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Fire Ecology of the Forest Habitat Types of Central Idaho

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RESEARCH SUMMARY

This report summarizes available information on fire as an ecological factor for forest habitat types occurring in central Idaho. The forest habitat types described for central Idaho by Steele and others (1981) are grouped into 11 Fire Groups based primarily on fire's role in forest succession.

For each Fire Group, information is presented on (1) the relationship of major tree species to fire, (2) fire effects on undergrowth, (3) fire effects on wildlife, (4) forest fuels, (5) the natural role of fire, (6) fire and forest succession, and (7) fire management considerations.

The Fire Groups are described as follows:

Fire Group Zero—Miscellaneous special habitats.

Fire Group One—Dry limber pine habitat types.

Fire Group Two—Warm, dry habitat types that support open forests of ponderosa pine or Douglas-fir.

Fire Group Three—Warm, moist ponderosa pine habitat types and warm, dry Douglas-fir habitat types usually dominated by ponderosa pine.

Fire Group Four—Cool, dry Douglas-fir habitat types.

Fire Group Five—Moist Douglas-fir habitat types.

Fire Group Six—Grand fir habitat types.

Fire Group Seven—Cool habitat types usually dominated by lodgepole pine.

Fire Group Eight—Dry, lower subalpine habitat types.

Fire Group Nine—Wet or moist, lower subalpine habitat types.

Fire Group Ten—Cold, upper subalpine and timberline habitat types.

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INTRODUCTION

Purpose

This report summarizes available fire ecology and management information relating to forest habitat types in central Idaho; specifically, on the Boise, Challis, Payette, and Salmon National Forests; the Fairfield and Ketchum Ranger Districts and Sawtooth National Recreation Area of the Sawtooth National Forest; and the Dubois Ranger District of the Targhee National Forest. The primary purpose of this report is to aid in understanding fire's role in central Idaho forests, especially the role of fire in forest succession.

Habitat types, as defined by Steele and others (1981), are arranged into eleven "Fire Groups" based on the response of the tree species to fire and similar postfire successions. The exception is Fire Group Zero, which is a collection of miscellaneous vegetation types. The actual successional sequence in any given stand depends upon a number of variables, such as preburn vegetation; the size, nature, and severity of the fire; climatic, topographic, and soil factors; and chance. Steele and Geier-Hayes (1982a, 1982b) show an example of the variation possible within a single habitat type. Thus, stands that key to the same habitat type might fall into different Fire Groups.

Habitat types are grouped according to the most probable successional path. A variation frequently encountered in a particular habitat type is mentioned in the text, but infrequent variations may not be noted. A certain reliance is placed on the judgment of the land manager in evaluating the local conditions of any particular site. The groups defined in this report are intended as a general guide, not a definitive treatment.

Format

This report is patterned after Fire Ecology of Montana Forest Habitat Types East of the Continental Divide (Fischer and Clayton 1983). The relationships of major tree species to fire, fire effects on wildlife and understory plant species, and fire use considerations relate to the central Idaho region as a whole. Consequently, these sections precede the individual Fire Group discussions of vegetation and soils, forest fuels, fire's natural role, forest succession, and fire management considerations.

Relationship of Major Tree Species to Fire—This section of the report discusses each important tree species in central Idaho with regard to its resistance or susceptibility to fire and its role as a successional component of forest communities. Particular attention is given to fire adaptations such as serotinous cones, corky bark, or seeds that require mineral soil for germination.

Undergrowth Response to Fire—This section summarizes the effect of fire on the response of important understory grass, forb, and shrub species. Fire-adaptive traits or survival strategies are highlighted, and the species' tendency to increase or decrease following fire is noted.

Wildlife Response to Fire—This section contains summaries of the general effects of fire on common central Idaho mammals, reptiles, amphibians, and birds. Fire response of wildlife is largely inferred from expected changes in habitat as a result of fire.

Fire Use Considerations—This brief section summarizes precautions that apply to the use of fire as a management tool. Emphasis is on effective fire use, site protection, minimizing damage to residual stand, and wildlife habitat protection.

Habitat Types and Phases, ADP Codes, and Physiographic Sections—The fire groups are defined with reference to "Forest Habitat Types of Central Idaho" (Steele and others 1981). A complete list of central Idaho forest habitat types is included as appendix A. Habitat types are designated in the standard format of "Seriesltype, phase," in which "series" refers to the dominant tree in potential climax; "type" denotes a characteristic or indicator understory species; and "phase" provides a further subdivision where needed. The "ADP codes" are automatic data processing codes for National Forest System use. Physiographic sections are as described by Steele and others (1981) and are illustrated in figure 1.

Vegetation—Following the list of habitat types that comprise each group, we describe the characteristic overstory and understory vegetation for that group. Climax and seral species are identified. A complete distribution of tree species showing their successional status is included as appendix B.

Forest Fuels—In this section we characterize the fuels likely to occur on forest sites in the fire group. Emphasis is on the kind and amount of dead, woody material on the forest floor. Where they contribute significantly to fire hazard, live fuels and standing dead fuels are also discussed. Discussions of forest fuels are based on field observations in central Idaho and on inventory data collected on similar habitat types in Montana and northern Idaho.

Role of Fire—This section describes fire and its historic role in shaping the vegetational composition of habitat types in the various fire groups. This section synthesizes

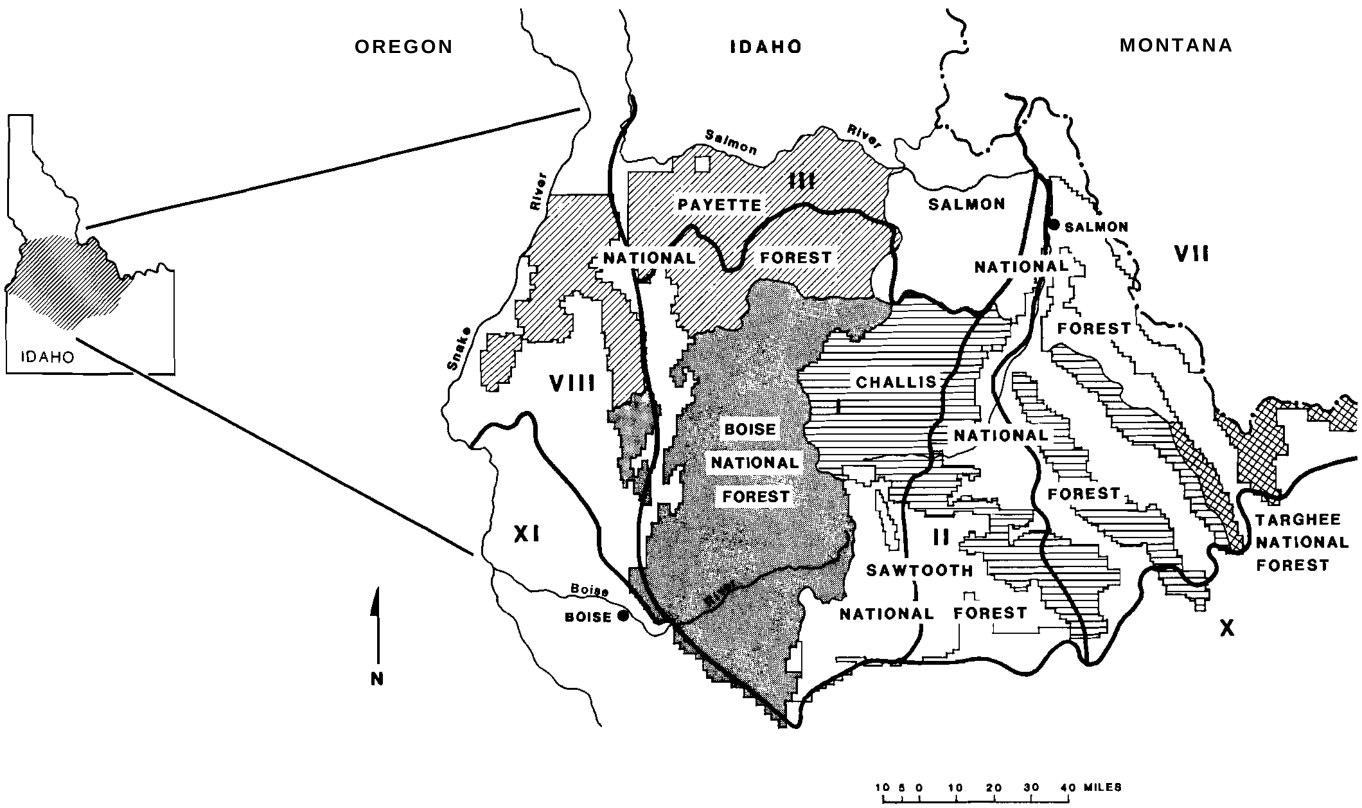


Figure 1—Physiographic sections of central Idaho (I—Southern Batholith, 11—Challis, III—Salmon Uplands, VII—Open Northern Rockies, VIII—Wallowa-Seven Devils).

information on susceptibility to fire, fuel conditions, and fire history, gleaned from an extensive search of the literature.

Fire severity is an important factor in shaping the vegetation in a forest stand. For the purpose of this report, three levels of fire severity are recognized: low (light), moderate, and severe (high). A low-severity or cool fire has minimal impact on the site. It burns in surface fuels consuming only the litter, herbaceous fuels, and foliage and small twigs on woody undergrowth. Moderate fires consume litter, upper duff, understory plants, and foliage on understory trees. If fuel ladders exist, individual trees or groups of overstory trees may torch out. A severe fire is one that burns through the overstory, consumes large woody surface fuels, and may remove the entire duff layer over much of the area. Heat from the fire impacts the upper soil layer and may consume the incorporated soil organic matter.

Forest Succession—The generalized succession diagram and accompanying text represent a simplified overview of fire's role in succession for the fire group. The diagram can be used from any stage of stand development, although generally the beginning of secondary succession following a stand-destroying fire is used as the starting point. In order to emphasize the role of fire in each group and keep the diagram simple, other factors that influence vegetational patterns are omitted.

Successional pathway flow charts represent a synthesis of confirmed knowledge and surmised possibilities that form a hypothesis concerning the many influences fire may have on the vegetation of a fire group. The flow charts are similar to those suggested by Kessell and Fischer (1981). Symbols are used for the tree species on this diagram and the flow charts in the following section. The symbols are defined as follows:

Abies grandis, grand fir (ABGR)
Abies lasiocarpa, subalpine fir (ABLA)
Picea engelmannii, Engelmann spruce (PIEN)
Pinus albicaulis, whitebark pine (PIAL)
Pinus contorta, lodgepole pine (PICO)
Pinus flexilis, limber pine (PIFL)
Pinus ponderosa, ponderosa pine (PIPO)
Pseudotsuga menziesii, Douglas-fir (PSME)
Larix occidentalis, western larch (LAOC)

Fire Management Considerations—This section suggests how the preceding information can be used to develop fire management plans that support resource management objectives. The discussion is intended to be suggestive, not dogmatic. Each individual manager is in a much better position than are the authors to relate the information presented in this report to a particular management situation.

The Fire Groups

The forest habitat types of central Idaho have been assembled into 11 fire groups (table 1), which are defined as follows:

Fire Group Zero: Miscellaneous special habitats. This group of special habitats includes scree, forested rock, wet meadows, mountain grasslands, aspen community groves, and deciduous riparian communities.

Table 1—Summary of central Idaho habitat type Fire Groups (see appendix A for formal listing of habitat types)

Habitat type	Physiographic section[1]
FIRE GROUP ZERO	
Forested rock	
Meadow	
Grassy bald	
Aspen	
Deciduous riparian, flood plain, and ravine	
FIRE GROUP ONE	
PIFL/HEKI	VII
PIFL/FEID	VII
PIFL/CELE	VII
PIFL/JUCO	VII
FIRE GROUP TWO	
PIPO/STOC	I
PIPO/AGSP	I, III, VIII
PIPO/FEID	III, I, VIII
PIPO/PUTR-AGSP	I, III, VIII
PIPO/PUTR-FEID	I, III, VIII
PIPO/SYOR	I, VIII
PSME/AGSP	All
PSME/FEID-FEID	II, VII
PSME/FEID-PIPO	III, I
PSME/SYOR	VII, II, I
PSME/CELE	II, VII
FIRE GROUP THREE	
PIPO/SYAL	VIII, III, I
PIPO/PHMA	I, III
PSME/CARU-PIPO	I, VIII, III
PSME/CAGE-PIPO	I, VIII, III
PSME/BERE-SYOR	I, II, VII
PSMEIBERE-CAGE	I
PSME/SPBE-PIPO	VIII, I
PSME/SYAL-PIPO	VIII, III, I
PSMEIPHMA-CARU	III, I
PSME/PHMA-PIPO	I, III, VIII

Habitat type	Physiographic section[1]
FIRE GROUP FOUR	
PSME/ARCO-ASMI	II, VII
PSME/ARCO-ARCO	II, VII
PSME/JUCO	II, VII
PSMEICAGE-SYOR	I, 111, 11, VII
PSMEICAGE-CAGE	II, I, VII
PSME/CELE	I, 11, III, VII
PSME/CARU-FEID	I, III, VII
PSMEICARU-CARU	II, VII, I, III
PSMEISPBE-CARU	11, 111, I
PSMEISPBE-SPBE	I, 11, III, VII
PSMEISYAL-SYAL	VII, III, I
PSMEIACGL-SYOR	II, VII
PIEN/HYRE	VII
FIRE GROUP FIVE	
PSME/BERE-BERE	I
PSME/OSCH	I, VIII
PSME/VAGL	I, III
PSMEIACGL-ACGL	I, II
PSMEIPHMA-PSME	II, VII
PSME/LIBO	III, VII
PSME/VACA	I, III
FIRE GROUP SIX	
ABGR/CARU	VIII,I
ABGR/SPBE	VIII,I
ABGRIACGL-PHMA	VIII, I
ABGRIACGL-ACGL	VIII, I
ABGR/LIBO-LIBO	VIII, I
ABGRILIBO-XETE	III
ABGR/VAGL	VIII, I
ABGR/XETE	VIII, I
ABGR/LIBO-VAGL	VIII, I
ABGR/COOC	I
ABGR/CLUN	VIII, I

Habitat type	Physiographic section
FIRE GROUP SEVEN	
ABGR/VACA	I
ABLA/VACA	I, III
ABLAIVASC-VASC	I, 11, III, VII
ABLAICACA-VACA	III, I
ABLAICACA-CACA	III, I
ABLAICACA-LEGL	II, I, III
ABLAIXETE-VASC	III
ABLAIXETE-LUHI	III
ABLAIXETE-VAGL	I, III, VII
ABLAIVAGL-VASC	III
ABLAICAGE-CAGE	I, 111, 11, VII
ABLA/CARU	I, II, VII
ABLA/ALSI	III
ABLAILIBO-VASC	I, III, VII
ABLNLIBO-XETE	III, I, VII
ABLAIVASC-CARU	I, III, VII
PICO/FEID	I, 11, III, VII
PICO/VACA	I, III, VII
PICO/CAGE	I
PICO/VASC	III, VII
FIRE GROUP EIGHT	
ABLA/ACGL	I
ABLA/LIBO-LIBO	I, III, VII
ABLNVAGL-VAGL	1,111
ABLA/SPBE	I, II
ABLA/JUCO	I, VII
ABLA/ARCO	I, II, VII
FIRE GROUP NINE	
PIEN/GATR	VII
PIEN/CADI	II, VII
PIEN/EQAR	II, VII
ABLA/CABI	I
ABLAICACA-LICA	III, I
ABLAISTAM-LICA	III
ABLA/STAM-STAM	I, II, VII
ABLAICLUN-MEFE	III, I
ABLAICLUN-CLUN	III, I
ABLNCOOC	III
ABLA/MEFE-MEFE	III, VIII
ABLNMEFE-LUHI	III
FIRE GROUP TEN	
ABLA/RIMO	VII, II
ABLAILUHI-VASC	III, I
ABLA/LUHI-LUHI	III, I
ABLAIVASC-PIAL	I, II
ABLAICAGE-ARTR	I, III
PIAL/ABLA	III, I, II
PIAL h.t.'s	II, VII

[1] I - Southern Batholith
II - Challis
III - Salmon Uplands
VII - Open Northern Rockies
VIII - Wallowa-Seven Devils

Fire Group One: Dry limber pine habitat types. These habitat types are found almost exclusively in the Challis and Open Northern Rockies physiographic sections of central Idaho (fig. 1).

Fire Group Two: Warm, dry habitat types that support open forests of ponderosa pine or Douglas-fir. Mature stands in this group are characterized by an open forest-to-savanna appearance, with an undergrowth of dry-site grasses and forbs.

Fire Group Three: Warm, moist ponderosa pine habitat types and warm, dry Douglas-fir habitat types usually dominated by ponderosa pine. In the absence of fire, Douglas-fir regeneration beneath the ponderosa pine is capable of taking over the site on the Douglas-fir habitat types.

Fire Group Four: Cool, dry Douglas-fir habitat types. These stands are generally found in the continental climate of the Challis and Open Northern Rockies physiographic sections and elsewhere above the cold limits of ponderosa pine. Douglas-fir is often the only conifer on the site.

Fire Group Five: Moist Douglas-fir habitat types. Douglas-fir generally grows well on these sites and dominates the mature stand.

Fire Group Six: Grand fir habitat types. These generally moist and productive sites often support diverse stands of seral tree species. Fire has played an important role in promoting these stands of "mixed forest."

Fire Group Seven: Cool habitat types usually dominated by lodgepole pine. This group includes stands in which fire-maintained lodgepole pine is a dominant seral species as well as stands in which it is a persistent dominant species.

Fire Group Eight: Dry, lower subalpine habitat types. This is a heterogeneous grouping of subalpine habitat types that range from moist to dry. Douglas-fir or a mixture of Douglas-fir and lodgepole pine, sometimes followed by spruce, are the major trees in a successional sequence leading toward a subalpine fir climax forest.

Fire Group Nine: Moist, lower subalpine habitat types. These sites are often dominated by Engelmann spruce. Fires are infrequent but often severe, with long-lasting effects. In some stands, spruce is climax and in the subalpine fir habitat types is a persistent seral species.

Fire Group Ten: Cold, upper subalpine and timberline habitat types. Fires are generally infrequent; the fires that do occur are often limited in extent by discontinuous fuels. Postfire succession is slow, owing to the harshness of the environment.

Nomenclature and Terminology

Trees and undergrowth plants are identified by their common names throughout the text of this report. The list of habitat types at the beginning of each Fire Group discussion reflects the common practice of noting scientific names, abbreviations, and common names. Habitat types are most often identified by abbreviation in the text. Appendix C lists scientific names and common names of plants used in the text.

In this report we use common silvicultural terms to describe general stand conditions such as age, density (stocking), and species composition. Definitions of terms such as even-aged, uneven-aged, overstocked, fully stocked, pure stand, mixed stand, and others have evolved from rather arbitrary and subjective definitions to very precise and quantitative definitions necessary for modern silviculture. Our usage of silvicultural terms conforms to the definitions of the Society of American Foresters (1971, 1958). These definitions tend toward the subjective rather than the quantitative, which is appropriate for the general nature of our discussions. Silviculturists should be aware of this usage so as not to misinterpret the intended level of precision.

RELATIONSHIP OF MAJOR TREE SPECIES TO FIRE

Wildfire, along with climate and topography, has been important in shaping forest ecosystems in the Western United States. It often creates a mosaic of seral vegetational types and age classes within a type. The frequency and severity of fire in an area may be particularly important in determining the species composition on a site (Cattelino and others 1979). The abundance of lodgepole pine, snowbrush ceanothus, and ponderosa pine, for example, is strongly related to fire history in central Idaho (Steele and others 1981).

Physical characteristics determine in large part a species' susceptibility or resistance to fire damage, and this in combination with regeneration strategy determines whether a species will increase or decrease on a site in the aftermath of fire. The fuel situation in close proximity to any individual or group of individuals is, of course, an important factor governing fire damage.

Table 2 summarizes the relative fire resistance of the principal conifers in central Idaho forests. An extensive review and summary of comparative autecological characteristics of northwestern tree species is provided by Minore (1979).

Limber Pine (*Pinus flexilis*)

The degree of cambium heating usually determines the extent of fire injury to limber pines. Young trees are usually killed by any fire that scorches their stems. The bark of young limber pine is too thin to prevent cambium injury, even from a low-intensity fire (Steele in press). Older trees are better able to withstand stem scorch from low-severity fires because the bark around the base of mature trees is often 2 inches (5 cm) thick. The needles of limber pine form into tight clusters around the terminal buds. This shields the buds from heat associated with crown scorch.

Keown (1977) conducted prescribed fire studies on limber pine woodlands at the western edge of the Great Plains in central Montana. His results apply to spring fires when temperatures, relative humidities, and winds were moderate, fuel moistures low, and soil moistures high. Results indicated a strong relationship between fuel type, fire severity, and fire injury to limber pine. On sites where grass was the primary fuel and where trees were present as either scattered individuals or in open stands, fire severity was low and limber pine mortality was light (about 20 percent) even though basal limbs commonly extended to the ground. In similar situations but with a dense undergrowth of shrubs (primarily shrubby cinquefoil), rather than a grass undergrowth, fire severity was high and limber pine mortality often reached 80 percent. The final situation reported by Keown (1977) was where a closed canopy forest bordered shrubland or grassland. Trees in these transition zones were less than 10 ft (3 m) tall, the lower branches often intermingled with ground fuels. The most severe fires occurred on these sites.

Table 2—Relative fire resistance of the more commercially important conifers occurring in central Idaho (source: Flint 1925)

Species	Thickness of bark of old trees	Root habit	Resin in old bark	Tolerance: Branch habit	Tolerance: Stand habit	Relative inflammability of foliage	Lichen growth	Degree of fire resistance
Ponderosa pine	Very thick	Deep	Abundant	Moderately high & open	Open	Medium	Medium to light	Very resistant
Douglas-fir	Very thick	Deep	Moderate	Moderately low & dense	Moderate to dense	High	Heavy to medium	Very resistant
Grand fir	Thick	Shallow[1]	Very little	Low & dense	Dense	High	Heavy	Medium
Lodgepole pine	Very thin	Deep[2]	Abundant	Moderately high & open	Open	Medium	Light	Medium
Engelmann spruce	Thin	Shallow	Moderate	Low & dense	Dense	Medium	Heavy	Low
Subalpine fir	Very thin	Shallow	Moderate	Very low & dense	Moderate to dense	High	Medium to heavy	Very low

[1]The shallow root habit characteristic of grand fir in moist, stream bottom habitats. Trees growing on well-drained, dry mountain slopes develop much deeper root systems (Flint 1925).

[2]Lodgepole pine is generally deep-rooted in well-drained, medium-textured soils. Root development is restricted by layers of coarse soils, impermeable layers, high water tables, or dense stand conditions (Pfister and Daubenmire 1975).

Many limber pine sites in central Idaho are exposed and rocky (Steele and others 1981). Limber pines on these sites are often characterized by profuse branching and a multiple-stemmed appearance. Closer examination of mature, apparently multiple-stemmed trees reveals that many are actually adjoining individuals established in close proximity (Woodmansee 1977). Limber pine has large, wingless seeds incapable of dispersal by winds. Clark's nutcracker (*Nucifraga* columbiana) has been identified as the primary, if not the only, reliable limber pine seed dispersal agent responsible for reestablishing limber pine on high-elevation, rocky, windswept sites following stand destruction (Lanner and Vander Wall 1980). Nutcrackers transport seeds as far as 14 miles (22 km) from a seed source to a favored cache site—usually high ridges or other exposed sites where lack of snow accumulation allows seed retrieval when food is needed (Vander Wall and Balda 1977; Tomback 1977; Tomback and Kramer 1980). Limber pine seed dispersal by ground squirrels was noted by Eggler (1941) in southern Idaho.

Ponderosa Pine (*Pinus ponderosa)*

Ponderosa pine has many fire-resistant characteristics. Seedlings and saplings are often able to withstand fire. Development of insulative bark and the tendency for meristems to be shielded by enclosing needles and thick bud scales contribute to the temperature resistance of pole-sized and larger trees.

Propagation of fire into the crown of pole-sized and larger trees growing in relatively open stands on dry sites is unusual because of three factors. First, the tendency of ponderosa pine to self-prune lower branches keeps the foliage separated from burning surface fuels. Second, the open, loosely arranged foliage does not lend itself to combustion or the propagation of flames. Third, the thick bark is relatively unburnable and does not easily carry fire up the bole or support residual burning. Resin accumulations, however, make the bark more flammable. Fire resistance of open stands is increased further by light fuel loads. When ponderosa pine occurs in open parklike stands, self-pruning is not effective, and such "wolf trees" are susceptible to "torching-out" during moderate to severe surface fires.

Ponderosa pine trees that are heavily infected by the dwarf mistletoe (Arceuthobium campylopodum) are more susceptible to fire-related mortality and crown scorch than uninfected or moderately infected trees. Severely infested stands contain increased amounts of both dead surface fuels and live aerial fuels. Also, infected branches, which are often twice normal diameter, resist natural pruning (Koonce 1981).

On moist sites, ponderosa pine often forms two-storied stands that may be quite susceptible to crown fire. The tendency for regeneration to form dense understories, or "dog hair" thickets, on such sites creates fuel ladders that can carry surface fires to the crowns of overstory trees. The fuel ladder effect is often enhanced on moist sites because of the greater level of stocking and the often increased occurrence of lichen and moss in the tree crowns. Crown fires are, consequently, more frequent on moist sites than they are on dry sites. Understory ponderosa pine may also be more susceptible to fire damage because crowded conditions can result in slower diameter growth and heavier loadings of dead fuels. Such trees do not develop their protective layer of insulative bark as early as would otherwise be expected. They remain vulnerable to cambium damage from ground fires longer than their counterparts in open stands. The thick, dense foliage of young stands or thickets also negates the fire-resisting characteristic of open, discontinuous crown foliage normally found in this species. Even if such stands or thickets do not "crown-out," crown scorching is much more likely than in more open situations. The thinning effect of fire is therefore much more pronounced in dense stands than it is in open stands.

Ponderosa pine seedling establishment is favored when fire removes the forest floor litter and grass, exposing mineral soil. Mineral soil exposure and canopy openings caused by fire allow ponderosa pine establishment.

Heavy accumulations of litter at the base of pole- and sawtimber-sized tree trunks increase the severity and duration of fire, often resulting in a fire scar or "cat face." Flammable resin deposits around wounds can make the tree susceptible to fire damage and usually cause enlargement of the scars.

Douglas-fir *(Pseudotsuga menziesii)*

Mature Douglas-fir has relatively high resistance to fire damage. Saplings and small poles, however, are vulnerable to surface fires because of their thin, photosynthetically active bark, resin blisters, closely spaced flammable needles, and thin twigs and bud scales. The moderately low and dense branching habit of saplings and poles enables surface fires to be carried into the crown. Even when fire fails to enter the crowns, many saplings and poles are seriously damaged by crown heating or scorching. Older trees develop a relatively unburnable, thick layer of insulative corky bark that provides protection against cool to moderately severe fires, but this protection is often offset by a tendency to have branches the length of the bole. The development of "gum cracks" in the lower trunk, which streak the bark with resin, can provide a mechanism for serious fire injury.

Douglas-fir occurs in open stands, but it also grows in dense stands with continuous understory fuels. Dense sapling and pole thickets can form an almost continuous layer of flammable foliage about 10 to 26 ft (3 to 8 m) above the ground that will support wind-driven crown fires. Even small thickets provide a route by which surface fires can reach the crowns of mature trees. Crowning is often aided by the presence of lichens. Crowning and "torch out" of individual Douglas-fir is also aided by the presence of large, dense witches'-brooms caused by the dwarf mistletoe (Arceuthobium douglasii) (Weir 1916; Alexander and Hawksworth 1975).

As with ponderosa pine, heavy fuel accumulations at the base of the tree increase the probability of fire injury. Petersen (1984) determined that bark-char (an indicator of cambium heating) had a strong influence on fire-related tree mortality when 50 percent or more of a Douglas-fir crown was scorched. Heavy litter accumulations may allow injury to the tree roots, causing delayed mortality (Connaughton 1936). Also, resin deposits usually enlarge old scars. Douglas-fir is more susceptible to rot when injured by fire than is ponderosa pine.

Douglas-fir regeneration is generally favored by fire, which reduces vegetational cover and exposes mineral soil so shallow taproots of seedlings can take hold. Ryker (1975) found good establishment of Douglas-fir on litter, indicating that a mineral soil seedbed may not be as critical for establishment of Douglas-fir regeneration on sites as it is for competing species. Severe fire-created microsites may be unfavorable for Douglas-fir regeneration—for example, south-facing burns and clearcuts. Ponderosa pine is often able to regenerate on such hotter, drier microsites.

In central Idaho Douglas-fir occupies the broadest range of environmental conditions of any conifer. This indicates considerable genetic diversity (Rehfeldt 1974).

Grand Fir *(Abies grandis)*

Grand fir (including grand fir and white fir hybrids) is moderately resistant to fire. It is more susceptible to fire damage than ponderosa pine and Douglas-fir, but more resistant than spruce, subalpine fir, and lodgepole pine (USDA-FS 1965). The thick bark contributes to grand fir's fire resistance; however, its relatively dense and low branches, flammable foliage, dense stand habit, and heavy lichen growth all increase its susceptibility to fire damage. Grand fir is very susceptible to bole rot caused by Indian paint fungus (Echinodontium tinctorium) when injured by fire (Aho 1977).

Grand fir in central Idaho and northeastern Oregon are the result of introgressive hybridization between two species: Abies *grandis* and Abies *concolor* (Daniels 1969). Inner bark color in these trees may be reddish purple as it is in Abies *grandis* or yellow as it is in Abies concolor, which also has thicker (4- to 6-inch or 10- to 15-cm) bark than Abies *grandis* (2-inch or 5-cm). Frederick (1972) found that trees with yellow interior bark had less incidence of decay (primarily caused by the Indian paint fungus) than trees with red inner bark. He also found that trees on drier sites had less decay than trees on wetter sites.

Steele and others (1981) suggest that hybridization and increased genetic diversity may have allowed grand fir to establish on sites drier than normal for the species in general.

Grand fir's fire resistance is strongly influenced by site. On relatively dry slopes its roots are deep, stands are relatively open, and the bark is thick so that it can withstand cool surface fires. On dry sites, however, grand fir may have relatively poor vigor. On moist sites the trees develop shallow lateral roots rather than a deep taproot, and these are easily killed by fire burning in the thicker duff (USDA-FS 1965). Decay fungi often enter trees through fire scars (Aho 1977). All factors considered, grand fir is not benefited by fire in central Idaho nearly as much as its competitors.

Fisher (1935) compared germination on several different seedbeds and found grand fir germinated best on ash. Seedlings will establish and grow in full sunlight, but early growth of grand fir is favored by partial shade (USDA-FS 1965).

Engelmann Spruce *(Picea engelmannii)*

Engelmann spruce is easily killed by fire. The dead, dry, flammable lower limbs, low-growing canopy, thin bark, and lichen growth in the branches contribute to the species' vulnerability. The shallow root system is readily subject to injury from fire burning through the duff. Large, old spruce may occasionally survive one or more light fires (Arno 1980), but deep accumulations of resinous needle litter around their bases generally make them particularly susceptible to fire damage. Survivors are often subjected to successful attack by wood-destroying fungi that easily enter through fire scars. The high susceptibility of spruce to fire damage is mitigated in part by the generally cool and moist sites where it grows. Despite its susceptibility to fire, spruce will usually be favored at the expense of subalpine fir where the two grow together (Wellner 1970).

Spruce is not an aggressive pioneer. It is a moderate seed producer, but viability is rated good and the vitality persistent (Alexander and Sheppard 1984). Initial establishment and early growth of seedlings is usually slow. Germination is often good on mineral soil and burned seedbeds where a constant supply of moisture is available and some large debris is left scattered about the site (Roe and others 1970). A survey of spruce regeneration in the Intermountain Region showed that mechanically exposed mineral soil was superior to all other types of seedbeds for seedling establishment and early survival (Roe and Schmidt 1964). Spruce seedlings will occur as members of a fire-initiated stand with other seral species. Spruce's shade tolerance allows it to establish and grow beneath a canopy of lodgepole pine or other seral species.

Restocking after fire will occur more quickly if some spruce seed trees survive within the burn than if regeneration is dependent on seed from trees at the fire edge. Pockets of spruce regeneration often become established around such surviving seed trees up to a distance of 300 feet (90 m), the effective seeding distance for spruce.

Lodgepole Pine (*Pinus contorta*)

Lodgepole pine is ranked as being moderately resistant to fire (Brown and Davis 1973; Tackle 1961; Starker 1934). It has thin (<0.4 inch or 1 cm thick) bark and a moderately high and open crown. The lower branches of this shade-intolerant tree self-prune in dense stands.

Lodgepole pines' most noteworthy adaptation to fire is its serotinous cones. Temperatures of 113 °F (45 °C) may be required to melt the resin binding the scales and release the small, winged seeds. Steele and others (1981) state that in central Idaho most lodgepole pine cones are nonserotinous. On the Boise and Payette National Forests the percentage of serotinous-cone-bearing trees was found to vary from 0 to 12 percent (Lotan 1975). A more complex situation than open vs closed cones may exist, however, according to Perry and Lotan (1977). Cones may have a wide variety of opening temperature requirements, hence old and new cones on the same tree may open at different temperatures. Cone habit in a given locality cannot be assumed. It must be determined by stand examination.

Aside from serotinous cones, other silvical characteristics (USDA-FS 1965; Tackle 1961) that contribute to lodgepole pine's success in dominating a site following fire are:

1. Early seed production. Cones bearing viable seed are produced by trees as young as 5 years in open stands and by trees 15 to 20 years old in more heavily stocked stands. This feature not only allows relatively young stands to regenerate a site following fire, but the seed from open cones can fill in voids left by the original postfire seeding from serotinous cones.
2. Prolific seed production. Good cone crops occur at 1- to 3-year intervals, with light crops intervening.
3. High seed viability. Seeds in 80-year-old serotinous cones, for example, have been found to be viable.
4. High seedling survival and rapid early growth, especially on mineral soil seedbeds exposed to full sunlight.

Lodgepole pine's success in revegetating a site following fire may result in dense, overstocked stands. Such stands are likely to stagnate and subsequently succumb to one or more destructive agents over their lifespan, for example, natural thinning, snow breakage, windthrow, dwarf mistletoe (Arceuthobium americanum) infestation, and mountain pine beetle (*Dendroctonus* ponderosae) attack. The individual or combined effect of these agents is often a significant buildup of dead, woody fuel on the forest floor. Thus, the stage is set for another stand-destroying wildfire.

Subalpine Fir *(Abies lasiocarpa)*

Subalpine fir is rated as the least fire-resistant Northern Rocky Mountain conifer because of its thin bark, resin blisters, low and dense branching habit, and moderate-to-high stand density in mature forests. As a result, fire most often acts as a stand-replacement agent when it burns through a subalpine fir forest. Even light ground fires can kill the cambium or spread into the ground-hugging branches and from there up into the crown. Subalpine fir is very susceptible to decay following injury.

Subalpine fir may begin producing cones when only 20 years old, but maximum seed production is by dominant trees 150 to 200 years old. Subalpine fir has the ability to germinate and survive on a fairly wide range of seedbeds.

Subalpine fir can occur in a fire-initiated stand with Douglas-fir, lodgepole pine, and other seral species because it germinates successfully on a fire-prepared seedbed. Subalpine fir is usually, however, a slow-growing minor component, and is usually not as conspicuous as less tolerant species.

In a closed canopy situation, establishment and early survival of subalpine fir are not hampered by deep shade. Subalpine fir can tolerate low light conditions better than most associated species. Engelmann spruce will, however, often grow faster than subalpine fir where light intensity exceeds more than 50 percent of full sunlight. Subalpine fir is shade-tolerant and is the indicated climax species on many sites containing lodgepole pine. Where a seed source exists, the fir will, consequently, invade and grow in the understory of most lodgepole stands. Given a long enough fire-free period, subalpine fir will replace lodgepole pine on sites where it is the indicated climax.

Whitebark Pine (*Pinus albicaulis)*

Whitebark pine is a semitolerant or midtolerant species (Arno and Hoff, in press) that has been known to invade burned sites. It occurs as the potential climax species on alpine timberline and exceptionally dry sites, but is a seral species in upper subalpine forests (Arno in press). Whitebark pine is moderately fire resistant. It has a relatively thin bark and is susceptible to fire injury from surface fires that kill the cambium. Whitebark pine's dry, exposed habitat and open structure tend to reduce its vulnerability. The fact that whitebark pine often reaches ages of 500 years or more reflects the reduced fire threat.

Whitebark pine may occur as small groups of trees, especially near its lower elevational limit where it appears with lodgepole pine, subalpine fir, and Engelmann spruce. The general impression of whitebark pine communities, however, is that of open stands where the undergrowth is continuous low shrubs, forbs, and grasses. Occasionally larger shrubs and stunted trees occur.

Fires that burn in the undergrowth are usually of low-to-moderate severity. The low, ground-hugging crowns of associated conifers can provide a fuel ladder, and downfall in the vicinity of mature trees locally increases crown fire potential; hence, severe fires are possible.

Severe wildfires starting in lower elevations can spread throughout the upper elevation forests to timberline. Although the open nature of a whitebark pine forest acts as a firebreak, many trees can be killed under these conditions. The most common fires are lightning fires that do not spread far. During extended periods of high fire danger, however, these usually benign fires may spread downhill into dense lower elevation forests.

Clark's nutcracker disperses whitebark pine seed as it does limber pine seed. The nutcracker caches the large, wingless seeds in the soil. Unretrieved seed. which are stored at an average soil depth of about 0.8' inch (2 cm), germinate and establish new pines (Hutchins and Lanner 1982; Tomback 1982; Lanner 1982). Experimental results indicate a 56 percent seedling survival rate over the first year; 25 percent by the fourth year (Tomback 1982). No other reliable seed dispersal agent for whitebark pine has been documented in the literature, although dispersal by ground squirrels was observed during cone collecting efforts on Teton Pass in the fall of 1984 (J. Hamilton 1985). According to Tomback (1982), Clark's nutcracker is in large part responsible for the "pioneering" status of whitebark pine in subalpine habitats.

UNDERGROWTH RESPONSE TO FIRE

Many of the common shrubs and herbaceous plants of central Idaho forests can renew themselves from plant parts that survive fire. Other plants are quite susceptible to fire kill and must reestablish from off-site seed, buried seed, or invasion from unburned patches within or immediately adjacent to the burned area.

Current understanding of the process of plant succession following fire in Inland Northwest forests and its management implications are summarized by Stickney (1982):

> . . .the severity of the disturbance treatment directly affects the representation of the survivor component in the postfire vegetation. Since survivors derive from plants already established at the time of disturbance, it is possible, by pretreatment inventory, to determine the potential composition for the survivor component. For this reason it also follows that forest stands with little undergrowth vegetation could be expected to have a sparse or limited survivor component following disturbance. In addition, if the colonizer component is composed mostly of shade-tolerant climax-like species the rate of survivor recovery can be expected to be slow. Nearly all of our native forest shrub species are capable of surviving burning, and they can therefore be expected to function as survivors. A majority of the predisturbance forest herb species also demonstrated the ability to survive fire, particularly those species with underground stems (rhizome) or rootcrowns (caudex). As a generalization, the more severe the fire treatment to vegetation, the less the survivor component. In the drier, more open forest types this usually results in a reduction of amount, but not major changes in composition. However, in the moister forest types, where the undergrowth is made up of more mesic shade-tolerant species, marked changes in postfire composition can occur as increasing severity reduces survivor representation.
>
> The severity of disturbance treatment (particularly fire) influences the potential for colonizer presence in two ways: (1) the degree of severity creates the character of the ground surface on which colonizer seedlings germinate, and (2) it activates onsite stored seed. Generalizing, the more severe the disturbance treatment the more favorable the site becomes for colonizers. As the extent of exposed mineral soil increases, the ground surface becomes more favorable as a site for germination and establishment of colonizer plants. Increases in treatment severity also favor germination of ground-stored seeds by increasing their exposure to light or heat.
>
> Predicting the occurrence of colonizers in postdisturbance vegetation is much less certain than predicting for survivors, but knowledge of the previous succession history can provide the potential composition of residual colonizers. Locally this information is often available from an adjacent or nearby clearcut. Least predictable is the offsite colonizer component, for its occurrence is dependent on the timing of the disturbance to the availability and dispersal of offsite airborne seed. Even in this case reference to local clearcuts can provide some idea of the composition for the most common offsite colonizer species likely to occur.

Table **3** summarizes current knowledge of plant responses to fire for some species that occur in central Idaho forests. Actual plant response to fire depends on many factors, including moisture content of the soil and duff, physiological stage of the plant, and the severity of the fire, especially in terms of the amount of heat that travels downward through the duff and upper layer of soil.

Table 3—Summary of postfire survival strategy and fire response information for some shrubs and herbaceous plants occurring in forests in central Idaho (sources: Armour and others 1984; Bradley 1984; Britton and others 1983; Crane and others 1983; Daubenmire and Daubenmire 1968; Freedman 1983; Hironaka and others 1983; Keown 1978; Klemmedson and Smith 1964; Kramer 1984; Lotan and others 1981; Lyon 1966, 1971; Lyon and Stickney 1976; McLean 1969; Miller 1977; Morgan and Neuenschwander 1984; Mueggler 1965; Noste 1985; Rowe 1983; Stickney 1981; Viereck and Dyrness 1979; Viereck and Schandelmeier 1980; Volland and Dell 1981; Woodard 1977; Wright 1980, 1978, 1972; Wright and Bailey 1980; Wright and others 1979; Zager 1980; Zimmerman 1979)

Species	Fire Group(s)	Fire survival strategy	Comments on fire response
SHRUBS:			
Acer glabrum Rocky Mountain maple	4,5,6,8	Sprouts from surviving crown.	Usually increases following fire.
Alnus sinuata Sitka alder	7,8,9	Sprouts from surviving root crown.	Usually increases on site following fire. Early seed production (after 5 years) aids in this increase.
Amelanchier alnifolia serviceberry	3,4,5,6	Sprouts from surviving large rhizome.	Pioneer species which usually survives even severe fires especially if soil is moist. Coverage usually increases following fire.
Arctostaphylos *uva-ursi* kinnikinnick	4,5,6,7,9	Sprouts from surviving root crown located below soil surface. Fibrous roots and stolons (runners) at soil surface.	Susceptible to fire-kill. Will survive some low severity fires when duff is moist and therefore not consumed by fire. May invade burned area from unburned patches.
Artemesia tridentata big sagebrush	2,4,7,10	Wind-dispersed seed; residual seed in soil. Subspecies vaseyana stores seed in soil, which germinates when heated by fire.	Very susceptible to fire-kill. Recovery is hastened when a good seed crop exists before burning.
Berberis repens creeping Oregon grape	3,4,5,7,8	Sprouts from surviving rhizomes, which grow 0.5 to 2 inches (1.5 to 5 cm) below soil surface.	Moderately resistant to fire-kill. Will usually survive all but severe fires that remove duff and cause extended heating of upper soil.
Ceanothus *velutinus* snowbrush ceanothus	4	Soil-stored seed germinates following heat treatment. It can also sprout from root crowns following a cool fire.	Usually increases following fire, often dramatically.
Cercocarpus ledifolius curlleaf mountain-mahogany	1,3,4	Does not sprout or sprouts weakly.	Seriously damaged by severe fires. Seeds need mineral soil to germinate.
Holodiscus discolor oceanspray	6	Sprouts from surviving root crown. It also has soil-stored seed that may require heat treatment.	Moderately resistant to fire-kill. Is often enhanced by fire. Seedlings favored by mineral soil exposure.
Juniperus communis common juniper	1,4,7,8,10	Bird-dispersed seed	Very susceptible to fire-kill. Seed commonly requires long germination period.
Ledum glandulosum Labrador-tea	7,9,10	Fire avoider, rhizomes. L. groenlandicum rhizomes about 15 to 30 cm deep.	Unknown probably poor response. L. groenlandicum cover is much reduced by fire.
Linnaea borealis twinflower	5,6,7,8,9	Sprouts from surviving root crown located just below soil surface. Fibrous roots and stolons (runners) at soil surface.	Susceptible to fire-kill. May survive some cool fires where duff is moist and not consumed. Can invade burned area from unburned patches.
Lonicera *utahensis* Utah honeysuckle	5,8,9	Sprouts from surviving root crown	Often a reduction in cover and frequency following fire.
Menziesia ferruginea rusty menziesia	9,10	Sprouts from surviving root crown.	Susceptible to fire-kill. Moderate to severe fires reduce survival and slow redevelopment.
Pachistima myrsinites mountain lover	6,7,8	Sprouts from surviving root crown and from buds along taproot.	Moderately resistant to fire-kill. Usually survives low to moderate severity fires that do not consume the duff and heat soil excessively. Usually increases.
Physocarpus malvaceus shallow ninebark	3,5,6,8	Sprouts from surviving root crown.	Susceptible to fire-kill. Roots may be damaged by moderate to severe fires. Often a slight decrease following fire.

(con.)

Table 3 (Con.)

Species	Fire Group(s)	Fire survival strategy	Comments on fire response
Prunus virginiana chokeberry	3,4	Sprouts from surviving root crown.	Usually increases coverage following fire.
Purshia tridentata antelope bitterbrush	2,3,4,7	A weak sprouter. Animal-dispersed seed and seed caches present on area prior to fire.	Very susceptible to fire-kill, especially in summer and fall. Decumbent growth form sprouts vigorously, columnar form does not. Spring burns enhance sprouting, fall burns are best for regeneration by seed.
Ribes cereum wax currant	2,3,4,5,7,8	A weak sprouter from root crown, soil-stored seed.	Susceptible to fire-kill. Seldom survives severe fire.
Ribes lacustre prickly currant	4,6,9	Sprouts from surviving root crown located beneath soil surface.	Resistant to fire-kill. Usually increase even after a severe fire. Seedlings may establish after low or moderate fires.
Ribes viscosissimum sticky currant	4,5	A weak sprouter, soil-stored seed may require heat treatment.	Susceptible to fire-kill. Relatively shade intolerant. May contribute substantially to postfire revegetation.
Rosa gymnocarpa baldhip rose	3,5,6	Sprouts from surviving root crowns.	
Rosa woodsii Woods rose	4,5,6	Sprouts from surviving root crowns.	Some ecotypes can spread by root sprouting.
Rubus parviflorus thimbleberry	5,6	Sprouts from surviving root rhizomes. It also has soil-stored seed.	May be enhanced by fire, producing multiple sprouts.
Salix scoulerana Scouler willow	3,4,5,6	Sprouts from surviving root crowns. Wind-dispersed seed.	Resprouts vigorously after fire. Height growth may be dramatic.
Shepherdia canadensis russet buffaloberry	4,5,6,7,8	Sprouts from surviving root crown and from buds along taproot.	Moderately resistant to fire-kill. Will usually survive cool to moderately severe fires that do not consume duff or heat soil extensively.
Sorbus scopulina mountain ash	2,3,4,5,6,7, 8,9,10	Sprouts from surviving root crown.	
Spiraea betulifolia white spirea	3,4,5,6,7,8	Sprouts from surviving root crown and from rhizomes which grow 2 to 5 inches (5 to 13 cm) below surface.	Resistant to fire-kill. Will usually survive even a severe fire. Generally increases coverage following fire.
Symphoricarpos albus common snowberry	2,3,4,7,8,10	Weak sprouter from surviving root crown.	Moderately resistant to fire-kill. Usually maintains prefire frequency and coverage.
Symphoricarpos albus mountain snowberry	7,8,9,10	Weak sprouter from surviving root crown.	Moderately resistant to fire-kill. Usually maintains prefire frequency and coverage.
Vaccinium globulare blue huckleberry	5,6,7,8,9	Sprouts from,surviving rhizomes	Increases after cool fires. May take longer to resprout following severe fires.
Vaccinium scoparium grouse whortleberry	6,7,8,9,10	Sprouts from surviving rhizomes which grow in duff layer or at surface of soil.	Moderately resistant to fire-kill. Will usually survive mild to moderately severe fires that fail to consume the lower layer of duff.
FORBS:			
Achillea millefolium yarrow	1,2,4,5	Sprouts from short shallow rhizome.	Reduced by severe fires
Adenocaulon bicolor trail-plant	6,9	Short, compact surface rhizomes. Airborne seed.	Decreased by fire or other disturbance. Postfire development slow.
Arnica cordifolia heartleaf arnica	4,5,6,7,8,9	Sprouts from surviving rhizomes which creep laterally from 0.4 to 0.8 inch (1 to 2 cm) below soil surface. Wind dispersed.	Susceptible to fire-kill. Shoots produce small crowns within the duff easily killed by all but mild fires, which occur when duff is moist. May rapidly invade burned area via windborne seed.
Arnica latifolia broadleaf or mountain arnica	7,8,9,10	Sprouts from surviving rhizomes which creep laterally in the soil.	Susceptible to fire-kill. Will usually survive mild to moderately severe fires. May exhibit rapid initial regrowth accompanied by heavy flowering and seedling establishment.

(con.)

Table 3 (Con.)

Species	Fire Group(s)	Fire survival strategy	Comments on fire response
Aster *conspicuus* showy aster	5,8	Sprouts from surviving rhizomes which mostly grow from 0.5 to 2 inches (1.5 to 5 cm) below soil surface	Moderately resistant to fire-kill. Will usually survive mild to moderately severe fires that do not result in excessive soil heating. May rapidly increase following fire.
Astragalus miser weedy milkvetch	4,5	Sprouts from buds along surviving taproot which may be 2 to 8 inches (5 to 20 cm) below the root crown.	Resistant to fire-kill. Can regenerate from taproot even when entire plant crown is destroyed. Can send up shoots and set seed the first year. May increase dramatically following fire. Note: milkvetch is poisonous to sheep and cattle.
Balsamorhiza sagittata arrowleaf balsamroot	2,3,4,5	Regrowth from surviving thick caudex	Resistant to fire-kill. Will survive even the most severe fire.
Clintonia *uniflora* queencup beadlily	9	Sprouts from surviving rhizomes.	Usually decreases following fire. Postfire environment evidently not conducive to rapid recovery.
Clematis columbiana Columbia clematis	5,6,7,9	Sprouts from surviving root crowns	
Coptis occidentalis western goldthread	7,9	Slender rhizomes.	Fire sensitive; generally is reduced following fire.
Disporum trachycarpum wartberry fairybell		Rhizomes.	D. hookeri is initially decreased by fire but recovers to preburn levels relatively rapidly.
Epilobium angustifolium fireweed	2,3,4,5,6,7, 8,9,10	Wind-blown seed and sprouts from rhizomes.	Needs mineral soil to establish, can persist vegetatively and flower the first summer following a fire. Large increase following fire.
Equisetum arvense common horsetail	3,7,8,9	Spreading rhizomes and wind-dispersed propagules.	Frequency unchanged or increased after fire. Especially favored by moist mineral soil exposure.
Fragaria *virginiana* wild strawberry	5,6,8	Sprouts from surviving stolons (runners) at or just below soil surface.	Susceptible to fire-kill. Will often survive cool fires that do not consume duff because of high duff moisture content.
Galium triflorum sweetscented bedstraw	8,9	Sprouts from surviving rhizomes.	Susceptible to fire-kill. Usually a sharp decrease following severe fire. Can increase following spring and fall fires.
Illiamna rivularis	5	Soil-stored seed.	Responds vigorously to severe burning, a pioneer species.
Lathyrus nevadensis Cusick's peavine	2,3,6,8,9	Rhizomes. In L. *ochroleucus* these are 0.5 to 2 inches (1.5 to 5 cm) below the mineral soil surface.	Lathyrus spp. exhibits intermediate susceptibility. L. *hijugatus* increases somewhat or remains unchanged in frequency after fire.
Moldavica parviflora American dragon head	5	Residual seed in duff.	Dramatic increase following fire. Decreases after second year.
Osmorhiza chilensis mountain sweet-cicely		Well-developed taproot, sometimes a branched caudex. Seeds transported by animals.	Little change or some increase in cover. Flowering stimulated by opened canopy.
Penstemon *wilcoxii* Wilcox's penstemon	2,3,4,5,6,8	Surficial branched woody caudex. Seeds sprout in first postfire year.	Adult plants susceptible, but often many seedlings postfire.
Pteridium aquilinum	6,7,8,9	Sprouts from surviving rhizomes.	Spreads vigorously following fire.
Pyrola secunda sidebells pyrola	5,6,8,9	Sprouts from surviving rhizomes which grow mostly in the duff or at soil surface.	Susceptible to fire-kill. Coverage frequently reduced following fire. May survive cool fires when duff moisture is high.
Senecio streptanthifolius arrowleaf groundsel	5	Nonrhizomatous, regenerates from off-site seed.	

(con.)

Table 3 (Con.)

Species	Fire Group(s)	Fire survival strategy	Comments on fire response
Smilacina racemosa feather or false Solomon's seal	5,6,8	Sprouts from surviving stout, creeping rhizomes.	Moderately resistant to fire-kill. May be killed by fires that remove duff and heat soil excessively. Usually maintains prefire frequency.
Smilacina stellata starry Solomon's seal	6,8	Sprouts from surviving creeping rhizomes	Moderately resistant to fire-kill. May be killed by fires that remove duff and heat upper soil. Frequency often reduced following fire.
Streptopus amplexifolius twisted stalk	6,7,8,9	Extensively rhizomatous.	Decreased by fire.
Thalictrum occidentale western meadowrue	5,6,7,8,9	Sprouts from surviving rhizomes.	Susceptible to fire-kill. Frequency usually reduced following fire. May survive cool fires that do not consume duff.
Trantvetlaria carolinensis false bugbane	7,9	Widely spreading rhizomes.	Slight decrease after fire.
Xerophyllum *tenax* beargrass	6,7,9,10	Sprouts from a surviving stout surface rhizome.	Sensitive to fire. Will increase after fires that do not consume duff. Sprouts will flower vigorously after a fire until new overstory canopy develops.
GRASSES:			
Agropyron spicatum bluebunch wheatgrass	1,2,4,5	Seed germination and some sprouts from surviving rhizomes.	Usually not seriously damaged by fire. Response depends on severity of fire and physiological state of plant. Damage will be greatest following dry year.
Bromus tectorum cheatgrass	1,2,3	Seed reserves in soil; variable germination seasons; relatively high heat resistance of seed.	Individual plants susceptible to heat-kill. Surviving seed germinate at various times during the year—fall, late winter, spring. Early summer burns before seed matures are more effective for controlling cheatgrass than midsummer and fall burns.
Calmagrostis canadensis bluejoint	2,3,4,5,6,7, 8,9	Invader, wind-disseminated seed; also an enduring sprouter.	Increases on wet to moist postfire sites.
Calamagrostis rubescens pinegrass	3,4,5,6,7,8	Sprouts from surviving rhizomes which grow within the top 2 inches (5 cm) of soil.	Moderately resistant to fire-kill. Will usually survive cool to moderately severe fires that do not completely consume duff. Burned areas are often successfully invaded by pinegrass.
Carex geyeri elk sedge	3,4,5,6,7, 8,10	Sprouts from surviving rhizomes.	Invades burned areas and forms dense stands. Often decreases immediately following fire; then increases.
Carex rossii Ross sedge	6,7,10	Seed stored in duff or soil germinates when heat treated. Sprouts from surviving rhizomes.	Increased coverage usually results following most fires severe enough to heat but not completely consume duff. Often increases.
Festuca idahoensis Idaho fescue	1,2,4,5,7,10	Seed germination and survival of residual plant.	Susceptible to fire-kill. Response will vary with severity of fire and physiological state of plant. Can be seriously harmed by hot summer fires. Only slightly damaged during spring when soil moisture is high or in fall when growing has ceased.
Koeleria cristata junegrass		Seed germination and residual plant survival.	Susceptible to fire-kill. Response will vary according to fire severity and physiological state of plant.
Luzula hitchcockii woodrush	7,10	Sprouts from surviving rhizomes.	Often a slight increase following fire.

WILDLIFE RESPONSE TO FIRE

The effects of fire on wildlife are primarily secondary effects; fire creates, destroys, enhances, or degrades favorable habitat (food supply, cover, shelter, physical environment) thereby causing changes in the subsequent occurrence and abundance of animal species on a burned area (fig. 2). Table 4 lists the probable effects of fire on some mammals, reptiles, and amphibians that occur in central Idaho forests. The indicated fire effects are either inferred from habitat requirements or from studies conducted on specific wildfire or prescribed fire areas. The user is reminded that a major problem in attempting any generalization about the effects of fire on wildlife is the variation in fires: intensity, duration, frequency, location, shape, extent, season, fuels, sites, soils, and prescribed fires as compared to wildfires (Lyon and others 1978).

The response of bird species to fire has been hypothesized by Kramp and others (1983), using a classification suggested by Walter (1977). Four fire-response categories are recognized in this classification: fire-intolerant, fire-impervious, fire-adapted, and fire-dependent.

Fire-intolerant species decrease in abundance after fire and are present only in areas characterized by very low fire frequency and severity. Characteristic central Idaho species include the hermit thrush (Catharus guttatus), red-breasted nuthatch (Sitta canadensis), and brown creeper (Certhia familiaris), which are closely associated with closed canopy forests. These birds prefer a dense nesting and foraging cover but do not use fire-created openings.

Fire-impervious bird species are unaffected by fire; they neither increase nor decrease because of fire. Bird species whose niche incorporates successional and climax community types may be expected to show the highest flexibility in response to fire.

Fire-adapted species are associated with habitat that is characterized by recurring fires of various severity. These species, however, do not depend on fire. Fire-adapted species may also occupy areas with the same frequency-severity ratio as fire intolerant species. Fire-adapted birds include those that use both dense canopy areas and openings; a predator such as the sharp-shinned hawk (*Accipiter* striatus) is an example. Such birds benefit by increased hunting success in recent burns, but generally depend on unburned habitat for nesting sites.

Fire-dependent species are associated with both fire-dependent and fire-adapted plant communities. When fire frequency decreases, these plant communities shift to fire-neutral or fire-intolerant types, and fire-dependent birds are unable to persist. In Central Idaho the blue grouse (Dendragapus *obscurus*) is probably fire-dependent. The bird requires medium to large fire-created forest openings with shrubs-grass-forb vegetation for breeding adjacent to dense foliage conifers for roosting and hooting.

Table 5 presents fire tolerance for some central Idaho bird species.

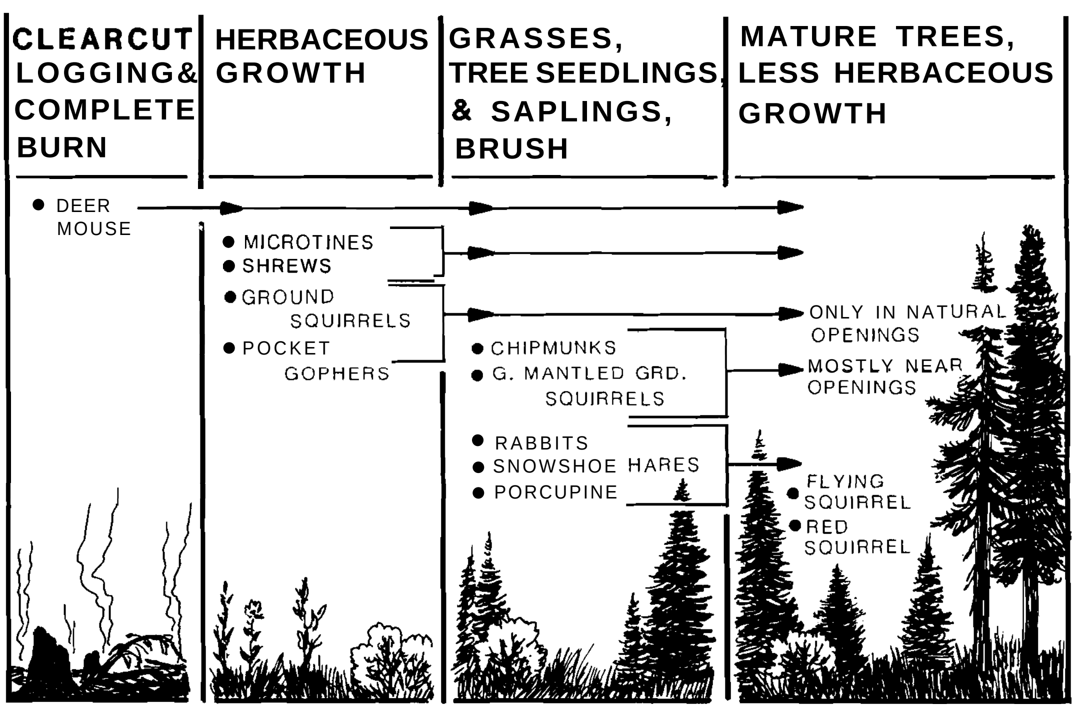


Figure 2—Small mammals found in the successional stages after clearcut logging and burning (Ream and Gruell 1980).

Table 4—Probable effects of fire on some central Idaho mammals, reptiles, and amphibians (major sources: Allen 1983; Beecham and others 1984; Bendell 1974; Bernard and Brown 1977; Black and Tabor 1977; Chandler and others 1983; Halvorson 1981, 1982; Hobbs and Spowart 1984; Kelsall and others 1977; Lyon and others 1978; Maser and others 1981; Melquist and Hornocker 1983; Peek and others 1985; Ream 1981; Thomas 1979; Verner and Bass 1980; Wright and Bailey 1982)

Species	Fire Group(s)	Habitat considerations	Fire effects
MARSUPIALIA (marsupials):			
Oppossum Didelphis virginiana	2,3,4,5,6	Prefers riparian zones but highly adaptable. Nests in hollow trees, brush piles.	Severe fires may destroy nest sites. Relatively impervious to cool surface fires.
INSECTIVORA (insect eaters):			
Masked shrew Sorex *cinereus*	2,3,4,5,6,7, 8,9,10	Prefers moist situations in forest or open. Requires a mat of ground vegetation for cover; stumps, logs, and slash piles for nest sites.	May be temporarily eliminated from severe burns where duff and ground cover are absent. Some direct mortality of nestlings possible.
Vagrant shrew S. vagrans	2,3	Prefers streamsides, marshes, and bogs, but also occurs in moist soil; mat of ground vegetation or debris for cover. Stumps, rotten logs for feeding and nesting.	May be temporarily eliminated from severe burns where duff, ground cover and debris are absent. Some direct mortality of nestlings possible.
Water shrew S. *palustris*	All	Prefers riparian areas at middle and high elevations. Requires small, cold streams and wet areas with protected banks and ground cover.	May be eliminated from severely burned areas where duff and streamside cover have been removed.
Pacific mole Scapanus orarius	2,3,4,5,6,7, 8,9,10	Rarely appear above surface. Prefer well-drained soils.	Relatively impervious to fires of average severity.
CHIROPTERA (bats):			
Little brown myotis Myotis *lucifugus*	2,3,7,8,9,10	Common in forest and at the forest edge. Requires snags and tree holes for roosting and for maternity colony sites.	Severe fire may destroy roosting and breeding sites. Relatively impervious to cool and moderate fires.
Small-footed myotis M. *subulalus*	2,3,7,8,9,10	Most common in ponderosa pine zone. May use hollow trees and snags for roosting and breeding.	Severe fires may destroy roosting and breeding sites but with little impact on populations.
Silver-haired bat Lasionycteris noctivagrans	2,3	Feeds in openings and adjacent to mature forest. Roosts in tree foliage; uses hollow trees and snags for breeding.	Severe fires may destroy some roosting and breeding sites. Relatively impervious to fire.
Big brown bat Eptesicus *fuscus*	1,2,3	Common over grassy meadows surrounded by ponderosa pine. Roosts and breeds in hollow trees and snags.	Severe fires may reduce breeding and roosting sites. Relatively impervious to fire.
Townsend's big-eared bat Plecotus townsendi	7,8,9,10	May be found in forests up through spruce-fir zone. Not a tree user.	Relatively impervious to fire.
LAGOMORPHA (pikas, hares, and rabbits):			
Pika Ochotona princeps	All	Prefers high-altitude talus slopes adjacent to forest openings containing grasses and forbs.	Relatively impervious to fire. Severe fires may create favorable forest openings with abundant grass-forb food supply.
Mountain cottontail *Sylvilagus nuttalli*	1,2,3	Prefers dense, shrubby undergrowth and pole-sized trees for cover. Uses downed logs for cover and nest sites.	Temporarily eliminated from severe burns but reoccupies as shrub cover increases. Will continue to use less than severe burns.
Snowshoe hare Lepus americanus	7,8,9,10	Prefers dense shrubs in forest openings or under pole-sized trees for food and cover. Uses downed logs for cover and nest sites.	Temporarily eliminated from severe burns. Populations may increase dramatically as shrubs resprout and dominate the area. Will continue to use many less than severe burns.
White-tailed jackrabbit L. townsendi	7,8,9,10	Prefers early grass-forb successional stages.	May increase where fire removes overstory and creates meadow-type habitat.

(con.)

Table 4 (Con.)

Species	Fire Group(s)	Habitat considerations	Fire effects
RODENTIA (gnawing mammals):			
Least chipmunk *Eutamias minimus*	7,8,9,10	Present in high mountain coniferous forests. Requires open areas with stumps, downed logs, and shrubs or other high vegetation for cover.	Temporarily decreases following severe fire that reduces cover. Returns first season after fire and usually abundant by third postfire year.
Redtail chipmunk *E. ruficaudus*	2,3,7,8,9,10	Most common in forest openings or edges with abundant shrub undergrowth.	May be temporarily reduced or eliminated on severe burns lacking cover. Use of moderate burns may continue at reduced level, especially if cover and fresh seed is abundant. Populations may exceed preburn levels by second or third postfire year.
Yellow pine chipmunk E. amoenus	All	Prefers shrub, seedling, and sapling stages of forest succession. Usually abundant in open ponderosa pine forests and edges. Needs shelter of downed logs, debris, or shrubs. Often burrows under downed logs and stumps.	Recent burns with stumps and shrubs are favored habitat, especially as seed and fruit-producing annuals become available.
Yellow-bellied marmot Marmota flaviventris	All	Prefers rocky outcrops or talus slopes, forest openings up through spruce-fir zone. Uses downed logs for cover; burrows under tree roots. Feeds on green grass and forbs.	Relatively impervious to fire. Benefits from fire-created openings dominated by grass and forbs.
Hoary marmot M. caligata	7,8,9,10	Found in alpine and subalpine habitats; on talus slopes near grassy alpine meadows.	Relatively impervious to fire. Benefits from fire-created grassy openings.
Uinta ground squirrel *Citellus armatus*	7,8,9,10	Prefers moist habitats with lush vegetation and soft soil; subalpine meadows; forest edges.	May increase dramatically on areas where fire has killed overstory; may be favored by increased light and temperature as well as increase in herbaceous growth.
Belding ground squirrel C. beldingi	2,3,4,5,6	Generally restricted to mountain meadows and early successional stages in ponderosa pine, lodgepole pine, and Douglas-fir forests. Nests underground; requires friable soil. Feeds on grasses, forbs, seeds, bulbs, etc.	Benefits from fire-created openings that produce abundant herbaceous undergrowth.
Columbian ground squirrel C. *columbianus*	1,2,4,5,6	Prefers subalpine meadows, forest edges, open woodlands, pine flats, and alpine tundra. Uses downed logs for cover. Burrows on rocky, partly forested gentle slopes.	May increase on areas where canopy has been opened by fire, especially if grass, forbs, and seed are abundant.
Golden-mantled ground squirrel *C.* lateralis	All	Widespread from ponderosa pine forest to alpine meadows. Most abundant in open forests lacking a dense undergrowth or understory. Needs downed logs, stumps, or rocks for cover. Burrows for shelter.	Generally increases on recently burned areas due to increased abundance of forbs, providing adequate escape cover exists.
Red squirrel (pine squirrel) *Tamiasciurus hudsonicus*	All	Found in late successional forests. Nests in tree cavities and branches. Feeds on conifer seeds, nuts, bird eggs, fungi. Uses downed logs for cover.	Essentially eliminated following stand-replacing fires. Cavities in fire-killed trees may be used for dens but only if surrounded by live trees.
Northern flying squirrel Glaucomys *sabrinus*	2,3,4,5,6,7, 8,9,10	Prefers a mature forest. Requires snags and trees with nest cavities. Also requires an abundance of downed logs. Feeds on conifer seed, serviceberries, and mushrooms.	Same as for red squirrel except may forage for fungi in recent burns.

(con.)

Table 4 (Con.)

Species	Fire Group(s)	Habitat considerations	Fire effects
Northern pocket gopher Thomomys talpoides	Wide range	Prefers disturbed areas of secondary vegetative growth; also pine forests, alpine parks, and meadows. Occurs mostly in deep sandy soils but also in clay and gravelly soils. Requires an herbaceous food source, especially annual forbs.	Population densities usually increase on areas burned by fires that open canopy and disturb the soil resulting in undergrowth of early successional forbs and grasses.
Beaver Castor canadensis	Wide range	Requires streams or lakes bordered by stands of aspen, alder, birch, poplars, or willow for food and building materials.	Usually increases following fires that initiate a successional sequence that includes aspen as an intermediate stage.
Western harvest mouse Reithrodontomys megalotis	Wide range	Generally restricted to grass-forb stages on all habitat types. Usually nests on ground but sometimes in woodpecker holes.	Generally favored by fires that result in establishment of seed-producing annual plants.
Deer mouse Peromyscus maniculatus	Wide range	Ubiquitous. Occurs in most successional stages of most habitat types. Nests in burrows, trees, and stumps. Uses downed logs for nesting sites and cover.	Populations reduce immediately following fire but significantly increase as soon as rain settles the ash. Most abundant small mammal on severely burned areas.
Bushy-tailed woodrat Neotoma cinerea	1,2,3,7,8,9 10	Prefers rocky situations. Dens in rock crevices; sometimes in hollow logs. Gathers conifer seed, berries, fungi, twigs, shoots, and green vegetation.	Relatively impervious to fires that occur in high-elevation rocky habitat. Usually not abundant on recent burns.
Southern red-backed mouse (boreal red-backed vole) Clethrionomys gapperi	All	Prefers mesic areas within coniferous forests that contain abundance of large debris on forest floor and undergrowth of shrubs and herbs. Feeds on conifer seed, bark, fungi, and green vegetation. A coniferous overhead tree canopy is preferred.	Usually eliminated from severely burned areas within 1 year after fire. If overstory trees are present and survive, favorable habitat may return in 7 or more years after the fire.
Mountain phenacomys (Heather vole) Phenacomys intermedius	All	Prefers open grassy areas and forest openings but also riparian zones. Nests under rocks, stumps, or other debris on forest floor. Often found in association with huckleberry.	Benefits from forest openings and early successional undergrowth that result from moderate to severe fires. Severe surface fires may destroy nesting habitat.
Meadow vole Microtus pennsylvanicus	1,2,3,7,8,9, 10	Requires a mat of ground cover for runways, palatable herbs, conifer seed, and moisture. Uses downed logs for cover and nest sites. Usually found near streamside.	Usually eliminated from severe burns where surface organic layer is absent. The wet nature of preferred habitat tends to resist fire.
Montane vole M. montanus	All	Habitat includes wet areas and mountain meadows within a relatively broad elevational range. Forages on ground for succulent stems and leaves of grasses and forbs. Constructs underground burrows.	Benefits from fire-created openings that support an undergrowth of grasses, sedges, and other wet site forbs.
Longtail vole M. longicaudus	2,3,7,8,9,10	Widespread in wet mountain meadows and forest edge, often near streams. Requires a grass-sedge-forb food source. Less restricted to runways and dense grass than other Microtus.	Use increases with removal of tree canopy especially on moist north slopes.
Water vole *Arvicola* richardsoni	7,8,9,10	Restricted to alpine marshes, willow-lined stream banks, and grass and sedge areas of the alpine and subalpine forests. Nests under roots, stumps, and logs.	Relatively impervious to fire. Severe fire that removes streamside cover may result in temporary loss of habitat.
Muskrat Ondatra zibethicus	Wide range.	Occupies cattail marshes, banks of ponds, lakes, or slow-moving streams. Requires a source of succulent grasses or sedges, or other aquatic vegetation.	Periodic fire retains marshes in a subclimax state and removes unfavorable vegetation that crowds out useful plants.

(con.)

Table 4 (Con.)

Species	Fire Group(s)	Habitat considerations	Fire effects
Western jumping mouse *Zapus* princeps	All	Requires a well-developed extensive herbaceous layer along edge of rivers, streams, lakes, or other wet areas and moist soil. Uses downed logs for cover and nest sites. Eats seed, grass, and forbs.	Generally eliminated from severe burns that lack the required vegetative cover.
Porcupine *Erethizon dorsatum*	7,8,9,10	Prefers medium and old-age conifer stands of less than 70 percent crown closure and containing shrubs and herbs. Uses hollow logs and tree cavities for dens.	Use of severely burned areas curtailed especially if overstory is killed. May continue to use light and moderate burns.
CARNIVORA (flesh-eaters):			
Coyote *Canis latrans*	Wide range	Widespread occurrence in most habitats and most successional stages. Uses hollow logs or stumps for dens. Preys on mice.	Increased use of burned areas that support abundant small mammal populations.
Gray wolf C. lupus	7,8,9,10	Highly adaptable but probably restricted to wilderness forests. Preys on other mammals.	Probable increased use of burned areas that support an abundant population of prey species.
Red fox *Vulpes* valpes	All	Prefers open areas in or near forest. Uses hollow stumps and logs for dens. Food includes berries, insects, birds, rodents, squirrels, rabbits, and other small mammals.	Benefits from fires that create favorable habitat for small mammal prey species, especially those that enhance snowshoe hare populations.
Black bear *Ursus* arnericanus	Wide range	Prefers mature forests mixed with shrubfields and meadows. Omnivorous. Requires windfalls, excavated holes, or uprooted or hollow trees for den sites.	Benefits from abundant regeneration of berry-producing shrubs following fire. Severe fires may destroy favorable den sites.
Grizzly bear *U. horribilis*	Wide range	Uses all available habitat but prefers early successional stages for feeding and mature forest for cover. Occurrence is increasingly restricted to wilderness-type lands.	Seral forest communities maintained by fire are important for preferred berry-producing plants.
Raccoon Procyon *lotor*	Wide range	Very adaptable to environmental change; in riparian situations; along marshes, streams, and lakes. Uses hollow trees and downed logs for dens. Omnivorous.	Relatively impervious to fire because of mobility and wide ecological amplitude.
Marten *Martes* arnericana	2,3,4,5,6,7, 8,9,10	A forest dweller; requires relatively dense climax or near-climax situation. Uses tree or snag cavities and hollow stumps for nest sites. Food includes tree squirrels, chipmunks, mice, berries, insects.	Eliminated from severely burned stands. Benefits from vegetative mosaics resulting from periodic small fires because of increased food supply. Burns containing adequate cover may be used for feeding during summer and fall.
Fisher M. pennanti	2,3,4,5,6,7, 8,9,10	Prefers forest of large trees with many windfalls and downed logs. Nests in tree holes, hollow logs, and snags. Eats squirrels, porcupines, woodrats, mice, rabbits, insects, and berries.	Preferred habitat is adversely affected by severe fire. Benefits from increase in prey species on burns adjacent to favorable habitat. Adapts better to early successional stages than marten.
Ermine (shorttail weasel) *Mustela* errninea	2,3,4,5,6,7, 8,9,10	Prefers mature dense forest for breeding and resting; meadows or other forest openings for hunting. Dens often located in hollow logs and snags. Voles are an important prey; also mice, shrews, and chipmunks.	Adversely affected by severe fire that removes ground debris or kills overstory trees. Benefits from increased biomass of prey species that usually results on fire-created grass-forb successional stages.
Longtail weasel M. frenata	Wide range	Ubiquitous—common in most habitats. Prefers open areas and young pole stands. Den sites include logs, stumps, and snags. A major predator of voles and mice. Also feeds on gophers, chipmunks, birds, insects, and vegetation.	Benefits from increased biomass of prey species that usually results on recently burned areas.

(con.)

Table 4 (Con.)

Species	Fire Group(s)	Habitat considerations	Fire effects
Mink M. vison	Wide range	May occur in any habitat containing fish-supporting marshes, lakes, and streams. Hollow logs and tree stumps along streams may be used for den sites.	Relatively impewious to most fires. May be adversely affected where fire removes streamside cover and debris.
Badger *Taxidea taxus*	Wide range	Grass-forb stages of conifer forest succession is a preferred habitat. Likes deep, friable soil for burrowing and rodent capturing.	Benefits from fires that result in grass-forb successional stages because of the abundant rodent populations that are often present.
Striped skunk Mephitis mephitis	Wide range	Prefers early successional stages of forest but may be found in all stages and cover types. Uses hollow logs, stumps, and snags for den sites. Food includes large insects and small rodents.	Relatively impervious to fire. Benefits from increased biomass of prey species that usually occur on severe burns.
River otter Lutra canadensis	Wide range	Occurs along streams, marshes, and lakes. Dens in bank. Aquatic.	Essentially impervious to fire. Severe fires may destroy essential escape cover along streams, thereby adversely affecting use.
Mountain lion (cougar, puma) *Felis concolor*	4,5,6,7,8,9, 10	Found throughout all habitat types and successional stages. Highly mobile. Hunts deer, hares, rodents, and porcupines.	Often flourishes on recently burned areas due to increased prey availability.
Lynx Lynx canadensis	7,8,9,10	Primarily in dense coniferous forests at higher elevations. May den in hollow logs. Snowshoe hare is an important prey species.	Benefits from fire-initiated shrub stages of succession that support large populations of snowshoe hare.
Bobcat L. *rufus*	Wide range	Found in most habitats and successional stages; shrub-sapling stages being especially desirable. May establish den under large logs or in hollow logs. Preys on rodents, reptiles, and invertebrates.	Relatively impervious to fire. Benefits from any fire-induced increase in availability of prey species.
ARTIODACTYLA (even-hoofed mammals):			
Elk *Cervus* canadensis	4,5,6,7,8,9, 10	Prefers semiopen forest but with areas of dense cover for shelter. Requires food supply of grass, forbs, and shrubs, especially Scouler willow, maple, sewiceberry, redstem, and chokecherry.	Severe burns usually experience a decline in first-year use; then an increase as preferred browse species become available. Moderate fires in forest may remove ground debris and other obstructions to movement.
Mule deer *Odocoileus hemionus*	Wide range	Occupies a wide range of habitats including open montane and subalpine coniferous forest; forest edges, woodlands, and shrubfields. Shrub-seedling-sapling stage of succession preferred. Needs trees and shrubs for cover on winter range. Preferred food includes tender new growth of palatable shrubs—ceanothus, cherry, mountain-mahogany, bitterbrush; many forbs and some grasses.	Fire may improve winter nutrition in grassland and mountain shrub communities by increasing the amount of green grasses. Often a decline in use during first postburn year and then an increase in subsequent years. Where antelope bitterbrush is an important winter range species, moderate to severe fires may be detrimental.
Whitetail deer *O.* virginianus	All	Prefers dense forest; rough, open shrublands; thickets along streams and woodlands. Diet includes shrubs, twigs, fungi, grasses, and forbs.	Fire-initiated early successional stages supporting new growth of grasses, forbs, and shrubs provide a preferred food source.
Moose Alces alces	All	Prefers subclimax forests with lakes and swamps. Ideal habitat includes a mosaic of numerous age classes and distribution of aspen and associated trees and shrubs within the wintering range.	Fires that result in abundant aspen and willow regeneration create a preferred habitat. Optimal successional stage occurs from 11 to 30 years following a severe fire.
Mountain goat *Oreomnos* americanus	7,8,9,10	Frequents alpine and high subalpine zones; on steep slopes. Feeds on grasses, sedges, and shrubs.	Relatively impewious to fire; usually above fire-prone forest areas. Fire that sweeps up through subalpine and alpine forests may create favorable goat range.

(con.)

Table 4 (Con.)

Species	Fire Group(s)	Habitat considerations	Fire effects
Bighorn sheep (mountain sheep) Ovis canadensis	7,8,9,10	Preferred habitat characterized by rugged rocky mountain slopes with sparse trees and adjacent to alpine meadows. Feeds on alpine shrubs and forbs in summer; shrubs and perennial grasses in winter.	Canopy removal by fire may yield increased productivity of undergrowth and makes available more open habitat thereby dispersing populations and reducing incidence of lungworm infections. Fire may retard successional advance of alpine grasslands and improve productivity and palatability of important forage species. Fire can improve nutrition in mountain shrublands by increasing availability of green grass.
CAUDATA (salamanders):			
Long-toed salamander Ambystoma macrodactylum	All	Occupies a variety of habitats from sagebrush steppe to alpine meadows. Requires ponds or lakes for breeding. Found in rotting logs, under bark and other debris surrounding quiet waters.	Adversely affected by severe fires that remove lake- or pond-side debris; otherwise relatively impervious to most fires.
Tiger salamander A. *tigrinum*	2,4,5,6,7,8, 9,10	Found in and near pools, ponds, lakes, and streams. Adults sometimes burrow in decayed logs in damp forest situations.	Impervious to fire except for minor direct mortality in severe fire situations.
SALIENTIA (frogs and toads):			
Bullfrog Rana catesbeiana	Wide range	Inhabits lakes, marshes, pools, ponds, reservoirs, and streams. Hides under debris at water's edge.	Relatively impervious to fire.
Spotted frog A. pretiosa	All	Highly aquatic.	Impervious to fire.
Leopard frog *R. pipiens*	Wide range	Stays around water. In summer it inhabits swamps, grassy woodland or short grass meadows.	Generally impervious to fire. Some direct mortality possible from fast-spreading surface fire.
Pacific tree frog Hyla regilla	All	Varied habitats. It may inhabit damp recesses among rocks and logs in damp woodland or forest. Uses downed logs for hiding and thermal cover.	Damp habitat minimizes fire effects. Surface fire under severe drying conditions could degrade habitat.
Chorus frog Pseudacris triseriata	7,8,9,10	Occupies high grasslands and mountain forests. Inhabits marshes, meadows, lake margins, and grassy pools. Usually found on the ground or in low plants.	Relatively impervious to fire because of wet habitat.
Boreal toad (western toad) Bufo *boreas*	All	Found in or near water. Burrows in loose soil.	Relatively impervious to fire.
SQUAMATA (snakes and lizards):			
Western skink Eumeces skiltonianus	1,2,4,5,6	Found in woodland and forest with dense vegetation. Inhabits rocky streamsides, dry grassy hillsides, forest openings, and meadows. Hides under logs and bark. Diet includes moths, beetles, crickets, grasshoppers, and spiders.	Severe surface fires will reduce cover and food supply.
Western whiptail Cnemidophorus tigris	1,2,3	Found in openings; avoids dense vegetation. Prefers open woodlands and warmer parts of the forest.	Severe fire may result in some direct mortality. Generally benefits from fire-created openings within its range.
Rubber boa (Rocky Mountain boa) Charina *bottae*	All	Found near streams and meadows in all forest types; prefers pole to mature stands. Uses rotting logs, and bark of fallen and standing dead trees for hiding. Feeds on rodents, insects, and lizards on forest floor.	Severe surface fire can remove cover and temporarily reduce abundance of prey species.

(con.)

Table 4 (Con.)

Species	Fire Group(s)	Habitat considerations	Fire effects
Racer (western yellow-bellied racer) Coluber constrictor	1,2,3	Inhabits open woodlands, wooded ravines, and thickets. Diet includes lizards, frogs, small rodents, snakes, and insects.	Surface fire may adversely affect food supply.
Gopher snake (bullsnake) Pituophis *melanoleucus*	1,2,4,5,6	Highly adaptable species; occupies a variety of habitats. Mainly hunts on surface for small mammals.	Relatively impervious to fire because of wide ecological amplitude.
Common garter snake (red-sided garter snake; valley garter snake) Tharnnophis *sirtalis*	All	Widely distributed in many different habitats which include a water source. Diet largely aquatic but includes small mammals.	Impervious to fire.
Western terrestrial garter snake T. elegans	Wide range	Found in all successional stages of all habitat types near permanent or intermittent streams and ponds.	Relatively impervious to fire because of its tendency to be close to water.
Western rattlesnake (prairie rattlesnake) Crotalus *viridis*	1,2,3,4,5,6	Highly variable habitats, including open woodlands to mountain forests. Often found in rock outcrops. Hunts on surface for rodents.	Relatively impervious to fire except for possible direct mortality in severe surface fire situations.

Table 5—Hypothesized fire tolerance for some central Idaho birds (adapted from Kramp and others 1983)'

Fire intolerant	Fire impervious	Fire adapted	Fire dependent
Ash-throated flycatcher	Common crow	American kestrel	Blue grouse
Bewick's wren	Robin	Robin	House wren
Black-capped chickadee'	Black-billed magpie	Black-headed grosbeak	Mourning dove
Black-throated gray warbler	Black vulture	Blue grosbeak	Sandhill crane
Brewer's sparrow	Blue-winged teal	Blue-winged teal	Turkey
Brown creeper	Brown-headed cowbird	Brewer's sparrow	
Burrowing owl	Canadian goose	Canadian goose	
Common bushtit	Cedar waxwing	Cassin's kingbird	
Cassin's finch'	Chestnut-collared longspur	Clark's nutcracker	
Chipping sparrow	Clark's nutcracker	Cliff swallow	
Golden-crowned kinglet	Cliff swallow	Common flicker	
Grasshopper sparrow	Common flicker	Common nighthawk	
Great horned owl*	Common raven	Cooper's hawk	
Hammond's flycatcher	Common snipe	Dark-eyed junco	
Hermit thrush	Eastern kingbird	Downy woodpecker	
Mountain chickadee"	European starling	Eastern bluebird	
Goshawk*	Gadwall	Eastern meadowlark	
Northern harrier*	Great blue heron	Fox sparrow	
Pine siskin	Horned lark	Gadwall	
Pygmy nuthatch	Lark bunting	Gambel's quail	
Red-breasted nuthatch'	Loggerhead shrike	Green-tailed towhee	
Red crossbill	MacGillivray's warbler	Hairy woodpecker	
Ruby-crowned kinglet	Mallard	House wren	
Rufous-sided towhee*	Mourning dove	Killdeer	
Sharp-shinned hawk'	Northern pintail	Lark sparrow	
Solitary vireo	Orchard oriole	Lazuli bunting	
Western flycatcher	Red-winged blackbird	Mallard	
Western tanager*	Snowy egret	Mountain bluebird	
White-crowned sparrow*	Song sparrow	Northern harrier	
White-throated sparrow	Steller's jay	Northern pintail	
Yellow-rumped warbler'	Townsend's solitaire	Poor-will	
Yellow warbler	Turkey vulture	Rufous-sided towhee	
		Savannah sparrow	
		Screech owl	
		Snowy egret	
		Three-toed woodpecker	
		Tree swallow	
		Vaux's swift	
		Vesper sparrow	
		Violet-green swallow	
		Western bluebird	
		Western kingbird	
		Western meadowlark	
		Western woodpewee	
		Wild turkey	
		Williamson's sapsucker	
		Winter wren	
		Yellow-bellied sapsucker	

'Breeding cover negatively impacted by fire, foraging use made of burned areas.

'Caution is urged in using this table. Assignment of a species to one or more categories is based, in most cases, on limited data and opinion. Definitions in the text for each category should be read carefully.

FIRE USE CONSIDERATIONS

The management implications of fire ecology information are presented at the end of each fire group discussion. The use of fire to accomplish certain resource management objectives is suggested. The following fire use considerations apply generally to all Fire Groups. They are presented here to avoid repetition.

Heat Effects and Insect Attack

Care must be taken when burning in forest stands to prevent or minimize scorching the crowns of residual overstory trees. Heavy fuel accumulations or slash concentrated near the base of overstory trees may require scattering or other treatment to avoid lethal cambium heating. Excessive crown scorch, cambium, damage or both can result in loss of vigor and increased susceptibility to bark beetle attack or tree mortality. For example, the relationships between crown defoliation and mortality caused by the western pine beetle (Dendroctonus *brevicomis*) in ponderosa pine has been generalized as follows (Stevens and Hall 1960):

Percent defoliation	Percent of trees killed by beetles
0-25	0-15
25-50	13-14
50-75	19-42
75-100	45-87

The season in which a fire occurs is an important factor influencing direct tree mortality, and the subsequent occurrence, duration, and severity of a beetle attack. The result of crown scorching is usually more severe during the active growth period early in the summer than later when growth has slowed, terminal buds have formed, and a food reserve is being accumulated (Wagener 1955, 1961). Likewise, crown scorching that occurs in early spring, before or immediately after bud burst, often results in minimum damage to the tree.

Understory vegetation and dead surface fuels can be burned without serious threat of subsequent damage by bark beetles if the overstory trees are not severely scorched (Fischer 1980; Safay 1981). If accidental scorching does occur, and bark beetle activity is detected, prompt removal of the severely scorched trees will reduce the probability of subsequent damage to healthy green trees. If scorching occurs outside the active growth period, scorched trees may recover and regain lost vigor. This may take 3 years, but signs of recovery should be visible during the first growing season that follows scorching.

Frequency of Burning

The effects of repeated burning on a given site are not well defined for central Idaho forests. Consequently, it seems prudent to follow the wildfire frequencies that existed prior to organized fire suppression (Arno 1976). Too frequent fire might result in loss of seed source, loss of nutrients, and a decline in the fertility of the site.

Large Woody Debris

An important consideration is the retention of enough woody material to maintain forest site quality. The relationships between organic matter and ectomycorrhizae in Intermountain Region forest soils have been described by Harvey and others (1981) and by Harvey (1982). They found ectomycorrhizal development was stimulated by the presence of decayed wood in the soil. Decayed wood also contributes moisture and nutrients that favor continued seedling growth. These potential benefits are especially important on moderately dry sites.

Scattered large logs left on a site also retard soil movement and provide shade for young seedlings. The more tolerant tree species, such as subalpine fir or Engelmann spruce, will not successfully regenerate without at least partial shade. Harvey and others (1981) suggest that about 11 to 17 tons/acre (2.5 to 3.8 kg/m^2) of fresh residues larger than 6 inches (15 cm) in diameter should be left on the site following logging and burning. In addition, only as much mineral soil should be bared as is necessary to obtain desired stocking. Amounts of organic matter in excess of the above requirements can be considered undesirable especially on dry sites. Excess buildup of fuels can set the stage for high-intensity wildfires that result in an extreme reduction of the soil's organic reserves. Numerical relationships for predicting duff and woody fuel consumption by prescribed fire in the Intermountain area are provided by Brown and others (1985).

A final reason for leaving moderate amounts of large-diameter woody debris scattered on the site following logging and burning is to supply food and cover for wildlife. Many small mammals that reside in central Idaho forests rely on forest floor debris for cover and nesting sites. Rotten logs are often important foraging sites for both mammals and birds. Logs, for example, are important feeding sites for pileated woodpeckers.

Woodpeckers and other cavity-nesting birds (and mammals) also require snags, preferably scattered patches of snags, for nesting sites (McClelland and Frissell 1975; McClelland and others 1979).

The need to retain moderate amounts of scattered large-diameter woody debris should not preclude slash disposal. Unabated logging slash represents a significant fire hazard on most sites, usually greatly in excess of the pretreatment situation. This increased hazard will exist for at least 3 to 5 years, even with a maximum compaction effect from winter snows.

Unabated logging slash as well as large accumulations of deadfall in untreated stands can affect elk behavior and movement. Elk use may be diminished when slash inside a treatment unit, or when dead and down material outside, exceeds 1.5 feet (0.5 m) in depth (Boss and others 1983).

Heat Effects on Soil

Properly applied, prescribed fire has a low risk of causing long-term adverse effects on the fertility of the most common central Idaho soils. The effect on naturally infertile soils as in the Idaho batholith is, however, unclear and should be monitored. The shallow, granitic soils of the

Idaho batholith, including the Salmon Uplands and Southern Batholith physiographic regions, tend to be very erodible (Gonsior and Gardner 1971; Megahan 1974; Clayton and others 1979). The presence of living vegetation, especially trees and tree roots, is important to soil stability, hence a severe fire can increase erosion and the possibility of landslides and other mass soil movement (Gonsior and Gardner 1971; Megahan and others 1978; Megahan 1983). The intense heat and ashes resulting from burning bulldozer-piled slash can affect regeneration success on the area occupied by the piles. Size of piles should, consequently, be kept small and burning should be deferred to periods of relatively high fuel and soil moisture (Holdorf 1982).

Prescribed Fire Planning

From a fire management perspective, a successful prescribed fire is one that is executed safely, burns under control, accomplishes the prescribed treatment, and attains the land and resource management objectives for the area involved. Successful prescribed burning requires planning. Such planning should be based on the following factors (Fischer 1978):

1. Physical and biological characteristics of the site to be treated.
2. Land and resource management objectives for the site to be treated.
3. Known relationships between preburn environmental factors, expected fire behavior, and probable fire effects.
4. The existing art and science of applying fire to a site.
5. Previous experience from similar treatments on similar sites.

FIRE GROUP ZERO: MISCELLANEOUS SPECIAL HABITATS

Group Zero is a miscellaneous collection of habitats that have fire ecology and management implications, but that do not fit into the central Idaho habitat type classifications.

Scree

The term "scree" refers to slopes covered with loose rock fragments, usually lying almost exactly at the maximum possible angle of repose so that any disturbance causes miniature rock slides down the face of the slope. Scree slopes may be treeless or they may support scattered trees with sparse undergrowth. Usually scree communities are regarded as special environments where the vegetation is in an uneasy equilibrium with the unstable substrate.

The trees most often associated with scree at lower elevations are ponderosa pine, limber pine, and Douglas-fir. At higher elevations, these habitats are occupied by lodgepole pine, Engelmann spruce, subalpine fir, or whitebark pine.

The discontinuous fuel often makes scree slopes unburnable. Individual trees or islands of vegetation may ignite, but fire spread is limited. A severe, wind-driven fire could pass over the intervening open spaces and destroy a scree community, but this rarely happens. In subalpine fir communities it is not unusual for a fire to spread from tree to tree aided by firebrands created when a subalpine fir crown torches-out. Due to the harsh environment, scree sites revegetate slowly.

Forested Rock

Forested rock is usually a very steep canyon wall or mountain side composed of rock outcrops, cliffs, and occasional clumps of trees clinging to ledges and crevices. Forested rock is especially prominent along the canyons of major rivers and in rugged upper subalpine areas near timberline. These sites bear a certain similarity to scree sites, but the substrate is relatively stable and climax vegetation frequently become established.

Surface fires do not burn well because of the vertical and horizontal discontinuity of ground fuels. The probability of crown fires depends on the density and arrangement of trees on the rock face. In some cases the islands of vegetation are so widely scattered as to be almost immune to wildfire. In other cases, particularly in low-elevation Douglas-fir-forested rock communities, unbroken foliage may extend from the base to the top of a cliff. Each tree forms a ladder into the lower branches of the next higher tree upslope. In such cases crown fires can occur over ground that would not support a less severe surface fire.

Revegetation of rocky sites depends on the severity of the fire, the characteristics and availability of soil, and the availability of a seed source.

Wet Meadow

A meadow is an opening in the forest that is characterized by herbaceous vegetation and abundant water. Subirrigation is common during at least some part of the growing season. Mountain meadows are frequently too wet to burn during the fire season. In midsummer, wet meadows often act as natural firebreaks, but during the late summer and early fall they may carry grass fires.

It is the nature of streamside meadows to gradually become drier in the course of primary succession, from the hydric to the mesic condition. The buildup of organic material and 'trapped sediments from the flowing water, combined with a possible deepening of the stream bed and lowering of the water table, can leave former meadows in an intermediate condition between wet meadow and grassland. In some such sites the meadow becomes bordered by fire-maintained grassland. Fire suppression has allowed conifers to invade meadows where they would not normally be found.

Mountain Grassland

A mountain grassland is a grass-covered opening within an otherwise continuous coniferous forest. Mountain grasslands may act as firebreaks and can be maintained as grassland by light fires, but usually their fire ecology is less obvious. Despain (1973), working in the Bighorn Mountains of Wyoming, found stable boundaries between grassland and forest, and theorized that topoedaphic factors may produce parks. Daubenmire (1943) suggested that edaphic factors might cause permanent parks.

Langenheim (1962), in west-central Colorado, speculated that grasslands dominated by Thurber fescue might be relicts from a warmer and drier period during the Pleistocene. Caution is indicated in management of stands adjacent to mountain grasslands until conditions responsible for their perpetuation are determined.

Aspen Communities

Aspen communities dominate a variety of sites in central Idaho. Aspen stands that appear below the elevational limits of conifers may be climax. More often aspen is a seral species although it may persist for long periods.

An aspen clone is long-lived and consists of many individual stems produced on a system of lateral roots. The individual stems (suckers or ramets) are not fire resistant, but the clone is fire resistant, sending up new suckers following fires. Fire may rejuvenate deteriorating stands and may be necessary to promote sufficient suckering to maintain aspen in areas where it is seral (DeByle and others in press).

Deciduous Riparian Communities

Riparian, flood plain, and ravine communities are typified by various species of cottonwood, birch, willow, dogwood, hawthorn, alder, and sedge. Although the species composition of these communities varies throughout the region, the communities are easily recognizable as wet sites dominated by deciduous species; conifers either are scarce or entirely absent. Wet-site, spruce-dominated communities are included in Fire Group Nine.

Under normal moisture conditions, riparian areas frequently may act as firebreaks. They can, however, burn severely when dry especially early in the spring after snowmelt and before green-up, or late in the fall. Many of the deciduous species found on these wet sites resprout following fire, and some of these, for example, alder, put up several new sprouts for each burned plant, thus increasing the stand's density.

The ecology of these communities is dominated by the predictable disturbances caused by floods and the fluctuations in stream course, water tables, soil depth, and soil particle-size distribution and organic matter accumulation that follow such flooding.

Fire Management Considerations

Group Zero sites burn poorly under normal summer weather conditions. Fire managers can take advantage of this fact when developing preattack plans and when delineating fire management areas, units, or zones. These sites can also serve as anchor points for fuel breaks and firebreaks.

Meadows, aspen communities, and riparian zones can be important wildlife habitats. Prescribed fire is often a suitable tool for maintaining desired forage conditions on these sites.

FIRE GROUP ONE: DRY LIMBER PINE HABITAT TYPES

ADP code	Habitat type-phase (Steele and others 1981)	Physiographic sections (Steele and others 1981)
080	*Pinus flexilis/Hesperochloa kingii* h.t. (PIFL/HEKI), limber pinelspikefescue	Open Northern Rockies
050	*Pinus flexilis/Festuca idahoensis* h.t. (PIFL/FEID), limber pine/ Idaho fescue	Open Northern Rockies
060	*Pinus flexilis/Cercocarpus ledifolius* h.t. (PIFL/CELE), limber pinelcurlleaf mountain-mahogany	Open Northern Rockies
070	*Pinus flexilis/Juniperus* communis h.t. (PIFLIJUCO), limber pine/ common juniper	Open Northern Rockies

Vegetation

Limber pine occurs primarily as an incidental forest type in the Open Northern Rockies section of central Idaho (Steele and others 1981). It occupies the driest forest sites—below the lower limits of Douglas-fir forests or on exposed rocky sites within the Douglas-fir zone (Steele and others 1981). Limber pine may either be the only tree species on the site, or codominant with Douglas-fir. Rocky Mountain juniper is a minor climax associate on some limber pine sites.

Spikefescue and bluebunch wheatgrass are primary undergrowth species on harsh sites. ldaho fescue and mountain big sagebrush may be conspicuous on less than severe sites. Curlleaf mountain-mahogany, creeping barberry, mountain snowberry, common juniper, and weedy milkvetch occur with varying frequencies.

Forest Fuels

Downed, dead woody fuels are rarely a fire hazard in Group One stands. In eastern Montana, for example, fuel loads range between 5 and 15 tons/acre (1 and 3.4 kg/m^2) on limber pine habitat types (Fischer and Clayton 1983; Brown and See 1981). About 80 percent or more of the downed woody fuel is 3 inches (7.6 cm) in diameter or larger. This material is often the result of fallen snags created by a previous fire. Such material is usually scattered about the site (fig. 3). Hazardous fuel conditions are often the result of dead herbaceous fuels.

Role of Fire

Fire history information for central Idaho limber pine sites is lacking. Arno and Gruell (1983) determined a mean fire interval (MFI) of 74 years within the PIFL/AGSP h.t. in southwestern Montana. This MFI may overestimate the average time between fires at a given point on the ground because fuels are so light that the trees may not be well scarred by fire (Arno and Gruell 1983).

Cooper (1975) found a number of 300-year-old Douglas-fir with four to six fire scars each on a PIFL/HEKI h.t. in northwestern Wyoming.

Limber pine invasion of adjacent grass and shrublands is a slow process. The fire-susceptibility of young limber pine and Douglas-fir would seem to preclude successful invasion of sites that experienced historical (pre-1900) grassland fire frequencies of 5 to 25 years. Successful invasion could occur, however, under a frequent fire regime of cool surface fires. Keown (1977) killed only 20 percent of the invading limber pines with low-severity prescribed fire in the spring; his severe fires killed 80 percent of the invaders.

Frequent low-intensity surface fires could favor development of limber pine stands by keeping fuels from reaching levels that would support severe tree-killing fires. The possibility that limber pine communities have burned frequently in the past with very slight effects (no scarring) cannot be ruled out. The existing evidence, however, suggests infrequent fires. The lack of continuous fuels, perhaps due in part to grazing, usually limits fire severity although occasional wind-driven crown fires can occur.

A

B

Figure 3—Low-elevation limber pine habitat types in Railroad Canyon, northeast of Leadore, ID, Salmon National Forest.

Forest Succession

A generalized concept of forest succession in Group One habitats and how fire affects this succession is shown in figure 4 (subsequent numbers in this section refer to fig. 4).

Grassland sites that are potential limber pine sites were probably maintained as grassland by frequent grass fires (No. 1). It is uncertain that this effect is taking place anywhere today; moreover, the frequency of fire required to prevent conifer invasion of the grassland is not known.

A shrub stage may develop within the PIFL/CELE and PIFL/JUCO h.t.'s. **A** thinning fire in the sapling stage could eliminate some shrubs (temporarily) and favor limber pine over Douglas-fir (No. **2). A** severe fire (No. **3)** at any stage can kill most of the trees and return grass to the site.

With a long, fire-free interval, the slow-growing trees will reach maturity and acquire some fire resistance due to a thickened bark. Light-to-moderate surface fires (if allowed to burn) would be most likely (No. 4) and would help maintain an open stand. If fire does not thin the mature forest over a very long period, then accumulating regeneration and litter can eventually contribute to a wind-driven, stand-destroying wildfire (No. **5).** Such a fire would return the site to grassland.

Successional pathways based on the combined effects of fire, plant succession, and fire exclusion are hypothesized in figure **5.**

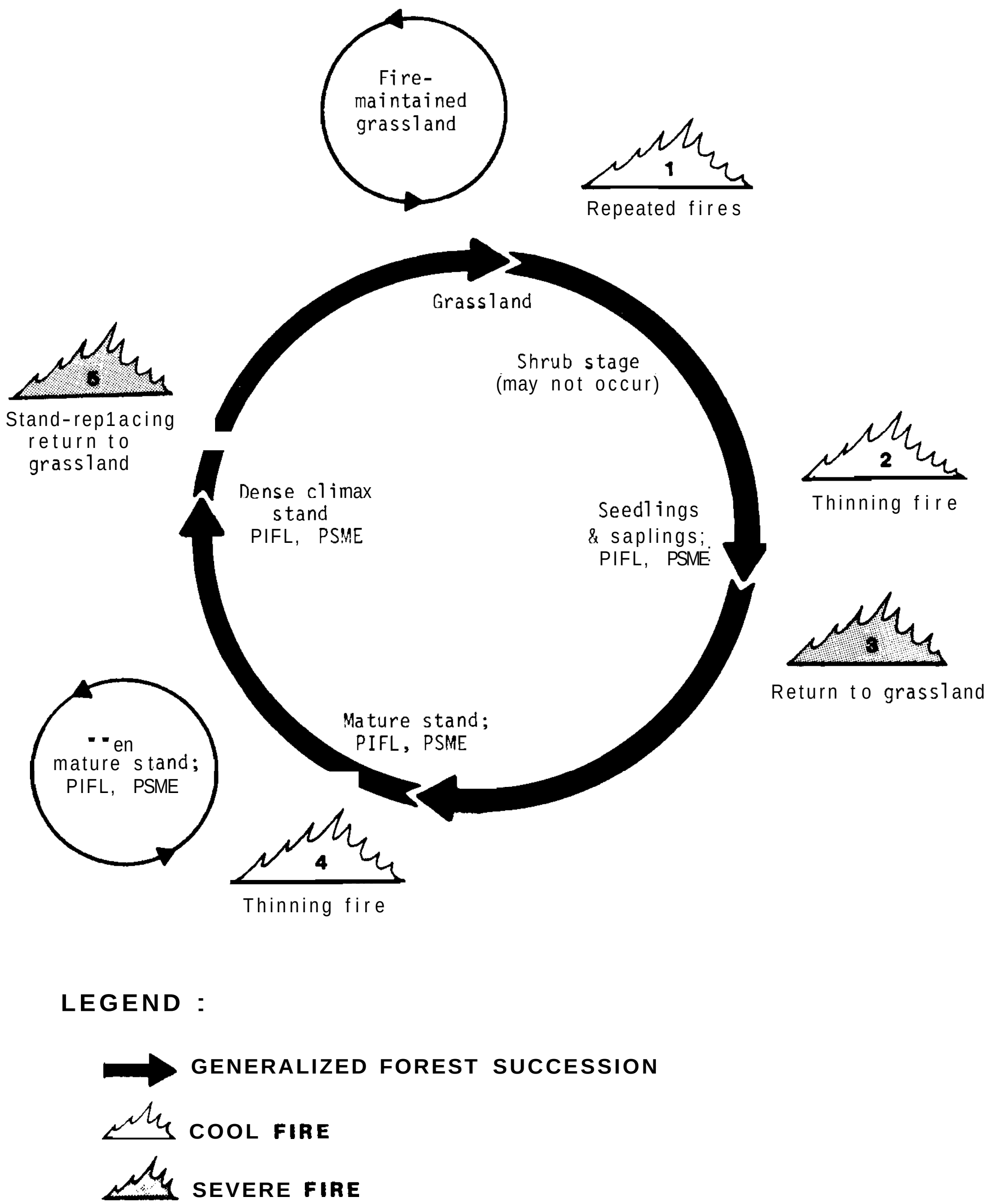
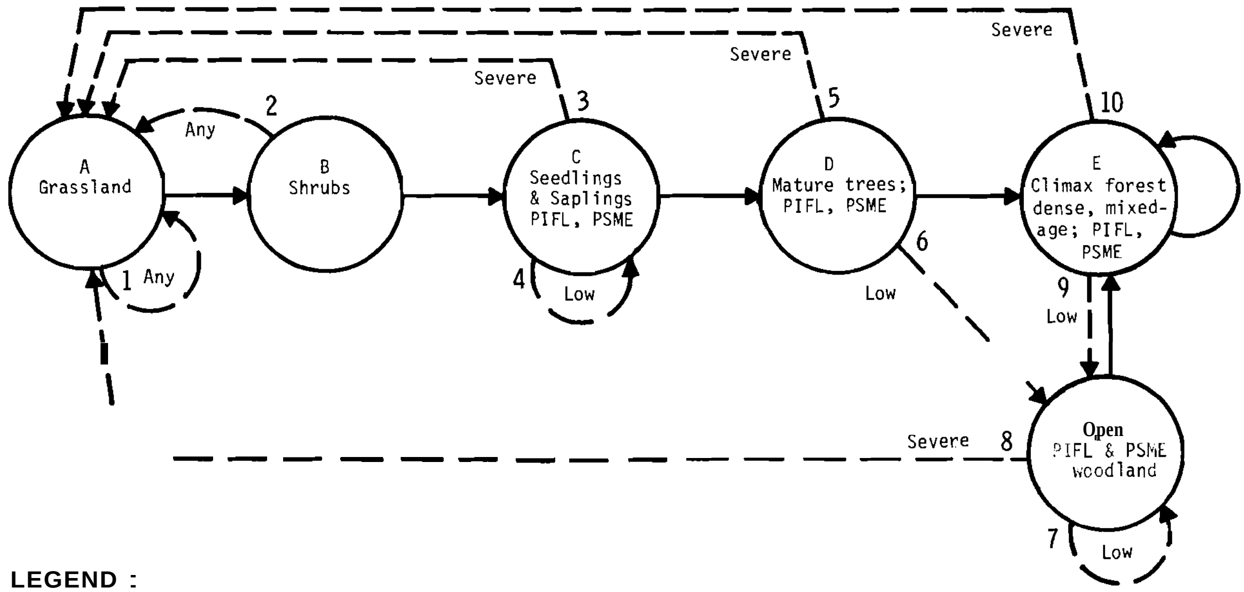


Figure 4—Generalized forest succession in Fire Group One: limber pine climax series habitat types.



LEGEND :

SUCCESSION IN ABSENCE OF FIRE
RESPONSE TO FIRE
LOW COOL OR LIGHT SURFACE FIRE
MOD. FIRE OF MODERATE SEVERITY
SEVERE HOT STAND–REPLACEMENT FIRE
1,2, etc. REFERENCE NUMBER (SEE TEXT)

Figure 5—Hypothetical fire-related successional pathways for Fire Group One habitat types.

Fire Management Considerations

Productivity of trees and undergrowth is usually low on limber pine sites. Consequently, high fire control expenditures are seldom justified unless life, private property, and adjoining high resource values are seriously threatened. Sparse surface fuels often limit fire spread in open stands. Such stands often serve as natural fuel breaks under most burning conditions. Severe fires can, however, seriously damage dense stands on steep, windswept slopes and ridges. Recovery on such sites will be slow.

Limber pine sites are most valuable as a source of food and cover for mule deer, elk, and bighorn sheep especially as winter range. Periodic surface fires csn benefit browse and forage production for wildlife on some sites. Periodic fire can also check limber pine invasion of adjoining grasslands.

FIRE GROUP TWO: WARM. DRY HABITAT TYPES THAT SUPPORT OPEN FORESTS OF PONDEROSA PINE OR DOUGLAS-FIR

ADP code	Habitat type-phase	Physiographic sections
	(Steele and others 1981)	(Steele and others 1981)
120	*Pinus ponderosa/Stipa occidentalis* h.t. (PIPOISTOC), ponderosa pine/western needlegrass	Southern Batholith
130	*Pinus ponderosa/Agropyron spicatum* h.t. (PIPO/AGSP), ponderosa pinelbluebunch wheatgrass	Southern Batholith, Salmon Uplands, and Wallowa-Seven Devils
140	*Pinus ponderosa/Festuca idahoensis* h.t. (PIPOIFEID), ponderosa pine/Idaho fescue	Salmon Uplands, Southern Batholith, and Wallowa-Seven Devils
161	*Pinus ponderosa/Purshia tridentata* h.t. - *Agropyron spicatum* phase (PIPO/PUTR-AGSP), ponderosa pine/bitterbrush - bluebunch wheatgrass phase	Southern Batholith, Salmon Uplands, and Wallowa-Seven Devils
162	*Pinus ponderosa/Purshia tridentata* h.t. - *Festuca idahoensis* phase (PIPOIPUTR-FEID), ponderosa pinelbitterbrush - Idaho fescue phase	Southern Batholith, Salmon Uplands, and Wallowa-Seven Devils
195	*Pinus ponderosa/Symphoricarpos oreophilus* h.t. (PIPOISYOR), ponderosa pine/mountain snowberry	Southern Batholith and Wallowa-Seven Devils
210	*Pseudotsuga menziesii/Agropyron spicatum* h.t. (PSME/AGSP), Douglas-fir/bluebunch wheatgrass	All sections

ADP code	Habitat type-phase (Steele and others 1981)	Physiographic sections (Steele and others 1981)
221	*Pseudotsuga menziesii/Festuca idahoensis* h.t. - *Festuca idahoensis* phase (PSMEIFEID-FEID), Douglas-firlldaho fescue - Idaho fescue phase	Challis and Open Northern Rockies
222	*Pseudotsuga menziesii/Festuca idahoensis* h.t. - *Pinus ponderosa* phase (PSMEIFEID-PIPO), Douglas-fir/Idaho fescue - ponderosa pine phase	Salmon Uplands and Southern Batholith
380	*Pseudotsuga menziesiil Symphoricarpos oreophilus* h.t. (PSME/SYOR), Douglas-firlmountain snowberry	Open Northern Rockies, Challis, and Southern Batholith
385	*Pseudotsuga menziesiil Cercocarpus ledifolius* h.t. (PSME/CELE), Douglas-fir1 curlleaf mountain-mahogany	Challis and Open Northern Rockies

Vegetation

Fire Group Two sites frequently border grasslands in central Idaho. Usually ponderosa pine and Douglas-fir are the only trees on the site, although aspen may be present as accidental individuals. Sites are frequently steep south- and west-facing slopes where a scarcity of soil moisture limits both establishment and growth rates of trees. Lower elevation ponderosa pine communities may occur on gentle terrain of varying aspect.

The fortuitous occurrence of a duff-consuming fire followed by a good seed crop and then adequate moisture can result in sporadic tree regeneration (Steele and others 1981). Good seed crops are infrequent.

Undergrowth is primarily composed of grass (fig. 6), although bitterbrush, big sagebrush, mountain snowberry, and curlleaf mountain-mahogany are major components on some sites. Common grass and forb species include bluebunch wheatgrass, Idaho fescue, western needlegrass, Wheeler's bluegrass, oniongrass, and arrowleaf balsamroot.

Forest Fuels

Downed, dead woody fuel loads are often light. The amount of material less than 3 inches (7.6 cm) in diameter rarely exceeds 5 tons/acre (1 kglm^2). The amount of material greater than 3 inches (7.6 cm) varies according to stand age and condition, but generally accounts for nearly 70 percent or more of the total downed woody fuel load. Large downed fuels commonly result from competition in dense stands, fire, insects, or disease; and damage by wind, snow, or tree-felling, and logging residues.

Stands are generally characterized by discontinuous patches of deep to very deep needle mat layers. Often, the most abundant surface fuel is dead, or curing grass. This is especially true for mature, open-grown stands. Downed woody fuel in such stands usually consists of widely scattered large deadfalls and concentrations of twigs, branchwood, and cones near the base of individual trees.

Fuel loadings in stands infested with dwarf mistletoe can be considerably greater than in uninfested stands. Severely infested ponderosa pine stands in central Oregon, for example, contained significantly greater amounts of dead surface fuels of all size classes than did uninfested or less severely infested stands (Koonce 1981). Weir (1916) noted that large, dense witches'-brooms caused by dwarf mistletoe in Douglas-fir are often broken from the trees during snowstorms and accumulate around the bases of the trees (Alexander and Hawksworth 1975). The presence of witches'-brooms in the crowns of ponderosa pine and Douglas-fir also increase the risk of individual tree "torch out" and subsequent crowning and spotting.

Role Of Fire

The natural role of fire in Fire Group Two habitat types is threefold (Davis and others 1980):

1. To maintain grasslands. Grassland areas capable of supporting ponderosa pine and Douglas-fir could be kept in treeless condition through frequent burning.

2. To maintain open stands. The open condition can be perpetuated by periodic fires that reduce the number of seedlings, that remove dense understories of saplings or pole-sized trees, or that thin overstory trees.

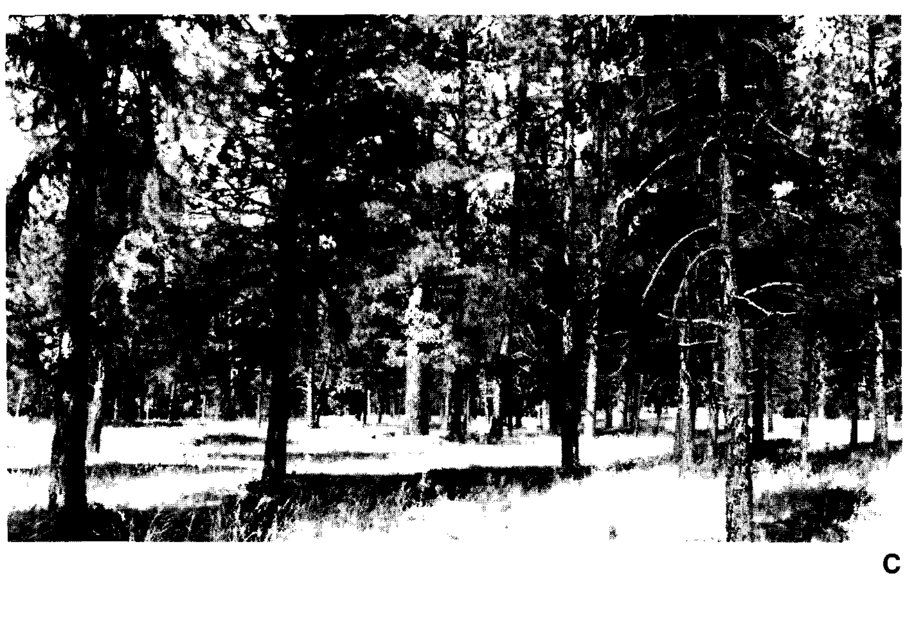
3. To encourage tree regeneration. Fire exposes mineral soil, reduces seedling-damaging insect populations, reduces competing vegetation, and increases nutrient availability. Depending on the subsequent seed crop, weather, and continuity of the seedbed, regeneration may appear as dense stands, separated thickets, or scattered individuals. Periodic fires can create uneven-aged stands comprised of groups of trees that vary in age from group to group. Severe fires may result in a predominantly even-aged stand if regeneration does occur.

Recent fire historv studies on the Salmon National Forest provide some information on historical fire frequencies. Data from six small stands in the Colson Creek drainage (Barrett 1984) show mean fire intervals ranging from 10 to 18 years for both ponderosa pine and Douglas-fir climax communities. Overall fire intervals range from 3 to 30 years. Other data from Salmon River ponderosa pine stands show presettlement mean fire intervals of 12 to 22 years (Arno and Wilson 1986). On the Boise National Forest, the mean fire interval for a stand belonging to the PIPO/SYOR h.t. in the Boise Basin was 11 years for the period prior to 1900 (Steele and others 1986).

Before 1900, fire was a frequent event in ponderosa pine stands adjacent to western grasslands, occurring at intervals of from 5 to 25 years. Arno (1976) reported a range of 2 to 20 years and mean fire-free intervals of 6 to 12 years for fires occurring somewhere in small Group

A

Figure 6—(A) PIPO/FEID h.t. on a warm, west-facing slope above the South Fork of the Salmon River, Salmon National Forest; (B) a PIPO/PUTR h.t. along the Middle Fork of the Boise River, Boise National Forest; (C) PIPO/FEID h.t. alongside the South Fork of the Payette River west of Lowman, ID, Boise National Forest. The widely spaced stumps indicate an open stand condition existed even before the last cutting.



C

Two ponderosa pine stands on the Bitterroot National Forest in western Montana. These figures should be considered conservative estimates of past mean fire intervals because many light surface fires can occur without scarring trees.

A fire interval of 50 years or more is suggested by Wright (1978) for the stands within the PIPO/PUTR h.t. He bases this hypothesis on observation and current knowledge of the susceptibility of bitterbrush to fire (Nord 1965; Weaver 1968; Wright 1978). Gruell (1986) suggests, however, that the fire interval was short and that many of the shrubs were not present in the densities we observe today. It has also been proposed that ponderosa pine communities with shrub undergrowth had longer fire intervals than those communities with grass undergrowth (Gruell and others 1982).

Successful fire control during the 20th century has undoubtedly affected some Group Two stands. In some areas, understory trees have created fuel ladders. Large, intense fires may result when fire control fails in these stands. Successful fire control also increases the area covered by Group Two stands by allowing ponderosa pine and Douglas-fir to invade formerly fire-maintained grasslands.

The relatively spotty or patchy distribution of dwarf mistletoe in ponderosa pine and Douglas-fir stands in central Idaho is due, in large part, to fire history. Severe fires often replaced infested stands with relatively mistletoe-free young stands. Partial burns resulting from less-than-severe fires often produced young trees that were rapidly infected by residual overstory trees that survived the fire (Alexander and Hawksworth 1975). According to Roth (1974a, 1974b), before fires were controlled in Oregon ponderosa pine stands, heat from repeated surface fires pruned back mistletoe-infected branches in the lower crowns, thus limiting the mistletoe plants to a sometimes inconspicuous presence high in the forest canopy (Alexander and Hawksworth 1975).

On Group Two sites, frequent light fires contribute little to soil erosion because few trees are killed and undergrowth and litter return quickly. An intense fire may accelerate erosion on the fragile batholith soils, but usually not as much as the mechanical disturbances often associated with modern fire suppression techniques.

Forest Succession

A generalized concept of forest succession in Fire Group Two and how fire affects this succession is shown in figure 7 (subsequent numbers in this section refer to fig. 7).

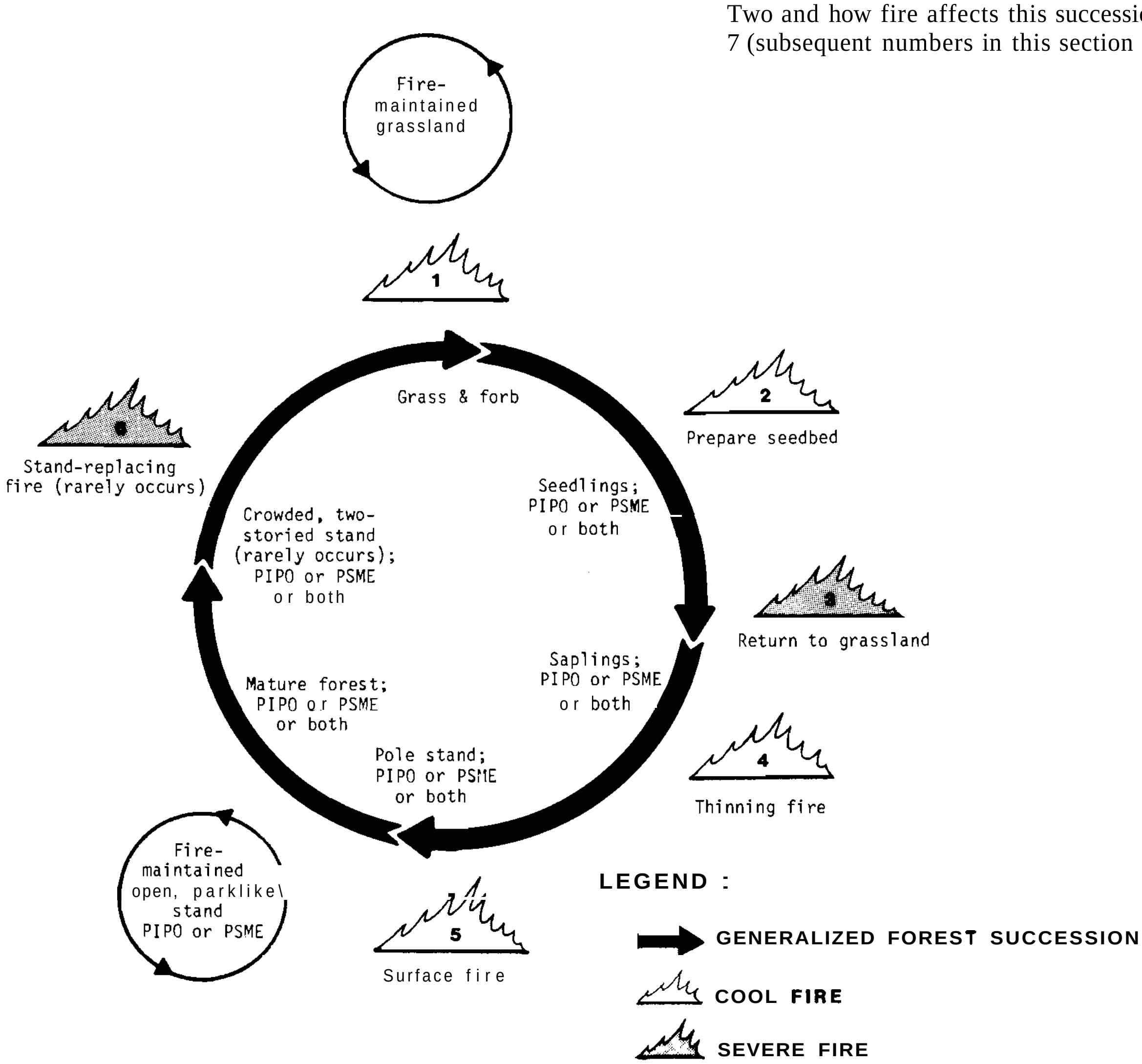


Figure 7—Generalized forest succession in Fire Group Two: warm, dry ponderosa pine habitat types.

Frequent fires could maintain a grassland community by killing tree seedlings (No. 1). Grasses dominate the undergrowth, but other herbs and small shrubs may be present. Depending on habitat type (see appendix B), ponderosa pine or Douglas-fir seedlings may become established gradually over a long fire-free period, resulting in an all-aged, all-sized stand; or as a single age class following a seedbed-preparing fire (No. 2). In the absence of additional fires, the seedlings develop into saplings. Fires during this period may have the effect of killing the young trees (No. 3) or thinning them (No. **4).**

With sufficient time the remaining trees mature to pole-size trees. Subsequent light ground fires tend to produce an open stand of mature trees (No. 5). The open nature of the stand is a direct result of the fires and stocking limitations and deteriorates if the fires are suppressed. The stand may then (in theory) become overstocked and accumulate enough fuel to support a severe stand-destroying fire (No. 6).

Successional pathways based on the combined effects of fire, plant succession, and fire exclusion are hypothesized in figure 8.

Fire Management Considerations

Silviculture—Hazardous fuels resulting from timber cutting can be reduced by prescribed burning. Depending on the situation, broadcast burning, understory burning, piling and burning, and jackpot burning may be appropriate. Lopping and scattering, unless followed by burning, is generally not an acceptable treatment, especially in ponderosa pine stands. "Red slash" creates a very serious fire hazard, particularly in partially cut or thinned pine stands, because needle fall and slash compaction occur so slowly. Fire hazard in untreated slash persists at a relatively high level for 3 to 5 years following cutting. Even after compaction is complete the hazard level will remain higher than before cutting. Carlton and Pickford (1982) predict that burning will produce a reduction in the depth of a ponderosa pine slash fuelbed equivalent to a natural settling period of 8 years for burns conducted in the spring, and at least 20 years for fall burns.

Fuel reduction burning generally results in removal of the duff layer over at least some of the burned area. The exposed mineral soil provides a favorable seedbed for ponderosa pine and Douglas-fir regeneration (Ryker and Losensky 1983).

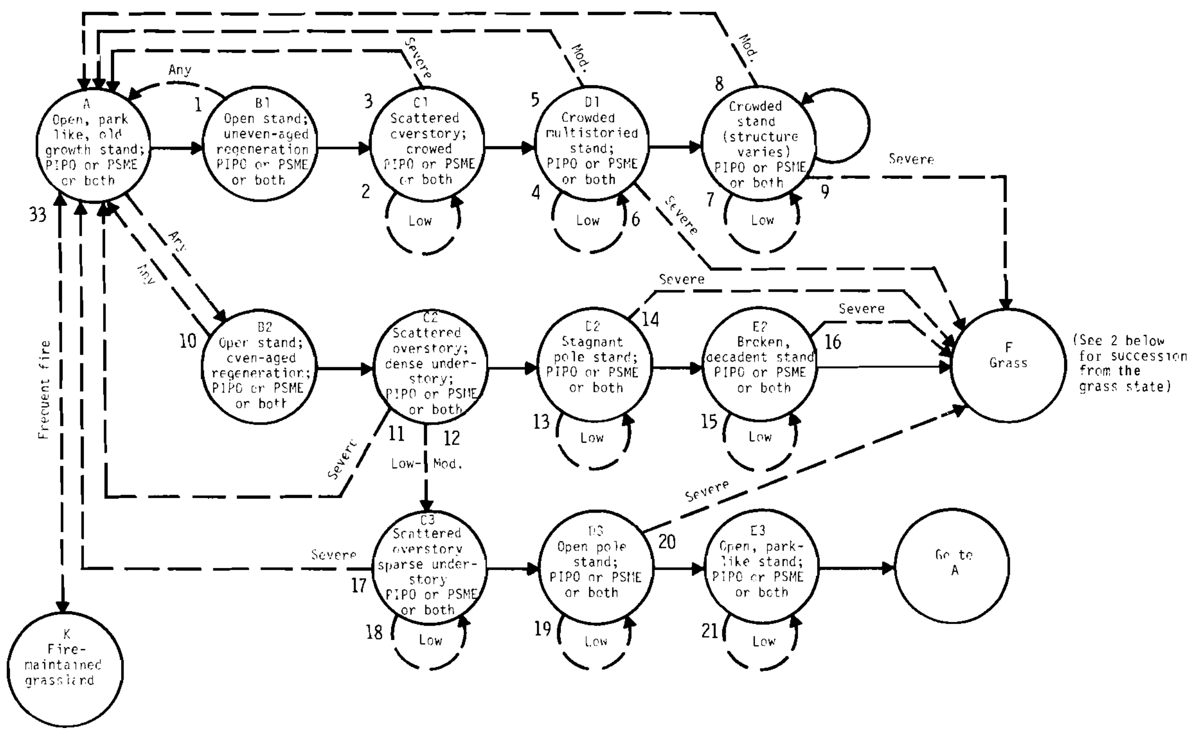
Prescribed understory burning can be an effective tool for reducing natural fuel accumulations in undisturbed stands of ponderosa pine, thereby minimizing potential damage from subsequent wildfire. Such fires can be planned to accomplish multiple objectives, including hazard reduction, site preparation, and increased forage production for livestock and wildlife. Where especially heavy fuel loadings exist, a two-stage burning technique can be used to minimize unacceptable damage to overstory trees (Maupin 1981). First entry burns are usually low-intensity burns employing narrow strip headfires that produce short flame lengths and only partial fuel reduction. Desired fuel reduction is obtained by a subsequent fire conducted under more severe burning conditions.

Range and Wildlife Management—Many Fire Group Two sites support livestock grazing during the summer. Many sites are important winter range for elk, mule deer, and occasionally bighorn sheep. In spring, black bear feed heavily on the perennial grasses and forbs of many sites. Properly applied, fire can increase forage production and enhance the nutritional value of the forage produced. Where sparse fuels exist, grazing may have to be deferred for at least a year before burning in order to create adequate fuels to carry the fire.

For wildlife habitat management, prescribed fire can be used to increase undergrowth forage production, control vegetation composition, and increase habitat diversity. A prescribed fire frequency of 25 to 30 years is recommended to maintain or enhance presence of desirable shrubs (Gruell and others 1982). Low-intensity spring or fall fires can be used to stimulate sprouting and to improve seedling establishment in senescent stands of bitterbrush. More intense fires that expose mineral soil are recommended to rejuvenate decadent willow (USDA-FS 1982). General guidelines for the use of prescribed fire for wildlife habitat improvements in Intermountain Region ponderosa pine stands have been suggested by the Forest Service (1982).

Fire Control—Natural regeneration on Group Two sites is often sporadic and growth is generally slow. Fire control should be geared to protecting desirable advanced regeneration, especially in stands where stocking is limited.

1. SUCCESSION FROM THE OPEN, PARKLIKE, OLD GROWTH PONDEROSA PINE OR DOUGLAS-FIR STATE



2. SUCCESSION FROM THE GRASS STATE

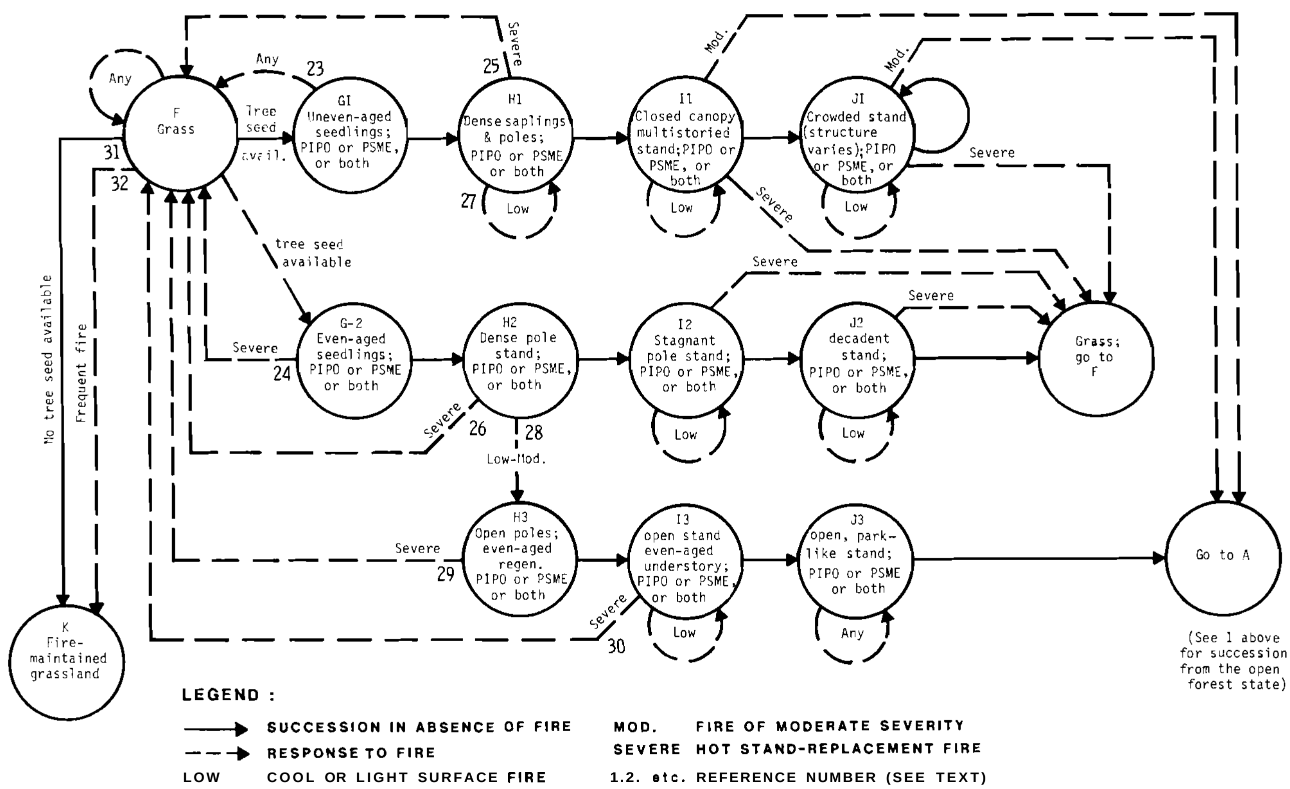


Figure 8—Hypothetical fire-related successional pathways for Fire Group Two habitat types: (1) hypothethical succession starting from an open, parklike, old growth ponderosa pine or Douglas-fir stand; and (2) hypothetical succession starting from the grass state.

FIRE GROUP THREE: WARM, MOIST PONDEROSA PINE HABITAT TYPES AND WARM, DRY DOUGLAS-FIR HABITAT TYPES USUALLY DOMINATED BY PONDEROSA PINE

ADP code	Habitat type-phase (Steele and others 1981)	Physiographic sections (Steele and others 1981)
170	*Pinus ponderosal Symphoricarpos albus* h.t. (PIPOISYAL), ponderosa pinelcommon snowberry	Wallowa-Seven Devils, Salmon Uplands, and Southern Batholith
190	*Pinus ponderosa/Physocarpus malvaceus* h.t. (PIPO/PHMA), ponderosa pinelninebark	Southern Batholith and Salmon Uplands
324	*Pseudotsuga menziesii/ Calamagrostis rubescens* h.t. - *Pinus ponderosa* phase (PSMEICARU-PIPO), Douglas-firlpinegrass - ponderosa pine phase	Southern Batholith, Wallowa-Seven Devils, and Salmon Uplands
334	*Pseudotsuga menziesii/Carex geyeri* h.t. - *Pinus ponderosa* phase (PSMEICAGE-PIPO), Douglas-firlelk sedge - ponderosa pine phase	Southern Batholith, Wallowa-Seven Devils, and Salmon Uplands
397	*Pseudotsuga menziesiil Berberis repens* h.t. - *Symphoricarpos oreophilus* phase (PSME/BERE-SYOR), Douglas-firloregon grape - mountain snowberry phase	Southern Batholith, Challis, and Open Northern Rockies
398	*Pseudotsuga menziesiil Berberis repens* h.t. - *Carex geyeri* phase (PSMEIBERE-CAGE), Douglas-firloregon grape - elk sedge phase	Southern Batholith
344	*Pseudotsuga menziesiil Spiraea betulifolia* h.t. - *Pinus ponderosa* phase (PSME/SPBE-PIPO), Douglas-firlwhite spirea - ponderosa pine phase	Wallowa-Seven Devils, and Southern Batholith
315	*Pseudotsuga menziesiil Symphoricarpos albus* h.t. - *Pinus ponderosa* phase (PSMEISYAL-PIPO), Douglas-firlcommon snowberry-ponderosa pine phase	Wallowa-Seven Devils, Salmon Uplands, and Southern Batholith
262	*Pseudotsuga menziesiil Physocarpus malvaceus* h.t. - *Calamagrostis rubescens* phase (PSMEIPHMA-CARU), Douglas-firlninebark - pinegrass phase	Incidental in Salmon Uplands and Southern Batholith
264	*Pseudotsuga menziesiil Physocarpus malvaceus* h.t. - *Pinus ponderosa* phase (PSMEIPHMA-PIPO), Douglas-firlninebark - ponderosa pine phase	Southern Batholith, Salmon Uplands, and Wallowa-Seven Devils

Vegetation

Fire Group Three includes those warm, dry Douglas-fir habitat types where ponderosa occurs as a major seral or climax associate and two relatively moist ponderosa pine habitat types found in central Idaho. The Douglas-fir habitat types in this group may support fire-maintained ponderosa pine stands that develop a Douglas-fir understory in the absence of fire or other disturbance (Davis and others 1980). The vegetation within ponderosa pine habitat types included here (PIPOISYAL, and PIPO/PHMA h.t.'s) regenerates more readily than those in Fire Group Two, increasing the opportunity for the kind of fuel ladder development characteristic of stands belonging to Douglas-fir habitat types included in this group. Examples of Fire Group Three stands are shown in figure 9.

The habitat types within Fire Group Three occur predominantly at low to middle elevations within the Wallowa-Seven Devils, Salmon Uplands, and Southern Batholith physiographic sections of central Idaho. East and south of these sections, conditions are drier. The lower tree line occurs at higher elevations and includes little or no ponderosa pine (Steele and others 1981); thus these situations fall into other Fire Groups.

Many stands have a shrub-dominated undergrowth that includes common snowberry, white spirea, rose, chokecherry, ninebark, antelope bitterbrush, Oregon grape, serviceberry, willow, and mountain snowberry. Recently burned stands may have snowbrush ceanothus as a dominant species. Elk sedge and pinegrass dominate undergrowth in some stands. Other common herbs include oniongrass, arrowleaf balsamroot, sticky geranium, and silvery lupine (Steele and others 1981).

Forest Fuels

Fuel loads are heavier on the average than those found in Fire Group Two ponderosa pine stands. The average downed dead fuel load for comparable stands sampled in Montana was about 10 tons/acre (2.24 kglm^2) with a range of from **2** to 30 tonslacre (0.45 to 6.73 kglm^2) (Fischer 1981a).

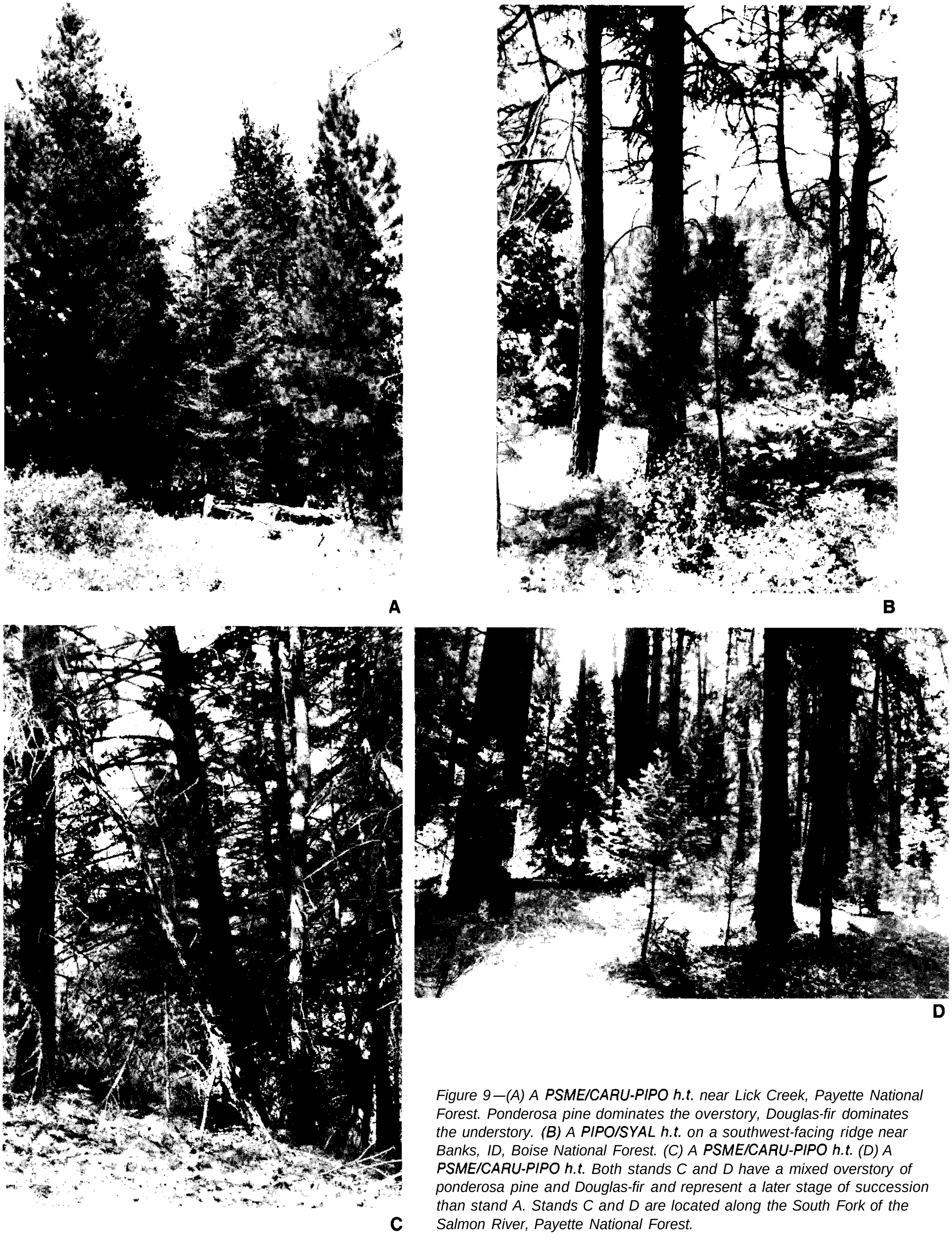


Figure 9—(A) A **PSME/CARU-PIPO h.t.** near Lick Creek, Payette National Forest. Ponderosa pine dominates the overstory, Douglas-fir dominates the understory. (B) A **PIPO/SYAL h.t.** on a southwest-facing ridge near Banks, ID, Boise National Forest. (C) A **PSME/CARU-PIPO h.t.** (D) A **PSME/CARU-PIPO h.t.** Both stands C and D have a mixed overstory of ponderosa pine and Douglas-fir and represent a later stage of succession than stand A. Stands C and D are located along the South Fork of the Salmon River, Payette National Forest.

Fuel conditions and associated fire hazard are usually determined by stand development which in turn is often governed by fire history. As a very general rule, fuel loads tend to increase with stand age as a result of accumulated downfall from insect and disease damage, blowdown, and natural thinning. Stands of the same age may, however, have widely different fuel loads. This is especially true in dense, young stands where heavy mortality from natural thinning or dwarf mistletoe infection (see Fire Group Two) can cause rapid fuel accumulation.

Live fuels can be a significant factor. Dense thickets of Douglas-fir regeneration may become established during fire-free periods. Overstory trees become susceptible to stand-destroying crown fires when such situations are allowed to develop. The presence of witches'-brooms also indicates a high potential for torch-out, crowning, and spotting.

Role of Fire

Fire's role in presettlement forest stands appears to have been important in establishing and maintaining open, old-growth stands. Relatively frequent fires:

1. Prepared seedbeds favorable to both ponderosa pine and Douglas-fir regeneration,
2. Controlled stocking levels in young stands, favoring sapling ponderosa pine over Douglas-fir,
3. Thinned suppressed pole-sized stands, again favoring ponderosa pine in mixed stands,
4. Maintained a ponderosa pine "fire climax" on Douglas-fir habitat types by killing the Douglas-fir understory,
5. Maintained open, parklike stands of ponderosa pine or Douglas-fir or open mixed stands of both species,
6. Prevented the development of "fuel ladders" of saplings or small poles that could carry fire into the crowns of the mature stand,
7. Pruned back mistletoe-infected branches in the lower crowns, thus limiting the mistletoe plants to a sometimes inconspicuous presence high in the forest canopy (Roth 1974a, 1974b), and
8. Regenerated browse and forage species.

Some of the most valuable ponderosa pine stands in central Idaho are growing on Douglas-fir sites because of reoccurring surface fires (Davis 1952). In the absence of fire, relatively dense, stagnant, multistoried Douglas-fir stands can develop. Not only are such stands susceptible to crown fires, but they are also often more susceptible to insect and disease problems.

Recent fire history investigations in the Colson Creek area, Salmon National Forest, suggest a mean fire interval of between 13 and 16 years for four small stands within the PSME/SYAL and PSMEIPHMA h.t.'s (Barrett 1984). Fire intervals ranged from 3 to 30 years based on the method of Arno and Peterson (1983). Mean fire intervals ranging from 10 to 22 years have been determined for stands within the Boise Basin, Boise National Forest (Steele and others 1986). When these stands are arranged on a dry-to-moist gradient, the mean fire interval progressively increases: 9.8 years for a stand within the PSME/CAGE h.t., 10.3 years for a stand within the PSMEISPBE h.t., 12.8 years for a dry site PSMEIPHMA stand, 15.9 years for a typical site PSMEIPHMA stand, and 21.7 years for a moist site PSMEIPHMA stand. All of the above stands occupy mid- to upper-slope positions. One stand belonging to the PSMEISPBE h.t. contradicted the dry-to-moist gradient, with a mean fire interval of 18.1 years. This stand was situated directly above a stream bottom; thus it is presumably less vulnerable to a spreading fire than the other stands. Remember, these short fire intervals represent historical fires; they very likely do not represent current fire history.

Light surface fires that temporarily remove regeneration and undergrowth should not be expected to cause serious erosion problems. Severe fires, on the other hand, can cause serious erosion and mass movement problems on the granitic soils common in this Fire Group (Gray and Megahan 1981). Severe stand-destroying fires have the effect of reducing evapotranspiration, which may increase the depth of the saturated zone relative to the soil depth, which in turn increases the landslide hazard (Megahan 1983).

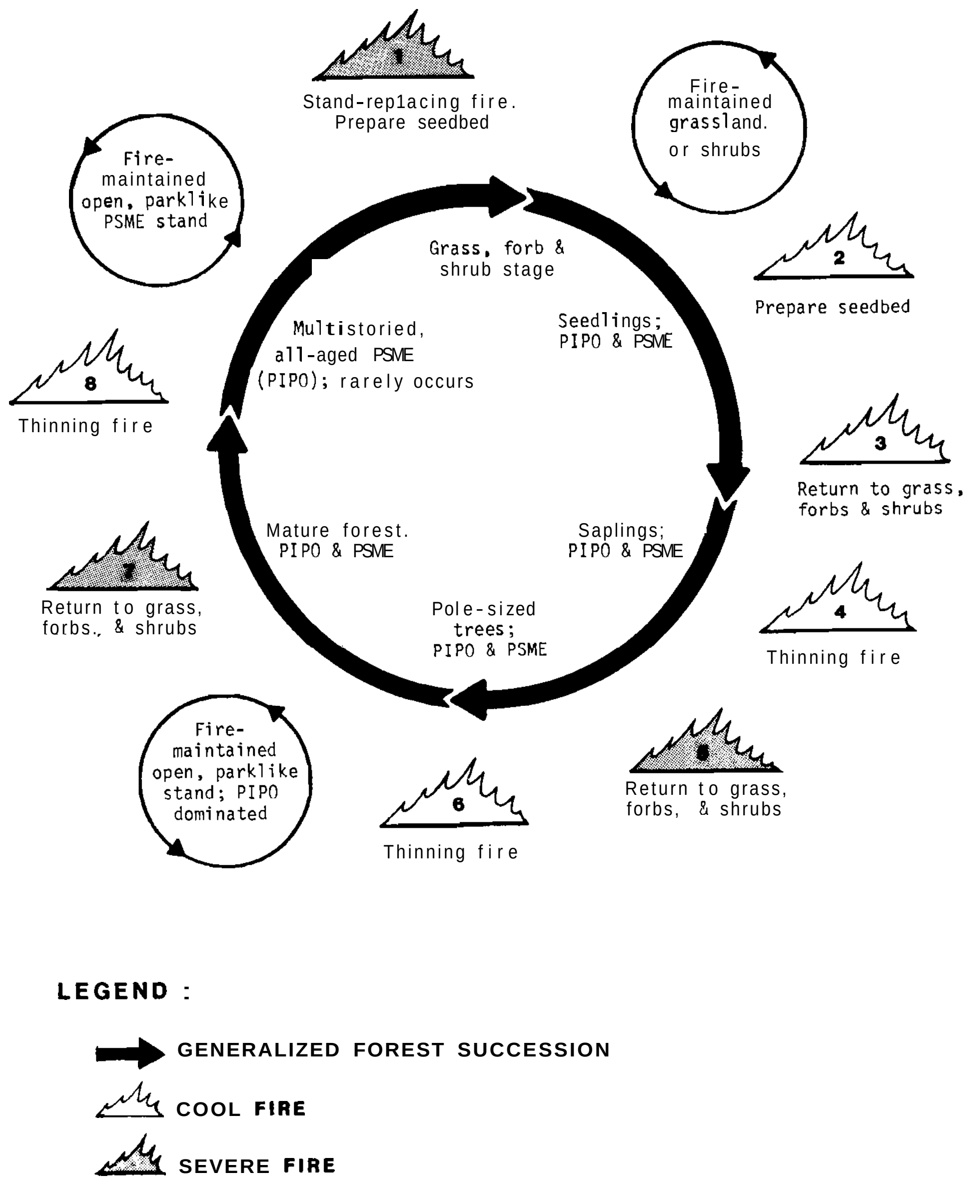
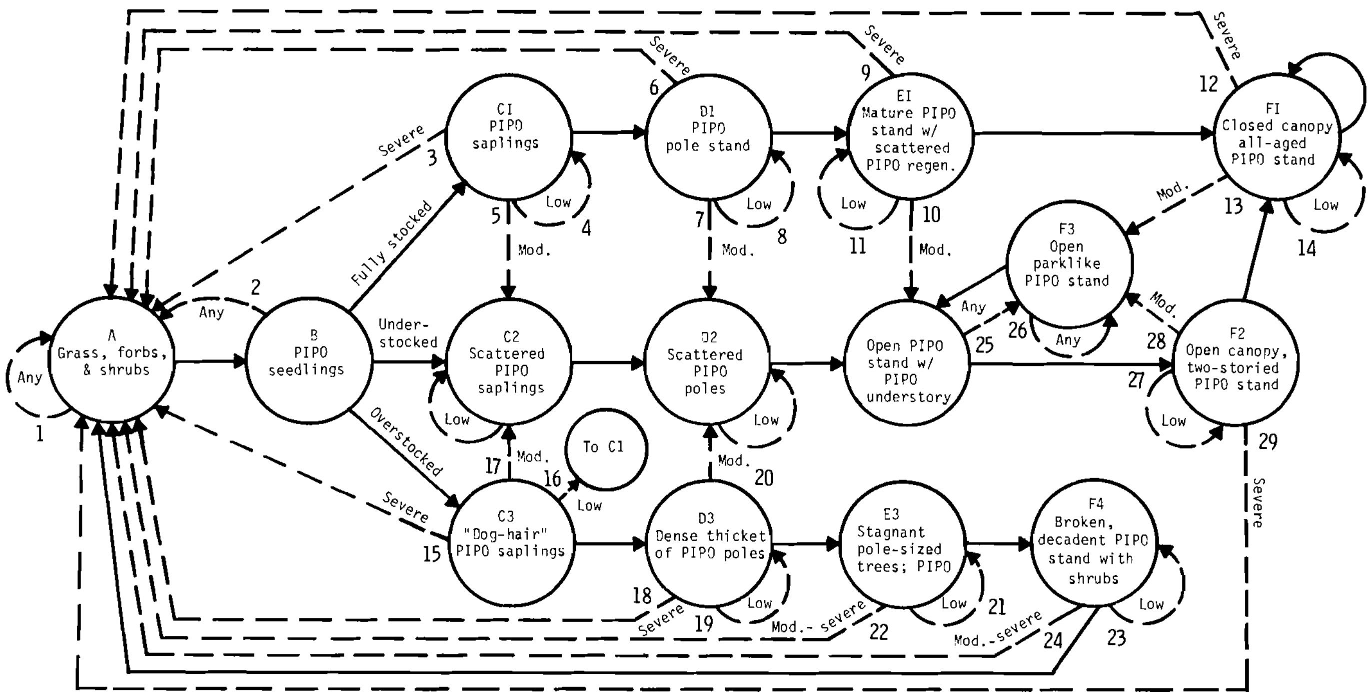


Figure 10—Generalized forest succession in Fire Group Three: warm, moist ponderosa pine habitat types and warm, dry Douglas-fir habitat types usually dominated by ponderosa pine.

Forest Succession

The theoretical Fire Group Three climax forest is an all-aged ponderosa pine or Douglas-fir stand. Old-growth stands tend to remain fairly open; but if dense understories develop, severe stand-replacing fire can occur, as shown in figure 10, No. 1 (subsequent numbers in this section refer to fig. 10). Grass, forbs, or shrubs along with conifer seedlings will become established on the site. Very frequent fires (No. **2)** maintain a grass or herb and shrub community on the site. Given an adequate seed source and site preparation, seedlings usually become established and eventually dominate the site. Douglas-fir seedlings require some shade for successful establishment on most Group Three sites. Any fire during the seedling stage would return the site to the herbs and shrubs (No. **3).** The effect of a fire in the sapling stage depends on stand composition and density. A relatively open stand of sapling ponderosa pine would be thinned by fire (No. 4). If Douglas-fir is present, the thinning will favor the pine. A cool surface fire would also thin a dense "dog hair" thicket of pine or pine and fir, again to the advantage of the pine. A moderately severe fire, however, would kill the entire thicket (No. 5). Pole stands that develop may be quite open, fully stocked, or overstocked. They may consist of ponderosa pine, a mixture of ponderosa pine and Douglas-fir, or perhaps only Douglas-fir. A light-to-moderate fire will thin the stand, removing undergrowth and susceptible Douglas-fir or ponderosa pine stems. Subsequent fires could maintain an open, ponderosa pine-dominated stand. Severe fires in young stands (No. 7) return the site to herbs and shrubs. Low-to-moderate fires remove existing regeneration and keep mature stands open (No. 8). Such fires also prepare the site for new regeneration. In the absence of fire, a multistoried all-aged stand of pine or fir will develop.

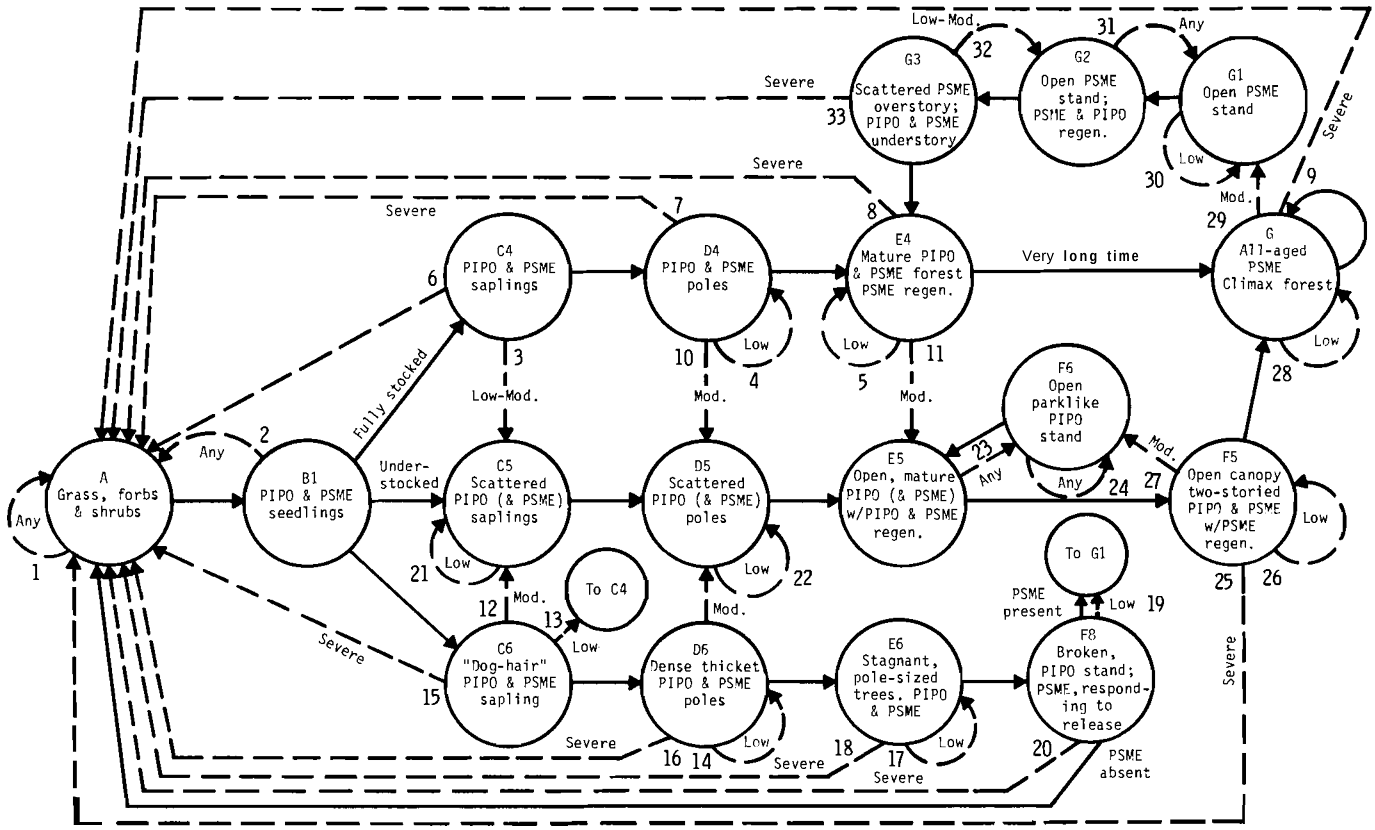


LEGEND :

——▶	SUCCESSION IN ABSENCE OF FIRE	MOD.	FIRE OF MODERATE SEVERITY
– – ▶	RESPONSE TO FIRE	SEVERE	HOT STAND-REPLACEMENT FIRE
LOW	COOL OR LIGHT SURFACE FIRE	1.2. etc.	REFERENCE NUMBER (SEE TEXT)

Figure 11—Hypothetical fire-related successional pathways for Fire Group Three ponderosa pine habitat types.

Hypothetical fire-related successional pathways for Fire Group Three are presented in figures 11 and 12. Figure 11 refers to ponderosa pine habitat types. Figure 12 refers to the Douglas-fir habitat types. Many of the successional stages and pathways hypothesized for Fire Group Two ponderosa pine stands (fig. 4) also apply to ponderosa pine stands in Fire Group Three. The major difference is that Group Three stands tend more toward the dense all-age and multistory condition than to the open, parklike condition shown for Group Two.



LEGEND :

——▶	**SUCCESSION IN ABSENCE OF FIRE**	MOD.	FIRE OF MODERATE SEVERITY
– – ▶	RESPONSE TO **FIRE**	SEVERE	HOT STAND–REPLACEMENT FIRE
LOW	COOL OR **LIGHT** SURFACE **FIRE**	1.2. **etc.**	REFERENCE NUMBER (SEE TEXT)

Figure 12—Hypothetical fire-related successional pathways for Fire Group Three Douglas-fir habitat types.

Fire Management Considerations

Wildfire Hazard Reduction—In the absence of fire, hazardous fuel situations can develop in Group Three stands. The combination of dense Douglas-fir or ponderosa pine understories, accumulated deadfall, decadent shrubs, and other types of accumulated debris and litter can produce fires severe enough to scorch the crowns and kill the cambium of overstory trees. Brown and others (1985) have determined relationships for predicting consumption of forest floor duff and downed, dead, woody fuel to assist managers in planning prescribed fires to safely reduce this hazard. Prescribed fire can also be used to reduce the hazard associated with logging slash resulting from clear-cuts and partial cuts. Most fire prescriptions can be written so as to accomplish silvicultural, range, and wildlife objectives as well as hazard reduction.

Silviculture—Where timber management is the objective, fire can be used to dispose of slash and eliminate mistletoe-infected residual trees on logged over areas, prepare seedbeds, reduce herbaceous competition before planting, control species composition, and reduce the probability of stand-destroying wildfires. Where ponderosa pine is a favored timber species, fire can be used to remove unwanted Douglas-fir regeneration once the pine attains a diameter of 5 inches (13 cm) or more. Wright (1978) recommends that there be an adequate number of trees 10 to 12 feet (3 to 4 m) tall before regular prescribed burning begins, although low-intensity surface fires will often leave pine 6 to 8 feet (2 to 2.5 cm) tall unharmed. Larger Douglas-fir trees will also survive most low-severity surface fires; so there need be little concern about completely eliminating fir from the stand. Where bole or root decay is common on overstory Douglas-fir, increased mortality should, however, be expected.

The practice of prescribed underburning in ponderosa pine-Douglas-fir stands may also reduce the susceptibility of such stands to damage by the western spruce budworm (Choristoreura *fumiferama*) and the tussock moth (Hemerocampa pseudotsugata) (Fellin 1980).

The use of fire on some sites, especially those within the PSME/CARU-PIPO h.t., may result in heavy coverages of pinegrass, especially following low- to moderate-severity fires. The resulting dense sod may impede tree seedling establishment, especially in the absence of bulldozer scarification. Weaver (1957) reports that successful regeneration of ponderosa pine on grassy sites in eastern Washington occurred on spots where slash piles were burned. Ponderosa pine seedlings planted on burned spots had increased survival and height growth after 5 years on sites within the PSME/PHMA h.t. on the Payette National Forest (Hall 1971).

On some sites, burning results in a lush vegetation of snowbrush ceanothus originating from seed stored in the forest floor. This situation, while favorable to wildlife, may impede seedling establishment and early development. Pre-harvest underburns coupled with a shelterwood cut that leaves an overstory in control of the site may discourage development of snowbrush (Martin 1982).

Range and Wildlife Habitat Management—Deer and elk winter and spring ranges can be rejuvenated with properly applied prescribed fire. Such fires can reduce establishment of Douglas-fir, remove accumulated dead plant materials, recycle nutrients, regenerate old shrubs, and increase distribution and production of nutrient-rich grasses, forbs, and legumes. On some sites burning will result in a lush vegetation of snowbrush ceanothus, a favored browse species. Willms and others (1980) found that deer and cattle preferred forage from burned Douglas-firbluebunch wheatgrass communities over unburned control areas. Refer to Fire Group Two fire management considerations for general guidelines for the use of prescribed fire for wildlife habitat improvement in ponderosa pine forests.

Recreation and Esthetics—Prescribed fire can be used to reduce fire hazard in areas immediately adjoining campgrounds. Such treatment not only reduces fire hazard, but also improves viewing and foot travel from the campground to the surrounding forest.

FIRE GROUP FOUR: COOL, DRY DOUGLAS-FIR HABITAT TYPES

ADP code	Habitat type-phase (Steele and others 1981)	Physiographic sections (Steele and others 1981)
372	Pseudotsuga *menziesii*/ Arnica cordifolia h.t. - Astragalus miser phase (PSME/ARCO-ASMI), Douglas-firlheartleaf arnica - weedy milkvetch phase	Challis and Open Northern Rockies
371	Pseudotsuga *menziesii*/ Arnica cordifolia h.t. - Arnica cordifolia phase (PSMEIARCO-ARCO), Douglas-firlheartleaf arnica - heartleaf arnica phase	Challis and Open Northern Rockies
360	Pseudotsuga *menziesii*/ Juniperus communis h.t. - (PSME/JUCO), Douglas-fir1 common juniper	Challis and Open Northern Rockies
332	Pseudotsuga *menziesii/Carex* geyeri h.t. - Symphoricarpos oreophilus phase (PSMEICAGE-SYOR), Douglas-firlelk sedge - mountain snowberry phase	Southern Batholith, Salmon Uplands, Challis, and Open Northern Rockies
331	Pseudotsuga *menziesii/Carex* geyeri h.t. - *Carex* geyeri phase (PSME/CAGE-CAGE), Douglas-firlelk sedge - elk sedge phase	Challis, Southern Batholith, and Open Northern Rockies
385	Pseudotsuga menziesiil Cercocarpus *ledifolius* h.t. (PSME/CELE), Douglas-fir/curlleaf mountain-mahogany	Challis, Open Northern Rockies, Southern Batholith, and Salmon Uplands

ADP code	Habitat type-phase	Physiographic sections
	(Steele and others 1981)	(Steele and others 1981)
325	*Pseudotsuga menziesiil Calamagrostis rubescens* h.t. - *Festuca idahoensis* phase (PSMEICARU-FEID), Douglas-firlpinegrass - Idaho fescue phase	Challis, Open Northern Rockies, Southern Batholith, and Salmon Uplands
323	*Pseudotsuga menziesiil Calamagrostis rubescens* h.t. - *Calamagrostis rubescens* phase (PSMEI CARU-CARU), Douglas-fir1 pinegrass - pinegrass phase	Challis, Open Northern Rockies, Southern Batholith, and Salmon Uplands
343	*Pseudotsuga menziesiil Spiraea betulifolia* h.t. - *Calamagrostis rubescens* phase (PSME/SPBE-CARU), Douglas-firlwhite spirea - pinegrass phase	Challis, Salmon Uplands, and Southern Batholith
344	*Pseudotsuga menziesiil Spiraea betulifolia* h.t. - *Spiraea betulifolia* phase (PSMEISPBE-SPBE), Douglas-firlwhite spirea - white spirea phase	Southern Batholith, Challis, Salmon Uplands, and Open Northern Rockies
310	*Pseudotsuga menziesiil Symphoricarpos albus* h.t. - *Symphoricarpos albus* phase (PSME/SYAL-SYAL), Douglas-firlcommon snowberry - common snowberry phase	Open Northern Rockies, Salmon Uplands, and Southern Batholith
392	*Pseudotsuga menziesii/Acer glabrum* h.t. - *Symphoricarpos oreophilus* phase (PSMEIACGL-SYOR), Douglas-firlmountain maple - mountain snowberry phase	Challis and Open Northern Rockies
493	*Picea engelmannii/Hypnum revolutum* h.t. (PIEN/HYRE), spruce/hypnum	Open Northern Rockies

Vegetation

Douglas-fir is the indicated climax within all habitat types except the PIEN/HYRE h.t. It generally dominates later successional stages as well. Habitat types in this group are generally too cold for ponderosa pine, although it may be a coclimax species at the warmest and driest extreme of the PSME/CELE h.t. With the exceptions of some sites within the PSMEICARU-CARU and PSMEI SPBE-CARU h.t.'s lodgepole pine is not a major seral species. Examples of Fire Group Four stands are shown in figure 13.

Forests in this group tend to be open, and tree regeneration is often difficult and sporadic. Undergrowth may be sparse but strongly competitive with tree seedlings following disturbance. Elk sedge and pinegrass dominate the undergrowth on some sites. Other grasses and forbs include bluebunch wheatgrass, Idaho fescue, pussytoes, ballhead sandwort, heartleaf arnica, weedy milkvetch, arrowleaf balsamroot, sticky geranium, and silvery lupine. Common shrubs include mountain snowberry, chokecherry, currant, big sagebrush, mountain mahogany, russet buffaloberry, willow, Oregon grape, woods rose, white spirea, common snowberry, mountain maple, and snowbrush ceanothus.

Most of the habitat types in this group have their main distribution in the Open Northern Rockies and Challis physiographic sections. These sections lie on the east side of major mountain systems and generally do not receive full benefit of winter storms bringing moisture from the Pacific Ocean. They do, however, receive some summer rain from storms originating from the Gulf of Mexico and California coast (Steele and others 1981). This basically dry climate with summer rain has severai consequences:

1. Tree growth is slow.
2. Tree seedlings establish readily with the aid of summer rain if seed is available.
3. Trees in overstocked stands do not respond well to release.
4. Lightning-caused fires are infrequent.

Figure 13—(A) A PSME/JUCO h.t. (B) A PSME/ARCO h.t. Both stands are in the Wildcat Creek drainage near Leadore, ID, Salmon National Forest. (C) A lower timberline forest on a north-facing slope in Railroad Canyon. Old limber pine show among the Douglas-fir, indicating an earlier stage of succession.

Forest Fuels

Downed, dead, woody fuels are relatively light. Similar sites in Montana averaged about 13 tons/acre (3 kg/m^2) (Brown and See 1981). Twigs and small branchwood less than 3 inches (7.62 cm) in diameter usually are the predominant woody fuels on the forest floor. Fine fuels are less abundant in this group than in Groups One, Two, and Three. Both undergrowth and regeneration are usually sparse. Individual Douglas-fir trees will, however, often have branches close to the ground; if sufficient ground fuels are available, torching can occur. The large, dense witches'-brooms caused by dwarf mistletoe in Douglas-fir are often broken from the trees during snowstorms. These accumulate around the bases of the trees and increase the likelihood of torching from surface fires (Weir 1916; Alexander and Hawksworth 1975). Also, large brooms on living or standing dead trees may promote crown fires and spot fires.

The combination of widely spaced, thick-barked trees and the characteristically depauperate undergrowth results in a very low fire hazard for most open stands of old-growth Douglas-fir.

Role Of Fire

The natural role of fire is poorly defined for this group. Severe stand-replacing fires seem likely for dense stands of the Open Northern Rockies and Challis physiographic sections, where relatively few lightning ignitions occur. In other areas relatively light fuel loads, sparse undergrowth, and generally open stands also suggest a relatively long fire interval. In southwestern Montana, Arno and Gruell (1983) estimated a mean fire-free interval of 41 years within the PSMEICARU-CARU h.t. Fire may have created and maintained open stand conditions by thinning pole stands and periodically removing understory seedlings. The probable role of fire in the distribution of dwarf mistletoe on Douglas-fir is as reported for Fire Group Two.

Severe stand-destroying fires may lead to accelerated erosion on some sites. Sites on granite substrates within the Southern Batholith and Salmon Uplands physiographic sections are the most susceptible to mass wasting following severe fires.

Forest Succession

The generalized forest succession discussed here and illustrated by figure 14 assumes that Douglas-fir is the dominant seral species on the site as well as the climax within all habitat types except the PIEN/HYRE h.t., where spruce is the theoretical climax. Sites where lodgepole pine is a dominant seral species (some sites within the PSME/CAGE-CAGE and PSME/SPBE-CARU h.t.'s) are represented in figure 18 (see Fire Group Five).

Frequent fire can maintain Fire Group Four sites as grasslands, as shown in figure 14, No. 1 (subsequent

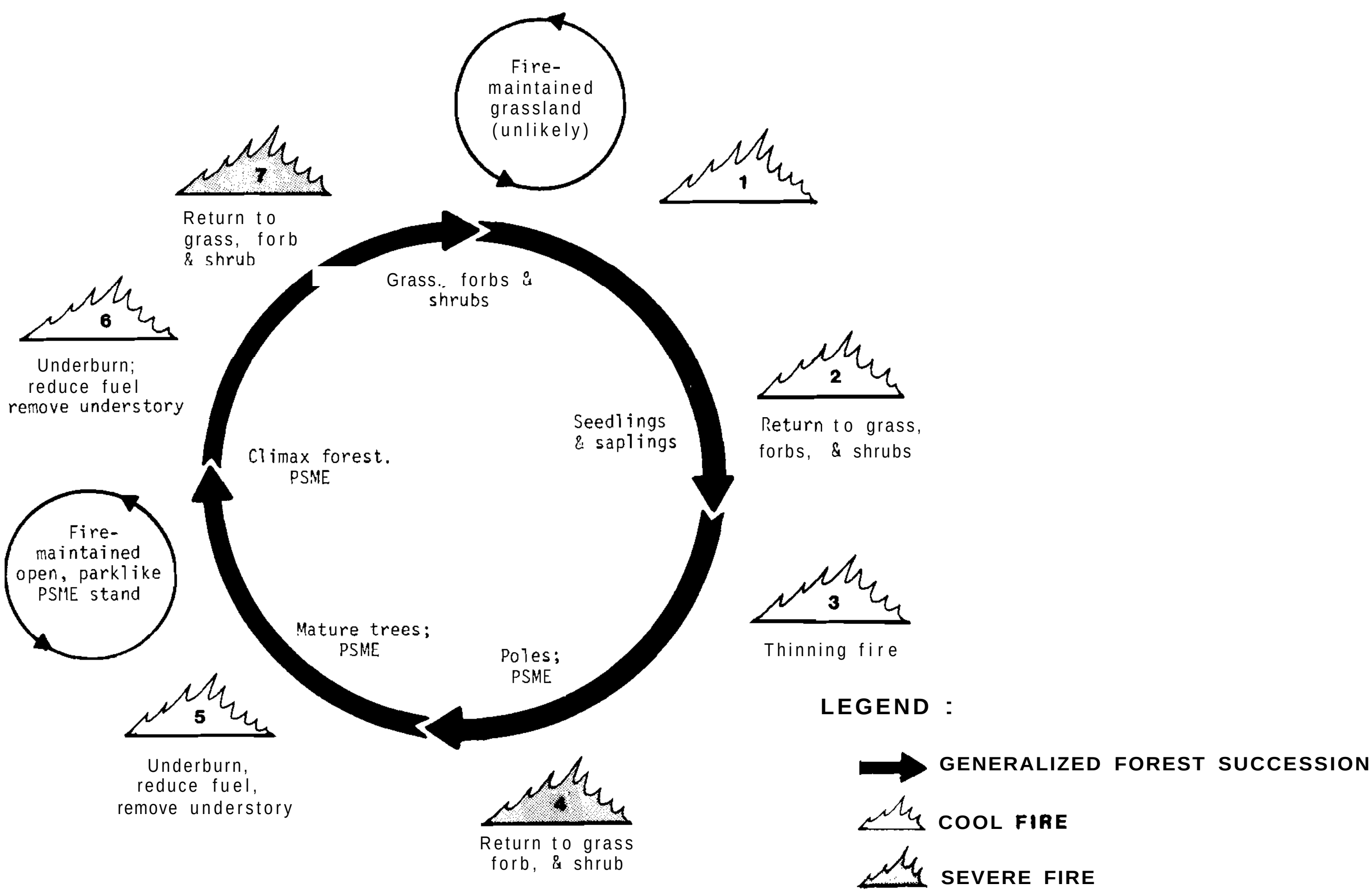


Figure 14—Generalized forest succession in Fire Group Four: cool, dry Douglas-fir habitat types beyond the normal range of ponderosa pine.

numbers in this section refer to fig. 14). Seedling establishment is often slow and requires a combination of favorable seedbed, adequate moisture, and abundant seed. When favorable conditions for seedling establishment do occur, an even-aged stand usually develops. Any fire in either seedling or sapling stages returns the site to grass (No. **2).**

A light surface fire thins a pole-sized stand by killing the more susceptible stems (No. **3). A** pole stand (No. 4) is killed by a severe fire, and the site returns to the grassy stage. A less-than-severe fire in a mature stand (No. 5) acts as an underburn and thins and opens the stand. Subsequent light fires maintain the open condition leading to a parklike Douglas-fir or Douglas-fir and spruce stand. In the absence of fire a near-climax situation develops. The near climax is characterized by a Douglas-fir or Douglas-fir and spruce overstory, sparse undergrowth, and moderate amounts of dead fuel on the forest floor. A light fire in such a stand will remove undergrowth and reduce dead woody fuel (No. 6). A severe fire (No. 7) in a climax or near-climax stand will destroy the stand and revert the site to the grasslforblshrub state.

Hypothetical successional pathways following fire and the absence of fire for most Group Four habitat sites are presented in figure 15. Figure 15 does not adequately represent those sites on which lodgepole pine is a major seral component (some sites within the PSME/CAGE-CAGE and PSME/PSME-CARU h.t.'s). Succession on those sites is better represented in figure 19 (see Fire Group Five).

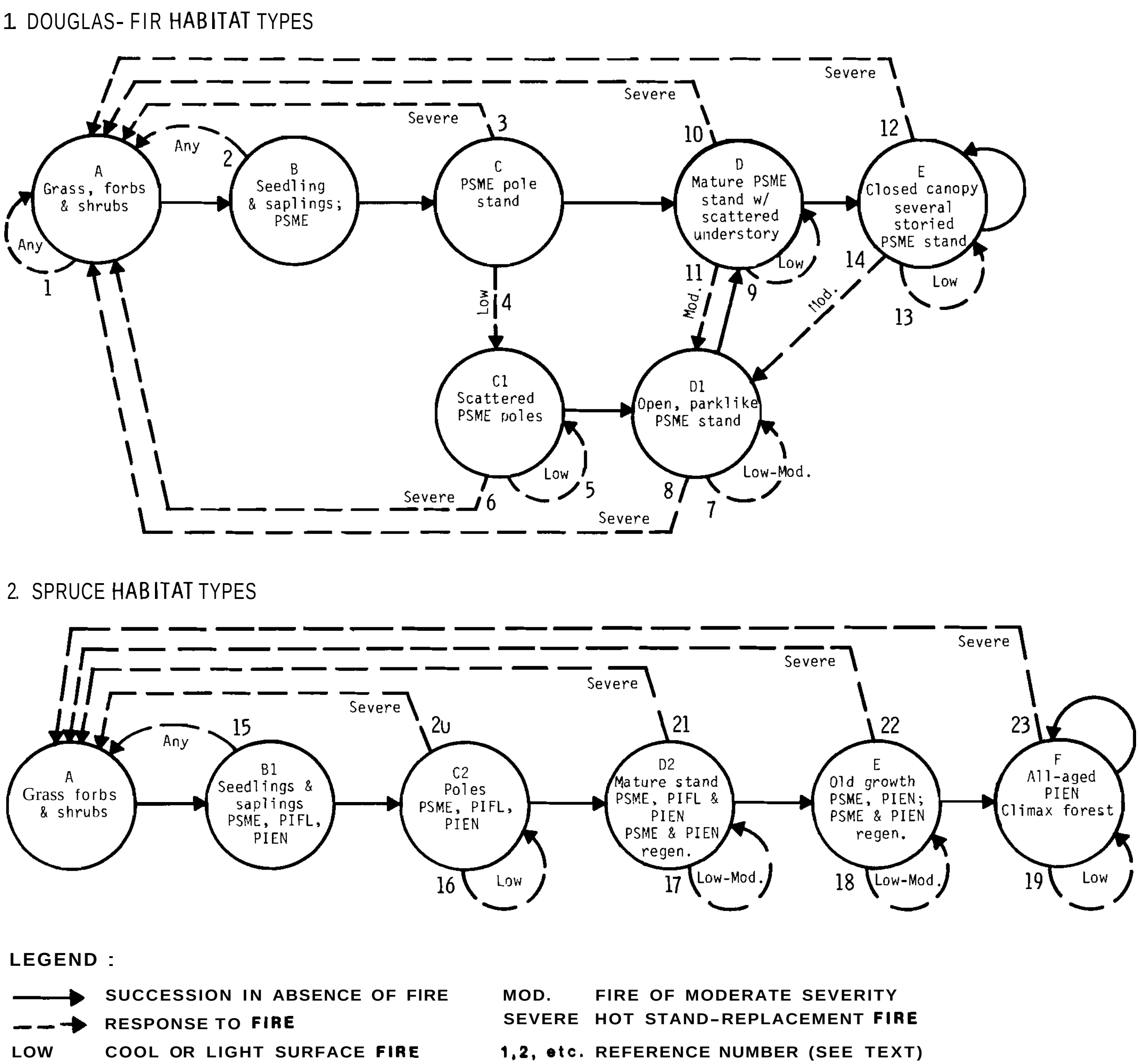


Figure 15—Hypothetical fire-related successional pathways for Fire Group Four habitat types.

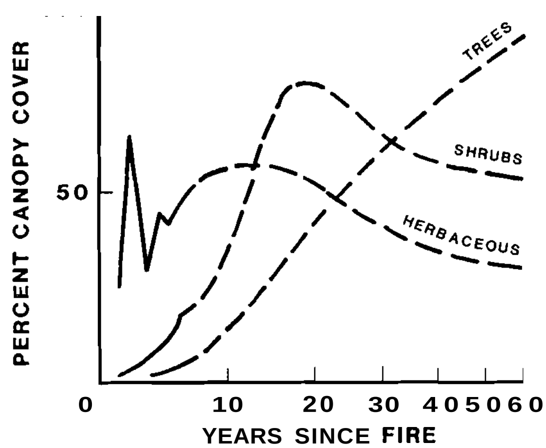


Figure 16—Theoretical development of Neal Canyon vegetal community (Lyon 1971).

Fire Management Considerations

Hazard Reduction and Site Preparation—Fire can be used following timber harvest to prepare seedbed (Ryker and Losensky 1983) and to reduce wildfire hazard from logging slash. Care must be taken to control fire intensity when burning in partially cut stands. The hazard reduction objective in such situations should be to remove fine fuels only. Attempts to burn larger sized slash could result in fire damage to the residual trees. Also, scattered large logs may provide the necessary protection needed for Douglas-fir seedling survival.

Where pinegrass is a component of the undergrowth, burning may lead to an increase in cover and density. This condition requires careful site preparation for successful regeneration of conifers (Steele and others 1981).

Wildlife Management—The occurrence of wildfire or the application of prescribed fire following logging can result in very favorable big game habitat on some sites, especially where snowbrush ceanothus seed is stored in the soil. The resulting seral stands of snowbrush, willow, aspen, mountain maple, serviceberry, and other preferred wildlife browse are very important to deer and elk. In some areas, the sites may be important for fawning and calving (Steele and others 1981).

A Prescribed Fire Case Study—A selectively logged stand of Douglas-fir in Neal Canyon on the Ketchum Ranger District, Sawtooth National Forest, was burned with prescribed fire on August 1, 1963. Major habitat types represented on the area are PSME/CARU (Fire Group Four) and PSME/ACGL (Fire Groups Four and Five). The basic objective of the fire was to destroy residual trees in a partially cut stand that was so heavily infested by dwarf mistletoe that the site was unproductive, and to regenerate a young healthy stand. The prefire stand contained mostly mistletoe-deformed saplings and poles. Lyon (1971) presents descriptions of the fire, the prefire forest community, and the first 7 years of postfire vegetal development. Effects on wildlife habitat are stressed.

The Neal Canyon prescribed fire was burned during daylight hours under conditions severe enough to produce crown fire in the overstory. All litter and herbaceous plants, all dead woody stems under **3** inches (7.6 cm) in diameter, and all live stems under 2 inches (5.1 cm) were completely consumed.

After seven growing seasons, the early seral herbaceous community contained nearly twice as many species as the preburn community. Virtually all the perennial herbaceous species resprouted and many new species appeared. Postfire canopy cover never dropped significantly below preburn levels (Lyon 1971).

The Douglas-fir overstory was killed in the fire, but a new forest has been established by planting, direct seeding, and some natural seeding. Canopy closure of the tree overstory is predicted before postfire year 30 (Lyon 1971).

Most of the preburn shrub species have resprouted, but the relative importance of several species has been significantly modified. Before the fire, crown volume per acre of Rocky Mountain maple was greater than all other shrub species. During the first 7 postfire years, however, Scouler willow and maple were about equal in crown volume, and crown volume per acre of snowbrush ceanothus nearly surpassed all other shrub species (Lyon 1971).

The Neal Canyon prescribed fire was judged to be successful in all respects. Silvicultural objectives were achieved, wildlife habitat was significantly improved, and there was no apparent watershed damage. Lyon (1971) presents a theoretical model (fig. 16) to show that the preburn forest community description can be used to predict postfire community structure and long-term development pattern.

Lyon (1971) properly cautions that sites with depauperate vegetal communities and fragile soils do not recover from burning in the relatively short-term periods suggested at Neal Canyon.

The increased flammability of both logging slash and standing, living and dead trees containing witches'-brooms was clearly demonstrated by the fire at Neal Canyon. Alexander and Hawksworth (1975) describe the situation:

> Flaming witches-brooms 2 to **3** feet in diameter were carried aloft in the convection column, fell and caused spot fires from 6 to 8 chains outside the control lines. The dense, heavy witches-brooms "exploded" on impact with the ground and almost instantly spread flames over a 12- to 15-foot circular area. In addition, some burning brooms rolled down hillsides after landing, causing further fire spread.

FIRE GROUP FIVE: MOIST DOUGLAS-FIR HABITAT TYPES

ADP code	Habitat type-phase	Physiographic sections
	(Steele and others 1981)	(Steele and others 1981)
396	*Pseudotsuga menziesii/ Berberis repens* h.t. - *Berberis repens* phase (PSME/BERE-BERE), Douglas-firloregon grape - Oregon grape phase	Southern Batholith
375	*Pseudotsuga menziesiil Osmorhiza chilensis* h.t. (PSMEIOSCH), Douglas-firlmountain sweet-root	Southern Batholith and Wallowa-Seven Devils
280	*Pseudotsuga menziesiil Vaccinium globulare* h.t. (PSMEIVAGL), Douglas. fir/blue huckleberry	Incidental in Southern Batholith and Salmon Uplands
393	*Pseudotsuga menziesii/Acer glabrum* h.t. - *Acer glabrum* phase (PSMEIACGL-ACGL), Douglas-firlmountain maple - mountain maple phase	Southern Batholith and Challis
265	*Pseudotsuga menziesiil Physocarpus malvaceus* h.t. - *Pseudotsuga menziesii* phase (PSMEIPHMA-PSME), Douglas-firlninebark - Douglas-fir phase	Challis and Open Northern Rockies
290	*Pseudotsuga menziesiil Linnaea borealis* h.t. (PSME/LIBO), Douglas-fir/twinflower	Incidental in Salmon Uplands
250	*Pseudotsuga menziesiil Vaccinium caespitosum* h.t. (PSMEIVACA), Douglas-firldwarf huckleberry	Incidental in Southern Batholith and Salmon Uplands

Vegetation

Douglas-fir is the indicated climax species in all habitat types. It is also the major seral species. Ponderosa pine can be a major seral species within the PSME/BERE-BERE and PSMEIOSCH h.t.'s. Except for the greater occurrence of Douglas-fir, these habitat types could be included in Fire Group Three. Similarly, lodgepole pine can be a major seral species at cool and moist extremes. Aspen and accidental individuals of subalpine fir occur at some sites.

Fire Group Five sites are more moist than Fire Group Four sites, so that fully stocked, closed-canopy forests develop (fig. 17). Regeneration following disturbance may, however, be slow due to competition from shrubs or pinegrass and elk sedge. Common shrubs include ninebark, mountain maple, serviceberry, Oregon grape, rose, mountain snowberry, blue huckleberry, dwarf huckleberry, twinflower, and bearberry. In addition to pinegrass and elk sedge, common herbs include bigleaf sandwort, Wilcox's penstemon, mountain sweet-root, heartleaf arnica, showy aster, false Solomon's seal, and western meadowrue.

Figure 17—A productive PSME/PHMA h.t. in an early ssucessional stage, near Roaring River, Boise National Forest.

Forest Fuels

Depending on stand density, down, dead, woody fuels vary between light and moderate; a range of about 5 to 20 tonslacre (1 to 5 kglm^2), although heavier fuel loads may occur. The most hazardous conditions occur in relatively closed stands with dense Douglas-fir understories. These stands are usually characterized by relatively large amounts of downed twigs and small branchwood less than 3 inches in diameter. Downed as well as standing dead trees resulting from dwarf mistletoe mortality and associated witches'-brooms may add greatly to fuel loads and corresponding fire hazard.

If dense understories are absent, fire hazard is reduced accordingly; however, the density of overstory trees and the presence of dead branches near the ground create a crown fire potential under severe burning conditions.

Fuel conditions in stands dominated by lodgepole pine tend to be less hazardous than stands dominated by Douglas-fir. Ladder fuels are much less prevalent, so the probability of fire going from the forest floor to the crowns is not as great.

Role of Fire

In western Montana, Freedman and Habeck (1984) estimated the historic mean fire-free interval for sites belonging to the PSMEISYAL-CARU and PSMEIVACA h.t.'s to be about 25 years, with an estimated range of

5 to 67 years (Arno 1976; Gabriel 1976). Arno (1980) further suggests that forests in the Douglas-fir series experience a range of fire severity resulting in a mosaic of fire effects.

In this group, fires of low-to-moderate severity would open dense stands of pole-sized or larger trees. Subsequent light burns would maintain these stands in a parklike condition. Long fire-free intervals may result in overstocked stands or open stands with dense understories, creating conditions that might eventually lead to a severe stand-replacing burn.

In these stands fire is an important factor in maintaining wildlife habitat. Fire opens up stands by killing overstory trees, reduces competition by removing understories and rejuvenates sprouting plants through top kill, thus increasing the availability of browse and forage.

As indicated in Fire Group Two, wildfire has played an important role in the distribution of Douglas-fir and its dwarf mistletoe. The patchy distribution of dwarf mistletoe is due, in large part, to fire history (Tinnin and Knutson 1973; Alexander and Hawksworth 1975).

Forest Succession

The theoretical climax stand is a multistoried Douglas-fir stand. Fire maintains many stands in an open, seral condition in the Salmon Uplands, Southern Batholith, and Wallowa-Seven Devils physiographic sections as shown in figure 18 (subsequent numbers in this section refer to fig. 18). Following a stand-replacing fire (No. 1) grass, forbs, and shrubs will dominate the site. If aspen is present, it resprouts and quickly dominates wherever surviving rootstock exists. Any fire will perpetuate this state (No. 2); if a shrub or aspen canopy develops, conifer establishment is slow. Douglas-fir seedlings establish on most sites, in the absence of fire, along with ponderosa pine at low elevations. Lodgepole pine will also establish on some colder sites, including low-elevation frost pockets, and can dominate the site if a seed source is available. Any fire in the seedlinglsapling state (No. 3) returns the site to grass, forbs, and shrubs.

A severe fire in the pole stage (No. **4)** will return the site to grass, forbs, and shrubs. If serotinous lodgepole pine is present, a stand of lodgepole may result. A light fire in a pole stand (No. 5) or a low-to-moderate fire in a large-pole or mature stand (No. 6) thins the stand, favoring ponderosa pine if present, resulting in an open stand of mixed species. Severe fire (No. 7) returns the site to herbs and shrubs. Without fire a climax Douglas-fir forest develops.

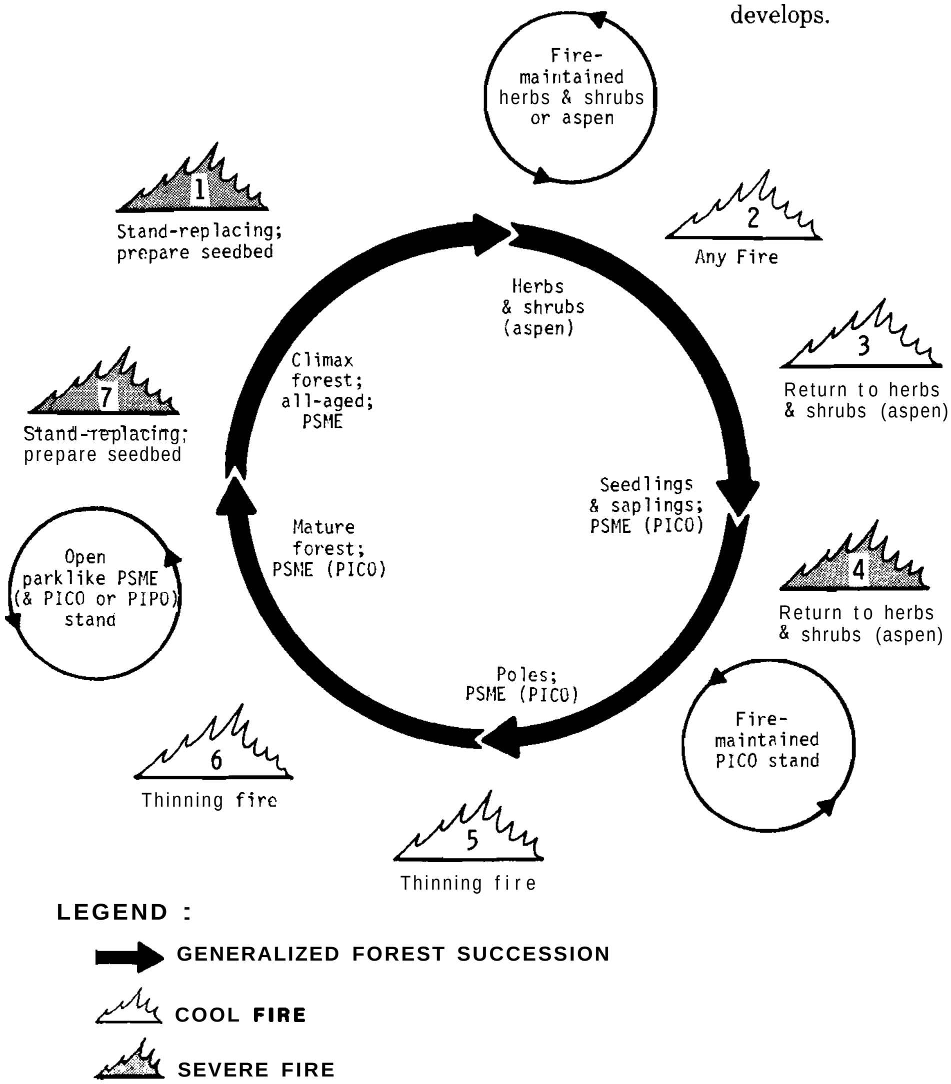


Figure 18—Generalized forest succession in Fire Group Five: moist Douglas-fir habitat types.

Group Five habitat types tend to support nearly pure stands of Douglas-fir or, at high elevations, mixed stands of Douglas-fir and lodgepole pine. Within its elevational range, ponderosa pine may mix with Douglas-fir. In cold air drainages all three species may be present. Ponderosa pine dominates some seral stands. Hypothetical successional pathways for stands with ponderosa pine as the dominate seral species are represented in figures 11 (see Fire Group Three) and 22 (see Fire Group Six). Most Fire Group Five stands follow the hypothetical successional pathways shown in figure 19.

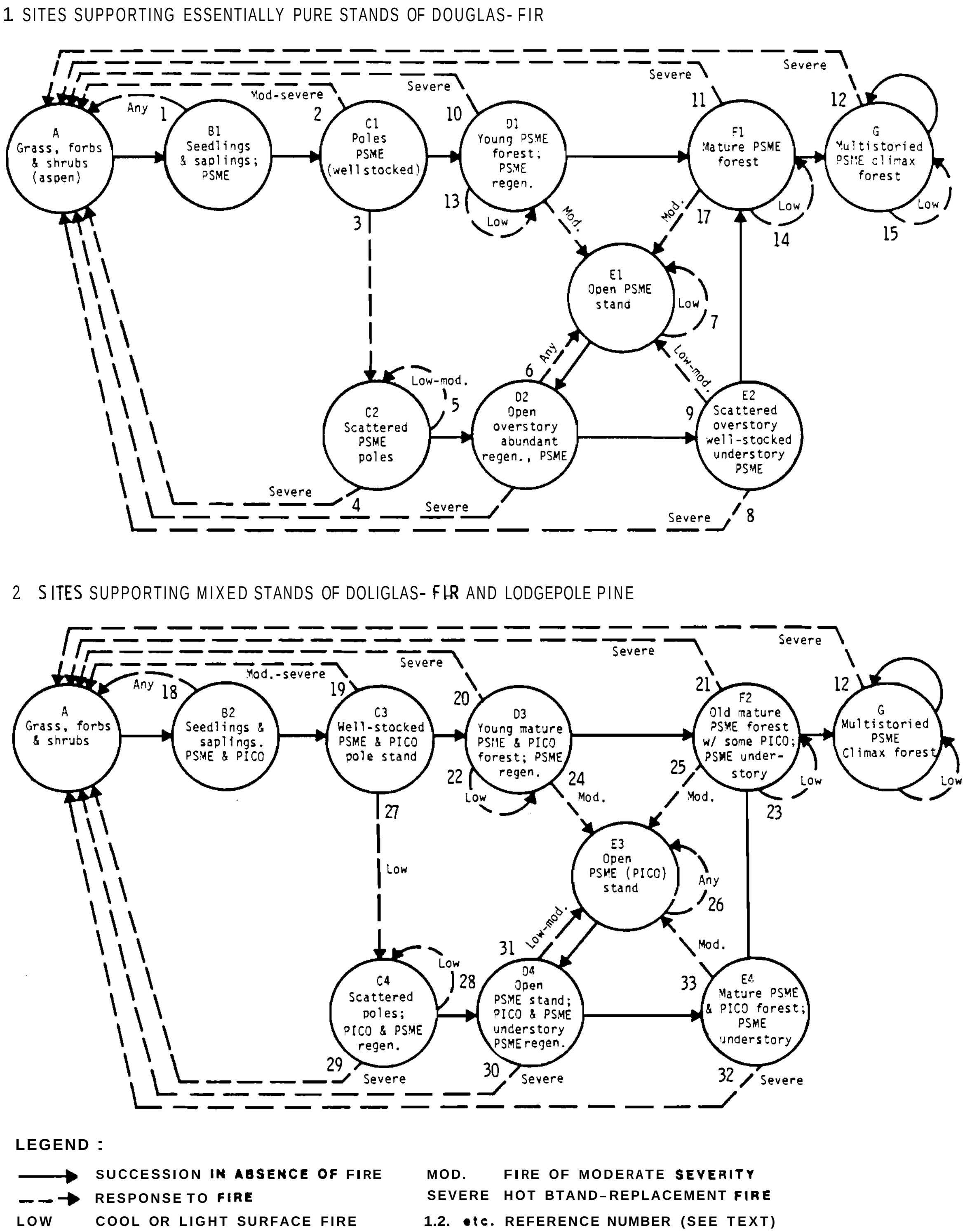


Figure 19—Hypothetical fire-related successional pathways for Fire Group Five habitat types.

Arno and others (1985) show the sequence of seral community types developing after stand-destroying wildfire and clearcutting with broadcast burning, mechanical scarification, or no followup treatment within moist PSME/PHMA and PSME/VAGL-XETE h.t.'s in western Montana.

Fire Management Considerations

Fire Group Five stands are quite variable, depending on site conditions, stand history, and successional stage. Fire management considerations must, therefore, be attuned to this variation.

Wildfire Supression—Protection from unwanted fire may be a major fire management consideration in stands where combinations of live and dead fuels result in a severe fire behavior potential. It may be difficult and impractical to abate the fire hazard in such stands except in conjunction with timber harvest operations. Preattack planning coupled with rapid detection and initial attack may be the only reasonable means to deal with such situations until such time as harvest operations can be scheduled.

Hazard Reduction and Site Preparation—Fire can be used to prepare seedbeds and reduce hazard following logging including the elemination of mistletoe-infected residual trees. Care must be taken to control fire intensity when burning in partially cut stands. The diameter of residual Douglas-fir trees and their branching habit will dictate, to a large extent, the kind of fire that can be prescribed. Guidelines for fuel consumption and duff reduction developed by Brown and others (1985) should be consulted.

On some sites, light or moderate fires may result in unusually high coverages of pinegrass. When this condition develops careful site preparation is required for successful regeneretion of conifers (Steele and others 1981).

Wildlife Management—Fire use considerations for wildlife management are similar to those discussed for Fire Group Four. Some Fire Group Five sites are represented in the prescribed fire case study presented in that discussion. Many Fire Group Five sites are excellent berry producers for bear, grouse, and humans. Spring burning can often increase berry production by top-killing old shrubs, thereby stimulating resprouting (Miller 1977).

FIRE GROUP SIX: GRAND FIR HABITAT TYPES

ADP code	Habitat type-phase (Steele and others 1981)	Physiographic sections (Steele and others 1981)
585	*Abies grandis/Calamagrostis rubescens* h.t. (ABGRICARU), grand fir/pinegrass	Wallowa-Seven Devils and Southern Batholith
505	*Abies grandis/Spiraea betulifolia* h.t. (ABGRISPBE), grand firlwhite spirea	Wallowa-Seven Devils and Southern Batholith
527	*Abies grandis/Acer glabrum* h.t. - *Physocarpus malvaceus* phase (ABGRIACGL-PHMA), grand firlmountain maple - ninebark phase	Wallowa-Seven Devils and Southern Batholith
526	*Abies grandis/Acer glabrum* h.t. - *Acer glabrum* phase (ABGRIACGL-ACGL), grand firlmountain maple - mountain maple phase	Wallowa-Seven Devils and Southern Batholith
591	*Abies grandisllinnaea borealis* h.t. - *Linnaea borealis* phase (ABGRI LIBO-LIBO), grand firl twinflower - twinflower phase	Wallowa-Seven Devils and Southern Batholith
592	*Abies grandisllinnaea borealis* h.t. - *Xerophyllum tenax* phase (ABGR/LIBO-XETE), grand firl twinflower - beargrass phase	Salmon Uplands
515	*Abies grandis/Vaccinium globulare* h.t. (ABGRIVAGL), grand fir/blue huckleberry	Wallowa-Seven Devils and Southern Batholith
510	*Abies grandis/Xerophyllum tenax* h.t. (ABGR/XETE), grand fir/beargrass	Salmon Uplands and Wallowa-Seven Devils
593	*Abies grandisllinnaea borealis* h.t. - *Vaccinium globulare* phase (ABGRILIBO-VAGL), grand fir/twinflower - blue huckleberry phase	Wallowa-Seven Devils and Southern Batholith
511	*Abies grandis/Coptis occidentalis* h.t. (ABGR/COOC), grand firl western goldthread	Salmon Uplands
520	*Abies grandis/Clintonia uniflora* h.t. (ABGRI CLUN), grand firl queencup beadlily	Wallowa-Seven Devils and Southern Batholith

Vegetation

The highly productive habitat types included in this fire group are typically more moist than Douglas-fir habitat types and warmer than subalpine fir habitat types. They are found between 3,400 ft (1,040 m) and 6,500 ft (1,980 m) in elevation and support a very diverse flora (Steele and others 1981). Seral communities include ponderosa pine, lodgepole pine, Douglas-fir, Engelmann spruce, western larch, and aspen. Undergrowth species are also varied. Shrubs include white spirea, pyramid spirea, blue huckleberry, common snowberry, Utah honeysuckle, mountain maple, serviceberry, Scouler willow, ninebark, rose, twinflower, and myrtle pachistima. Herbs may include pinegrass, elk sedge, Ross sedge, heartleaf arnica, western pipsissewa, western meadowrue, sweetroot, beargrass, strawberry, Nevada peavine, pathfinder, Hooker fairybells, western goldthread, queencup beadlily, sidebells pyrola, Solomonplume, and Sitka valerian. See figure 20 for examples of Fire Group Six grand fir stands.

A

B

C

*Figure 20—(A) An **ABGR/ACGL-ACGL h.t.** near Lost Valley Reservoir, Payette National Forest. The overstory is dominated by Dougas-fir, with spruce and grand fir subdominant. A few ponderosa pine and western larch veterans are still present in the stand. (B) An **ABGR/ACGL-PHMA h.t.** near the Cabin Creek Campground, Payette National Forest. Douglas-fir and ponderosa pine comprise the overstory and grand fir the understory. (C) An **ABGR/CLUN h.t.** dominated by Douglas-fir with some ponderosa pine and western larch. Understory is grand fir.*

Forest Fuels

Quantitative descriptions of fuel loadings on central Idaho grand fir habitat types are lacking. Downed, woody fuel loadings on similar habitat types inventoried by Fischer (1981b) in western Montana ranged between about 13 and 38 tons/acre. The heavier loadings tended to occur in very moist streamside locations. Drier upland sites varied between 13 and 20 tons/acre. Brown and See (1981) show total downed woody fuel loadings averaging about 16 tons/acre (3.6 kg/m^2) within the ABGRIXETE h.t. and about 20 tons/acre (4.5 kg/m^2) within the ABGRICLUN h.t. in western Montana and northern Idaho National Forests.

Live fuels in the form of understory fir and pine can add greatly to the crown fire hazard, especially under severe burning conditions. The often luxuriant undergrowth of shrubs and moist-site forbs may retard fire spread under normal summertime moisture conditions.

Role of Fire

Detailed information about the presettlement fire history of central Idaho grand fir stands is scarce. Fire has, nonetheless, altered these forests (Steele and others 1981). The dominance of seral species on drier sites and their presence in most stands, suggests fire's role. On drier grand fir sites frequent surface fires maintained open stands dominated by fire-tolerant ponderosa pine along with some Douglas-fir. Hall (1976, 1980) estimates that natural underburns occurred every 10 years in a mixed conifer-pinegrass forest in the Blue Mountains of Oregon. Part of this mixed conifer-pinegrass community is similar to those of the ABGR-CARU h.t. (Steele and others 1981).

On cooler and wetter sites, fires were less frequent. Fires of low-to-moderate severity favored open, seral stands of ponderosa pine, Douglas-fir, larch, and possibly lodgepole pine. Long fire-free intervals, however, allowed grand fir to dominate and form a closed canopy. Following severe, stand-replacing fires, persistent shrubs or pinegrass dominate some sites when conifers fail to establish. The mean fire interval for grand fir habitat types on the Nez Perce National Forest in north-central Idaho was estimated to be 70 to 120 years (Arno 1980).

Forest Succession

The theoretical Fire Group Six climax forest consists of all-aged grand fir and some incidental subalpine fir. The more common old-growth or near-climax stands usually contain some longer lived midtolerant species. The general path of succession is depicted in figure 21 (subsequent numbers in this section refer to fig. 21).

In this fire group, the initial herb and shrub community can persist if conifer regeneration is not prompt. Fire in this stage or during the seedling and sapling stage (Nos. 1 and 2), maintains a thick sod of pinegrass in the dry habitat types or a dense layer of shrubs in some of the moist habitat types. The composition of the initial stand is variable. At high elevations or in frost pockets lodgepole pine may dominate as it does in Fire Group Seven. At low elevations on south and west slopes, ponderosa pine may be the first and essentially the only conifer to establish on the site. Douglas-fir and other conifers will regenerate in sheltered microsites and eventually in the shade of the ponderosa pine. On less harsh sites a mixed conifer stand establishes with ponderosa pine, western larch, Douglas-fir, lodgepole pine, spruce, grand fir, and even an occasional subalpine fir seedling.

A severe fire in a pole stand (No. 3) returns the site to herbs and shrubs. A surface fire (No. 4) thins the stand, favoring ponderosa pine, Douglas-fir, and if within its range, larch. Repeated low-intensity surface fires maintain an open stand of ponderosa pine and Douglas-fir with an understory of true firs and spruce. Low-to-moderate fires (No. 5) in a mature mixed conifer forest result in a similar, fire-maintained seral stand. A severe fire (No. 6) returns the site to herbs and shrubs. In the absence of fire, grand fir, spruce, and some subalpine fir dominate the understory in old-growth stands because ponderosa pine and Douglas-fir will have difficulty regenerating under the dense canopy. As it matures, grand fir develops a thicker, more fire-resistant bark. Occasional low-to-moderate fires (No. 7) create openings in the canopy and expose mineral soil. This allows some reproduction of all species and maintains the mixed condition. The less shade-tolerant seral species will be lost from the near-climax stand in the absence of fire, leaving true firs and spruce. When fire does occur in the near-climax or the climax forest (No. 8) stand replacement is likely.

Ponderosa pine and Douglas-fir are seral species in the warm and dry habitat types of this fire group. The ABGR/CARU, ABGR/SPBE, ABGRIACGL-PHMA, ABGRIACGL-ACGL, and ABGR/LIBO-LIBO h.t.'s all fit into this warm, dry subgroup. The ABGR/LIBO-LIBO h.t. may support some lodgepole pine in seral stands, but ponderosa pine and Douglas-fir will dominate. Succession in these habitat types is considered in part 1 of figure 21. The remaining habitat types in this fire group are generally cool and moist, hence ponderosa pine is a minor seral species while lodgepole pine and Engelmann spruce dominate. Western larch may occur as a minor seral species or, within the ABGRICLUN h.t., a major seral species on the Payette National Forest. Stands belonging to the ABGR/VACA are included in Fire Group Seven, but some stands respond to fire as do Fire Group Six stands. This cool, moist subgroup consists of the ABGR/VAGL, ABGRILIBO-XETE, ABGRICLUN, ABGRIXETE, and ABGR/COOC h.t.'s. Hypothetical successional pathways for stands within these habitat types are represented in part 2 of figure 22.

Fire Management Considerations

Group Six sites have the highest potential for growing timber. Protection from fire damage is, consequently, an important fire management task in managed stands. This task is often complicated by the presence of hazardous fuel conditions which in many instances are the result of the successful fire suppression efforts of the past. In seral stands dominated by large ponderosa pine and Douglas-fir, dense fir-dominated understories can be burned during relatively mild conditions thereby lessening the chance of stand-destroying wildfires under severe burning condi-

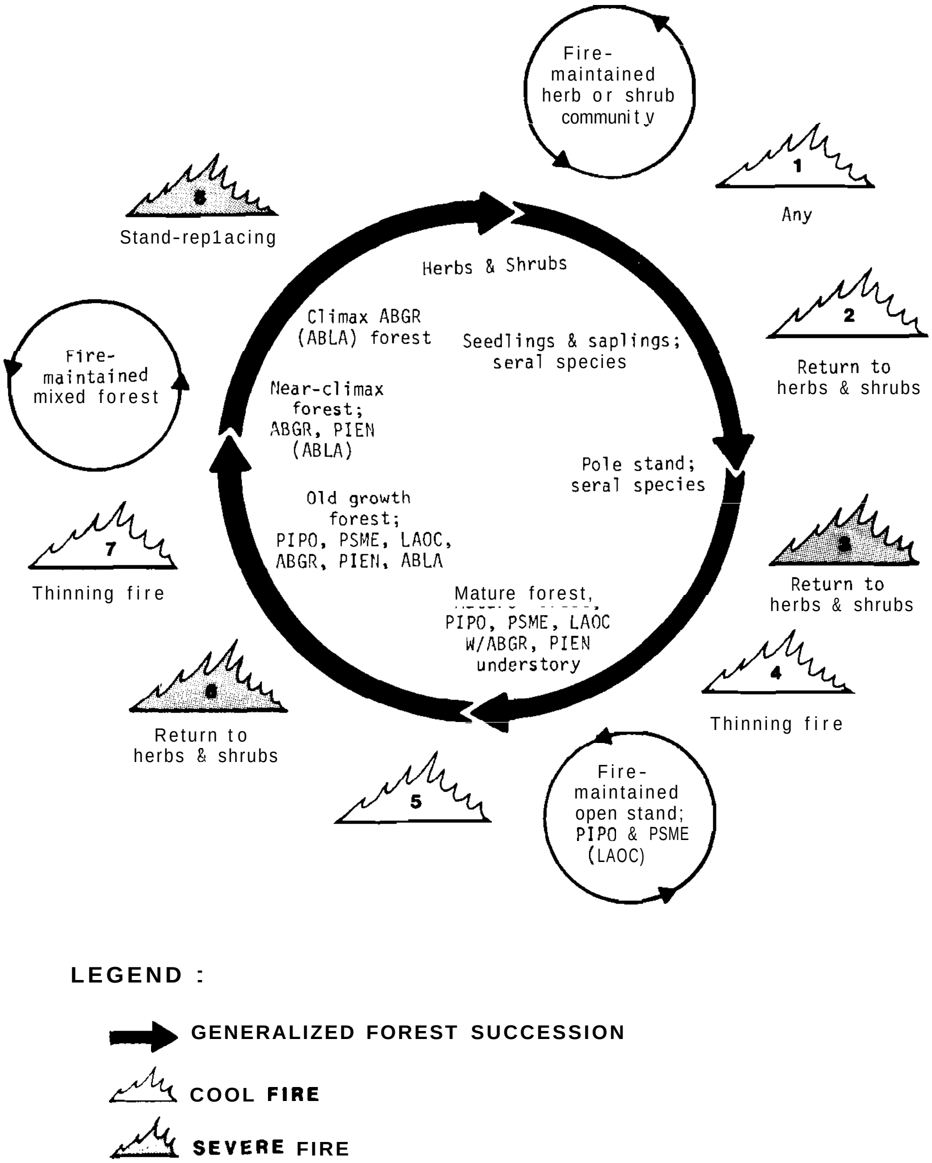


Figure 21—Generalized forest succession in Fire Group Six: grand fir habitat types.

tions. Many unproductive stands, however, would probably benefit from being destroyed by fire.

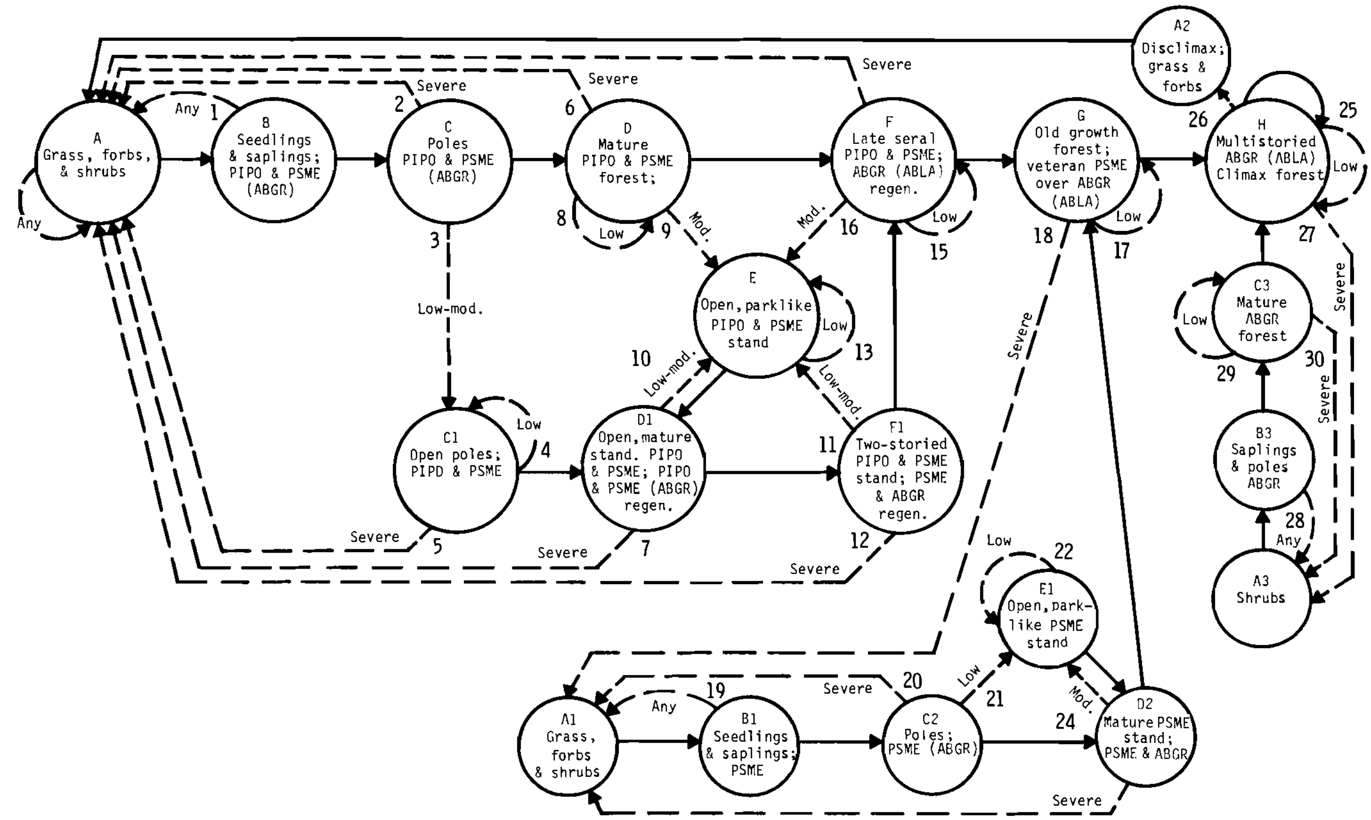
Prescribed fire can be used following cutting to reduce fresh logging slash, accumulated woody debris, and undesirable understory trees. Used in conjunction with clearcutting, broadcast fire can, in addition to fuel reduction, provide a favorable seedbed for ponderosa pine and western larch. Broadcast burning may be inappropriate when partial cutting leaves heat-susceptible grand fir in the overstory. Large-diameter grand fir may, however, survive prescribed understory burning if slash and other woody debris is cleared from the base of crop trees and flame lengths are controlled to minimize crown scorch.

Logging and burning on many Group Six sites often result in a dense stand of tall shrubs that may dominate the site for at least 20 years. This may or may not be a desirable response, depending on land management objectives for the site. The lush shrubbery can provide favorable browse for big game animals. If immediate domination of the site by shrubs is undesirable, the preharvest prescribed burning (Martin 1982), described in Fire Group Three, may be an appropriate treatment.

Ponderosa pine stands can be maintained on Group Six grand fir sites by periodic underburning once the pine has attained a diameter of 5 inches or more as described in Fire Group Three. Periodic prescribed fires designed to favor pine over fir will lessen the risk of serious losses from western spruce budworm and the tussock moth.

In some Group Six habitat types, blue huckleberry is an important food source for bear, grouse, and humans. Berry production can be maintained or increased by periodic spring burning (Miller 1977), as described in Fire Group Five, and by maintaining open stand conditions.

1. SUCCESSION WITH PONDEROSA PINE AND DOUGLAS-FIR



2. SUCCESSION WITH MIXED SERAL STANDS

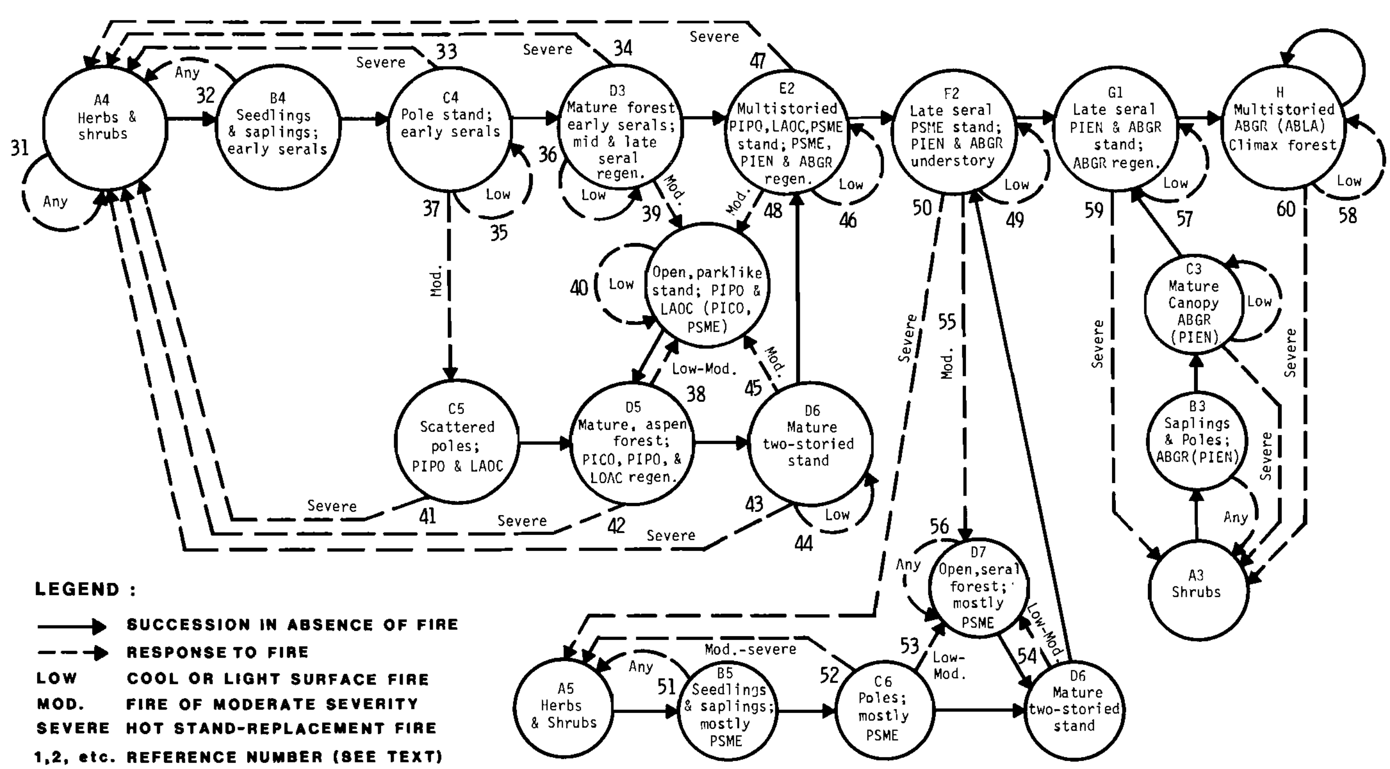


Figure 22—Hypothetical fire-related successional pathways for Fire Group Six habitat types.

FIRE GROUP SEVEN: COOL HABITAT TYPES USUALLY DOMINATED BY LODGEPOLE PINE

ADP code	Habitat type-phase (Steele and others 1981)	Physiographic sections (Steele and others 1981)
580	*Abies grandis/Vaccinium caespitosum* h.t. (ABGR/VACA), grand firldwarf huckleberry	Southern Batholith
640	*Abies lasiocarpa/Vaccinium caespitosum* h.t. (ABLA/VACA), subalpine firldwarf huckleberry	Southern Batholith and Salmon Uplands
732	*Abies lasiocarpa/Vaccinium scoparium* h.t. - *Vaccinium scoparium* phase (ABLAIVASC-VASC), subalpine fir/grouse whortleberry - grouse whortleberry phase	Southern Batholith, Challis, Salmon Uplands, and Open Northern Rockies
654	*Abies lasiocarpa/ Calamagrostis canadensis* h.t. - *Vaccinium caespitosum* phase (ABLAICACA-VACA), subalpine fir/bluejoint - dwarf huckleberry phase	Southern Batholith
651	*Abies lasiocarpal Calamagrostis canadensis* h.t. - *Calamagrostis canadensis* phase (ABLAICACA-CACA), subalpine fir/bluejoint - bluejoint phase	Salmon Uplands and Southern Batholith
655	*Abies lasiocarpal Calamagrostis canadensis* h.t. - *Ledum glandulosum* phase (ABLA/CACA-LEGL), subalpine fir/ bluejoint - Labrador-tea phase	Challis, Southern Batholith, and Salmon Uplands
691	*Abies lasiocarpal Xerophyllum tenax* h.t. - *Vaccinium globulare* phase (ABLAIXETE-VAGL), subalpine fir/beargrass - blue huckleberry phase	Southern Batholith, Salmon Uplands, ans Open Northern Rockies
692	*Abies lasiocarpal Xerophyllum tenax* h.t. - *Vaccinium scoparium* phase (ABLA/XETE-VASC), subalpine fir/ beargrass - grouse whortleberry phase	Salmon Uplands
694	*Abies lasiocarpal Xerophyllum tenax* h.t. - *Luzula hitchcockii* phase (ABLAIXETE-LUHI), subalpine firlbeargrass - smooth woodrush phase	Salmon Uplands
721	*Abies lasiocarpa/Vaccinium globulare* h.t. - *Vaccinium scoparium* phase (ABLAIVAGL-VASC), subalpine fir/blue huckleberry - grouse whortleberry phase	Salmon Uplands
791	*Abies lasiocarpa/Carex geyeri* h.t. - *Carex geyeri* phase (ABLA/CAGE-CAGE), subalpine fir/elk sedge - elk sedge phase	Southern Batholith, Salmon Uplands, Challis, and Open Northern Rockies
750	*Abies lasiocarpal Calamagrostis rubescens* h.t. (ABLA/CARU), subalpine fir/pinegrass	Southern Batholith, Challis, and Open Northern Rockies
740	*Abies lasiocarpa/Alnus sinuata* (ABLA/ALSI), subalpine fir/Sitka alder	Incidental in Salmon Uplands
663	*Abies lasiocarpa/Linnaea borealis* h.t. - *Vaccinium scoparium* phase (ABLAILIBO-VASC), subalpine firltwinflower - grouse whortleberry phase	Southern Batholith, Salmon Uplands, and Open Northern Rockies
662	*Abies lasiocarpa/Linnaea borealis* h.t. - *Xerophyllum tenax* phase (ABLA/ LIBO-XETE), subalpine firltwinflower - beargrass phase	Salmon Uplands, Southern Batholith, and Open Northern Rockies
731	*Abies lasiocarpa/Vaccinium scoparium* h.t. - *Calamagrostis rubescens* phase (ABLA/VASC-CARU), subalpine fir/ grouse whortleberry - pinegrass phase	Southern Batholith, Salmon Uplands, and Open Northern Rockies
905	*Pinus contorta/Festuca idahoensis* h.t. (PICOIFEID), lodgepole pine/Idaho fescue	Southern Batholith and occasionally in Challis, Salmon Uplands, and Open Northern Rockies
920	*Pinus contorta/Vaccinium caespitosum* c.t. (PICO/VACA c.t.), lodgepole pine/dwarf huckleberry	Southern Batholith

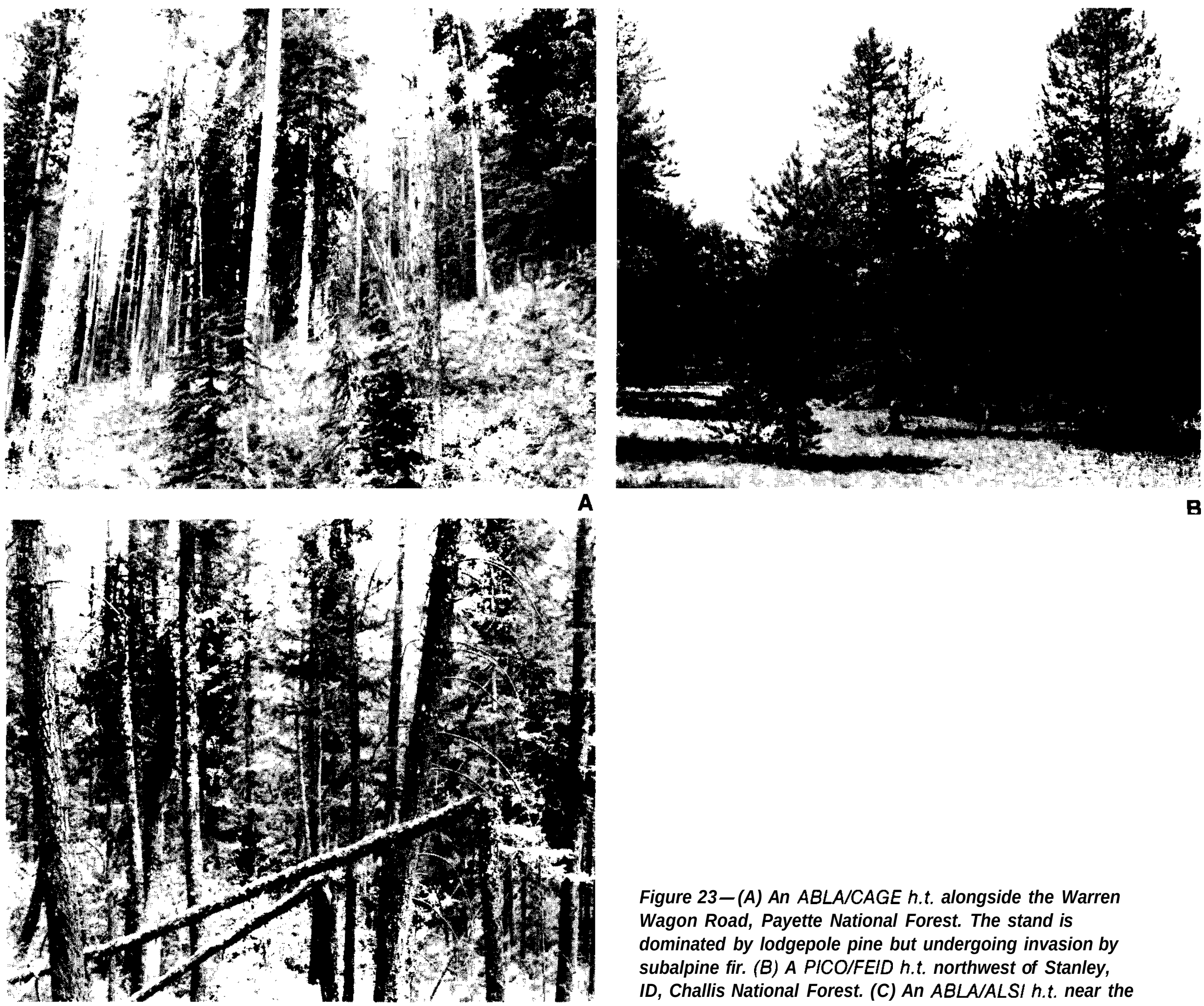
ADP code	Habitat type-phase	Physiographic sections
	(Steele and others 1981)	(Steele and others 1981)
940	*Pinus contorta/Vaccinium scoparium* c.t. (PICO/VASC c.t.), lodgepole pine/grouse whortleberry	Southern Batholith, Salmon Uplands, and Open Northern Rockies
955	*Pinus contorta/Carex geyeri* c.t. (PICO/CAGE c.t.), lodgepole pine/elk sedge	Southern Batholith

Vegetation

There are two subgroups in Fire Group Seven. One group consists of lodgepole pine habitat types and community types that support essentially pure stands of lodgepole pine, with little evidence that any other species is climax. The other group contains grand fir and subalpine fir habitat types where succession is commonly dominated by lodgepole pine (fig. **23).** Grand fir, spruce, and subalpine fir occur on most fir habitat types. Douglas-fir is also found on some sites, and ponderosa pine is a minor seral species on some ABGR/VACA sites.

On some severe sites, lodgepole pine can be dominant and appear almost stable within the ABLAIVACA, ABLAIVASC, and sometimes ABLA/VAGL h.t.'s. These situations should be treated as belonging to the first subgroup of essentially pure lodgepole pine stands.

The most common shrubs are dwarf huckleberry, blue huckleberry, and grouse whortleberry. Other shrubs include Labrador-tea, myrtle pachistima, Sitka alder, mountain snowberry, and big sagebrush. The herbaceous layer is frequently dominated by grass. Pinegrass, bluejoint, elk sedge, or Idaho fescue may be predominant. Other common species include beargrass, smooth woodrush, twinflower, Ross sedge, western needlegrass, Hook violet, heartleaf arnica, silvery lupine, Sitka valerian, and rosy pussytoes.



A

B

C

Figure 23—(A) An ABLA/CAGE h.t. alongside the Warren Wagon Road, Payette National Forest. The stand is dominated by lodgepole pine but undergoing invasion by subalpine fir. (B) A PICO/FEID h.t. northwest of Stanley, ID, Challis National Forest. (C) An ABLA/ALSI h.t. near the Lick Creek Road, Salmon National Forest.

Forest Fuels

Brown (1975) has characterized fuel cycles and fire hazard in lodgepole pine stands, as shown in figure 24. Curve A of that figure corresponds to what Muraro (1971) describes as typical fire hazard in lodgepole pine where young, especially dense stands are most hazardous. Least hazardous are moderately dense-to-open advanced, immature, and mature stands. Hazard increases as stands become overmature and as ground fuels build up from downfall and establishment of shade-tolerant species. Curve C depicts conditions not uncommonly found. Ground fuel quantities and fire potential remain relatively low throughout the life of the stand until it undergoes decadence. Individual stands can vary anywhere between curves A and C during younger growth periods, and develop higher fire potential at later periods of growth (curve B).

In a young lodgepole stand the snags created by the previous fire provide an immediate source of downfall. Lyon (1977, 1984) found that after 2 years with little windthrow, lodgepole pine snags on the Sleeping Child Burn (Bitterroot National Forest) fell at an annual rate of 13.4 percent (fig. 25). Overall, an average of 497 snags per acre was reduced to an average of 75 snags per acre after 15 years (table 6). After 21 years, nearly 93 percent of all snags had fallen (fig. 25).

Table 6—*Average number of snags per acre by size class and year of count, Sleeping Child Burn, Bitterroot National Forest, MT (Lyon 1977) (totals may not agree because of rounding)*

Size class	Year 1962	1963	1966	1969	1971	1976
Inches						
Under 3	266	265	96	41	28	4
3 *to* 8	159	156	124	103	85	50
8 *to* 12	64	62	40	36	24	19
Over 12	7	7	7	6	4	3
Total	497	390	268	186	141	75

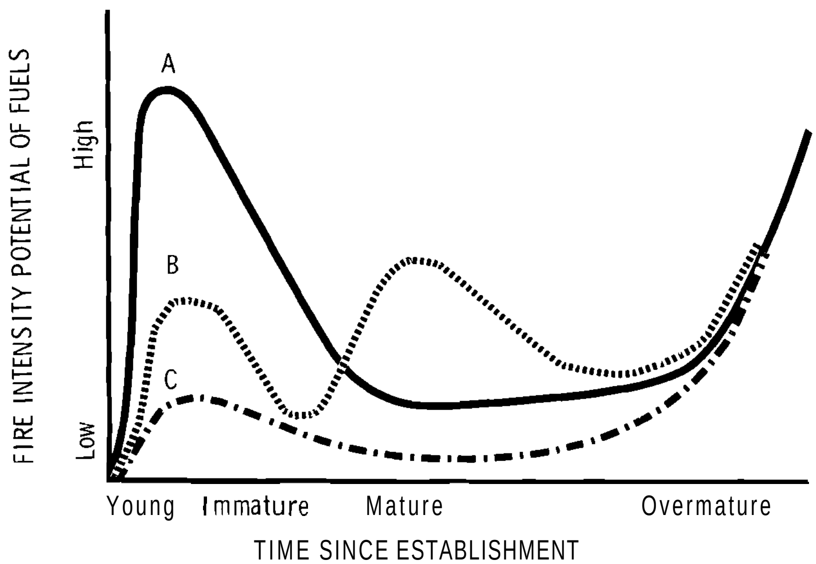


Figure 24—Fuel cycles and fire intensity potential in lodgepole pine (Brown 7975).

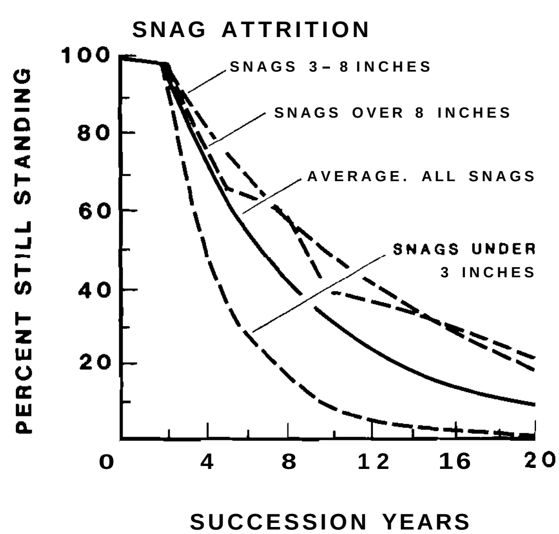


Figure 25—Percentage of lodgepole pine snags still standing, by year and diameter class, Sleeping Child Burn, Bitterroot National Forest, MT, 1962-82 (Lyon 7984).

Aside from fire-created snags, sources of downfall are natural thinning; snow breakage and windthrow of live trees: dwarf mistletoe-related mortality; and mountain pine beetle attack and subsequent mortality. Dwarf mistletoe often adds to the ground fuel and causes witches'-brooms that enhance vertical fuel continuitv and thus increase the likelihood of ground fuels creating a "fire ladder" to burn out individual tree crowns (Brown 1975). The witches'-brooms also tend to trap fallen needles, thus increasing the scattering of vertically situated fine fuels, which are ideally situated for optional fire flammability (Alexander and Hawksworth 1975). Immature dwarf mistletoe-infested lodgepole pine stands have much more dead material on the ground, more stems, and more foliage near the ground, than comparable uninfested stands (Hawksworth and Hinds 1964). Mountain pine beetle attack is often the mechanism that causes the lodgepole stand to break up. Cumulative mortality during a mountain pine beetle epidemic (average duration about 11 years) frequently amounts to 85 percent or more of the large, 8-inch (20-cm) diameter trees in a lodgepole pine stand (Cole and Amman 1980).

Published fuel inventory data for central Idaho lodgepole pine stands are lacking. Data from Montana and northern Idaho indicate down, dead woody fuel loads of 3 to 35 tonslacre (0.7 to 8 kg/m^2) (Fischer 1981c; Brown and See 1981). As a general rule, central Idaho lodgepole pine stands are less heavily laden with downed, dead, woody fuel than are neighboring stands in Montana where fuel loadings in excess of 150 tonslacre (34 kg/m^2) have been reported (Mathews 1980).

Moderate to heavy fuel loads are much more likely to occur in seral stands of lodgepole pine than in climax stands in central Idaho. This is true for live fuels as well as dead, woody fuels. Dense understories of spruce and subalpine fir (or grand fir) develop beneath the overstory lodgepole pine within subalpine fir (or grand fir) habitat types. When sufficient surface fuels exist beneath such understories an effective fuel ladder is created and crown fire hazard is great.

The association between successional stage and fuel loading on lodgepole pine sites is reflected in table 7. The values in table 7 represent the results of fuel inventories on 36 stands belonging to the ABLAIVASC and ABLAICAGE h.t.'s within the Teton Wilderness, western Wyoming (Oberheu and Mutch 1976). The recent burn stand condition was characterized by moderate to dense stocking of even-aged lodgepole pine seedlings or saplings, 3 to 40 years old. These stands contained heavy loadings of large-diameter, windthrown, fire-killed snags and very little duff. The even-aged lodgepole pine stands were characterized by dense, even-aged lodgepole, 85 to 140 years old, with closed or nearly closed canopies and evidence of some natural thinning in progress. Decay had reduced the heavy loading of down material from the previous fire. The transition stands were characterized by mostly mixed overstories of old-age lodgepole pine 230 to 250 years old, along with spruce and subalpine fir over spruce-fir understories. Increasingly large-diameter fuel loadings reflect the breakup of the lodgepole pine stand. The spruce-fir stands were characterized by overstories of subalpine fir and scattered, very large spruce, 250 years or more in age. Heavy fuel loads reflect the downing of dead lodgepole.

Role of Fire

Arno (1980) concluded that more frequent (generally between 25 and 50 years apart) low-to-medium severity surface fires were associated with lodgepole pine-dominated communities having dry summers. In areas with moist summers, fire was less frequent and more severe, with large stand-replacement fires more prevalent, although stand-replacement fires did occur to some extent in all areas where lodgepole pine was dominant.

Romme (1982) found that light surface fires on a high plateau west of Old Faithful in Yellowstone National Park spread slowly and covered only small areas before going out. Growth is slow on these unfavorable sites, and it takes over 300 years before fuel accumulations support fire. Then a severe stand-replacement crown fire would be most likely.

In central Idaho, the most persistent and possibly climax lodgepole pine stands occur in broad, high-elevation valleys where its dominance appears to be related to its ability to withstand daily temperature extremes and fluctuating water tables (Steele and others 1981). These stands often consist of widely spaced trees with little undergrowth on gentle slopes; fire appears to be a minor factor. Lodgepole pine competes well with other tree species on sites with shallow granitic soils, where summer frosts are frequent and summer rainfall is low (Lotan and Perry 1983).

Table 7—Dead fuel loads associated with stands within the ABLA/VASC and ABLAICAGE h.t.'s, Teton Wilderness, WY (source Oberheu and Mutch 1976)

Stand condition	Stand age	Downed, dead woody fuel by size classes (inches) 0-1/4	1/4-1	1-3	3+ sound	3+ rotten	Total	Litter	Duff
	Years	*Tons per acre*							
Recent burn	3-40	0.1	0.3	1.1	25.3	17.0	43.8	0.5	10.1
Even-aged lodgepole	85-140	.1	.5	1.0	4.2	2.8	8.6	1.2	28.9
Transition	230-250	.2	.8	1.9	12.2	9.5	24.6	1.5	33.2
Spruce-fir	250+	.2	.9	2.3	10.2	14.2	27.8	1.0	37.3

In subalpine fir and grand fir habitat types, where lodgepole pine is the dominant seral species, fire-induced stands of lodgepole pine cover large areas, and the reduced seed sources of other conifers delay their replacement (Steele and others 1981). Repeated wildfire further depletes seed sources of other conifers in the area. This leads to even more uniform stands of lodgepole pine, which become increasingly flammable. Fuels build up in mature lodgepole stands as a result of natural thinning, mortality caused by mountain pine beetle outbreaks and dwarf mistletoe infestations, and deadfall from previous fires. Suppressed understories of subalpine fir and spruce create fuel ladders from dead surface fuels to the overstory. Eventually a chance ignition leads to a stand-replacement fire. Soils may become unstable following such a fire especially on the steep slopes of the Idaho batholith.

Pinegrass often persists under near-climax conditions in lower elevation stands. Following fire, it can increase rapidly from rhizomes and develop a dense sod that impedes establishment of other species, including trees (Steele and others 1983).

The Lodgepole Pine Fire Cycle—Brown (1975) summarized the lodgepole pine fire cycle and the many interrelated factors that influence it (fig. 26). His discussion of fire cycles and community dynamics in lodgepole pine forests is an important source of information on the role of fire in lodgepole pine forests. Brown also discussed the different effects of fires of varying severity on lodgepole pine forests. The critical role of fuel and duff moisture in determining fire severity and, consequently, fire effects is emphasized.

Fire and Dwarf Mistletoe—Infection by dwarf mistletoe, as noted earlier, usually enhances the flammability of lodgepole pine, thereby increasing the risk of severe wildfire and subsequent stand replacement. Such fires maintain lodgepole pine on the burned site and, in turn, assure that mistletoe seed sources are not eliminated. This can be an especially important role of fire in seral lodgepole pine stands growing on subalpine fir habitat types because succession toward nonsusceptible climax tree species is interrupted. In the unlikely event that no infected lodgepole pine remain adjacent to a burned area, the fire-regenerated stand could remain free of dwarf mistletoe.

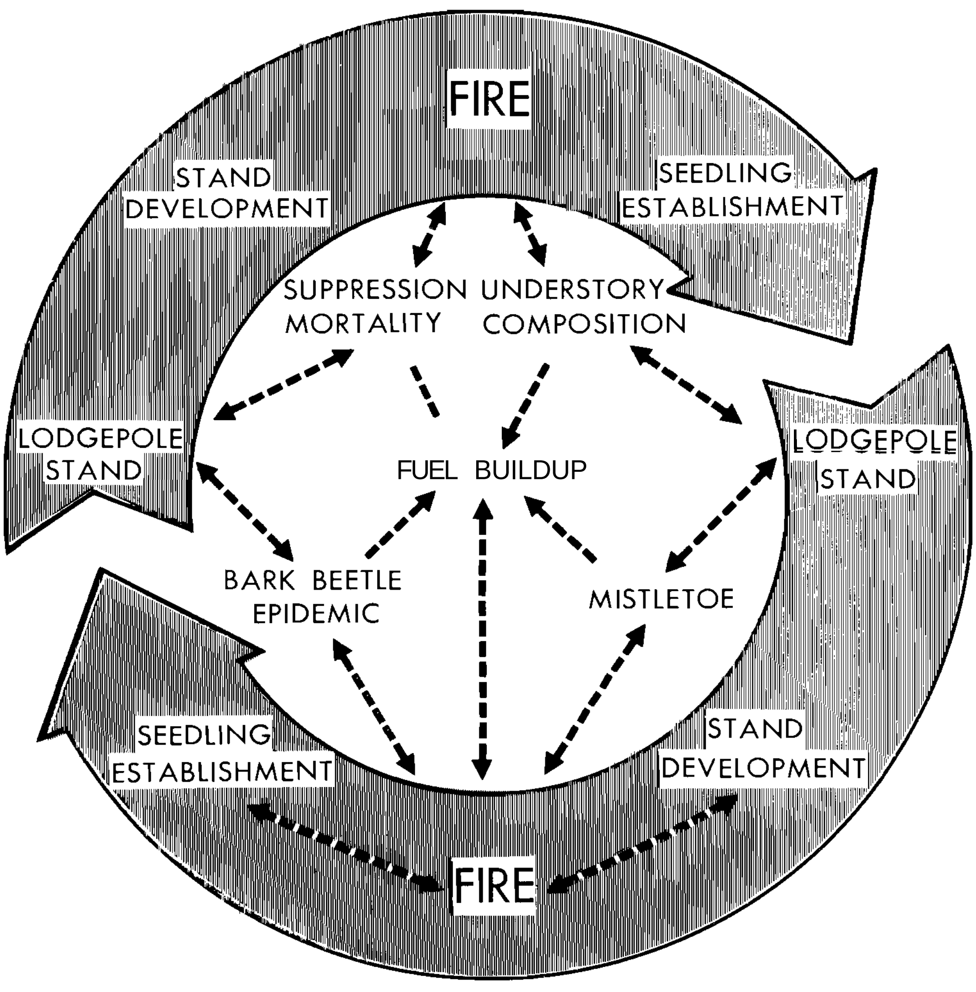


Figure 26—Lodgepole pine fire cycle showing interrelationships among influences (Brown 1975).

More likely, however, the spread of mistletoe from adjacent unburned mature stands into reproduction on the burned area would be relatively slow. Hawksworth (1958) reported an average spread rate of 1 to 2 feet (0.3 to 0.6 m) per year. Taylor (1969) found that infection in regenerated lodgepole pine burns in Yellowstone National Park was directly correlated with time since burn—only 1 percent of the lodgepole pines in the new stand were infected after 57 years; 10 percent after 111 years; and 36 percent after about 300 years. In situations where less-than-severe fires occur, surviving mistletoe-infected residual lodgepole pines will quickly infect young trees as soon as they are tall enough to remain at least partially uncovered by winter snows.

Fire and the Mountain Pine Beetle—The interactions of fire and mountain pine beetle are inextricable in most lodgepole pine forests. The following excerpt from Amman (1977) describes this interrelationship:

> ROLE OF MOUNTAIN PINE BEETLE WHERE LODGEPOLE PINE IS SERAL
>
> Absence of fire: Lodgepole pine stands depleted by the beetle and not subjected to fire are eventually succeeded by the more shade-tolerant species consisting primarily of Douglas-fir at the lower elevations and subalpine fir and Engelmann spruce at the higher elevations throughout most of the Rocky Mountains. Starting with a stand generated by fire, lodgepole pine grows at a rapid rate and occupies the dominant position in the stand. Fir and spruce seedlings also established in the stand grow more slowly than lodgepole pine.
>
> With each infestation, the beetle kills most of the large, dominant lodgepole pines. After the infestation, both residual lodgepole pine and the shade-tolerant species increase their growth. When the lodgepole pines are of adequate size and phloem thickness, another beetle infestation occurs. This cycle is repeated at 20 to 40 year intervals depending upon growth of the trees, until lodgepole pine is eliminated from the stand.
>
> The role played by the mountain pine beetle in stands where lodgepole pine is seral is to periodically remove the large, dominant pines. This provides growing space for subalpine fir and Douglas-fir, thus hastening succession by these species. The continued presence of the beetle in these mixed-species stands is as dependent upon fire as that of lodgepole pine. Without it both are eliminated.
>
> Presence of fire: Where lodgepole pine is seral, forests are perpetuated through the effects of periodic fires (Tackle 1964). Fires lend to eliminate competitive tree species such as Douglas-fir, the true firs, and spruces. Following fire, lodgepole pine seedlings may be abundant. If serotinous cones are present, they will open because of the intense heat and release their seed (Clements 1910, Lotan 1975).
>
> Large accumulations of dead material caused by periodic beetle infestations result in very hot fires when they do occur (Brown 1975). Hot fires of this nature eliminate Douglas-fir, which otherwise is more resistant to fire damage than lodgepole pine. The dominant shade-tolerant species are eliminated, resulting in a return to a pure lodgepole pine forest. On the other hand, light surface fires would not be adequate to kill large, thick-barked Douglas-fir and return lodgepole pine to a dominant position in the stand.
>
> Following regeneration of lodgepole pine after fire, the mountain pine beetle-lodgepole interactions would be similar to those described in the absence of fire. A fire may interrupt the sere at any time, reverting the stand back to pure lodgepole pine. However, once succession is complete, lodgepole pine seed will no longer be available to seed the burned areas except along edges where the spruce-fir climax joins persistent or climax lodgepole pine.
>
> ROLE OF MOUNTAIN PINE BEETLE WHERE LODGEPOLE PINE IS PERSISTENT OR CLIMAX
>
> Lodgepole pine is persistent over large acreages, and because of the number of shade-tolerant individuals of other species found in such persistent stands, the successional status is unclear (Pfister and Daubenmire 1975). In any case, lodgepole pine persists long enough for a number of beetle infestations to occur. In such cases and when lodgepole pine is climax because of climatic or soil conditions, the forest consists of trees of different sizes and ages ranging from seedlings to a few overmature individuals. In these forests, the beetle infests and kills most of the lodgepole pines as they reach larger sizes. Openings created in the stand as a result of the larger trees being killed, are seeded by lodgepole pine The cycle is then repeated as other lodgepole pines reach sizes and phloem thicknesses conducive to increases in beetle populations.
>
> The result is two- or three-story stands consisting of trees of different ages and sizes. A mosaic of small clumps of different ages and sizes may occur. The overall effect is likely to be more chronic infestations by the beetle because of the more constant source of food. Beetle infestations in such forests may result in death of fewer trees per hectare during each infestation than would occur in even aged stands developed after fires and in those where lodgepole pine is seral.
>
> Fires in persistent and climax lodgepole pine forests should not be as hot as those where large epidemics of beetles have occurred. Smaller, more continuous deposits of fuel are available on the forest floor. The lighter beetle infestations, and thus lighter accumulations of fuel, would result in fires that would eliminate some of the trees but probably would not cause total regeneration of the stand. This would be beneficial to the beetle because a more continuous supply of food would

be maintained. Where large accumulations of fuel occur after large beetle epidemics, fire would completely eliminate the beetles' food supply from vast acreages for many years while the entire stand of trees grow from seedlings to sizes conducive to beetle infestation.

The mountain pine beetle's evolutionary strategies have been successful. It has exploited a niche that no other bark beetle has been able to exploit, that of harvesting lodgepole pine trees as they reach or slightly before they reach maturity. Such trees are at their peak as food for the beetle Harvesting at this time in the age of the stand maintains the vigor of the stand, and keeps the stand at maximum productivity.

Forest Succession

The theoretical climax forest on Fire Group Seven sites varies according to habitat type as shown in figure 27 (subsequent numbers in this section refer to fig. 27). Except for stands belonging to the PICO c.t.'s and the PICO/FEID h.t., however, fire usually interrupts succession short of the climax condition.

Following a stand-destroying fire an herblshrub stage dominates the site Because most trees have open cones, seedlings establish over a period of several years. A fire in the herblshrub stage (No. **1)** will, however, extend its period of dominance A fire during the seedling/sapling stage also returns the site to herbs and shrubs (No. 2). The likelihood of a fire at this stage is not great on most Group Seven sites.

The lack of fuels in most pole-stage stands renders fire unlikely, but should fire occur, its effects will depend on fire severity. **A** cool fire (No. **3)** thins the stand and prepares a seedbed for lodgepole regeneration. A severe fire (No. **4)** will destroy the stand; however, a new stand of lodgepole pine will generally recur. The effect of fire in a mature lodgepole forest is essentially the same as in the pole forest. **A** cool fire thins the stand and a severe fire recycles the stand (Nos. 5 and 6). The probability of a severe stand-destroying fire greatly increases as a previously unburned mature forest starts to break up and an understory of climax species develops. At this stage, a thinning fire (No. 7) is unlikely; if the stand is dry enough to burn it will probably burn severely (No. 8) because of hazardous fuel conditions.

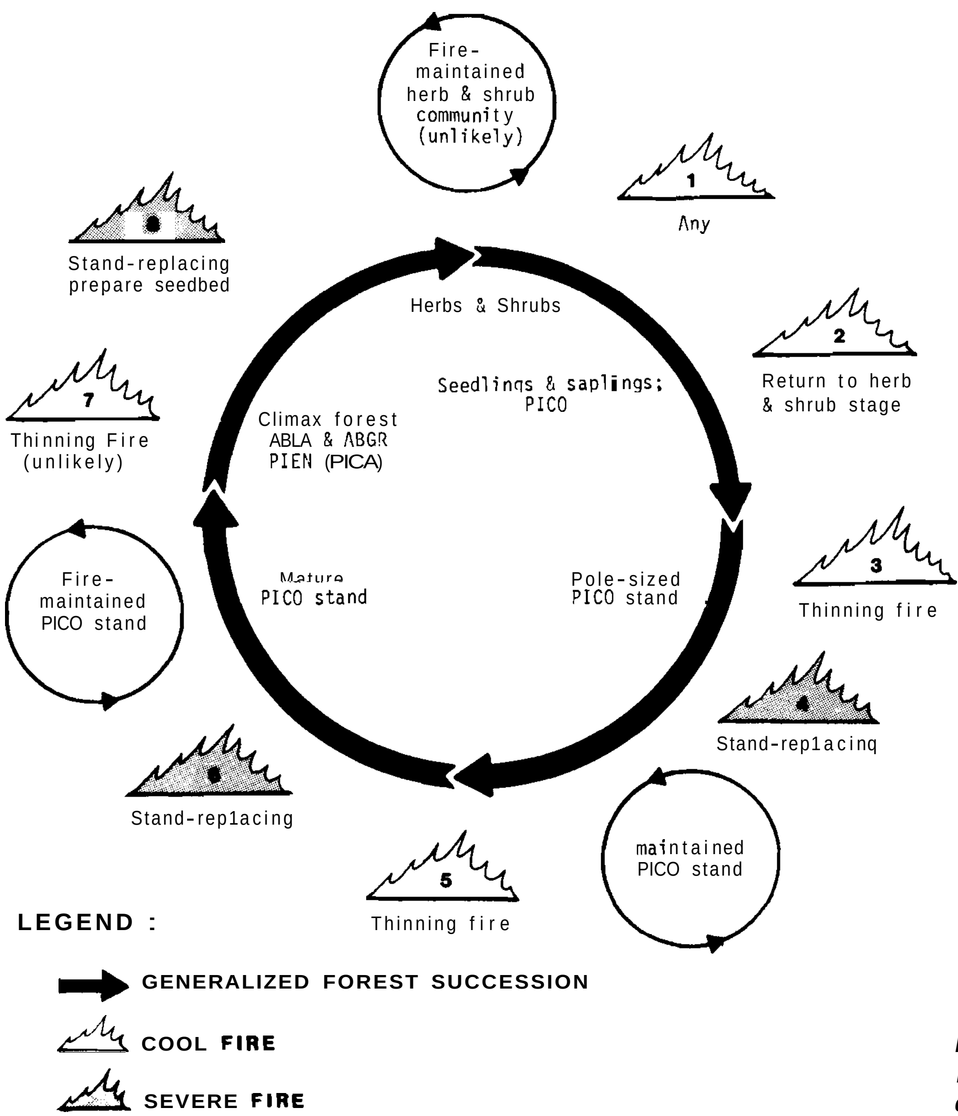
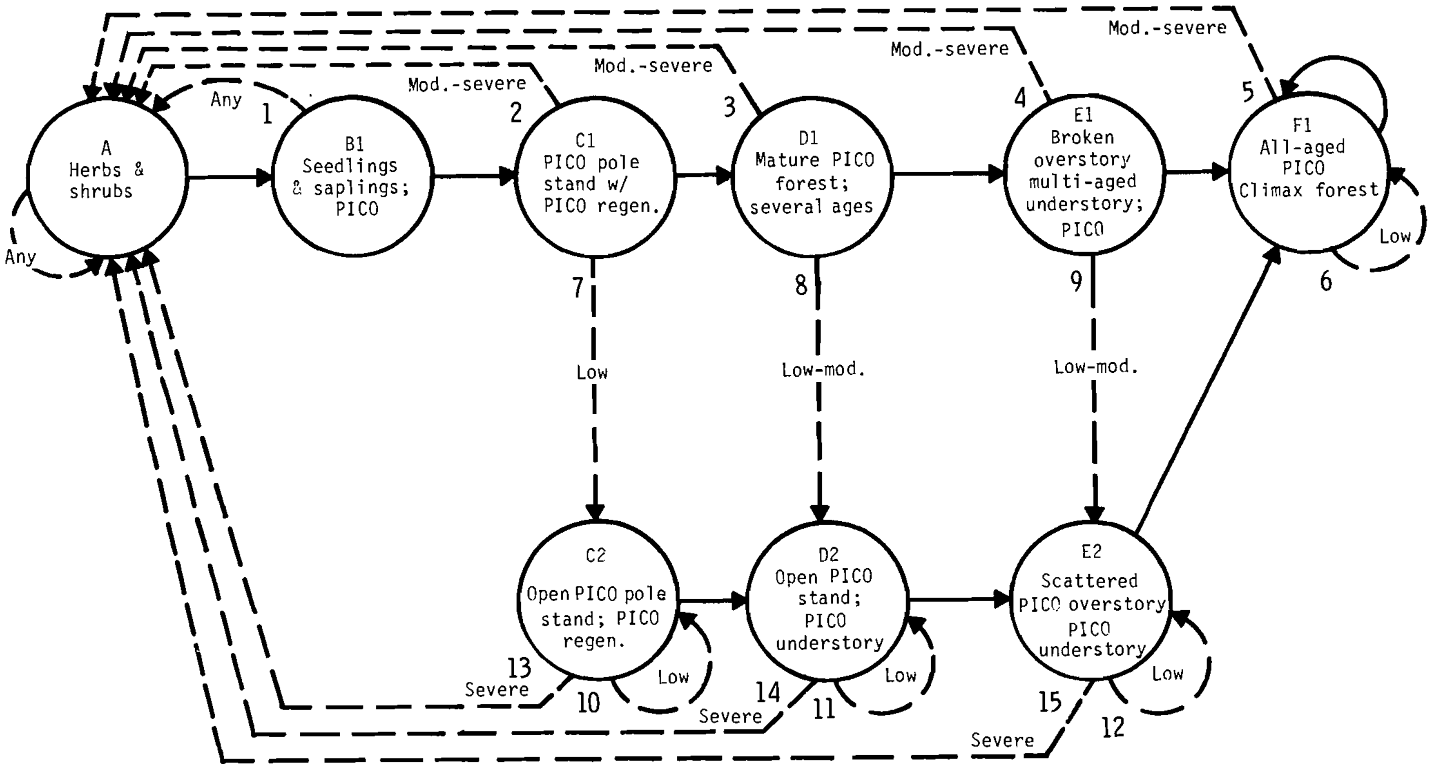


Figure 27—Generalized forest succession in Fire Group Seven: cool habitat types usually dominated by lodgepole pine.



LEGEND :

———▶	SUCCESSION IN ABSENCE OF FIRE
– – –▶	RESPONSE TO FIRE
LOW	COOL OR LIGHT SURFACE FIRE
MOD.	FIRE OF MODERATE SEVERITY
SEVERE	HOT STAND–REPLACEMENT FIRE
1.2, etc.	REFERENCE NUMBER (SEE TEXT)

Figure 28—Hypothetical fire-related successional pathways for Fire Group Seven.

Hypothetical successional pathways for Fire Group Seven stands are represented in figure 28.

Arno and others (1985) show the sequence of seral community types developing after stand-destroying wildfire and also for clearcutting with broadcast burning, mechanical scarification, or no followup treatment within the ABAL/XETE h.t. in western Montana.

Fire Management Considerations

A primary fire management consideration in the Fire Group Seven habitat types is protection of high-hazard stands from unwanted fire during extended periods of drought and during severe fire weather conditions. Fires at such time often crown and result in complete stand mortality if the lodgepole stand is ready physiognomically to burn (Despain and Sellers 1977). Of course, in some management situations, this may be an acceptable result.

Opportunities for use of understory fire are limited in natural stands because of the low fire resistance of lodgepole pine, spruce, and subalpine fir. The other side of this problem is that during "safe" fire weather, it is often difficult to sustain a fire in Group Seven stands. Low-to-medium severity surface fires, however, do occur. Thus, there may be opportunities to use prescribed fires to accomplish specific management objectives.

The primary use of prescribed fire in this group has been and undoubtedly will continue to be for hazard reduction and site preparation in conjunction with tree harvesting and subsequent regeneration. Broadcast burning and pile and windrow burning have been the most often used methods of accomplishing these tasks. Successful broadcast slash burning usually yields increased forage production for big game. Slash disposal of any kind aids big game movement.

Prescribed fire can be an effective tool for controlling dwarf mistletoe in lodgepole pine stands. Alexander and Hawksworth (1975) suggest two purposes for use of fire for mistletoe control: (1) to eliminate infected residual trees in logged-over areas, and (2) to destroy heavily infested, unproductive stands so that they can be replaced with young healthy stands.

2 GRAND FIR AND SUBALPINE FIR CLIMAX TYPES

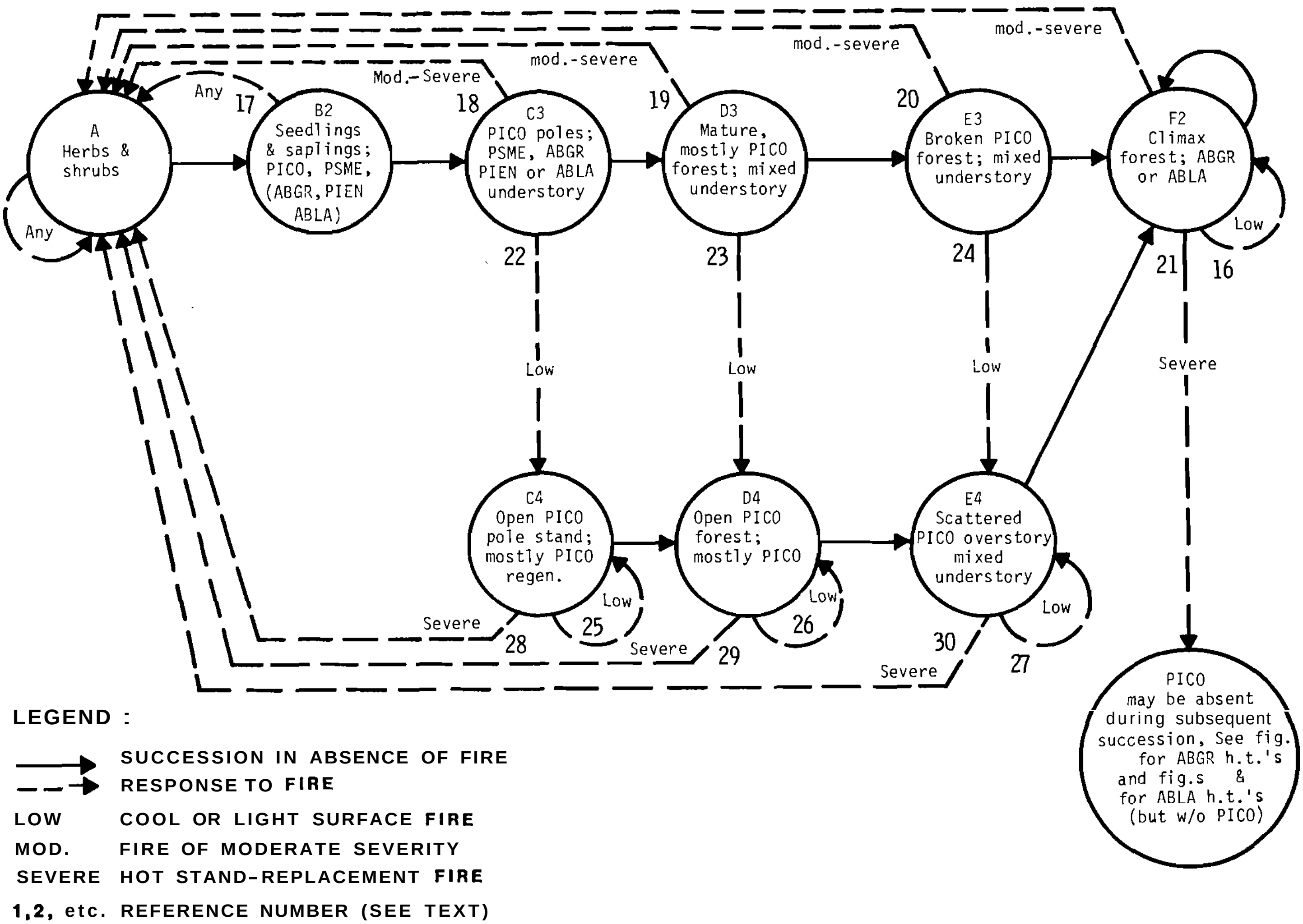


Figure 28 (Con.)

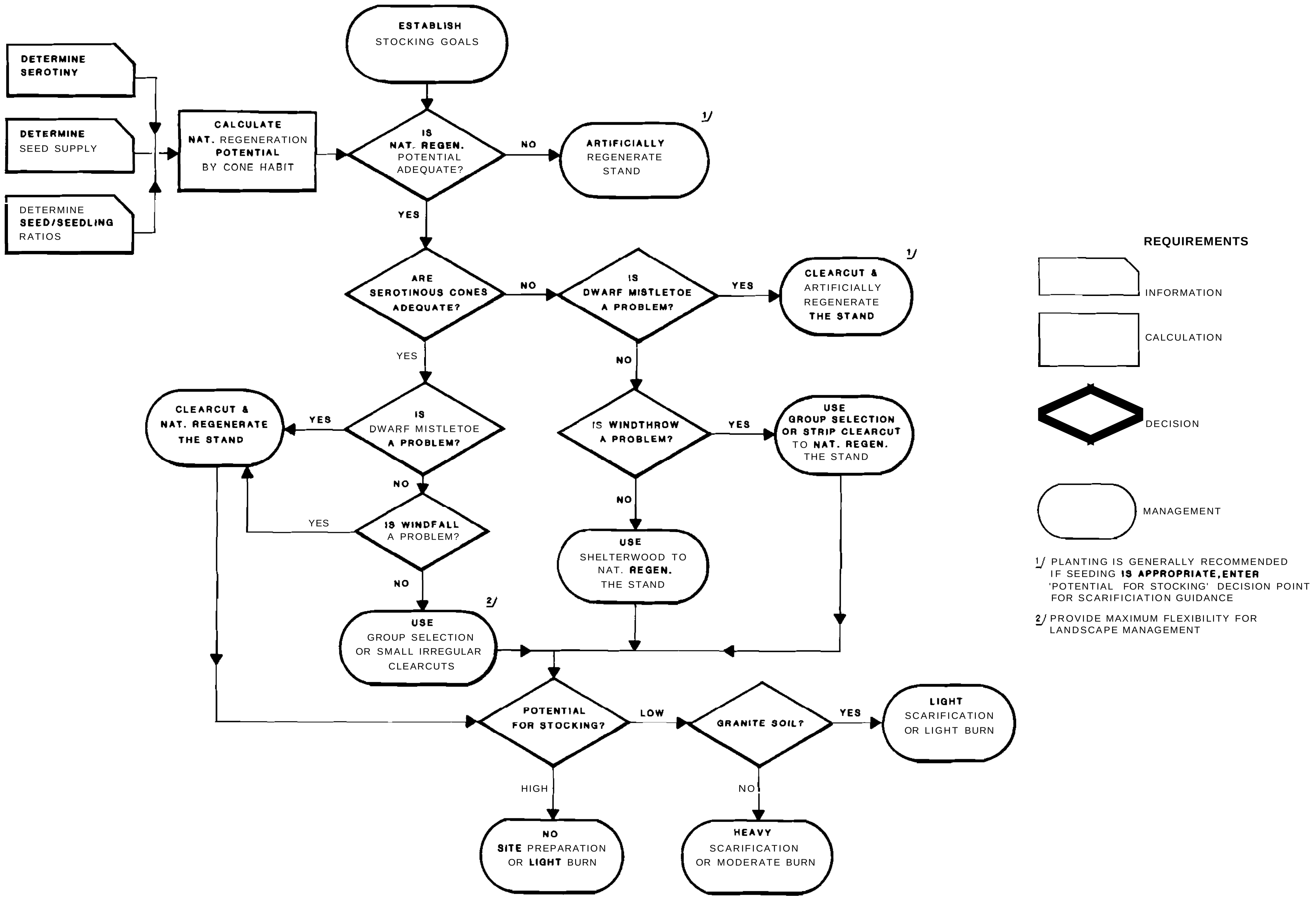


Figure 29—The decision chain for lodgepole pine regeneration (Lotan and Perry 1983).

The various considerations that determine the appropriate use of fire for site preparation and regeneration of lodgepole pine forests have been summarized by Lotan and Perry (1983) in figure 29.

As indicated earlier, the primary concern in the fire management of many lodgepole pine forests is the prevention of stand-destroying fires over large areas. Timber harvest for a variety of products and subsequent slash disposal are the primary techniques to meet this objective when economic considerations are favorable Harvest schedules should be developed and implemented to create age-class mosaics of lodgepole pine This minimizes the areal extent of stand-destroying fires. Silvicultural practices designed to harvest trees before they become susceptible to mountain pine beetle attack (Cole and Amman 1980) can greatly reduce the threat of severe fires in second-growth stands of lodgepole pine The use of lodgepole pine for house logs, firewood, poles, posts, wood chips, and sawlogs may provide opportunities for fuel management-related harvesting.

In some wilderness areas, periodic crown fires play a vital role in natural development of lodgepole pine ecosystems, and their use should be considered when consistent with the need to protect human life, property, and resource values outside wilderness. A case for fire use in lodgepole pine stands is presented by Fellin (1980):

> In many areas where natural fires have been suppressed, forest residues resulting from mountain pine beetle epidemics accumulate until hot fires occur, According to Cole (1978), "such fires are normally more destructive than ones that would have otherwise occurred if fires had not been suppressed, and they tend to perpetuate future extremes in the mountain pine beetle1 lodgepole pine/fir interactions." Several opinions have been expressed that the bark beetle epidemics now rampant in the Rockies and Intermountain West may be a product of fire exclusion (Schwennesen 1979). In Glacier National Park, the mountain pine beetle epidemic took such a strong hold because fire suppression programs were so successful and trees that ordinarily might have been burned are now mature and ripe for the beetles (Kuglin 1980).
>
> Cole (1978) suggests that a deliberate program of fire management and prescribed fire can be instituted to moderate the mountain pine beetle-lodgepole pine-fire interaction cycle His premise is that both wildfire and prescribed fire management plans can be developed to use fire to "create a mosaic of regenerated stands within extensive areas of timber that have developed." D. Cole (1978) believes that prescribed fires can create these ecosystem mosaics more effectively than wildfires. With the recent change from fire control to fire management, managed wildfires will be, in fact, prescribed fires.

Guidelines have been developed by McGregor and Cole (1985) to assist forest managers in integrating pest management techniques for the mountain pine beetle with other resource considerations in the process of planning and executing balanced resource management of lodgepole pine forests. The guidelines present visual and classification criteria and methods for recognizing and summarizing occurrence and susceptibility status of lodgepole pine stands according to habitat types and successional roles and important resource considerations associated with them. McGregor and Cole (1985) review appropriate silvicultural systems and practices, including use of fire, for commercial and noncommercial forest land designations, including parks, wilderness, and other reserved areas.

FIRE GROUP EIGHT: DRY, LOWER SUBALPINE HABITAT TYPES

ADP code	Habitat type-phase (Steele and others 1981)	Physiographic sections (Steele and others 1981)
645	*Abies lasiocarpa/Acer glabrum* h.t. (ABLA/ACGL), subalpine fir/mountain maple	Southern Batholith
661	*Abies lasiocarpa/Linnaea borealis* h.t. - *Linnaea borealis* phase (ABLAILIBO-LIBO), subalpine fir/twinflower - twinflower phase	Southern Batholith, Salmon Uplands, and Open Northern Rockies
723	*Abies lasiocarpa/Vaccinium globulare* h.t. - *Vaccinium globulare* phase (ABLA/VAGL-VAGL), subalpine fir/blue huckleberry - blue huckleberry phase	Southern Batholith and Salmon Uplands
705	*Abies lasiocarpa/Spiraea betulifolia* h.t. (ABLA/SPBE), subalpine fir/white spirea	Southern Batholith and Challis
745	*Abies lasiocarpa/Juniperus communis* h.t. (ABLA/JUCO), subalpine fir/common juniper	Southern Batholith and Open Northern Rockies
780	*Abies lasiocarpa/Arnica cordifolia* h.t. (ABLA/ARCO), subalpine firlheartleaf arnica	Southern Batholith, Challis, and Open Northern Rockies

Vegetation

Fire Group Eight is a collection of warm, lower subalpine habitat types that are generally dominated by seral Douglas-fir although subalpine fir is the indicated climax. A mixture of Douglas-fir and lodgepole pine may dominate seral stands belonging to the ABLAILIBO, ABLAISPBE, ABLAIVAGL, ABLAIJUCO, and ABLAIARCO h.t.'s. Englemann spruce may dominate late seral stands within the ABLAIVAGL-VAGL, ABLAILIBO, and ABLAIARCO h.t.'s (fig. 30).

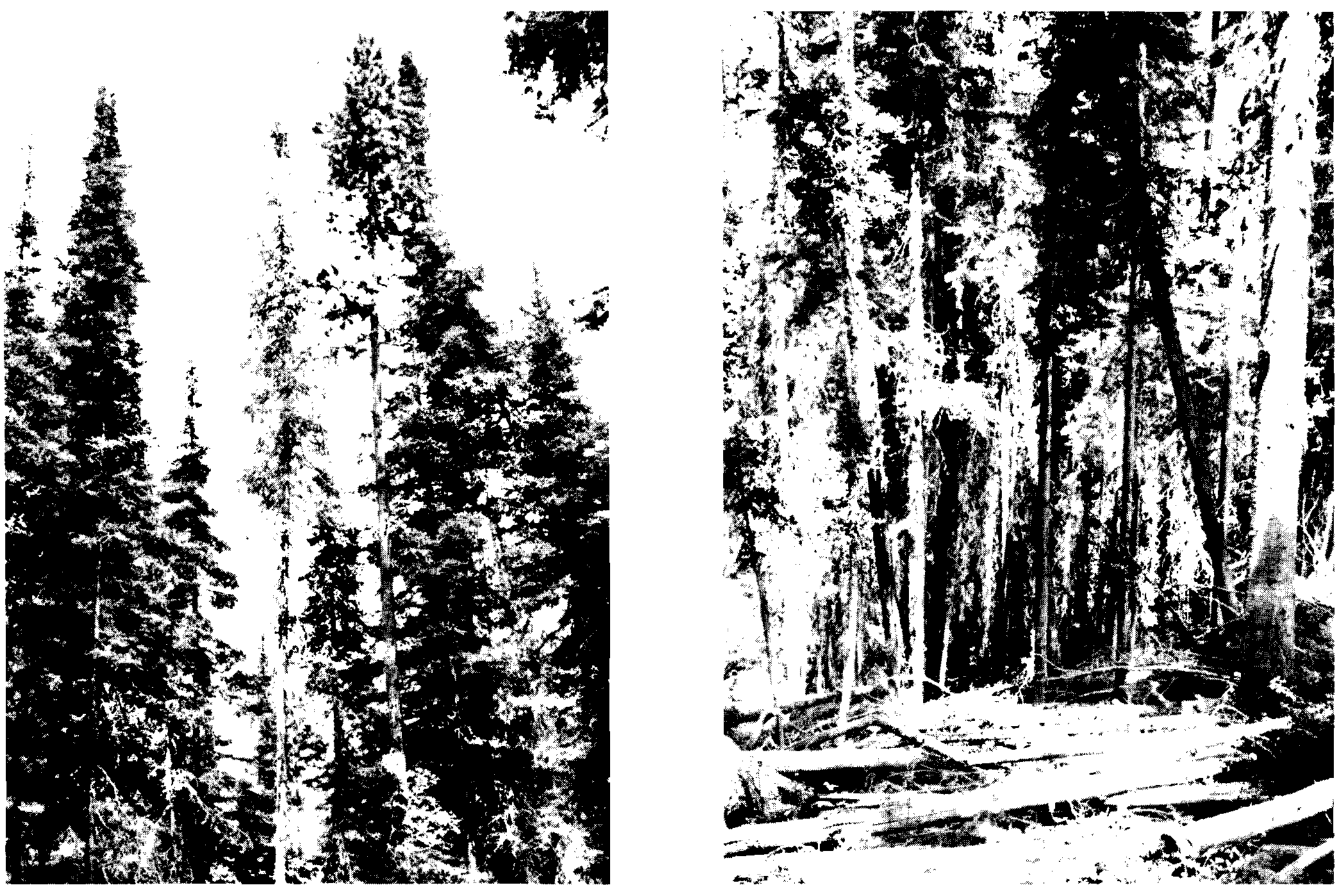
Common shrubs are white spirea, common juniper, russet buffaloberry, mountain snowberry, blue huckleberry, Utah honeysuckle, Sitka alder, mountain maple, and mountain ash. Columbia clematis occurs on these sites along with herbs such as heartleaf arnica, sidebells pyrola, twinflower, elk sedge, pinegrass, western meadowrue, and Wilcox's penstemon. Mosses are notable in some stands within the drier ABLAIJUCO and ABLAIARCO h.t.'s.

Forest Fuels

Downed, dead, woody fuel loadings on lower subalpine habitat types in Montana and northern Idaho averaged between 20 and 25 tonslacre (5 and 6 kglm^2) (Brown and See 1981); stands inventoried by Fischer (1981c) ranged between 1 and 80 tonslacre. As a general rule, the heaviest downed, dead, woody fuel loads on central Idaho forests occur in lower subalpine stands of this Fire Group.

A large percentage of the fuel load is made up of material greater than 3 inches (7.62 cm) in diameter; 10- and 20-inch (25- and 50-cm) material is not uncommon. The large material is the result of downfall of dead overstory trees. The long fire-free intervals characteristic of this Fire Group allow these large materials to accumulate for many decades. Because of the long time spans involved, much of the material is rotten.

Live and standing dead fuels can contribute significantly to overall fire hazard during dry conditions. Dense spruce and fir understory trees along with low-hanging, moss-covered live and dead branches of overstory trees form effective fuel ladders to the overstory tree crowns.



A B

Figure 30—Two views of the same ABLA/LIBO h.t. near the Lick Creek Road, Salmon National Forest. (A) The stand is dominated by late seral Engelmann spruce and subalpine fir although a few seral lodgepole pines remain. (B) The forest floor shows characteristic fuel buildup associated with the breakup of the former lodgepole stand.

Relatively deep duff layers may form on forest floors. When this duff layer becomes dry and burns it can cause considerable mortality by heating the shallow roots of subalpine fir and Engelmann spruce. Dry rotten logs on the forest floor are partially incorporated into the duff layer and will intensify this effect. The fuel loadings for the transition and spruce-fir classes listed in table 7 (Fire Group Seven) should be representative of similar stands in the group.

Role of Fire

Fire history information is generally lacking. Where available, fire history studies of subalpine forest mainly apply to lodgepole pine-dominated seral stands. Gabriel (1976) indicates that some of the stands he studied in the Bob Marshall Wilderness are similar to stands in Fire Group Eight. One of Gabriel's stands contained fire-scarred trees although the entire area did not burn each time. In another stand, he found no sign of fire in the past 280 years. Other stands showed evidence of light fires during the last 100 years.

Stand composition following a fire may be quite variable. Low-to-moderate surface fires generally favor residual Douglas-fir over the thinner barked lodgepole pine. Severe fires favor lodgepole pine regeneration if serotinous cones are present in the prefire stand. Some large, thick-barked Douglas-fir trees often survive fires severe enough to kill all the lodgepole pine, thus ensuring its presence in future stands. Cones in tips of fire-killed Douglas-fir may provide viable seed. Any fire will set back invasion of the stand by spruce or subalpine fir, which eventually dominate the site in the absence of fire.

The theoretical climax forest is dominated by subalpine fir. This climax requires such a long fire-free period to develop that it is rarely found. A near-climax situation characterized by a dense understory of subalpine fir along with an overstory of this species accompanied by Douglas-fir and spruce is more common.

Forest Succession

A general pattern for forest succession in Fire Group Eight is shown in figure 31. (All numbers in the section refer to fig. 31.) The time required for seedlings to establish following a fire varies, depending upon site conditions, moisture, and seed source, including the presence or absence of serotinous-coned lodgepole pine. Following a

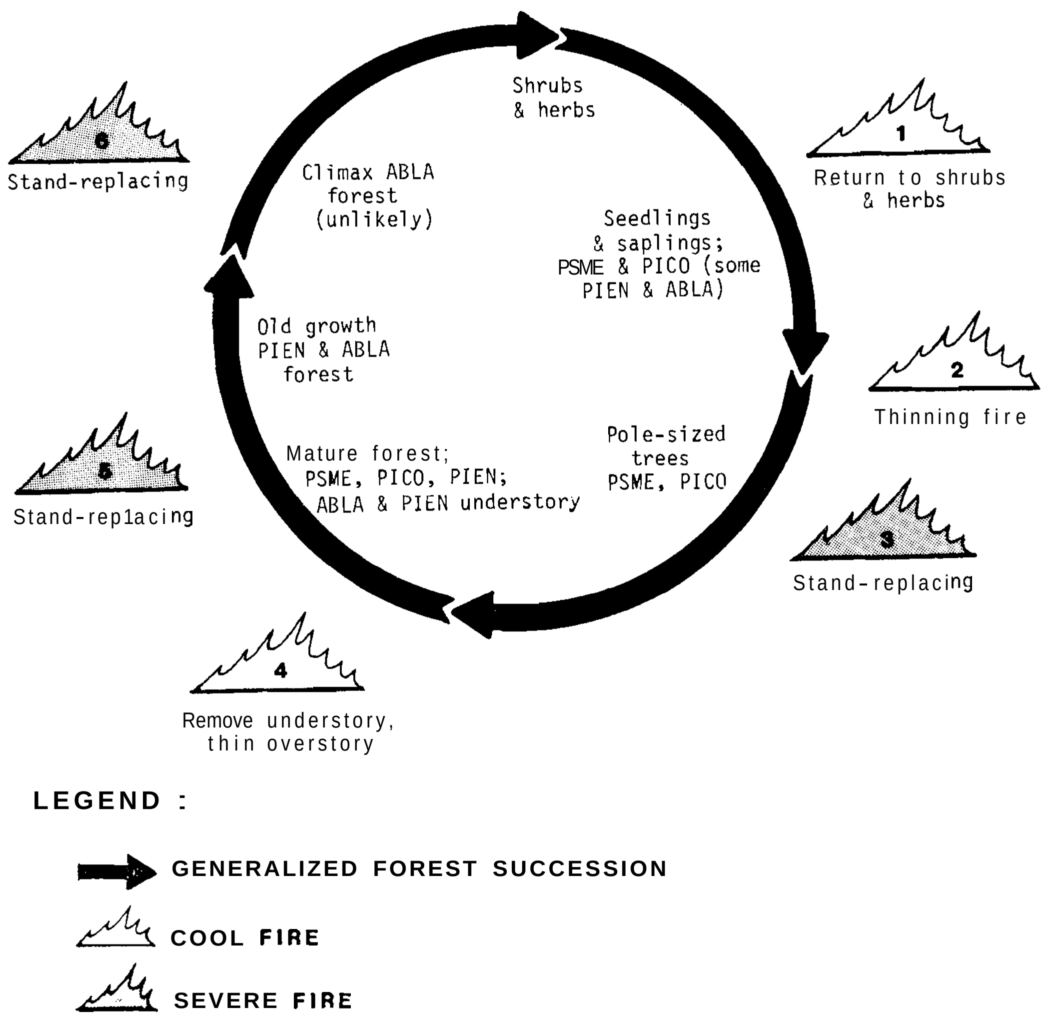
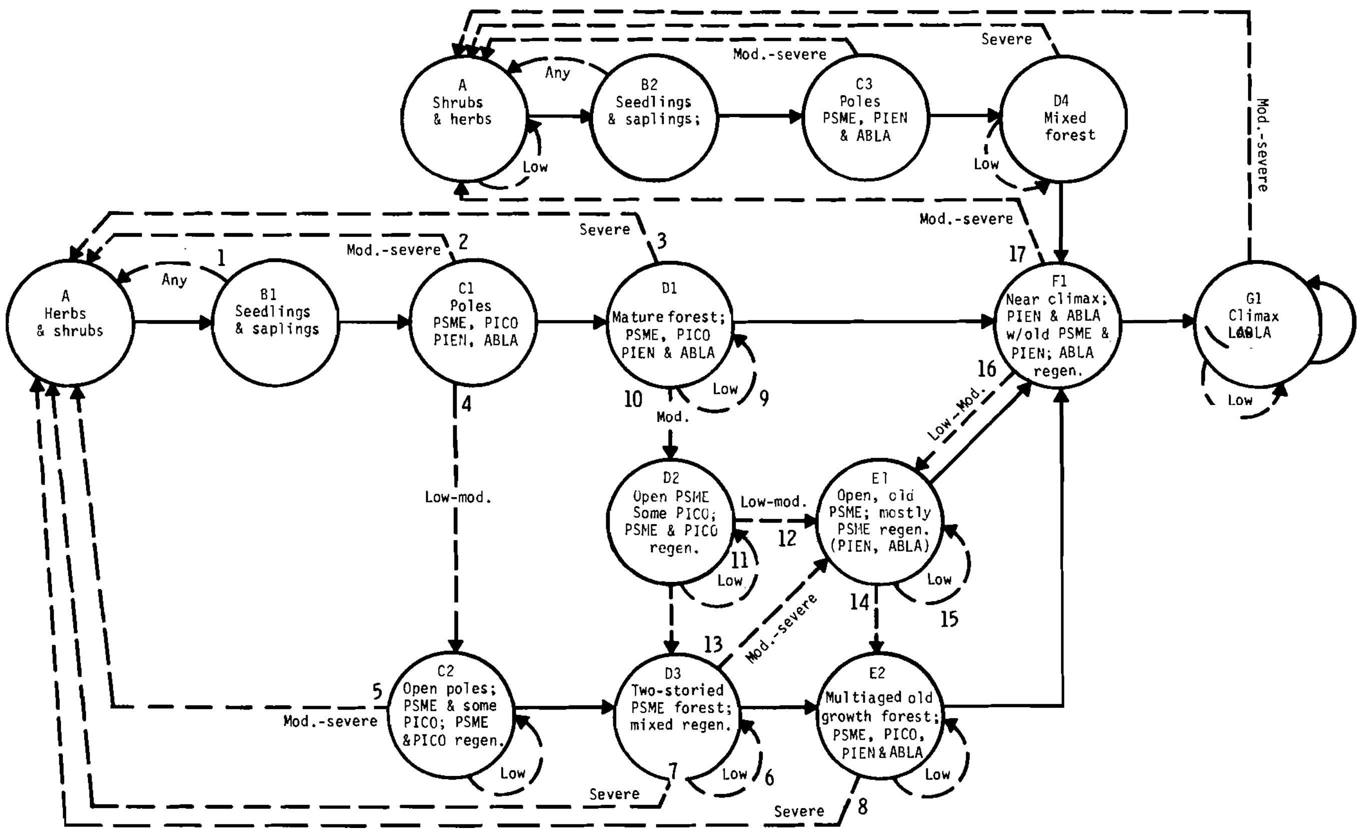


Figure 31—Generalized forest succession in Fire Group Eight: lower subalpine habitat types.

1 MIXED SPECIES SUCCESSION



2 SUCCESSION WITHOUT LODGEPOLE PINE AND SPRUCE (ABLA/ACGL h. t.)

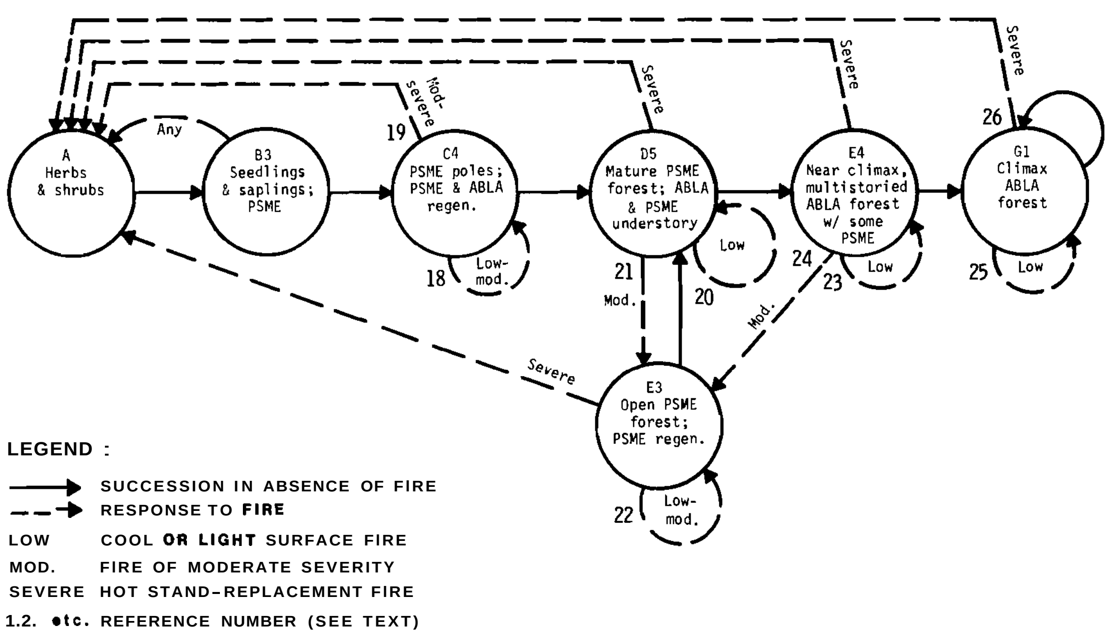


Figure 32—Hypothetical fire-related successional pathways for Fire Group Eight.

stand-replacement fire (Nos. 3, 5, and 6) within the ABLAIACGR h.t., a tall shrub field can persist for decades. Douglas-fir is generally the only seral conifer on stands belonging to the ABLAIACGR h.t. Within other habitat types in this fire group, the seedlings and saplings on the site are generally a mixture of Douglas-fir and lodgepole pine. Any fire in the seedlinglsapling stage would return the site to shrubs and herbs (No. 1).

Pole-size stands are usually mixtures of Douglas-fir and lodgepole pine. A low-to-moderate fire can favor the more fire-resistant Douglas-fir (No. **2).** A severe fire (No. 3) could favor lodgepole pine if cones in the prefire stand were serotinous. If no fire occurs, a mature stand of Douglas-fir and lodgepole pine will develop. There may also be some spruce in the stand, and regeneration under the canopy is likely to be spruce and subalpine fir on many sites. A surface fire would remove most of this fire-susceptible understory and overstory lodgepole pine, opening the stand and favoring Douglas-fir (No. 4). Severe fire (No. 5) would return the site to herbs and shrubs and might again favor lodgepole pine if sufficient trees had serotinous cones. Periodic fire favors lodgepole pine on some sites. If fire continues to be absent, a climax subalpine fir forest will develop.

The hypothetical successional pathway diagram for Fire Group Eight is shown in figure 32. Because both lodgepole pine and spruce are normally absent within the ABLAIACGL h.t., a separate pathway is shown for this habitat type.

The mixed species pathway generally applies to all habitat types except the ABLAIACGL. Remember, however, that spruce is lacking on stands belonging to the ABLAISPBE h.t.

Fire Management Considerations

Fire protection is usually an important fire management consideration during severe burning conditions especially on sites managed for timber production. At other times, fire may be of low-to-moderate severity and result in only moderate damage or no damage to overstory trees, despite the relatively low resistance of many of the species present. Large, overstory Douglas-fir should easily survive fires of low-to-moderate severity.

Fire can be used to dispose of logging slash on harvest areas, but broadcast burning for site preparation is often hampered by high duff moisture and scarcity of acceptable burning days during traditional spring and fall prescribed burning periods. Summer burning has, consequently, become common in subalpine sites in some areas.

Where timber production is not a management objective, opportunities may exist for implementing fire management prescriptions that allow the use of naturally ignited fires. Such fires can create vegetational mosaics that provide a diversity of wildlife habitat. Vegetational mosaics can also reduce the probability of widespread wildfire damage to soil and watershed values.

FIRE GROUP NINE: WET OR MOIST, LOWER SUBALPINE HABITAT TYPES

ADP code	Habitat type-phase	Physiographic sections
	(Steele and others 1981)	(Steele and others 1981)
440	*Picea engelmannii/Galium triflorum* h.t. (PIENIGATR), Engelmann spruce1 sweetscented bedstraw	Open Northern Rockies
490	*Picea engelmannii/Carex disperma* h.t. (PIENICADI), Engelmann spruce/soft-leaved sedge	Challis and Open Northern Rockies
410	*Picea engelmannii/Equisetum arvense* h.t. (PIENIEQAR), Engelmann sprucelcommon horsetail	Challis and Open Northern Rockies
605	*Abies lasiocarpa/Caltha biflora* h.t. (ABLAICABI), subalpine firlmarsh marigold	Southern Batholith
652	*Abies lasiocarpa/ Calamagrostis canadensis* h.t. - *Ligusticum canbyi* phase (ABLAICACA-LICA), subalpine firlbluejoint - Canby's ligusticum phase	Salmon Uplands and Southern Batholith
637	*Abies lasiocarpa/Streptopus amplexifolius* h.t. - *Ligusticum canbyi* phase (ABLA/STAM-LICA), subalpine firltwisted stalk - Canby's ligusticum phase	Salmon Uplands
636	*Abies lasiocarpa/Streptopus amplexifolius* h.t. - *Streptopus amplexifolius* phase (ABLA/STAM-STAM), subalpine firltwisted stalk - twisted stalk phase	Southern Batholith, Challis, and Open Northern Rockies
625	*Abies lasiocarpa/Clintonia uniflora* h.t. - *Menziesia ferruginea* phase (ABLAICLUN-MEFE), subalpine firlqueencup beadlily - menziesia phase	Salmon Uplands and Southern Batholith
621	*Abies lasiocarpa/Clintonia uniflora* h.t. - *Clintonia uniflora* phase (ABLAICLUN-CLUN), subalpine fir/queencup beadlily - queencup beadlily phase	Salmon Uplands and Southern Batholith
638	*Abies lasiocarpa/Coptis occidentalis* h.t. (ABLAICOOC), subalpine fir/western goldthread	Salmon Uplands

ADP code	Habitat type-phase	Physiographic sections
	(Steele and others 1981)	(Steele and others 1981)
671	*Abies lasiocarpa/Menziesia ferruginea* h.t. - *Menziesia ferruginea* phase (ABLA/MEFE-MEFE), subalpine firlmenziesia - menziesia phase	Salmon Uplands, Wallowa-Seven Devils, and Southern Batholith
672	*Abies lasiocarpa/Menziesia ferruginea* h.t. - *Luzula hitchcockii* phase (ABLA/MEFE-LUHI), subalpine firlmenziesia - smooth woodrush phase	Salmon Uplands

Vegetation

Englemann spruce is usually dominant either as a persistent seral species or, mainly in the Challis and Open Northern Rockies sections, as the climax species. Within the ABLAICLUN h.t., Douglas-fir and lodgepole pine may be major seral species and lodgepole pine may precede Engelmann spruce as a major seral species within the ABLA/COOC h.t. Lodgepole pine and Douglas-fir occur as minor seral species or accidentals within other habitat types in this Fire Group. Western larch may be present in seral stands belonging to the ABLAICLUN, ABLA/COOC, and ABLA/MEFE h.t.'s. Grand fir may be a coclimax species within ABLAIMEFE-MEFE and ABLAICLUN-CLUN h.t.'s.

On many sites wet-site herbs and mosses dominate the undergrowth, while shrubs and herbs more characteristic of drier sites grow on hummocks'or at the base of trees (Steele and others 1981). Seral stands may be dominated by wet-site herbs. On better drained sites the undergrowth is variable and shrubs may dominate early seral communities. Some characteristic undergrowth shrubs are prickly currant, blue huckleberry, menziesia, Labrador-tea, bearberry, honeysuckle, and grouse whortleberry. The rich herb layer includes queencup beadlily, sweetscented bedstraw, red baneberry, arrowleaf groundsel, claspleaf twisted stalk, soft-leaved sedge, common horsetail, fireweed, sidebells pyrola, western meadowrue, brook saxifrage, marsh marigold, bluejoint, Canby's ligusticum, Columbian monkshood, fivestamen miterwort, spreading sweet-root, bracted pedicularis, western goldthread, Piper's anenome, darkwoods violet, shooting star, beargrass, and heartleaf arnica.

Forest Fuels

Fuel conditions are similar to those of Group Eight. Total downed, dead, woody fuel loads may average slightly heavier than in Group Eight because of the larger size attained by overstory spruce and the longer fire-free intervals often experienced on these wet sites.

A large percentage of the downed woody fuel exceeds 3 inches (7.6 cm) in diameter (see table 7, Fire Group Eight). The combination of deep duff and large amounts of dead, rotten fuel can result in a severe surface fire during unusually dry moisture conditions. When dense understories exist, such fires can easily spread to the tree crowns and destroy the stand (fig. 33). Even if a severe surface fire does not crown, there is a good chance the overstory spruce and subalpine fir will be killed by cambium heating.

A

B

Figure 33—ABLA/CACA-LEGL h.t.'s occupying low benches along Cloochman Creek, Payette National Forest.

Under normal moisture conditions for these sites, a lush undergrowth of shrubs and herbs usually serves as an effective barrier to rapid fire spread. These stands are probably more susceptible to damage from fire which sweeps in from adjoining areas than from fire that starts within the stand.

Role of Fire

Fire history is lacking for these moist, subalpine forest stands in central Idaho. Evidence from similar habitats in other Rocky Mountain areas suggests that fewer fires occur on these sites than on the drier upland subalpine sites. The mean fire-free intervals for sites within a ABLA/CLUN h.t. at Coram Experimental Forest in northwestern Montana were about 140 years (Sneck [Davis] 1977). Fires at Coram were reported to be small, moderately severe surface fires that occasionally crowned, especially near ridgetops (Arno 1980). Romme and Knight (1981) found intervals of 300 to 400 years between fires in drainage bottoms compared to 300 years for drier upland sites of the Medicine Bow National Forest in southwestern Wyoming.

Steele and others (1981) found evidence of fire in spruce habitat types of central Idaho that suggests less frequent fires than on adjacent slopes. The characteristically wet undergrowths of Fire Group Nine stands do not normally support surface fires. Under severe burning conditions they are, however, susceptible to damage from wind-driven crown fires originating in adjacent stands.

Forest Succession

A general outline of forest succession for Fire Group Nine is shown in figure 34 (subsequent numbers in this section refer to fig. 34). Following a stand-replacing fire, herbs and shrubs will dominate until seedlings and saplings become well established. Within the ABLA/CACA-VACA h.t., aspen may be present in the immediate postfire vegetation if it was present in the prefire stand. Spruce generally dominates the initiating stand, with lodgepole pine, Douglas-fir, and western larch as minor seral species within some habitat types. Sometimes grand fir or subalpine fir are also present.

A fire during the seedlinglsapling stage is unlikely, but if one did occur the area would return to the shrub/herb

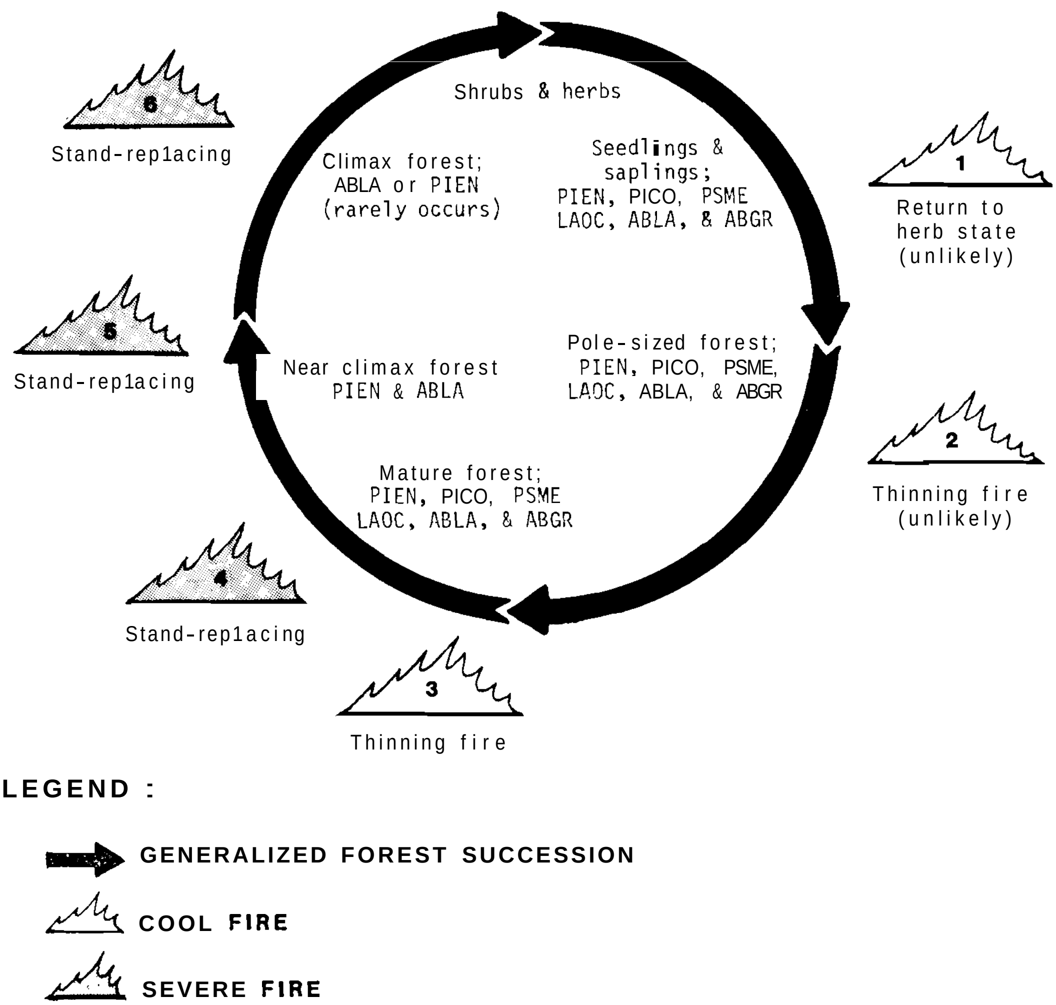


Figure 34—Generalized forest succession in Fire Group Nine: very moist lower subalpine habitat types.

stage (No. 1). The moisture of the sites and lush undergrowth make fires unlikely during the pole stage as well. Any fire that did occur would probably be a cool surface fire that would thin the poles favoring the more resistant Douglas-fir, if present, and larch (No. 2). A cool fire in a mature stand would also thin the more susceptible stems and reduce accumulated surface fuels (No. 3). It is at this stage that stand replacement fires become a possibility (No. **4).** In many stands in this Fire Group other disturbances such as spring flooding and windthrow help maintain the mature forest stage by creating openings and mineral soil for seral tree establishment. During the time required to achieve the near climax and climax situations, stand replacement fires (Nos. 5 and 6) are very likely. The theoretical climax rarely occurs.

The pattern of tree succession in Group Nine (fig. 35) is relatively simple. This simplicity is more a reflection of lack of knowledge than lack of vegetative complexity of Group Nine communities. Perhaps the most significant information gap has to do with the frequency of occurrence and related effects of cool to moderately severe fires on these moist sites. Figure 35 indicates a minimum impact for cool fire and does not include moderately severe fires. Intuitively, one might expect that fires of moderate severity do occur and thin out groups of trees rather than individual trees throughout the stand. If this in fact is the case, the effect of a moderately severe fire is the same as a severe fire, but on a small area within the stand.

The simplicity of this figure also reflects the assumption that Group Nine sites are generally either too moist to burn or, under conditions of extended summer drought, susceptible to wind-driven crown fire. In other words, either the whole thing burns, or it hardly burns at all.

Arno and others (1985) show the sequence of seral community types that develop after stand-destroying wildfire and after clearcutting with broadcast burning, mechanical scarification, and no follow-up treatment within the ABLA/MEFE h.t. in western Montana.

Fire Management Considerations

Fire protection is usually necessary in undisturbed stands during severe burning conditions. This is especially true for areas where timber production is a management objective. At other times, fires may be of low to moderate severity and result in little or no damage to overstory trees (other than subalpine fir), despite the relatively low fire resistance of the species present. If slash is present, unacceptable tree mortality can result even under moderate burning conditions.

Broadcast burning is an effective method for reducing slash hazard and for preparing seedbeds in clearcuts, but not in partial cuts. Timing of a burn is important. Group Nine sites are so cool and moist that opportunities for broadcast burning are limited. The moisture content of the duff must be low enough to allow the fire to bare mineral soil over 20 percent or more of the area. Often, such favorable moisture conditions occur only during late summer.

Burning slash in large windrows or piles can create enough heat to alter the physical structure of the soil. Lower densities and slower growth of conifers on such sites can persist for 15 years or more (Vogl and Ryder 1969). Consequently, windrows should be narrow and piles should be small. Slash disposal plans should consider leaving some large residues for nutrient cycling and to shade seedlings.

Additional guidelines for using fire for slash disposal and site preparation in spruce-fir stands are provided by Roe and others (1970). This reference should be consulted along with local silvicultural guides before planning fire use in these habitats.

The often complex structure of subalpine forests reflects their fire history. Their natural development has not, as a general rule, been noticeably affected by past fire suppression policies (Habeck and Mutch 1973). Management objectives for these sites are often oriented toward non-

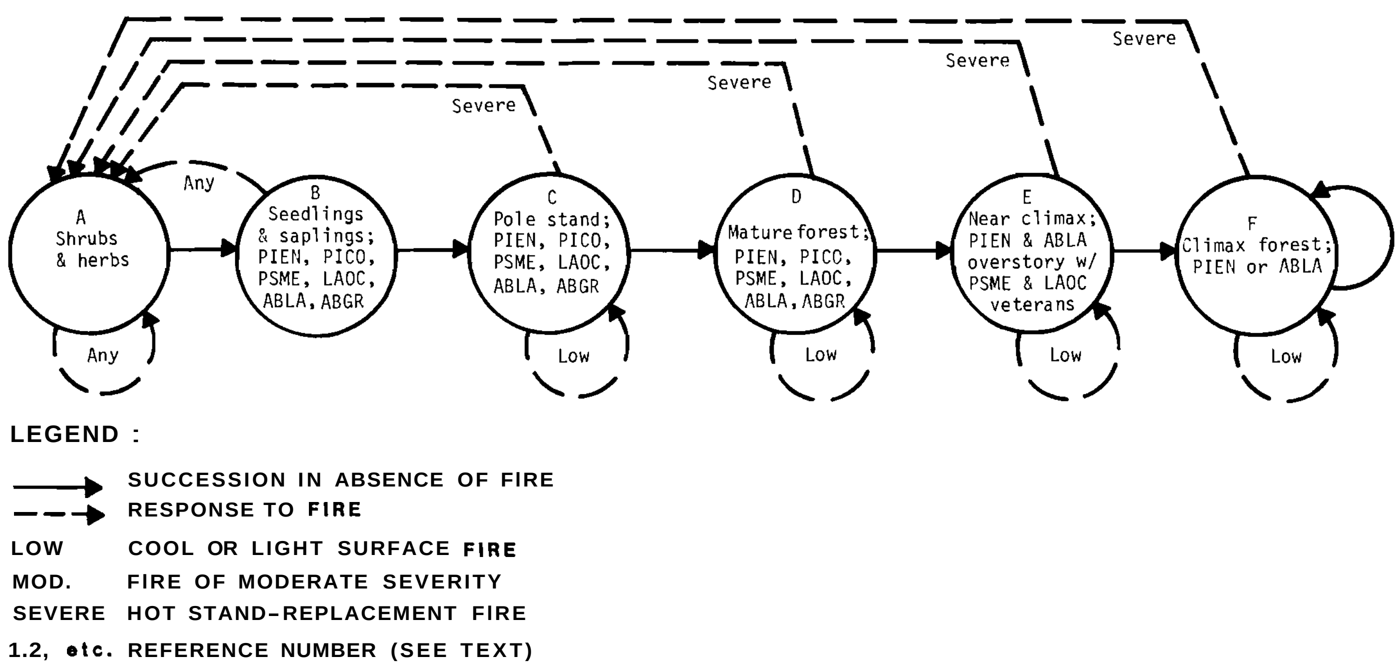


Figure 35—Hypothetical fire-related successional pathways for Fire Group Nine habitat types.

consumptive uses, such as watershed protection and wildlife habitat. On some sites the disturbances associated with modern fire suppression might result in more lasting damage than the fire would cause. Consequently, the appropriate fire management policy may be one that allows certain ignitions to burn according to a predetermined fire management prescription (Fischer 1980).

FIRE GROUP TEN: COLD, UPPER SUBALPINE AND TIMBERLINE HABITAT TYPES

ADP code	Habitat type-phase	Physiographic sections
	(Steele and others 1981)	(Steele and others 1981)
	Upper Subalpine	
810	*Abies lasiocarpa/Ribes montigenum* h.t. (ABLA/RIMO), subalpine fir/mountain gooseberry	Open Northern Rockies and Challis
831	*Abies lasiocarpa/Luzula hitchcockii* h.t. - *Vaccinium scoparium* phase (ABLA/LUHI-VASC), subalpine fir/smooth woodrush - grouse whortleberry phase	Salmon Uplands and Southern Batholith
833	*Abies lasiocarpa/Luzula hitchcockii* h.t. - *Luzula hitchcockii* phase (ABLA/LUHI-LUHI), subalpine firlsmooth woodrush - smooth woodrush phase	Salmon Uplands and Southern Batholith
734	*Abies lasiocarpa/Vaccinium scoparium* h.t. - *Pinus albicaulis* phase (ABLA/VASC-PIAL), subalpine fir/grouse whortleberry - whitebark pine phase	Southern Batholith and Challis
793	*Abies lasiocarpa/Carex geyeri* h.t. - *Artemisia tridentata* phase (ABLA/CAGE-ARTR), subalpine fir/elk sedge - big sagebrush phase	Southern Batholith, Salmon Uplands, and Challis
	Timberline	
850	*Pinus albicaulis-Abies lasiocarpa* h.t.'s (PIAL-ABLA), whitebark pine-subalpine fir	Salmon Uplands, Southern Batholith, and Challis
870	*Pinus albicaulis* Series (PIAL h.t.'s), whitebark pine	Challis and Open Northern Rockies

Vegetation

Fire Group Ten habitat types occur at or near upper timberline. Severe winds, low temperature, and thin soils all contribute to harsh site conditions. On exposed dry ridges conditions are even more harsh.

In cirque basins and on north slopes near timberline, trees characteristically grow as islands interspersed with open meadows (Arno and Harnrnerly 1984). Above these areas lie krummholz. In some areas whitebark pine is the only tree present while other areas support clusters of whitebark pine and subalpine fir (fig. 36). Individual stands of whitebark pine may be 500 or more years old, with high basal areas and biomass (Forcella and Weaver 1977).

In the upper subalpine forests, subalpine fir is the indicated climax. Succession is slow, and stands tend to remain open; thus seral species seldom disappear. Whitebark pine, lodgepole pine, spruce, and occasionally Douglas-fir may all be seral. Limber pine may occur on limestone substrate in the Open Northern Rockies physiographic section. Spruce is also more prevalant in the Open Northern Rockies.

Stands are generally open, with mountain gooseberry, grouse whortleberry, mountain snowberry, and big sagebrush the most common shrubs. Broadleaf arnica, woodrush, snowlover, coiled lousewort, Parry rush, elk sedge, false-hellebore, pokeweed fleece-flower, Idaho fescue, and western needlegrass are found in the herbaceous layer.

Figure 36—A PIAL-ABLA forest in the vicinity of Cloochman Creek Road, Payette National Forest.

Forest Fuels

Fuel inventory data for Group Ten habitat types are scarce. Data from stands in the Selway-Bitterroot Wilderness in western Montana and central Idaho showed a wide range of downed woody fuel loadings. The average total loading for 153 plots in three different habitat types was about 14 tonslacre (3.14 kglm^2); material greater than 3 inches (7.6 cm) in diameter accounted for 11 tons/acre (2.47 kg/m^2) of this total. Fuels tend to be very discontinuous. Typically, most of the fuel load is the result of a few, scattered, large-diameter downfalls resulting from wind and snow breakage, windthrow, and insect- and disease-caused mortality. Such fuels do not reflect a serious fire hazard. The usually sparse and often discontinuous nature of fine surface fuels (live or dead), the short fire season, and the normally cool, moist site are mitigating factors that must be considered.

Role of Fire

The severity of Group Ten sites and the prevailing climate near and at timberline minimize the possibility of severe fires. Lightning does ignite fires, but the patchiness of trees and fuel, the short fire season, and the prevalance of rain showers with lightning storms limit the number of fires and their spread. Gabriel (1976) concluded that the fire history at high elevations in the Bob Marshall Wilderness was one of lightning strikes igniting many fires that burned small patches, ranging from a single tree to a few acres.

In the more continuous forests of this Fire Group, the most pronounced fire effect is to produce stand-replacing fires at long intervals of 100 to 300 years (Heinselman 1981). Stand-destroying fires in Group Ten are most likely to occur during extended periods of drought when very severe wind-driven crown fires develop in the forests below and burn into the upper subalpine and timberline forests. Vegetational recovery following such fires is usually slow because of the extremely short growing season and cold climate. The wet or dry subalpine meadow that forms the early successional stage may last a century or more (Billings 1969; Stahelin 1943).

Forest Succession

Secondary succession begins with a mixture of herbs and shrubs, and possibly some conifer seedlings in the shelter of snags, logs, or shrubs (fig. 37). Herbaceous plants will probably prevail for an extended period. Fire may initiate secondary succession but probably will not maintain it. On moist sites and north slopes physical disruption of the stand by snow and wind, and snow and rock slides is more important than fire in maintaining early stages of succession.

Perhaps 100 years or more will elapse before conifers dominate some Group Ten sites. It may take another century for a mature forest to develop. It is unlikely that fuel or stand conditions will support a fire of any consequence during this period. Surface fires do occur, especially in whitebark pine stands on south slopes and ridges. Such fires act as underburns reducing fuels and killing some overstory trees. Severe fires may occur over small areas, but their effect will usually be limited to the creation of

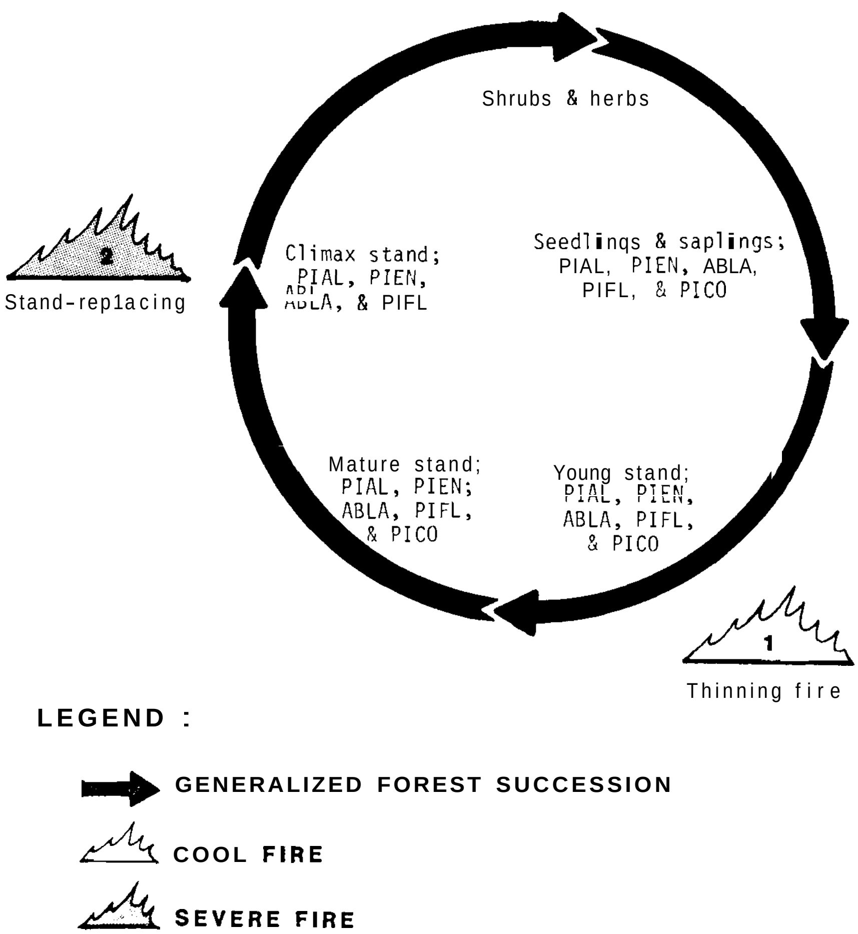
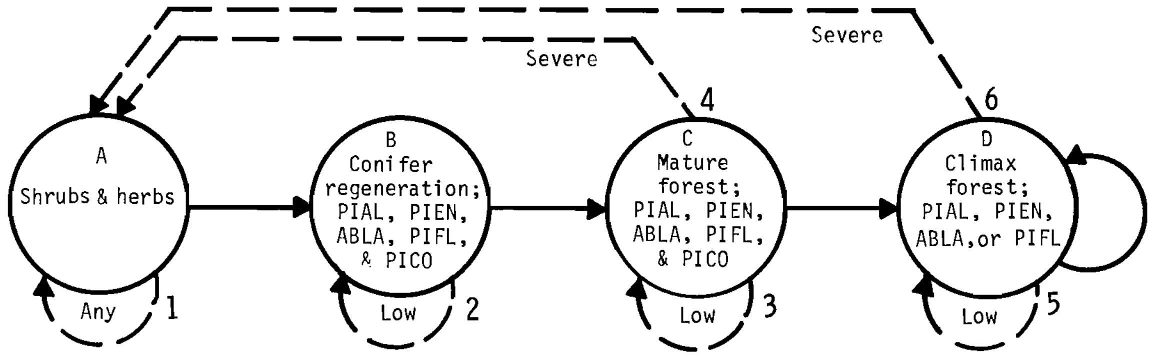


Figure 37—Generalized forest succession for Fire Group Ten: cold upper subalpine and timberline habitat types.



LEGEND :

——▶	SUCCESSION IN ABSENCE OF FIRE
– – ▶	RESPONSE TO FIRE
LOW	COOL OR LIGHT SURFACE FIRE
MOD.	FIRE OF MODERATE SEVERITY
SEVERE	HOT STAND-REPLACEMENT FIRE
1, 2, etc.	REFERENCE NUMBER (SEE TEXT)

Figure 38—Hypothetical fire-related successional pathways for Fire Group Ten habitat types.

vegetative mosaics. Eventually the mature forest will begin to break up under the impact of wind and snow breakage, windthrow, insect and disease attacks, and senescence. Stand-destroying fires, especially those that invade from low-elevation forests become a possibility during periods of extended drought.

Without disturbance, the mature trees will progress into a climax stand. This advanced successional stage requires decades, and sometimes centuries. Fires of low-to-moderate severity rarely affect a mature stand because of the open structure and lack of continuous fine woody fuels; however, severe fires that enter the crowns and kill the cambium of trees return the site to the early successional stages (fig. 37).

A simple successional pathway postulated for Fire Group Ten is shown in figure 38.

Fire Management Considerations

Timber production is rarely an important management objective in Fire Group Ten forests. Watershed, wildlife, and recreation are often the dominant values. Consumptive uses are often restricted by natural area or wilderness designation. Fire is infrequent, and when it does occur damage in terms of management objectives is usually slight. These sites are, however, fragile and can easily be damaged by modern, mechanized firefighting equipment.

For many Group Ten habitats, the primary fire management consideration should be the development of prescriptions that allow fire to more nearly play its natural role (Fischer 1984).

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APPENDIX A: HABITAT TYPES OF CENTRAL IDAHO

ADP code[1]	Abbreviation		Habitat types and phases: Scientific name	Habitat types and phases: Common name
000			*PINUS FLEXILIS SERIES*	
080	PIFL/HEKL	h.t.	*Pinus flexilis/Hesperochloa kingii* h.t.	*limber pine/spikefescue*
050	PIFL/FELD	h.t.	*Pinus flexilis/Festuca idahoensis* h.t.	*limber pine/Idaho fescue*
060	PIFL/CELE	h.t.	*Pinus flexilis/Cercocarpus ledifolius* h.t.	*limber pine/curlleaf mountain-mahogany*
070	PIFL/JUCO	h.t.	*Pinus flexilis/Juniperus communis* h.t.	*limber pine/common juniper*
100			*PINUS PONDEROSA SERIES*	
120	PIPO/STOC	h.t.	*Pinus ponderosa/Stipa occidentalis* h.t.	*ponderosa pine/western needlegrass*
130	PIPO/AGSP	h.t.	*Pinus ponderosa/Agropyron spicatum* h.t	*ponderosa pine/bluebunch wheatgrass*
140	PIPO/FEID	h.t.	*Pinus ponderosa/Festuca idahoensis* h.t.	*ponderosa pine/Idaho fescue*
160	PIPO/PUTR	h.t.	*Pinus ponderosa/Purshia tridentata* h.t.	*ponderosa pine/bitterbrush*
161	-AGSP	phase	*-Agropyron spicatum phase*	*-bluebunch wheatgrass phase*
162	-FEID	phase	*-Festuca idahoensis phase*	*-Idaho fescue phase*
195	PIPO/SYOR	h.t.	*Pinus ponderosa/Symphoricarpos oreophilus* h.t.	*ponderosa pine/mountain snowberry*
170	PIPO/SYAL	h.t.	*Pinus ponderosa/Symphoricarpos albus* h.t.	*ponderosa pine/common snowberry*
190	PIPO/PHMA	h.t.	*Pinus ponderosa/Physocarpus malvaceus* h.t	*ponderosa pine/ninebark*
200			*PSEUDOTSUGA MENZIESII SERIES*	
210	PSME/AGSP	h.t.	*Pseudotsuga menziesii/Agropyron spicatum* h.t	*Douglas-fir/bluebunch wheatgrass*
220	PSME/FEID	h.t.	*Pseudotsuga menziesii/Festuca idahoensis* h.t.	*Douglas-fir/Idaho fescue*
221	-FEID	phase	*-Festuca idahoensis phase*	*-Idaho fescue phase*
222	-PIPO	phase	*-Pinus ponderosa phase*	*-ponderosa pine phase*
380	PSME/SYOR	h.t.	*Pseudotsuga menziesii/Symphoricarpos oreophilus* h.t.	*Douglas-fir/mountain snowberry*
370	PSME/ARCO	h.t.	*Pseudotsuga menziesii/Arnica cordifolia* h.t.	*Douglas-fir/heartleaf arnica*
372	-ASMI	phase	*-Astragalus miser phase*	*-weedy milkvetch phase*
371	-ARCO	phase	*-Arnica cordifolia phase*	*-heartleaf arnica phase*
360	PSME/JUCO	h.t.	*Pseudotsuga menziesii/Juniperus communis* h.t.	*Douglas-fir/common juniper*
330	PSME/CAGE	h.t.	*Pseudotsuga menziesii/Carex geyeri* h.t.	*Douglas-fir/elk sedge*
332	-SYOR	phase	*-Symphoricarpos oreophilus phase*	*-mountain snowberry phase*
334	-PIPO	phase	*-Pinus ponderosa phase*	*-ponderosa pine phase*
331	-CAGE	phase	*-Carex geyeri phase*	*-elk sedge phase*
395	PSME/BERE	h.t.	*Pseudotsuga menziesii/Berberis repens* h.t.	*Douglas-fir/oregon grape*
397	-SYOR	phase	*-Symphoricarpos oreophilus phase*	*-mountain snowberry phase*
398	-CAGE	phase	*-Carex geyeri phase*	*-elk sedge phase*
396	-BERE	phase	*-Berberis repens phase*	*-Oregon grape phase*
385	PSME/CELE	h.t.	*Pseudotsuga menziesii/Cercocarpus ledifolius* h.t.	*Douglas-fir/curlleaf mountain-mahogany*
320	PSME/CARU	h.t.	*Pseudotsuga menziesii/Calamagrostis rubescens* h.t.	*Douglas-fir/pinegrass*
325	-FEID	phase	*-Festuca idahoensis phase*	*-Idaho fescue phase*
324	-PIPO	phase	*-Pinus ponderosa phase*	*-ponderosa pine phase*
323	-CARU	phase	*-Calamagrostis rubescens phase*	*-pinegrass phase*
375	PSME/OSCH	h.t.	*Pseudotsuga menziesii/Osmorhiza chilensis* h.t.	*Douglas-fir/mountain sweet-root*
340	PSME/SPBE	h.t.	*Pseudotsuga menziesii/Spiraea betulifolia* h.t.	*Douglas-fir/white spirea*
344	-PIPO	phase	*-Pinus ponderosa phase*	*-ponderosa pine phase*
343	-CARU	phase	*-Calamagrostis rubescens phase*	*-pinegrass phase*
341	-SPBE	phase	*-Spiraea betulifolia phase*	*-white spirea phase*
310	PSME/SYAL	h.t.	*Pseudotsuga menziesii/Symphoricarpos albus* h.t.	*Douglas-fir/common snowberry*
315	-PIPO	phase	*-Pinus ponderosa phase*	*-ponderosa pine phase*
313	-SYAL	phase	*-Symphoricarpos albus phase*	*-common snowberry phase*
280	PSME/VAGL	h.t.	*Pseudotsuga menziesii/Vaccinium globulare* h.t.	*Douglas-fir/blue huckleberry*
390	PSME/ACGL	h.t.	*Pseudotsuga menziesii/Acer glabrum* h.t.	*Douglas-fir/mountain maple*
392	-SYOR	phase	*-Symphoricarpos oreophilus phase*	*-mountain snowberry phase*
393	-ACGL	phase	*-Acer glabrum phase*	*-mountain maple phase*
260	PSME/PHMA	h.t.	*Pseudotsuga menziesii/Physocarpus malvaceus* h.t.	*Douglas-fir/ninebark*
262	-CARU	phase	*-Calamagrostis rubescens phase*	*-pinegrass phase*
264	-PIPO	phase	*-Pinus ponderosa phase*	*-ponderosa pine phase*
265	-PSME	phase	*-Pseudotsuga menziesii phase*	*-Douglas-fir phase*
290	PSME/LIBO	h.t.	*Pseudotsuga menziesii/Linnaea borealis* h.t.	*Douglas-fir/twinflower*
250	PSME/VACA	h.t.	*Pseudotsuga menziesii/Vaccinium caespitosum* h.t	*Douglas-fir/dwarf huckleberry*
400			*PICEA ENGELMANNII SERIES*	
493	PIEN/HYRE	h.t.	*Picea engelmannii/Hypnum revolutum* h.t.	*spruce/hypnum*
440	PIEN/GATR	h.t.	*Picea engelmannii/Galium triflorum* h.t.	*spruce/sweetscented bedstraw*
490	PIEN/CADI	h.t.	*Picea engelmannii/Carex disperma* h.t.	*spruce/soft-leaved sedge*
410	PIEN/EQAR	h.t.	*Picea engelmannii/Equisetum arvense* h.t.	*spruce/common horsetail*

(con.)

APPENDIX A. (Con.)

ADP code[1]	Abbreviation	Habitat types and phases: Scientific name	Habitat types and phases: Common name
500		*ABIES GRANDIS SERIES*	
585	ABGR/CARU h.t.	*Abies grandis/Calamagrostis rubescens* h.t.	*grand firlpinegrass*
505	ABGR/SPBE h.t.	*Abies grandis/Spiraea betulifolia h.t.*	*grand firlwhite spirea*
515	ABGR/VAGL h.t.	*Abies grandisflaccinium globulare h.t.*	*grand firlblue huckleberry*
510	ABGR/XETE h.t.	*Abies grandis/Xerophyllum tenax h.t.*	*grand firlbeargrass*
525	ABGR/ACGL h.t.	*Abies grandis/Acer glabrum h.t.*	*grand firlmountain maple*
527	-PHMA *phase*	*-Physocarpus malvaceus phase*	-ninebark *phase*
526	-ACGL *phase*	*-Acer glabrum phase*	*-mountain maple phase*
590	ABGR/LIBO h.t.	*Abies grandis/Linnaea borealis* h.t.	*grand firltwinflower*
593	-VAGL *phase*	*-Vaccinium globulare phase*	*-blue huckleberry phase*
592	-XETE *phase*	*-Xerophyllum tenax phase*	-beargrass *phase*
591	-LIBO *phase*	*-Linnaea borealis phase*	-twinflower *phase*
580	ABGR/VACA h.t.	*Abies grandis/Vaccinium caespitosum* h.t.	*grand firldwarf huckleberry*
511	ABGR/COOC h.t.	*Abies grandis/Coptis occidentalis h.t.*	*grand firlwestern goldthread*
520	ABGR/CLUN h.t.	*Abies grandis/Clintonia uniflora h.t.*	*grand firlqueencup* beadlily
600		*ABIES LASIOCARPA SERIES*	
605	*ABLAICABI* h.t.	*Abies lasiocarpa/Caltha biflora h.t.*	*subalpine firlmarsh marigold*
650	ABLA/CACA h.t.	*Abies lasiocarpa/Calamagrostis canadensis* h.t.	*subalpine firlbluejoint*
655	-LEGL *phase*	*-Ledum glandulosum phase*	*-Labrador-tea phase*
654	-VACA *phase*	*-Vaccinium caespitosum phase*	*-dwarf huckleberry phase*
652	-LICA *phase*	*-Ligusticum canbyi phase*	-Canby's *ligusticum phase*
651	-CACA *phase*	*-Calamagrostis canadensis phase*	-bluejoint *phase*
635	ABLA/STAM h.t.	*Abies lasiocarpa/Streptopus amplexifolius h.t.*	*subalpine firltwisted stalk*
637	-LICA *phase*	*-Ligusticum canbyi phase*	-Canby's *ligusticum phase*
636	-STAM *phase*	*-Streptopus amplexifolius phase*	*-twisted stalk phase*
620	ABLA/CLUN h.t.	*Abies lasiocarpa/Clintonia uniflora h.t.*	*subalpine firlqueencup* beadlily
625	-MEFE *phase*	*-Menziesia ferruginea phase*	-menziesia *phase*
621	-CLUN *phase*	*-Clintonia uniflora phase*	-queencup beadlily
638	ABLA/COOC h.t.	*Abies lasiocarpa/Coptis occidentalis h.t.*	*subalpine firlwestern goldthread*
670	ABLA/MEFE h.t.	*Abies lasiocarpa/Menziesia ferruginea h.t.*	*subalpine firlmenziesia*
672	-LUHI *phase*	*-Luzula hitchcockii phase*	*-smooth* woodrush *phase*
671	-MEFE *phase*	*-menziesia ferruginea phase*	-Menziesia *phase*
645	ABLA/ACGL h.t.	*Abies lasiocarpa/Acer glabrum h.t.*	*subalpine firlmountain maple*
640	ABLA/VACA h.t.	*Abies lasiocarpa/Vaccinium caespitosum h.t.*	*subalpine firldwarf huckleberry*
660	ABLA/LIBO h.t.	*Abies lasiocarpa/Linnaea borealis* h.t.	*subalpine firltwinflower*
661	-LIBO *phase*	*-Linnaea borealis phase*	-twinflower *phase*
662	-XETE *phase*	*-Xerophyllum tenax phase*	-beargrass *phase*
663	-VASC *phase*	*-Vaccinium scoparium phase*	*-grouse whortleberry phase*
740	ABLA/ALSI h.t.	*Abies lasiocarpa/Alnus sinuata* h.t.	*subalpine* fir/Sitka *alder*
690	ABLA/XETE h.t.	*Abies lasiocarpa/Xerophyllum tenax* h.t.	*subalpine firlbeargrass*
691	-VAGL *phase*	*-Vaccinium globulare phase*	*-blue huckleberry phase*
692	-VASC *phase*	*-Vaccinium scoparium phase*	*-grouse whortleberry phase*
694	-LUHI *phase*	*-Luzula hitchcockii phase*	*-smooth* woodrush *phase*
720	ABLA/VAGL h.t.	*Abies lasiocarpa/Vaccinium globulare h.t.*	*subalpine firlblue huckleberry*
723	-VAGL *phase*	*-Vaccinium globulare phase*	*-blue huckleberry phase*
721	-VASC *phase*	*-Vaccinium scoparium phase*	*-grouse whortleberry phase*
705	ABLA/SPBE h.t.	*Abies lasiocarpa/Spiraea betulifolia h.t.*	*subalpine firlwhite spirea*
830	ABLA/LUHI h.t.	*Abies lasiocarpa/Luzula hitchcockii* h.t.	*subalpine firlsmooth* woodrush
831	-VASC *phase*	*-Vaccinium scoparium phase*	*-grouse whortleberry phase*
833	-LUHI *phase*	*-Luzula hitchcockii phase*	*-smooth* woodrush *phase*
730	ABLA/VASC h.t.	*Abies lasiocarpa/Vaccinium scoparium* h.t.	*subalpine firlgrouse whortleberry*
731	-CARU *phase*	*-Calamagrostis rubescens phase*	-pinegrass *phase*
732	-VASC *phase*	*-Vaccinium scoparium phase*	*-grouse whortleberry phase*
734	-PIAL *phase*	*-Pinus albicaulis phase*	-whitebark *phase*
750	ABLA/CARU h.t.	*Abies lasiocarpa/Calamagrostis rubescens h.t.*	*subalpine firlpinegrass* h.t.
790	ABLA/CAGE h.t.	*Abies lasiocarpa/Carex geyeri h.t.*	*subalpine firlelk sedge* h.t.
791	*-CAGE phase*	*-Carex geyeri phase*	*-elk sedge phase*
793	-ARTR *phase*	*-Artemisia tridentata phase*	*-big sagebrush phase*

(con.)

APPENDIX A. (Con.)

ADP code[1]	Abbreviation		Habitat types and phases: Scientific name	Common name
			ABIES LASIOCARPA SERIES (con.)	
745	ABLA/JUCO	h.t.	Abies *lasiocarpa/Juniperus* communis h.t.	subalpine fir/common juniper
810	ABLA/RIMO	h.t.	Abies *lasiocarpa/Ribes montigenum* h.t.	subalpine firlrnountain gooseberry
780	ABLA/ARCO	h.t.	*Abies lasiocarpa/Arnica cordifolia* h.t.	subalpine firlheartleaf arnica
850	PIAL-ABLA	h.t.'s	*Pinus albicaulis-Abies lasiocarpa* h.t.'s	whitebark pine-subalpine fir
870			*PINUS ALBICAULIS* SERIES	
870	PIAL	h.t.'s	*Pinus albicaulis* h.t.'s	whitebark pine
900			*PINUS* CONTORTA SERIES	
920	PICO/VACA	c.t.	*Pinus contorta/Vaccinium* caespitosum c.t.	lodgepole pineldwarf huckleberry
940	PICO/VASC	c.t.	*Pinus contorta/Vaccinium* scoparium c.t.	lodgepole pinelgrouse whortleberry
950	PICO/CAGE	c.t.	*Pinus contorta/Carex geyeri* c.t.	lodgepole pine/elk sedge
905	PICO/FEID	h.t.	*Pinus contorta/Festuca* idahoensis h.t.	lodgepole pinelldaho fescue

'Automatic data processing codes.

APPENDIX B: OCCURRENCE AND ROLES OF TREE SPECIES BY HABITAT TYPES

Occurrence of tree species through the series of habitat types, showing their status in forest succession as interpreted from central Idaho reconnaissance plot data (Steele and others 1981).

C = major climax species S = major seral species a = accidental
c = minor climax species s = minor seral species ( ) = only in certain areas of h.t.

Habitat type-phase	JUSC	POTR	PIFL	PIPO	PSME	PICO	PIEN	LAOC	ABGR	ABLA	PIAL
PIFL/FEID	(c)	–	C	–	C	–	–	–	–	–	–
PIPO/STOC	–	–	–	C	–	–	–	–	–	–	–
PIPO/AGSP	–	–	–	C	a	–	–	–	–	–	–
PIPO/FEID	–	a	–	C	a	–	–	–	–	–	–
PIPOIPUTR, AGSP	–	a	–	C	a	–	–	–	–	–	–
PIPOIPUTR, FEID	–	–	–	C	a	–	–	–	–	–	–
PIPO/SYOR	–	–	–	C	a	–	–	–	–	–	–
PIPO/SYAL	–	(s)	–	C	a	–	–	–	–	–	–
PSME/AGSP	–	a	–	(C)	C	–	–	–	–	–	–
PSMEIFEID, FEID	–	–	–	–	C	a	–	–	–	–	–
PSMEIFEID, PIPO	–	–	–	C	C	a	–	–	–	–	–
PSME/SYOR	–	a	(c)	(c)	C	a	–	–	–	–	–
PSMEIARCO, ASMI	a	–	s	–	C	–	a	–	–	–	–
PSMEIARCO, ARCO	–	a	(s)	–	C	(s)	a	–	–	a	a
PSME/JUCO	–	–	(s)	–	C	(s)	–	–	–	a	a
PSMEICAGE, SYOR	–	a	a	–	C	(s)	–	–	–	a	a
PSMEICAGE, PIPO	–	–	–	S	C	a	–	–	–	–	–
PSMEICAGE, CAGE	–	a	a	–	C	(s)	–	–	–	a	a
PSMEIBERE, SYOR	–	–	–	(c)	C	–	–	–	–	–	–
PSMEIBERE, CAGE	–	–	–	S	C	–	–	–	–	–	–
PSMEICAGE, BERE	–	–	–	(S)	C	(c)	–	–	–	–	–
PSME/CELE	–	–	(c)	(C)	C	a	–	–	–	–	–
PSMEICARU, FEID	–	–	–	–	C	–	–	–	–	–	–
PSMEICARU, PIPO	–	–	–	S	C	(S)	–	–	–	–	–
PSMEICARU, CARU	–	s	–	–	C	(S)	a	–	–	a	a
PSME/OSCH	–	–	–	(S)	C	–	–	–	–	a	a
PSMEISPBE, PIPO	–	a	–	S	C	a	a	–	–	a	a
PSMEISPBE, CARU	–	–	–	–	C	(S)	–	–	–	–	–
PSMEISPBE, SPBE	–	–	a	–	C	(s)	–	–	–	a	a
PSMEISYAL, PIPO	–	(s)	–	S	C	(s)	–	–	–	–	–
PSMEISYAL, SYAL	–	a	–	–	C	a	–	–	–	a	a
PSMEIACGL, SYOR	s	–	s	–	C	–	–	–	–	–	–
PSMEIACGL, ACGL	–	(S)	–	(S)	C	–	–	–	–	a	a
PSMEIPHMA, PIPO	–	–	–	S	C	–	–	–	–	a	–
PSMEIPHMA, PSME	–	–	–	–	C	–	–	–	–	–	–
PIEN/HYRE	–	–	S	–	C	–	C	–	–	–	–
PIEN/CADI	–	a	–	–	a	S	C	–	–	c	–
ABGR/CARU	–	–	–	S	S	(S)	a	–	C	a	a
ABGR/SPBE	–	(s)	–	S	S	–	a	a	C	–	–
ABGRNAGL	–	a	–	s	S	s	S	(s)	C	(c)	–
ABGRIACGL, PHMA	–	–	–	S	S	–	a	a	C	(c)	–
ABGRIACGL, ACGL	–	–	–	S	S	–	a	a	C	(c)	–
ABGRILIBO, VAGL	–	–	–	s	S	s	s	(s)	C	(c)	–
ABGRILIBO, LIBO	–	–	–	S	S	s	a	a	C	–	–
ABGR/VACA	–	–	–	(s)	(S)	S	s	s	C	c	–
ABGR/CLUN	–	–	–	s	s	(s)	S	S	C	(c)	–
ABLNCABI	–	a	–	–	–	a	S	–	–	C	–
ABLNCACA, LEGL	–	–	–	–	s	S	S	–	a	C	–
ABLNSTAM, LICA	–	–	–	–	a	s	S	–	a	C	–
ABLNSTAM, STAM	–	–	–	–	a	s	S	–	–	C	–

(con.)

APPENDIX B. (Con.)

Habitat type-phase	JUSC	POTR	PIFL	PIPO	PSME	PICO	PIEN	LAOC	ABGR	ABLA	PIAL
ABLA/CLUN, CLUN	–	–	–	a	S	s	S	(S)	(c)	C	–
ABLAIMEFE, MEFE	–	–	–	–	s	(S)	S	(S)	(c)	C	–
ABLA/ACGL	–	a	–	–	S	–	–	–	–	C	–
ABLNVACA	–	a	–	–	s	S	s	–	a	C	s
ABLAILIBO, LIBO	–	–	–	–	S	S	S	–	a	C	a
ABLAIXETE, VAGL	–	–	–	–	(S)	S	S	–	–	C	–
ABLAIXETE, VASC	–	–	–	–	(S)	S	s	–	–	C	(s)
ABLAIXETE, LUHI	–	–	–	–	–	(s)	(S)	–	–	C	s
ABLAIVAGL, VAGL	–	–	–	a	S	a	S	–	a	C	a
ABLA/SPBE	–	–	–	a	S	(S)	a	–	–	C	a
ABLA/LUHI, VASC	–	–	–	–	–	S	s	–	–	C	s
ABLAILUHI, LUHI	–	–	–	–	–	s	s	–	–	C	s
ABLNVASC, CARU	–	–	–	–	s	S	s	–	–	C	–
ABLAIVASC, VASC	–	–	–	–	a	S	s	–	–	C	s
ABLAIVASC, PIAL	–	–	–	–	–	(S)	a	–	–	C	C
ABLNCARU	–	–	–	–	S	S	–	–	a	C	s
ABLAICAGE, CAGE	–	a	–	–	(S)	(S)	(s)	–	–	C	s
ABLAICAGE, ARTR	–	–	–	–	(s)	a	–	–	–	C	c
ABLA/JUCO	–	–	–	–	(S)	(S)	s	–	–	C	s
ABLA/RIMO	–	–	–	–	a	–	(s)	–	–	C	S
ABLA/ARCO	–	–	–	–	s	(S)	S	–	–	C	s
PIAL/ABLA	–	–	–	–	–	(s)	a	–	–	C	C
PICO/FEID	–	–	–	–	–	C	–	–	–	–	(c)

APPENDIX C: SCIENTIFIC NAMES OF PLANTS MENTIONED IN TEXT

Common name	Scientific name
alder	Alnus spp.
alpine knotweed	Polygonurn phytolaccaefoliurn
antelope bitterbrush	Purshia tridentata
arrowleaf balsamroot	Balsarnorhiza sagittata
arrowleaf groundsel	Senecio triangularis
aspen	Populus trernuloides
baldhip rose	Rosa gyrnnocarpa
ballhead sandwort	Arenaria congesta
bearberry	Arctostaphylos uva-ursi
beargrass	Xerophyllum tenax
bigleaf sandwort	Arenaria rnacrophylla
big sagebrush	Arternisia tridentata
birch	Betula spp.
bitterbrush	Purshia tridentata
blue huckleberry	Vacciniurn globulare
bluebunch wheatgrass	Agropyron spicaturn
bluejoint	Calarnagrostis canadensis
bracted pedicularis	Pedicularis bracteosa
broadleaf arnica	Arnica latifolia
brook saxifrage	Saxifraga arguta
Canby's ligusticum	Ligusticurn canbyi
chokecherry	Prunus virginiana
coiled lousewort	Pedicularis contorta
Columbia clematis	Clematis colurnbiana
Columbian monkshood	Aconiturn columbianum
common horsetail	Equisetum arvense
common juniper	Juniperus cornrnunis
common snowberry	Syrnphoricarpos albus
cottonwood	Populus spp.
creeping barberry	Berberis repens
creeping Oregon grape	Berberis repens
curlleaf mountain-mahogany	Cercocarpus ledifolius
currant	Ribes spp.
dampwoods blueberry	Vacciniurn globulare
darkwoods violet	Viola orbiculata
Douglas-fir	Pseudotsuga rnenziesii
dwarf huckleberry	Vacciniurn caespitosurn
elk sedge	Carex geyeri
Engelmann spruce	Picea engelrnannii
fairybells	Disporurn trachycarpurn
false bugbane	Trautvetteria caroliniensis
false-hellebore	Veratrurn viride
false Solomon's seal	Srnilacina racernosa
firestamen miterwort	Mitella pentandra
fireweed	Epilobiurn angustifoliurn
grand fir	Abies grandis
grouse whortleberry	Vacciniurn scopariurn
hawthorn	Crataegus spp.
heartleaf arnica	Arnica cordifolia
Hook violet	Viola adunca
Hooker fairybells	Disporurn hookeri
honeysuckle	Lonicera caerulea
hypnum	Hypnurn revolutum
Idaho fescue	Festuca idahoensis
Indian poke	Veratrurn viride
junegrass	Koeleria cristata
kinnikinnick	Arctostaphylos uva-ursi
Labrador-tea	Ledum glandulosum
larch	Larix occidentalis
limber pine	Pinus flexilis
lodgepole pine	Pinus contorta
marsh marigold	Caltha biflora
menziesia	Menziesia ferruginea
mountain arnica	Arnica latifolia
mountain ash	Sorbus scopulina
mountain big sagebrush	Arternisia tridentata ssp. vaseyana
mountain gooseberry	Ribes rnontigenurn
mountain-mahogany	Cercocarpus ledifolius
mountain maple	Acer glabrurn
mountain snowberry	Syrnphoricarpos oreophilus
mountain sweet-root	Osrnorhiza chilensis
myrtle pachistima	Pachistirna rnyrsinites
Nevada peavine	Lathyrus nevadensis
ninebark	Physocarpus rnalvaceus
oceanspray	Holodiscus discolor
oniongrass	Melica bulbosa
pathfinder	Adenocaulon bicolor
Parry rush	Juncus parryi
pinegrass	Calarnagrostis rubescens
Piper's anemone	Anemone piperi
pokeweed fleeceflower	Polygonurn phytolaccaefoliurn
ponderosa pine	Pinus ponderosa
prickly currant	Ribes lacustre
pussytoes	Antennaria racernosa
pyramid spirea	Spiraea pyrarnidata
quaking aspen	Populus trernuloides
queencup beadlily	Clintonia uniflora
red baneberry	Actaea rubra
Richardson geranium	Geranium richardsonii
Rocky Mountain maple	Acer glabrurn
rose	Rosa spp.
Ross sedge	Carex rossii
rosy pussytoes	Antennaria rnacrophylla
russet buffaloberry	Shepherdia canadensis
Scouler willow	Salix scoulerana
sedge	Carex spp.
serviceberry	Arnelanchier alnifolia
shooting star	Dodecatheon jeffreyi
showy aster	Aster conspicuus
shrubby cinquefoil	Potentilla fruticosa
sidebells pyrola	Pyrola secunda
silvery lupine	Lupinus argenteus
Sitka alder	Alnus sinuata
Sitka valerian	Valeriana sitchensis
smooth woodrush	Luzula hitchcockii
snowberry	Syrnphoricarpos spp.
snowbrush ceanothus	Ceanothus velutinus
snowlover	Chionophila tweedyi
soft-leaved sedge	Carex disperrna
spikefescue	Hesperochloa kingii
spreading sweet-root	Osrnorhiza chilensis
spruce	Picea engelrnannii
starry Solomon-plume	Srnilacina stellata
starry Solomon's seal	Srnilacina stellata
sticky geranium	Geranium viscosissirnurn
strawberry	Fragaria spp.
subalpine fir	Abies lasiocarpa
sweetscented bedstraw	Galium triflorurn
thimbleberry	Rubus parviflorus
Thurber fescue	Festuca thurberi
twinflower	Linnaea borealis
twisted stalk	Streptopus arnplexifolius
Utah honeysuckle	Lonicera utahensis
wax currant	Ribes cereurn
weedy milkvetch	Astragalus miser
western goldthread	Coptis occidentalis
western larch	Larix occidentalis
western meadowrue	Thalictrurn occidentale
western needlegrass	Stipa occidentalis
western pipsissewa	Chirnaphila umbellata
Wheeler bluegrass	Poa nervosa
white spirea	Spiraea betulifolia
whitebark pine	Pinus albicaulis
Wilcox's penstemon	Pensternon wilcoxii
wild strawberry	Fragaria spp.
willow	Salix spp.
woodrush	Luzula hitchcockii
Woods rose	Rosa woodsii
Yarrow	Achillea millefolium

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Crane, M. F.; Fischer, William C. Fire ecology of the forest habitat types of central Idaho. General Technical Report INT-218. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1986. 86 p.

Discusses fire as an ecological factor for forest habitat types occurring in central Idaho. Identifies "Fire Groups" of habitat types based on fire's role in forest succession. Considerations for fire management are suggested.

KEYWORDS: fire ecology, forest ecology, forest fire, fire management, habitat types