
Henry, Calvin	**ENOP**	**Available**	**LIGHT**

Employee Contact List (2001).

EMPLOYEE	WORK PHONE	HOME PHONE	RADIO CALL NUMBER
Gillund, David	**406-777-5552 x205**	**777-9814**	**L1**
Browder, Sharon	**406-777-5552 x204**	**642-3209**	**L4**
Miwa-Vogan, Emily	**406-777-5552 x202**	**777-1275**	**L9**
McDonald, Sue	**406-777-5552 x203**	**777-2571**	**L7**
Henry, Calvin	**406-777-2062**	**777-4178**	**L2**

Appendix J. Step Up Plan

Staffing Class	Burning Index	Step-up Action
SC-1	0-?	-Normal tour of duty exists for all staff. -Set up and provide training (refresher and Initial Attack [IA]) for all staff interested in participating in fire suppression actions. -Perform fireline, fuel break, and road maintenance. -Prescribed burning occurs as necessary
SC-2	?-?	-Same as SC-1.
SC-3	?-?	-All SC-1 actions and conditions noted below. -Begin monitoring Regional Daily Situation Reports and notify the State of Montana (Local District Office) of possible fire danger and refuge needs. -Available fire qualified staff have PPE ready to respond to wildfire report.
SC-4	?-?	-Continue with all SC-1,2,3 actions with further conditions noted below. -Fire vehicles are fire ready to respond to wildfire report. -Refuge implements Southwest Montana Area Fire Restriction Plan (see Appendix ?, for details). Stage 1 or Stage 2 fire restrictions may be implemented depending on conditions. -All prescribed fire activity requires Regional Office and area MAC group approval.
SC-5	97th% +	-Continue with all SC-1,2,3,4 actions with further conditions noted below. -Coordinate Emergency Preparedness Funding requests with the State DNRC to provide capability needed to handle fire conditions. -Implement Stage 2 fire restrictions. Establish OT schedules as necessary for all staff to meet required IA needs or ensure that the State DNRC has Refuge manning needs covered.

Appendix K. Communication Plan

System	Channel		Function	Frequency				Assignment
	King	Other		Tx	Rx	TxCG	RxCG	
Refuge	1		Refuge Burn Operations	170.050	170.075			All
Refuge	4		All Valley Fire	154.445	154.445			All
Refuge	12		National Weather Service		162.400			All
Refuge	13		Ravalli County Sheriff	155.415	155.415			All

Appendix N. Fire effects on predominant plant species at Lee Metcalf National Wildlife Refuge

Predominant species are discussed. All accounts are taken verbatim from the Fire Effects Information System database (FEIS - http://www.fs.fed.us/database/feis/).

Ponderosa Pine *(Pinus ponderosa var. scopulorum*)

FIRE ECOLOGY OR ADAPTATIONS : Interior ponderosa pine depends on frequent surface fires to maintain stand health and stability . Consequently, interior ponderosa pine communities may have evolved flammable properties to encourage recurrent, low-intensity burning. The resinous needles provide an abundant, annual source of highly flammable fuel, with yearly accumulations in dense stands exceeding 3,500 pounds per acre (3,120 kg/ha). Despite such characteristics, fire frequencies for interior ponderosa pine under natural fire regimes vary greatly according to site conditions and geographical area. Fire has been a major ecological force in the pine forests of the Southwest. Results of fire scar analysis indicate that prior to 1876, fires occurred an average of every 2 years in northern Arizona. Stands farther north have also been significantly influenced by fire. Average fire frequency in the Black Hills of South Dakota was estimated at 10 to 25 years. Pine forests in Wind Cave National Park have burned every 13 to 21 years. In the Sandhills of Nebraska, outlying stands of interior ponderosa pine have been restricted to river canyon walls by fires which averaged every 3.5 years between 1851 and 1900. In the central Rockies, however, the average mean fire interval is somewhat longer, perhaps because the more open nature of these stands results in less litter accumulation to carry fire. Interpretation of fire scar data from interior ponderosa pine stands in the Front Range of Colorado indicated that prior to 1840, stands had a mean fire interval of 66 years. Study sites exhibited a variable fire regime; small fires burned every 20.9 years, and large fires occurred an average of every 41.7 years. In most cases these figures are thought to be conservative estimates; intervening light ground fires may have occurred without scarring trees. Interior ponderosa pine has developed a number of adaptive traits which help to minimize fire damage to tissues. Thick, exfoliating bark and a deep rooting habit make large trees tolerant of most ground fires. Mature trees tend to self-prune lower branches, thereby spatially separating foliage from burning ground fuels and reducing the potential for crown fires. Crown fires are further discouraged by long needles which are loosely arranged within an open-structured crown. In addition, the foliar moisture content of this tree is relatively high (28 to 36%). Trees burned during the dormant season are often able to survive extensive crown scorch damage because buds are large and enclosed within thin, insulative bud scales. Fire creates a favorable seedbed for interior ponderosa pine by exposing bare mineral soil and removing competing vegetation. However, postburn establishment is successful only when a good seed crop coincides with above average rainfall.

IMMEDIATE FIRE EFFECT ON PLANT: The effect of fire on interior ponderosa pine is generally related to tree size, fire intensity, and tree density. Low-intensity fires readily kill seedlings less than 12 inches (30 cm) in height. Larger interior ponderosa pine seedlings can sometimes survive heat generated by low-intensity surface fires, especially dormant-season fires. Larger seedlings, saplings, and pole-sized trees are damaged but not killed by low-intensity fires. Beyond the pole stage, interior ponderosa pine is quite resistant to the majority of ground fires. Heat from fire can damage foliage, buds, cambium, and roots, although fire damage to roots is usually a factor only in very young trees, due to the deeply rooted nature of this tree. In most cases, larger trees can withstand proportionally greater crown and stem damage than smaller trees because their thicker bark affords better insulation against cambial damage, and because their height elevates foliage and buds some distance from the flame zone. Site index can also affect postburn mortality of interior ponderosa pine. Young, fast-growing trees on good sites

typically survive fire better than overmature, slow-growing trees on poor sites. Trees producing heavy cone crops are more prone to mortality because nutrients are diverted to cone development and maturation rather than to recovery.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT: Postburn mortality of interior ponderosa pine varies considerably depending on the extent of crown and bole damage. However, the exact relationship between the extent of fire damage (bole and crown) and mortality is not well understood. Damage to cambium is a more important factor in postfire mortality in small-diameter classes, and crown damage more important in pole-sized and larger trees. Bole damage: Interior ponderosa pine's resistance to fire is due in large part to the early development of thick, exfoliating bark that insulates the cambium from excessive heat damage. Besides being relatively nonflammable, pine bark does not conduct heat readily because of its low density and low moisture content. Bark on some old-growth trees may be 3 or more inches (6+ cm) thick. Lethal exposure time (minutes) is approximately equal to 3 times the squared bark thickness in centimeters, or 2 times the squared bark thickness in inches. Doubling the bark thickness increases the lethal exposure time by a factor of four. Diameter increases alone have a significant impact on the partitioning of heat around the stem. Cambial damage is most likely to occur when high-intensity fires are maintained at the base of a tree. Cambium must be completely girdled in order to kill trees, making smaller trees more susceptible to mortality. Trees only partially girdled have a good chance of survival. Trees can tolerate basal girdling of less than 25 percent if crown and root damage are minimal. As the extent of girdling increases and larger patches are killed, even those trees with less than 60 percent crown scorch (high survival potential) are likely to succumb. Damage which occurs more than several feet up on the bole appears to increase postburn mortality more than a similar amount of damage near the base. Cambial damage is rather inconspicuous initially, and charring of the bark is usually a poor indicator of its occurrence. Thin-barked trees may be killed without any external sign of charring, whereas thick-barked trees may be extensively charred but sustain only slight damage. Narrow strip killing beneath deep bark crevices is the most common form of cambial damage. An immediate assessment of cambial damage can be made by checking areas where stem charring is most severe. Healthy cambium is somewhat moist and cream colored, whereas dead cambium is dry, brown or gray, and has a sour, fermented smell. The first external sign of cambial damage is often large amounts of pitch exuding from the fringes of deeply charred bark. Another indication is an abrupt change in the pattern of bark beetle borings. Callus formation around the killed cambium eventually causes the bark to fall away, exposing sapwood. The bark may begin to loosen and slough within days to weeks on thin-barked trees, but this process may take several years on thick-barked trees. Flammable resin accumulations around the wound make these areas highly susceptible to subsequent fire damage. The occurrence of fire before the wound has entirely healed results in the formation of a fire scar or "cat face". Repeated fires tend to enlarge fire scars. Trees are highly susceptible to fire mortality if existing scars exceed 25 percent of the base circumference. Otherwise, if the exposed sapwood of existing scars is sound, fire does not have a measurable impact on survival. If the wood is rotten or infested with insects, however, the tree will probably burn through at the base. Following prescribed fire, an estimated 1 percent of trees previously scarred by fire will probably fall over. Crown damage: Crown scorch is widely considered to be the principle cause of pine mortality following fire. Crown scorching generally weakens the tree, but mortality is usually negligible in healthy, vigorous trees when less than 30 percent of the crown length is killed. The literature contains highly variable reports on the extent of crown scorch damage trees can sustain . Following prescribed burns in Colorado, Harrington reported that up to 90 percent scorch damage resulted in minimal mortality in trees that had sustained crown damage only. The author cautioned, however, that mortality would be likely if such extensive damage were combined with some degree of bole damage. Sixty-one percent of trees sustaining 100 percent scorch during fall burning survived. Although crown scorch damage is important, numerous studies indicate that bud kill is even more crucial than crown scorch in determining the survival potential of fire-damaged trees. Buds

of interior ponderosa pine are large and protected by heavy bud scales that have lethal temperatures 68 degrees Fahrenheit(20 deg C) higher than that of needles. Consequently, extensive scorching of pine foliage sometimes occurs with only light damage to buds and twigs, allowing vigorous trees to maintain shoot growth on defoliated branches. Some trees can sustain scorch damage of up to 90 percent as long as 50 percent of buds and twigs survive. The preburn condition of a tree strongly influences survival potential. Immature, fast-growing trees generally tend to survive the same proportion of scorch better than older, slow-growing trees. Young interior ponderosa pines have a high chance of surviving 100 percent crown scorch if 20 percent of the buds survive; older trees will survive the same damage if 40 percent of the buds survive. The height of bud kill also influences the survival potential of trees by reducing the crown ratio. Ryan recommends maintaining a crown ratio of 30 and 40 percent in vigorous young trees and older, mature trees, respectively. Season of burn: Interior ponderosa pine usually survives fires during the dormant season, largely because insulating scales form once leader growth stops and because dormant-season fires are usually relatively cool. Trees are least resistant to thermal damage during early spring and most resistant in the fall when dormant. Trees can withstand up to 50 percent crown scorch from fall burning but only 30 percent crown scorch from spring burning.

PLANT RESPONSE TO FIRE: Postfire seedling establishment: Postfire regeneration of interior ponderosa pine is exclusively through seed. Foliage-scorched trees are an important seed source for postburn reestablishment. Although seed trees may not live longer than two postfire seasons, juvenile cones continue to mature on trees with less than 66 percent of the live crown scorched. These seeds are generally highly viable. Fire encourages natural regeneration by exposing mineral soil and removing litter accumulations and competing vegetation. The degree to which interior ponderosa pine depends on fire to prepare suitable seedbeds may vary according to geographic region. Southwest - Fire has played a dominant role in the ecology of interior ponderosa pine in the Southwest. Fire creates optimal conditions for germination and establishment of this species and may alleviate some of the problems associated with the early stages of seedling establishment (See Regeneration slot). Following prescribed burning of uneven-aged stands of interior ponderosa pine in the Southwest, Sackett observed that the majority of seeds germinated where fire had eliminated either all or part of the forest floor. Fifty-eight percent of seed germination occurred on mineral soil seedbeds, while only 39 percent occurred where the L-layer or the L- and F-layers were consumed. (See Fire Case Study #1 for a breakdown of seedbed characteristics in relation to forest floor consumption.) Initial establishment after prescribed burns in Arizona was excellent and was attributed not only to the creation of mineral soil seedbeds but also to improved moisture relations, more favorable soil temperatures, and increased availability of nutrients. This series of studies indicated that fire behavior and ecosystem responses varied greatly between sites dominated by patches of saplings, poles, and sawtimber. The most pronounced changes were observed on sites beneath mature sawtimber where fuel loadings were almost completely consumed during burning. Seedlings were usually concentrated in areas beneath mature pines where heavy fuels had accumulated; almost no seedlings became established on unburned controls. Increased nutrient availability on burned sites may be a significant factor in producing seedlings vigorous enough to withstand the combined environmental stresses of fall drought, 1st year frost heaving, and subsequent spring drought. Ultimately, however, substantial seedling losses occurred on these sites because of subsequent interval burning, drought, frost heaving, and animal browsing. Black Hills - Interior ponderosa pine regenerates prolifically in the Black Hills. Fire exposes bare mineral soil and no doubt further enhances seedling establishment in this area. Central Rockies - Along the Front Range, interior ponderosa pine seedling establishment on low-elevation woodland sites tends to occur episodically. On these dry sites, good seed crops during favorable moisture years may be more responsible for seedling establishment than fire. Litter buildup on these sites is typically light, resulting in infrequent fires and an abundance of exposed mineral soil seedbeds. Although fire undoubtedly influences the interval between periods of successful regeneration, it is

probably not solely responsible for the episodic regeneration characteristic of this area. Postfire growth and recovery: Since crown scorch damage decreases photosynthesis, generation of new needle tissue is necessary for recovery. On sites in Colorado, crown condition improved after 2 years in 74 to 91 percent of trees in each of five damage classes. Wyant and others reported that in Colorado prescribed fall underburning did not substantially affect the physiological processes of dormant buds. In fact, the postfire environment was highly conducive to crown growth. Mean fascicle lengths and length and diameter of bud shoots produced during the first postburn growing season were substantially greater on burned than on unburned plots. The authors of this study speculated that crown growth would be enhanced for at least two postburn seasons. The response of interior ponderosa pine after burning is not well understood or documented. Underburning may enhance the water status of individual trees by reducing understory competition and by decreasing transpiration loss by reducing crown surface area, thereby increasing the total moisture available to the remaining crown. Furthermore, if water supplies are adequate, tree growth is enhanced by the higher air and soil surface temperatures associated with burned areas. On sites where underburning was used to thin stands, reduction in understory competition resulted in increased diameter and height growth of pine. Interior ponderosa pine growth is severely limited by low nitrogen availability. Accumulation of litter is often cited as the cause of retarded organic nitrogen mineralization on many pine sites. Usually there is a net postburn loss of total nitrogen from the forest floor, but a concomitant postburn increase in available soil inorganic nitrogen is often reported. These postburn nitrogen surges generally benefit tree growth.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE: Underburning in interior ponderosa pine stands can release substantial amounts of nutrients bound up in surface organic matter. On sites in the Southwest, fall prescribed fire often reduces organic debris by 28 to 37 percent. Increased microbial activity immediately following prescribed burning may further reduce forest floor debris. Covington and Sackett indicated that microbial mineralization was probably responsible for decreasing forest floor organic matter by an additional 440 grams per square meter within 7 months of a prescribed burn, thereby reducing fuels without nutrient volatilization. Refer to Covington and Sackett and Ryan and Covington for further details.

FIRE MANAGEMENT CONSIDERATIONS : Repeated prescribed underburns can be used to thin interior ponderosa pine and maintain open stocking of trees. Such burns would reduce numbers of seedlings, remove dense understories in sapling- or pole-sized stands, and thin low-vigor overstory trees. In the absence of fire, overstocked seedling patches usually develop into "doghair" thickets of interior ponderosa pine saplings. Trees in these stands are less vigorous and more susceptible to mortality from low-intensity fires than trees in more open stands. Fire exclusion has profoundly influenced the stability of interior ponderosa pine stands. Covington and Sackett listed the following management problems associated with reduced fire frequencies: (1) overstocked sapling patches (2) reduced growth (3) stagnated nutrient cycles (4) increased disease, insect infestations, and parasites (5) decreased seedling establishment (6) increased fuel loadings (7) increased vertical fuel continuity due to dense sapling patches (8) increased severity and destructive potential of wildfires

Black Cottonwood (*Populus trichocarpa*)

FIRE ECOLOGY OR ADAPTATIONS: Black cottonwood is highly susceptible to fire damage because of its thin bark and relatively shallow root system. After 10 to 20 years, the bark may become thick enough to afford some fire protection.

IMMEDIATE FIRE EFFECT ON PLANT: Seedlings and saplings are usually killed by fire of any intensity. Mature trees may survive low-intensity fires, and portions of the plant may survive fires of moderate intensity. Trees of all ages are killed by high-intensity fire. Fire wounds

on mature trees, acting as points of entry, may facilitate the onset of heartwood decay, which can lead to substantial mortality.

PLANT RESPONSE TO FIRE: Black cottonwood can sprout from the stump following top-kill by fire. Black cottonwood also has the ability to sprout from the root, but this regenerative activity following fire has not been documented. Fire can create conditions favorable for seedling establishment. It thins the overstory, allowing light to penetrate, and exposes bare mineral soil. Postfire establishment via off-site seed is possible if soil moisture is adequate.

Douglas Hawthorne (*Crataegus douglasii*)

FIRE ECOLOGY OR ADAPTATIONS: Douglas hawthorn is fire tolerant. This tree has a shallow and diffuse root structure that allows for sprouting and sucker-rooting following the destruction of aboveground parts.

IMMEDIATE FIRE EFFECT ON PLANT: Both high- and low-severity fires will consume the aboveground parts of Douglas hawthorn.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT: The structural configuration of Douglas hawthorn limbs makes it highly flammable due to the sheltering of dry grasses and twigs. These fuels may create a "ladder" for fire to be carried up to the crown, destroying the entire thicket.

PLANT RESPONSE TO FIRE: The range of Douglas hawthorn is limited by fire. Removal of the plant may require years of growth for full reestablishment. Frequent fires may confine Douglas hawthorn plants to dense thickets.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE: Daubenmire hypothesized that the expanded range of Douglas hawthorn stands in eastern Washington was the result of improved agricultural cropping practices which exclude stubble burning. Douglas hawthorn thickets have redeveloped from stump sprouts as the number and size of fires have decreased.

Bebb Willow (*Salix bebbiana*)

FIRE ECOLOGY OR ADAPTATIONS: Bebb willow is greatly favored by fire in most habitats. It will sprout rapidly from basal stems following disturbance. It has small, extremely light seeds capable of dispersing over long distances.

IMMEDIATE FIRE EFFECT ON PLANT: Fire will kill aboveground parts of Bebb willow. High-severity fires can completely remove organic layers and leave charred roots of willow exposed, thus eliminating basal sprouting.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT: Spring and fall prescribed burns in a Minnesota prairie killed aboveground portions of Bebb willow. In wet habitats, fire killed the tops of Bebb willow but did no apparent harm to underground parts.

PLANT RESPONSE TO FIRE : Bebb willow will sprout vigorously from the basal stem following fire. Quick hot fires will maximize sprouting. The light seeds readily colonize exposed mineral soil after hot fires. Bebb willow usually becomes the dominant species in willow stands that follow forest fires on upland sites and in thickets adjacent to streams, swamps, and lakes of interior Alaska. The degree to which this species invades after fire, however, depends on the time of year, weather, and presence of a mineral seedbed. A wet period after seed dispersal allows for germination, but a dry period can cause enough seed viability loss to prevent germination. The chance of Bebb willow establishing after a fire lessens as available mineral soil seedbeds become occupied by faster growing herbaceous species and mosses.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE: Following a low-severity August evening burn in central Saskatchawan, revegetation started within a few days. By the sixth growing season, alder (Alnus spp.), Bebb willow, and aspen (Populus spp.) were the dominant broadleaf species. Bebb willow was common in the moss-herb stage 2 to 5 years after fire on white spruce (Picea glauca) dominated sites in Alaska and persisted through the shrub and tree stage 6 to 25 years after fire. Bebb willow density declines in these stands as more shade-tolerant species become established.

FIRE MANAGEMENT CONSIDERATIONS: Prescribed burning is a common wildlife management tool used to rejuvenate decadent Bebb willow communities.

Wood's Rose (*Rosa woodsii*)

FIRE ECOLOGY OR ADAPTATIONS: Wood's rose is moderately fire tolerant and is usually favored by low-severity fire. It can persist after low- to moderate-severity fire because of its ability to sprout from undamaged or buried root crowns and rhizomes. It occasionally germinates from on-site or off-site seed sources after fire.

IMMEDIATE FIRE EFFECT ON PLANT: Wood's rose is typically top-killed by fire. Root crowns and underground rhizomes survive low- or moderate-severity fires. However, the shallow root crowns of Wood's rose are susceptible to injury, and populations consequently decrease following high-severity fire.

PLANT RESPONSE TO FIRE: Wood's rose recovery varies with fire severity. Top-killed plants will sprout from the root crown and underground surviving rhizomes. Reproduction from seed is rarely observed after fire. When seedlings are observed in a burn area, their rate of growth is slow compared to that of other species.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE: Wood's rose doubled in abundance by postfire year 2. Following a moderate- to high-severity fire at Manning Basin northeast of Montpelier, Idaho, Wood's rose recovered to near preburn densities by postfire year 2. The first growing season after a spring burn in an aspen-conifer stand, west Boulder River, Montana, the density per acre of Wood's rose showed significant increase. The average height for Wood's rose following the first postburn growing season was about half or less of their average preburn height. One year following a high-severity fire in a northern Arizona ponderosa pine forest, postfire biomass of Wood's rose was only about 0.25 that of prefire levels.

Common Snowberry *(Symphoricarpos albus*)

FIRE ECOLOGY OR ADAPTATIONS: Common snowberry is classified as a "survivor" and has high resistance to fire. It is a rhizomatous species with rhizomes buried 2 to 5 inches (5-12.5 cm) deep in mineral soil. After fire has killed the top of the plant, new growth sprouts from these rhizomes. This rhizomatous growth response is highly variable and depends on conditions at specific sites. Regeneration from buried seed is favored by fires of low severity and short duration that remove little of the soil organic level. Common snowberry occurs in a wide variety of community/habitat types and plant associations. There are many fire regimes included within these plant communities.

IMMEDIATE FIRE EFFECT ON PLANT: Common snowberry is top-killed by fire, but below ground parts are very resistant to fire. Variable response to fire has been reported but in general, light- to moderate-severity fires increase stem density, and common snowberry survives even severe fires. To eliminate rhizomatous sprouting, fire intensity must be severe enough to kill the roots and rhizome system.

PLANT RESPONSE TO FIRE: Common snowberry, as a rhizomatous sprouter, is among the

first to recolonize a site after fire. Growth in the 1st postfire year varies, but is generally considered to be good. With light to moderate soil disturbance, reprouting will return common snowberry coverage in a year and common snowberry may produce fruit the 1st year. Sprout height can reach one-half to three-fourths of preburn stem height in the 1st year and equal preburn height in 4 years. Another source states common snowberry will grow 1 foot (0.3 m) the 1st year. Cover and volume measurements consistently exceed preburn values the 2nd year and canopy cover of common snowberry increases rapidly to a maximum in 3 to 5 years after a fire and may maintain this increased coverage. Fire severity and soil moisture content at time of burning may determine damage to the rhizome and root system of common snowberry and be responsible for variation in recovery response.

FIRE MANAGEMENT CONSIDERATIONS: Common snowberry is one of the first species to recolonize a postburn site. New growth provides forage and often bears increased fruit crops. Cover is provided for small wildlife species and lush vegetation can protect soil surfaces from splash erosion, but can also offer severe competition to new tree seedlings. The living rhizome systems can be important in retaining nutrients released by fire. One study found that planting grass seed to control erosion reduced coverage of common snowberry and other native shrubs on several burned sites in Oregon. In Saskatchewan, to burn common snowberry it is recommended waiting 4 days after heavy rains. In addition, if spring burning, a minimum temperature of 55 degrees Fahrenheit (13 ^{o}C), wind speed of 2-12 mi hr^{-1} (3-19 km hr^{-1}), and a maximum relative humidity of 50% is suggested. After burning, a 2-year wait is needed to build up enough fuel to burn again. Common snowberry may be susceptible to frequent burning. If planting common snowberry, prompt, early spring planting is required or it may experience moisture stress in the short term. Common snowberry has a low surface to volume ratio and will have a high flammability if there are many dead stems. It is capable of producing firebrand material. When located near fire control lanes, it should be red-flagged as spot fire potential.

Red-osier Dogwood (*Cornus sericea*)

FIRE ECOLOGY OR ADAPTATIONS: Red-osier dogwood is able to sprout from surviving roots or stolons and from the base of aerial stems following fire. It can be killed by severe fires which cause extended heating of the upper soil. Red-osier dogwood is considered to be a semi-fire-tolerant, seed-banking species. Light fires which partially remove the duff stimulate germination of buried seed. In a northern Idaho grand fir (Abies grandis) forest seed bank study, red-osier dogwood seed was found in the top 2 inches (5 cm) of soil; however, viability was low (4%) . In another postfire soil germination study, all red-osier dogwood plants were sprouts from root fragments.

IMMEDIATE FIRE EFFECT ON PLANT: Aboveground foliage of red-osier dogwood is usually killed by fire. However, the roots will survive all but the most severe fires which remove the duff and heat the upper soil for extended periods.

PLANT RESPONSE TO FIRE: Red-osier dogwood generally increases following fire, and it may invade a recently burned area from adjacent unburned areas. It may take some time before resprouting red-osier dogwood regains its former cover and volume. A Montana study in aspen found that 2 years after prescribed burning red-osier dogwood resprouts had attained 72 percent of their prefire cover and 54 percent of their prefire volume, while density was back to prefire levels. In moist forests of British Columbia, red-osier dogwood appears to increase in abundance following logging and burning. It established in a logged and burned Manitoba black spruce (Picea mariana) stand by the fifth postfire year. On Minnesota black spruce sites most fires stimulate sprouting of red-osier dogwood, although severe fires favor tree seedlings. A study in the cedar-hemlock (Thuja spp.-Tsuga spp.) zone of northern Idaho found no red-osier dogwood in closed stands. It established with very slight frequency (1%) in logged stands without fire; somewhat higher frequency (5%) in areas with both single and multiple broadcast burns; and

highest frequency (12%) in areas that were piled and burned. In a northwestern Montana subalpine fir/queencup beadlily (Abies lasiocarpa/Clintonia uniflora) habitat type, red-osier dogwood cover was highest (15%) in stands that had burned 35 to 70 years ago and very low in clearcuts (0-1.4%) whether dozer piled or not. In Wisconsin shrub-carrs (wet ground tall-shrub communities) light to medium fires cause resprouting in red-osier dogwood and serve to maintain the shrub-carr. Following prescribed burning in central Wisconsin shrub-invaded sedge meadows, red-osier dogwood resprouted and was favored over other shrubs.

FIRE MANAGEMENT CONSIDERATIONS: In the northern Rockies red-osier dogwood is a common member of the seral brushfields which occur following fire and compete with tree seedlings. In order to reduce brushfields on sites that are away from streams and floodplains, the use of logging methods which cause a relatively high amount of site disturbance followed by a fire which removes most of the soil organic horizons is recommended. In northwestern Montana, clearcutting alone apparently dislodged enough roots of red-osier dogwood so that few plants were able to sprout. Postfire sprouts in the early stages of growth are the most valuable for beaver. Following fire in Minnesota, red-osier dogwood became more important to moose and white-tailed deer, even though it grew only near streams and was not abundant within the burn.

Spotted Knapweed (*Centaurea maculosa*)

FIRE ECOLOGY OR ADAPTATIONS: Spotted knapweed probably resists low-severity fire because of its stout taproot. Spotted knapweed probably colonizes after fire from seeds buried in soil or from off-site sources.

IMMEDIATE FIRE EFFECT ON PLANT: Low-severity fire probably top-kills spotted knapweed. Buried seeds probably remain undamaged by most fires.

PLANT RESPONSE TO FIRE: Spotted knapweed shows moderate increases after fire. Established plants may regrow and/or buried seed may germinate after fire. In the Lick Creek drainage of the Bitterroot National Forest, Montana, shelterwood cuts in dry Douglas-fir and ponderosa pine communities showed increases in spotted knapweed after prescribed spring fires on both wet and dry duff. On the wet burn site, spotted knapweed prefire cover was 0.5 percent and postfire cover was 1.0 percent. On the dry burn site, spotted knapweed prefire cover was 1.9 percent and postfire cover was 3.6 percent. On a western Montana site prescribed burned in the fall, prefire spotted knapweed herbaceous volume was 238 cubic feet per acre. There were 0.57 to 1.21 tons per acre of fine (0-0.25 inch class) fuel. The fire had a rate of spread of 805 to 1,126 meters per hour, and flame height of 8 to 10 feet (2.4-3.1 m). Knapweed was not present in postfire year 1, but was present at 476 cubic feet per acre herbaceous volume in postfire year 2. Spotted knapweed has been reported on burned sites several years after wildfires. Spotted knapweed appeared on site in western Montana 3 to 5 years after a severe wildfire. Spotted knapweed was present on a burn 3 years after a wildfire in the White Cap Wilderness, Idaho. The presence or absence of spotted knapweed in the prefire vegetation of either wildfire was not reported.

FIRE MANAGEMENT CONSIDERATIONS: Spotted knapweed infests areas at the rural-urban interface. Fire in spotted knapweed-infested fields may burn severely or not at all, depending on fuel load and continuity. The fire severity depends on the amount of dry knapweed stems and the amount of fine grass fuels. A fuel model has been developed for spotted knapweed. The fuel model uses three components for calculating fuel load: old standing knapweed on site for at least one winter, newly grown knapweed, and litter and fine grasses. Independent variables are litter depth and cover and spotted knapweed plant height and percent canopy cover. If short, fine grasses have greater than 40 percent canopy cover, a short grass fuel model should be used instead. In order to ensure that fires carry in spotted knapweed, they should be conducted in early spring prior to grass and forb growth. Early April test fires in spotted knapweed fields did not burn completely because of low wind speed and high moisture content of early growth by grasses and forbs. The spotted knapweed fuel model predicts flame

heights for windspeeds less than 2.5 miles per hour (4 km/hr) to be less than 4 inches (10 cm) which is probably too low for fire to carry. In preliminary field tests of the fuel model, flame heights ranged from 1 to 4 feet (0.3-1.2 m) at wind speeds ranging from 3 to 8 miles per hour (5-13 km/hr). The average moisture content of spotted knapweed is presented for different developmental stages during the summer in Montana. Prescribed burning alone is probably not effective for controlling spotted knapweed and may cause increases, but prescribed burning may be useful in conjunction with herbicides. In Montana, Carpenter tested the possibility that burning may reduce herbicide interception by old spotted knapweed stems and may increase seed germination, increasing the effectiveness of subsequent herbicide treatment. However, burning did not increase herbicide effectiveness. The April fire was followed by an unusually dry period so spotted knapweed did not germinate prior to the May herbicide treatment. Using prescribed fire to reduce big sagebrush (Artemisia tridentata) in semiarid grasslands may expose sites to invasion by spotted knapweed.

Canada Thistle *(Cirsium arvense*)

FIRE ECOLOGY OR ADAPTATIONS: Canada thistle survives fire due to the presence of perennating buds located on an extensive underground root system. It invades burned areas via wind-dispersed seed.

IMMEDIATE FIRE EFFECT ON PLANT: Fire top-kills Canada thistle. Prescribed fires were conducted in Oregon on December 10 and April 7 of the same year. Canada thistle was dormant at the time of burning, but dense patches of the previous year's growth were completely consumed by the fire.

PLANT RESPONSE TO FIRE: After top-kill, plants resume growth from perennating buds located on the roots. Total herbage production was unaffected following winter and spring prescribed fires in Oregon. Although there were fewer mature plants, the high density of new vegetative shoots compensated for the loss in herbage production. Patches of Canada thistle were reduced in Minnesota after 4 years of consecutive spring burning of low to moderate intensity. Density and aboveground biomass were unchanged after a spring fire (May, before growth began) and increased after both summer (August, peak of growth) and fall (October, winter dormancy) fires in Manitoba. The increase on the fall fire was lower than on the summer fire. Fewer total and functional flower heads were produced following dormant-season winter and spring fires. Flowering activity was also inhibited following a May fire in Minnesota.

FIRE MANAGEMENT CONSIDERATIONS: Prescribed spring burning may be a useful means of slowing the spread of Canada thistle. Spring fire would reduce the number of mature plants. They would also reduce the number of functional flower heads, resulting in lower seed production and a slow-down in the spread of new plants. Dormant-season fire is also beneficial to many native grass species, which would make stands more productive. Increased grass production would interfere with Canada thistle growth and reproduction, and possibly decrease its spread.

Kentucky Bluegrass *(Poa pratensis)*

FIRE ECOLOGY OR ADAPTATIONS: During grassland fires, the fire front passes quickly and temperatures 1 inch (2.5 cm) below the soil surface rise very little. During a late April prescribed fire in an oak savanna in Minnesota, where Kentucky bluegrass formed an almost complete sod between bunches of native tallgrasses, temperatures immediately below the soil surface rarely exceeded 125 degrees Fahrenheit (51 deg C). Located a couple of inches below the soil surface, Kentucky bluegrass rhizomes survive and initiate new growth after aboveground plant portions are consumed by fire. Although the plant survives because of soil-insulated rhizomes, postfire plant vigor and density are greatly affected by phenological stage at time of

burning (see Fire Effects On Plant). Seedling establishment is unimportant in immediate postfire recovery. However, burning may enhance seed germination of Kentucky bluegrass during the second postfire growing season. On an Iowa prairie codominated by big bluestem (Andropogon gerardii var. gerardii), indiangrass (Sorghastrum nutans), and Kentucky bluegrass, Kentucky bluegrass seedlings were more abundant in 1986 on plots burned in May, June, August, or November of 1985 than on unburned plots.

IMMEDIATE FIRE EFFECT ON PLANT: Plant phenological stage at time of burning greatly influences fire damage to herbaceous plants. In general, as new foliage of perennial grasses reaches full development major food reserves have been depleted, so that plants are injured most from fires occurring at this time. Because Kentucky bluegrass is a cool-season grass, active in the spring and fall, it is most susceptible to fire damage at those times. Late spring fires, after plants have been growing for about a month or more, are the most damaging to Kentucky bluegrass. Sampling at the end of the first growing season after late spring burning shows that Kentucky bluegrass basal cover and tiller density are typically much lower in burned areas than in nearby unburned areas. Cool fires conducted when plants are dormant have little effect on Kentucky bluegrass.

PLANT RESPONSE TO FIRE: Kentucky bluegrass's fire response varies greatly depending on season of burning, fire frequency, and postfire precipitation and soil moisture. Season of burning: Kentucky bluegrass postfire cover, biomass, and flower stalk density are often greatly reduced during the first postfire growing season by a single late spring fire. Three examples are presented to demonstrate rather typical first-year responses to late spring burning: (1) in mixed-grass prairie unburned for several years in north-central Nebraska, a single prescribed fire in mid-April or mid-May greatly reduced Kentucky bluegrass basal cover in October, with cover on burned plots only half that found on unburned plots, (2) after a single mid-April fire on a tallgrass prairie site unburned for several years in Iowa, Kentucky bluegrass relative biomass decreased from 80 percent to 25 percent during the first postfire growing season, and (3) in the mountains of western Montana, Kentucky bluegrass frequency was reduced 27.5 percent by a single late May fire in a sagebrush/bunchgrass habitat type. Kentucky bluegrass biomass production and density may be unaffected or increase after burning at other times of the year, such as early spring, summer, or fall. It consistently recovers more quickly from burning at these times of year than from burning in late spring. In fields dominated by cool-season grasses in Wisconsin, Kentucky bluegrass was reduced to one-fifth of its original density after 6 years of annual burning in May; annual burning in March or October did not affect Kentucky bluegrass density. A different study in Wisconsin showed that flower stalk density was reduced 70 percent by three annual mid-May prescribed fires but was slightly increased by annual burning in late March or early April. Although summer grass fires can be relatively intense, Kentucky bluegrass is dormant at this time. It may not be harmed by summer burning, and if precipitation is favorable, it may even increase. In mixed-grass prairie in north-central South Dakota, Kentucky bluegrass frequency increased or remained unchanged on uplands burned in early August followed by a wet spring, but decreased on uplands burned in summer following a dry spring. Kentucky bluegrass's density tripled 1 year after late October and early November low-intensity prescribed fires in aspen stands in Colorado. In ponderosa pine habitat types in British Columbia, Kentucky bluegrass biomass was unchanged by an October prescribed fire. Fire frequency: Even after late spring burning, unless burned a second time, Kentucky bluegrass density and cover often return to preburn levels within 1 to 3 years. For example, burning in May or June in Wind Cave National Park, South Dakota, consistently reduced Kentucky bluegrass canopy coverage, height, shoot density, flower stalk density, and biomass during the first postfire growing season but not during postfire years 2 and 3]. In fact, biomass and density were often greater on burned plots than on control plots during postfire year 2. Other studies in mixed-grass prairie have shown Kentucky bluegrass cover can be reduced for 2 or 3 years by a single late spring fire. Kentucky bluegrass cannot withstand frequent spring burning. In the tallgrass prairie, its density decreases with increased fire frequency, and it may be eliminated from sites that are burned

annually for several years. In the Flint Hills of northeastern Kansas, Kentucky bluegrass canopy coverage under different burning regimes was 30.3 percent on an area unburned for 11 years, 7.0 percent on an area burned 1 and 5 years before sampling, and 0 percent on an area burned annually for 5 years. Vogl sampled several pine barrens in northern Wisconsin and reported that Kentucky bluegrass frequency either increased or decreased within 1 year of a single spring fire but that Kentucky bluegrass was eliminated on sites spring burned more than once every few years. Influence of postfire moisture: Kentucky bluegrass is more susceptible to fire damage on ridge sites than in depressions, especially in dry years. In fact, in swales and low prairie sites that receive upslope moisture, Kentucky bluegrass often increases after spring burning. In bluegrass fields in Wisconsin, Kentucky bluegrass density and biomass increased in depressions but decreased or remained unchanged on ridgetops after two successive mid-April fires. In eastern South Dakota, Kentucky bluegrass recovered well from early May burning if irrigated. On burned but unirrigated plots, however, biomass decreased sharply. In eastern North Dakota, lowland and upland prairies were burned on May 8, 1966. Postfire data on August 4, 1966 showed that Kentucky bluegrass frequency increased on lowlands but remained unchanged on uplands. Biomass on both uplands and lowlands decreased, but the decrease was much greater on uplands . When postfire growing season precipitation was "considerably below normal" in Wind Cave National Park, South Dakota, Kentucky bluegrass biomass on burned areas was less than half that found on unburned areas whether burned on September 18, February 13, or April 10. In a sagebrush/rough fescue habitat type in Montana, Kentucky bluegrass biomass increased the first summer after a mid-May prescribed fire. This increase was unexpected because bluegrass should be susceptible to burning at this time. This increase may be due to the high moisture availability in surface soils at this site due to concave slope shape. In contrast, another study in western Montana found Kentucky bluegrass decreased after a prescribed fire on May 24 in a sagebrush/fescue habitat type.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE: In the Mountain West, Kentucky bluegrass is often more abundant in recently burned areas than in nearby unburned areas. Sampling 2- to 36-year-old burns in sagebrush/grassland habitat types in southeastern Idaho, Humphrey found that Kentucky bluegrass was more abundant in recent than in old burns. McKell compared four different-aged burns in the Gambel oak (Quercus gambelii) zone of north-central Utah. Kentucky bluegrass cover and density were higher 1 year after a November fire and 2 years after a January fire, but on 9- and 18-year-old burns cover and density were the same as on nearby unburned areas. In the Klamath Mountains of southern Oregon, Kentucky bluegrass was a codominant grass in open ponderosa pine stands that were burned annually in the spring for 16 years.

FIRE MANAGEMENT CONSIDERATIONS: Burning for bluegrass control: Frequent (annual or biennial) late spring burning can be used to control Kentucky bluegrass and promote the growth of warm-season grasses in the Midwest. The timing of burning is critical and should take place just prior to the resumption of warm-season grass growth. Such burning favors warm-season grasses because they are dormant at the time of burning. Conversely, cool-season species like Kentucky bluegrass are harmed by late spring fire because they resume growth in the early spring and are thus actively growing at the time of burning. In mixed-grass prairie, mid-May has proven to be the most effective time to burn for Kentucky bluegrass control and has resulted in concomitant increases in warm-season grasses. In native bluestem prairie in eastern Kansas, Kentucky bluegrass has been nearly eliminated from sites annually spring burned for decades . In aspen parkland in northwestern Minnesota, 13 years of annual spring burning in late April, when bluegrass was 4 to 6 inches high (10-15 cm), reduced Kentucky bluegrass to about half its original percent composition. After 10 years of biennial spring burning on the Curtis Prairie on the University of Wisconsin Arboretum, Kentucky bluegrass frequency decreased from 60 to 13 percent. Burning to promote bluegrass growth: When using prescribed fire to promote the growth of cool-season species in the Northern Great Plains, Kentucky bluegrass will probably respond best to very early spring (March-April) or late summer (August-September) fires. Disease

control: In Kentucky bluegrass commercial seed fields, burning after harvest successfully controls several diseases. It is effective in controlling ergot (Claviceps purpurea); silver top, caused by the fungus Fusarium trianctum; and the mite, Siteroptes cerealium. Burning also helps control leaf rust (Puccinia poae-nemoralis) and other fungi harbored in crop residue. Wildlife considerations: Succulent new grass shoots arising from burned mountain grasslands are highly palatable to wildlife. On the Front Range in Colorado, mule deer and bighorn sheep ate considerably more Kentucky bluegrass on areas burned in late September than on nearby unburned areas. Following late October and early November fires in aspen stands in Colorado, Kentucky bluegrass cover increased and thus provided more forage to wildlife. Where Kentucky bluegrass is desired for providing ruffed grouse drumming ground cover, it can be burned when the soil is damp and plants are dormant. Burning under aspen: Powell reported that in south-central Colorado, aspen/Kentucky bluegrass communities have only a moderate probability of carrying a prescribed fire and only if livestock grazing is deferred for at least one season. For fall prescribed burning, the likelihood of a relatively uniform burning treatment may be increased by burning after aspen leaf fall.

Reed Canary Grass (*Phalaris arundinacea*)

FIRE ECOLOGY OR ADAPTATIONS: Reed canarygrass can survive fires because of its rhizomes.

IMMEDIATE FIRE EFFECT ON PLANT: Fire probably top-kills reed canarygrass.

PLANT RESPONSE TO FIRE: Early April fires may cause increases in reed canarygrass, while mid to late May burns can prevent it from producing seed.

FIRE MANAGEMENT CONSIDERATIONS: Reed canarygrass can be controlled to a limited extent by burning every 2 to 3 years during the dry season. Prescribed fires are recommended in April and May to prevent shrub invasion of sedge and reed canarygrass meadows. Marshes, where reed canarygrass is present, can be burned in winter (when the ice is 9 to 12 inches [23-30 cm] thick) to reduce plant density and improve wildlife feeding areas.

Common Cattail (*Typha latifolia*)

FIRE ECOLOGY OR ADAPTATIONS: Common cattail rhizomes are buried in the soil and are often under water where they cannot be harmed by the heat of fire. When aboveground foliage is consumed by fire, common cattail quickly initiates new top-growth from these surviving underground regenerative organs.

IMMEDIATE FIRE EFFECT ON PLANT: The effects of fire on common cattail vary with water depth and soil moisture. On flooded sites and on sites with exposed but saturated soils, fire consumes most or all of the aboveground biomass, but underground rhizomes remain undamaged and plants survive. When soils become dry because of drought or marshland drainage, fires can burn deep into the organic horizons, consuming the rhizomes and killing the plant.

PLANT RESPONSE TO FIRE: Common cattail quickly sprouts from surviving rhizomes following fires that remove the top-growth. If burned when plants are dormant, new top-growth is initiated in the spring, and annual productivity is not lowered. Even following summer fires, plants quickly initiate new growth from surviving underground rhizomes and grow until killed by fall frosts. After an early September fire in Utah, common cattail grew to 1.3 feet (0.4 m) in height before winter dormancy. Hybrid cattail (T. X glauca) stands in New Brunswick, Canada, were burned in spring, summer, or fall in both flooded and drained marshes. Summer burning on drained sites resulted in the greatest reductions in cover, density, and height 3 years after burning. Three years after burning on flooded marsh, hybrid cattail increased in cover but showed little or no change in cover, stem density, or height.

FIRE MANAGEMENT CONSIDERATIONS: Prescribed burning in late fall, winter, or early spring when plant tops are dry opens up common cattail stands by removing years of accumulated litter. In northern latitudes, winter burning has advantages in that fires can be better directed over ice than open water, as the ice allows for faster movement of men and equipment. Additionally, winter fires are easier to control because they are of lower intensity than fires during warmer months. Annual burning is difficult because more than 1 year of litter is needed to carry fire in cattail stands. On marshes where water levels can be controlled, drawdown followed by burning and rapid reflooding kills common cattail if regrowth is kept completely submerged. Following marsh drawdown and burning in Utah, common cattail quickly resprouted and covered areas that were reflooded with up to 8 inches (20 cm) of water. No plants survived, however, on areas flooded with 8 to 18 inches (20-46 cm) of water. When winter burning over ice in southwestern Ontario, Ball found that slow-moving backfires left the shortest cattail stubble which subsequently needed the least amount of water level increase to submerge the stalks. Furthermore, snow buildup over ice can protect the stalks from burning, resulting in tall stubble that is difficult to submerge the following spring. Thus, when using winter burning in conjunction with water level manipulation to control cattail, it is best to burn over ice in early winter before snow accumulation or in early spring after snow melt. In Utah, common cattail was controlled with a combination of burning and cutting. Stands were first cut, then the cut material burned. This made it easier to flood the cut stems, and allowed a second cutting, if needed, to be made very close to the ground. In the Southern High Plains region of Texas, winter burning did not improve common cattail nutritive quality.

Appendix L. Wildfire Situation Analysis (WFSA)

WILDLAND FIRE SITUATION ANALYSIS

Incident Name:
Jurisdiction:

Date and Time Completed:

This page is completed by the Agency Administrator(s).

Section I, WFSA Information Page

A. Jurisdiction(s): Assign the agency or agencies that have or could have fire protection responsibility, e.g., USFWS, BLM, etc.

B. Geographic Area: Assign the recognized "Geographic Coordination Area" the fire is located in, e.g., Northwest, Northern Rockies, etc.

C. Unit(s): Designate the local administrative unit(s), e.g., Hart Mountain Refuge Area, Flathead Indian Reservation, etc.

D. WFSA #: Identify the number assigned to the most recent WFSA for this fire.

E. Fire Name: Self-explanatory.

F. Incident #: Identify the incident number assigned to the fire.

G. Accounting Code: Insert the local unit's accounting code.

H. Date/Time Prepared: Self-explanatory.

I. Attachments: Check here to designate items used to complete the WFSA. "Other could include data or models used in the development of the WFSA. Briefly describe the "other" items used.

I.	Wildland Fire Situation Analysis
To be completed by the Agency Administrator(s)	

A. Jurisdiction(s)	**B. Geographic Area**
C. Unit(s)	**D. WFSA #**
E. Fire Name	**F. Incident #**

G. Accounting Code:
H. Date/Time Prepared _____@_____
I. Attachments

- Complexity Matrix/Analysis *	_____	
- Risk Assessment/Analysis *	_____	
Probability of Success *	_____	
Consequences of Failure *	_____	
- Maps *	_____	
- Decision Tree **	_____	
- Fire Behavior Projections *	_____	

- Calculations of Resource Requirements *	_____	
- Other (specify) * Required ** Required by FWS	_____	

This page is completed by the Agency Administrator(s).

Section II. Objectives and Constraints

A. Objectives: Specify objectives that must be considered in the development of alternatives. Safety objectives for firefighter, aviation, and public must receive the highest priority. Suppression objectives must relate to resource management objectives in the unit resource management plan.

Economic objectives could include closure of all or portions of an area, thus impacting the public, or impacts to transportation, communication, and resource values.

Environmental objectives could include management objectives for airshed, water quality, wildlife, etc.

Social objectives could include any local attitudes toward fire or smoke that might affect decisions on the fire.

Other objectives might include legal or administrative constraints which would have to be considered in the analysis of the fire situation, such as the need to keep the fire off other agency lands, etc.

B. Constraints: List constraints on wildland fire action. These could include constraints to designated wilderness, wilderness study areas, environmentally or culturally sensitive areas, irreparable damage to resources or smoke management/air quality concerns. Economic constraints, such as public and agency cost, could be considered here.

II.	Objectives and Constraints
To be Completed by the Agency Administrator(s)	

A. Objectives (Must be specific and measurable)

1. Safety

   - Public

   - Firefighter

2. Economic

3. Environmental

4. Social

5. Other

B. Constraints

This page is completed by the Fire Manager and/or Incident Commander.

Section III. Alternatives

A. Wildland Fire Management Strategy: Briefly describe the general wildland fire strategies for each alternative. Alternatives must meet resource management plan objectives.

B. Narrative: Briefly describe each alternative with geographic names, locations, etc., that would be used when implementing a wildland fire strategy. For example: "Contain within the Starvation Meadows' watershed by the first burning period."

C. Resources Needed: Resources described must be reasonable to accomplish the tasks described in Section III.B. It is critical to also look at the reality of the availability of these needed resources.

D. Final Fire Size: Estimated final fire size for each alternative at time of containment.

E. Estimated Contain/Control Date: Estimates of each alternative shall be made based on predicted weather, fire behavior, resource availability, and the effects of suppression efforts.

F. Cost: Estimate all incident costs for each alternative. Consider mop-up, rehabilitation, and other costs as necessary.

G. Risk Assessment - Probability of Success/Consequences of Failure: Describe probability as a percentage and list associated consequences for success and failure. Develop this information from models, practical experience, or other acceptable means. Consequences described will include fire size, days to contain, days to control, costs, and other information such as park closures and effect on critical habitat. Include fire behavior and long-term fire weather forecasts to derive this information.

H. Complexity: Assign the complexity rating calculated in "Fire Complexity Analysis" for each alternative, e.g., Type II, Type I.

I. A map for each alternative should be prepared. The map will be based on the "Probability of Success/Consequences of Failure" and include other relative information.

III.	**Alternatives (To be completed by FMO / IC)**

	A	B	C
A. Wildland Fire Strategy			
B. Narrative			
C. Resources needed Handcrews Engines Dozers Airtankers Helicopters			
D. Final Size			

E. Est. Contain/ Control Date			
F. Costs			
G. Risk Assessment **- Probability of success** **- Consequence of failure**	_____ _____	_____ _____	_____ _____
H. Complexity			

I.	**Attach maps for each alternative**

This page is completed by the Agency Administrator(s), FMO and/or Incident Commander.

Section IV. Evaluation of Alternatives

A. Evaluation Process: Conduct an analysis for each element of each objective and each alternative. Objectives shall match those identified in Section II.A. Use the best estimates available and quantify whenever possible. Provide ratings for each alternative and corresponding objective element. Fire effects may be negative, cause no change, or may be positive. Examples are: 1) a system which employs a "-" for negative effect, a "0" for no change, and a "+" for positive effect; 2) a system which uses a numeric factor for importance of the consideration (soils, watershed, political, etc.) and assigns values (such as -1 to +1, -100 to +100, etc.) to each consideration, then arrives at a weighted average. If you have the ability to estimate dollar amounts for natural resource and cultural values, this data is preferred. Use those methods which are most useful to managers and most appropriate for the situation and agency. To be able to evaluate positive fire effects, the area must be included in the resource management plan and consistent with prescriptions and objectives of the fire management plan.

Sum of Economic Values: Calculate for each element the net effect of the rating system used for each alternative. This could include the balance of:

pluses (+) and minuses (-), numerical rating (-3 and +3), or natural and cultural resource values in dollar amounts. (Again, resource benefits may be used as part of the analysis process when the wildland fire is within a prescription consistent with approved fire management plans and in support of the unit's resource management plan.)

IV.	Evaluation of Alternatives
To be Completed by the Agency Administrator(s) and Fire Manager / Incident Commander	

A. Evaluation Process	**A**	**B**	**C**
Safety Firefighter Aviation Public			
Sum of Safety Values			

Economic Forage Improvements Recreation Timber Water Wilderness Wildlife Other (specify)			
Sum of Economic Values			
Environmental Air Visual Fuels T & E Species Other (specify)			
Sum of Environmental Values			

Social Employment Public Concern Cultural Other (Specify)			
Sum of Social Values			
Other			

This page is completed by the Agency Administrator(s) and Fire Manager and/or Incident Commander.

Section V. Analysis Summary

A. Compliance with Objectives: Prepare narratives that summarize each alternative's effectiveness in meeting each objective. Alternatives that do not comply with objectives are not acceptable. Narrative could be based on effectiveness and efficiency. For example: "most effective and least efficient," "least effective and most efficient," or "effective and efficient." Or answers could be based on a two-tiered rating system such as "complies with objective" and "fully complies with or exceeds objective." Use a system that best fits the manager's needs.

B. Pertinent Data: Data for this Section has already been presented, and is duplicated here to help the Agency Administrator(s) confirm their selection of an alternative. Final Fire Size is displayed in Section III.D. Complexity is calculated in the attachments and displayed in Section III.H. Costs are displayed on page 4. Probability of Success/Consequences of Failure is calculated in the attachments and displayed in Section III.G.

C. External and Internal Influences: Assign information and data occurring at the time the WFSA is signed. Identify the Preparedness Index (1 through 5) for the National and Geographic levels. If available, indicate the Incident Priority assigned by the MAC Group. Designate the Resource Availability status. This information is available at the Geographic Coordination Center, and is needed to select a viable alternative. Designate "yes," indicating an up-to-date weather forecast has been provided to, and used by, the Agency Administrator(s) to evaluate each alternative. Assign information to the "Other" category as needed by the Agency Administrator(s).

Section IV. Decision

Identify the alternative selected. Must have clear and concise rationale for the decision, and a

signature with date and time. Agency Administrator(s) is mandatory.

V.	Analysis Summary
To be Completed by the Agency Administrator(s) and Fire Manager / Incident Commander	

Alternatives	A	B	C
A. Compliance with Objectives Safety Economic Environmental Social Other			
B. Pertinent Data Final Fire Size Complexity Suppression Cost Resource Values Probability of Success Consequences of Failure			

C. External / Internal Influences

National & Geographic
Preparedness Level _____

Incident Priority _____

Resource Availability _____

Weather Forecast
(long-range) _____

Fire Behavior Projections _____

VI. Decision

The Selected Alternative is: _____

Rationale:

_____ _____

Agency Administrator's Signature Date/Time

This Section is completed by the Agency Administrator(s) or designate.

Section VII. Daily Review

The date, time, and signature of reviewing officials are reported in each column for each day of the incident. The status of Preparedness Level, Incident Priority, Resource Availability, Weather Forecast, and WFSA validity is completed for each day reviewed. Ratings for the Preparedness Level, Incident Priority, Resource Availability, Fire Behavior, and Weather Forecast are addressed in Section V.C. Assign a "yes" under "WFSA Valid" to continue use of this WFSA. A "no" indicates this WFSA is no longer valid and another WFSA must be prepared or the original revised.

Section VIII. Final Review

This Section is completed by the Agency Administrator(s). A signature, date, and time are provided once all conditions of the WFSA are met.

VIII. Daily Review

To be completed by the Agency Administrator(s) or Designate

Selected to be reviewed daily to determine if still valid until containment or control

	PREPAREDNESS LEVEL	INCIDENT PRIORITY	RESOURCE AVAILABILITY	WEATHER FORECAST	FIRE BEHAVIOR PROJECTIONS	WFSA VALID

Date	Time	By	

If WFSA is no longer valid, a new WFSA will be completed!

VIII. Objectives Final Review

The elements of the selected alternative were met on: _____ _____

Date Time

By:_____

(Agency Administrator(s)

A GUIDE FOR ASSESSING FIRE COMPLEXITY

The following questions are presented as a guide to assist the Agency Administrator(s) and staff in analyzing the complexity or predicted complexity of a wildland fire situation. Because of the time required to assemble or move an Incident Management Team to wildland fire, this checklist should be completed when a wildland fire escapes initial attack and be kept as a part of the fire records. This document is prepared concurrently with the preparation of (and attached to) a new or revised Wildland Fire Situation Analysis. It must be emphasized this analysis should, where possible, be based on predictions to allow adequate time for assembling and transporting the ordered resources.

Use of the Guide:

1. Analyze each element and check the response "yes" or "no."

2. If positive responses exceed, or are equal to, negative responses within any primary factor (A through G), the primary factor should be considered as a positive response.

3. If any three of the primary factors (A through G) are positive responses, this indicates the fire situation is, or is predicted to be, Type I.

4. Factor H should be considered after all the above steps. If more than two of these items are answered "yes," and three or more of the other primary factors are positive responses, a Type I team should be considered. If the composites of H are negative, and there are fewer than three positive responses in the primary factors (A-G), a Type II team should be considered. If the answers to all questions in H are negative, it may be advisable to allow the existing overhead to continue action on the fire.

GLOSSARY OF TERMS

Potential for blow-up conditions - Any combination of fuels, weather, and topography excessively endangering personnel.

Rate or endangered species - Threat to habitat of such species or, in the case of flora, threat to the species itself.

Smoke management - Any situation which creates a significant public response, such as smoke in a metropolitan area or visual pollution in high-use scenic areas.

Extended exposure to unusually hazardous line conditions - Extended burnout or backfire situations, rock slide, cliffs, extremely steep terrain, abnormal fuel situation such as frost killed foliage, etc.

Disputed fire management responsibility - Any wildland fire where responsibility for management is not agreed upon due to lack of agreements or different interpretations, etc.

Disputed fire policy - Differing fire policies between suppression agencies when the fire involves multiple ownership is an example.

Pre-existing controversies - These may or may not be fire management related. Any controversy drawing public attention to an area may present unusual problems to the fire overhead and local management.

Have overhead overextended themselves mentally or physically - This is a critical item that requires judgment by the responsible agency. It is difficult to write guidelines for this judgment because of the wide differences between individuals. If, however, the Agency Administrator feels the existing overhead cannot continue to function efficiently and take safe and aggressive action due to mental or physical reasons, assistance is mandatory.

FIRE COMPLEXITY ANALYSIS

			Yes/No	
A.	FIRE BEHAVIOR: Observed or Predicted			
	1.	Burning Index (from on-site measurement of weather conditions). Predicted to be above the 90% level using the major fuel model in which the fire is burning.	___	___
	2.	Potential exists for "blowup" conditions (fuel moisture, winds, etc.)		___ ___
	3.	Crowning, profuse or long-range spotting.	___	___
	4.	Weather forecast indicating no significant relief or worsening conditions.		___
	___			
		Total		___ ___
B.	RESOURCES COMMITTED			
	1.	200 or more personnel assigned.		___ ___
	2.	Three or more divisions.		___ ___

3.	Wide variety of special support personnel.	___	___	
4.	Substantial air operation which is not properly staffed.	___	___	
5.	Majority of initial attack resources committed.		___	___
	Total		___	___

C. RESOURCES THREATENED

1.	Urban interface.		___	___
2.	Developments and facilities.	___	___	
3.	Restricted, threatened or endangered species habitat.	___	___	
4.	Cultural sites.	___	___	
5.	Unique natural resources, special designation zones or wilderness.		___	___
6.	Other special resources.		___	___
	Total		___	___

D. SAFETY

1.	Unusually hazardous fire line conditions.	___	___	
2.	Serious accidents or facilities.	___	___	
3.	Threat to safety of visitors from fire and related operations.	___	___	
4.	Restricted and/or closures in effect or being considered.	___	___	
5.	No night operations in place for safety reasons.	___	___	
	Total		___	___

E. OWNERSHIP

		Yes/No		
1.	Fire burning or threatening more than one jurisdiction.	___	___	
2.	Potential for claims (damages).		___	___
3.	Conflicting management objectives.	___	___	
4.	Disputes over fire management responsibility.		___	___
5.	Potential for unified command.		___	___
	Total		___	___

F. EXTERNAL INFLUENCES

1.	Controversial wildland fire management policy.	___	___	
2.	Pre-existing controversies/relationships.		___	___
3.	Sensitive media relationships.	___	___	
4.	Smoke management problems.		___	___
5.	Sensitive political interests.	___	___	
6.	Other external influences.		___	___
	Total		___	___

G. CHANGE IN STRATEGY

1.	Change in strategy to control from confine or contain.		___	___
2.	Large amount of unburned fuel within planned perimeter.	___	___	
3.	WFSA invalid or requires updating.	___	___	
	Total		___	___

H. EXISTING OVERHEAD

1.	Worked two operational periods without achieving initial objectives.		___	___
2.	Existing management organization ineffective.		___	___
3.	IMT overextended themselves mentally and/or physically.	___	___	
4.	Incident action plans, briefings, etc., missing or poorly prepared.	___	___	
	Total		___	___

Signature_____

Date_____ Time_____