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# Fire Response of Shrubs of Dry Forest Habitat Types in Montana and Idaho

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PHOTOGRAPHED BY J. C. HARRIS  
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## RESEARCH SUMMARY

Information on biological attributes and response to fire has been summarized for 20 shrub species associated with dry forest habitat types of Idaho and Montana.

The effect of fire on shrubs is an important element in planning prescribed fire treatments designed to modify the shrub component of a stand. Information on individual species' biological attributes and response following fire has been synthesized from literature sources.

Foresters responsible for planning fire management and specifying burn objectives need such information to design prescribed fire treatments that alter the shrub component of a stand.

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# Fire Response of Shrubs of Dry Forest Habitat Types in Montana and Idaho

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## INTRODUCTION

This report summarizes shrub characteristics and fire response information for managers to use in writing fire prescriptions. The shrub component of a stand can be enhanced or depleted by prescribed fire if the manager understands the biology of the species. Knowing that ceanothus stores seed for long periods onsite and that heat treatment induces germination helps identify sites with potential for reestablishment. Ecotypes of antelope bitterbrush resprout differently after fire; some resprout while others do not. Vegetative resprouting of bearberry is rare after fire and its resistance is low to moderate, contrasted to willow or serviceberry, which are high because of their ability to resprout. Prescriptions that include seasonal timing and control of fire severity permit treatments to exploit the biology of the species with different response potential. The basic biology of important species is known to some degree. But such information is widely dispersed throughout the literature and therefore not easily accessible to managers. This paper serves to provide the manager with a ready source of published information on shrubs of dry habitat types.

Guides for writing fire prescriptions to alter vegetation require information on how plants respond to fire treatment. Rooting habit, regeneration capabilities, and phenology are plant attributes important to consider when using fire. Shrub response is of concern to managers where such plants are important browse for wildlife and cattle, provide thermal and hiding cover for wildlife, and may potentially compete with tree seedlings. Foresters developing and executing prescribed fire programs are often less familiar and less experienced with shrub species than they are with trees.

The species included in this report are shrubs associated with the drier forested habitats of western Montana and Idaho. Important shrub species from the *Pinus flexilis*, *Pinus ponderosa*, and *Pseudotsuga menziesii* habitat types (Pfister and others 1977; Steele and others 1981) were selected. These sites are referred to throughout the text, and are the basis for interpreting and integrating information from studies involving the selected species on both drier and more moist sites.

Various systems have been developed for classifying plants according to how they are adapted to survive fire. Plant species are classified herein by two systems that use somewhat contrasting approaches. The first approach, from Lyon and Stickney (1976), associates a fire survival strategy with a given type of response, that is, "increase"

or "decrease." The fire survival strategies are (1) surviving plant parts, (2) onsite seeds, and (3) offsite seeds. Surviving parts are root crowns, rhizomes, and underground stems. Onsite seed strategies are subdivided as long viability, short viability, and fortuitous (chance) survival. Offsite seed strategies are classified as airborne and other transport. This listing of fire adaptations is used to characterize the fire response of shrub species.

The second concept (Rowe 1983) is based on the source of meristematic plant tissue that perpetuates a species after fire. The following list presents the criteria for assigning a species to a survival strategy on the basis of meristematic tissues, establishment requirements, and long-term persistence. A two-letter code (for example, VI) indicates the regeneration methods of the shrub and a description term ("invader") indicates persistence mode. A summary of species attributes useful in predicting response to fire is provided for reference (table 1).

### I. Regeneration method

#### A. Mode of regeneration and reproduction

##### 1. Vegetative based (plant relies on surviving parts to regenerate)

- a. V species - able to resprout if burned in the juvenile stage.
- b. W species - able to resist fire in the adult stage and to continue extension growth after it (though fire may kill juveniles).

##### 2. Disseminule based (plant relies on seed to reestablish)

- a. D species - with highly dispersed seed
- b. S species - storing long-lived seed in the soil
- c. C species - storing seed in the canopy

##### 3. Competitive classification

- a. T species - tolerants that can establish immediately after a fire and can persist indefinitely thereafter without further disturbance.
- b. R species - tolerants that cannot establish immediately after disturbance, but must wait until some additional requirement has been met (for instance, shade).
- c. I species - intolerants that can only establish immediately after a fire. Rapid growth pioneers, they tend to die out without recurrent disturbances.

Table 1—Summary of shrub species attributes that determine response following fire treatment

Attributes	AMAL	ARUV	ARTR	BERE	CELE	CEVE	JUNIP	PAMY	PHMA	LIBO
I. Vegetative regeneration										
A. Resprouters										
1. Root crown	X					X		X		
2. Rhizome or underground		X(L) <sup>1</sup>		X					X	X(L)
3. Aboveground stem					X(L)					
B. Resists as adults					X(L)					
II. Seedling regeneration										
A. Onsite seed										
1. Airborne dispersal										
a. Short viability			X							
b. Long viability										
2. Animal/other dispersal										
a. Short viability	X	X(?)		X	X		X(?)	X(?)	X	X(?)
b. Long viability						X				
B. Offsite dispersal										
1. Airborne dispersal										
a. Short viability			X		X(H)					
b. Long viability										
2. Animal/other dispersal										
a. Short viability	X	X(?)		X			X(?)	X(?)	X	X(?)
b. Long viability										
III. Shade tolerance										
A. Tolerant		X	X	X	X		X	X		X
B. Intolerant	X						X		X	
IV. Persistence mode										
A. Invaders			X							
B. Evaders						X				
C. Avoiders					X(L)		X			X
D. Resisters					X(L)					
E. Endurers	X	X		X				X	X	

(con.)

Table 1 (Con.)

Attributes	PRVI	PUTR	RHTR	RIBES	ROSA	RUPA	SASC	SHCA	SPBE	VACCI
I. Vegetative regeneration										
A. Resprouters										
1. Root crown	X	X(1)	X	X(L)	X	X(L)	X			
2. Rhizome or underground								X	X	X
3. Aboveground stem										
B. Resists as adults										
II. Seedling regeneration										
A. Onsite seed										
1. Airborne dispersal										
a. Short viability										
b. Long viability										
2. Animal/other dispersal										
a. Short viability	X	X	X(?)	X(H)	X(?)	X(H)		X(?)	X(?)	X
b. Long viability										
B. Offsite dispersal										
1. Airborne dispersal										
a. Short viability							X			
b. Long viability										
2. Animal/other dispersal										
a. Short viability	X	X	X(?)	X(H)	X(?)	X(H)			X	X
b. Long viability										
III. Shade tolerance										
A. Tolerant			X		X	X			X	X
B. Intolerant	X	X		X			X	X		
IV. Persistence mode										
A. Invaders							X			
B. Evaders				X		X(H)				
C. Avoiders		X(2)								
D. Resisters										
E. Endurers	X	X(1)	X		X	X(L)		X	X	X

<sup>1</sup>(L) Low intensity fire; (H) high intensity fire; (1) sprouting ecotype; (2) nonsprouting ecotype; (?) no indication by literature, but the suspected response.



II. Persistence mode

- A. Seed based, reproducing primarily by diaspores
  - 1. Invaders - rapidly spreading plants that establish early, with short-lived seed (DI species).
  - 2. Evaders - species with relatively long-lived seeds that are stored in the soil or canopy (CI, SI, and ST species).
  - 3. Avoiders - shade-tolerant species that slowly reinvade burned areas; late successional, often with symbiotic relationships and vertical extensions.
- B. Remains because of adaptation to direct fire
  - 1. Resisters - shade-intolerant species whose adult stages can survive low-severity fires (WI species).
  - 2. Endurers - resprouting species, shade-intolerant or tolerant, with shallow or deep-buried perennating buds (VI or VT species).

The information available for each species was rated to identify strengths and weaknesses (table 2). The biological information was considered under the categories of re-establishment and physiology. The fire response was broken down into fire tolerance and treatment strategy. Treatment strategy means information obtained from studies where a fire treatment was applied to influence fire effects. A three-level availability rating was developed, with (1) meaning only general information not specific to fire, (2) some information related to fire response, and (3) considerable information useful in planning fire treatments. A rating of 3 does not necessarily mean that more study is not desirable.

The information for each species follows a format to describe the basic biology, fire response, and uses or values. Species are classified into broad life-form groups. The biology section discusses site, both sexual and vegetative reproduction, and seasonal periodic development. The fire response section discusses the species as an increaser or decreaser in relation to fire. A statement on the management implications concludes the description.

Table 2—Fire information status and research needs rating for shrub species

Information	AMAL	ARUV	ARTR	BERE	CELE	CEVE	JUNIP	LIBO	PAMY	PRMA
Biology										
Reestablishment	3	2	3	2	3	3	2	1	2	2
Physiology	2	2	3	2	1	1	2	1	1	2
Fire response										
Fire tolerance	3	2	3	2	3	3	3	2	1	3
Treatment strategy	2	1	3	2	2	3	3	2	1	2

Table 2 (Con.)

Information	PRVI	PUTR	RUTR	RIBES	ROSA	RUPA	SASC	SHCA	SPBE	SYMP	VASE
Biology											
Reestablishment	3	3	1	2	2	3	3	1	3	3	2
Physiology	2	2	1	2	1	2	1	2	1	2	2
Fire response											
Fire tolerance	3	3	1	2	2	3	3	1	3	3	2
Treatment strategy	2	3	2	2	3	3	3	1	2	2	2

<sup>1</sup> - only general information available; 2 - some information related to fire response; 3 - considerable information useful in planning fire treatment.

## GENERAL SHRUB RESPONSE

Management goals for manipulating shrubs might be to increase availability for wildlife browse or to reduce shrub abundance to favor trees. A strategy to rejuvenate decadent shrub populations would require scheduling the burn during or immediately after the peak of the seasonal trend in root carbohydrate reserves. Root carbohydrate reserves in shrubs are usually highest during dormancy, especially in species that flower in early spring. In general, spring and fall fires increase the shrub component, while the usually more severe summer fires restrict shrub development.

Shrubs most often are top-killed by fire; they may then resprout vigorously from root crowns or underground parts. Basal sprouting is usually stimulated if the shrub crown is completely killed, which is desirable for wildlife browse. Growth hormones from the partially killed shrub crown maintain some apical dominance in the live branches, which will inhibit growth of new basal sprouts. Complete kill of the aerial crown concentrates growth on lower sprouting plant parts. This is often desirable for the production of wildlife browse.

Although not yet well documented, age and vigor are indicators of shrub response to fire. Older, diseased plants in poor condition generally will respond less vigorously and likely die.

Other factors such as competition levels, fuel consumption, and browsing will also influence postburn shrub survival and response. All of these factors compound the difficulty of accurately predicting shrub responses, though some general statements can be made. Shrubs on moist microsites, or extending into moister habitat types, will have a greater chance of surviving and responding to a fire than similar shrub populations stressed on a dry, exposed site. Nevertheless, the potential survival and regrowth on moist locations may be reduced by any remaining live woody vegetation competing for nutrients, light, and water. Moist sites usually tend to have higher fuel loadings, which when burned might increase the mortality level. These same sites may also possess high duff moisture levels, which can result in less duff reduction by fire and in lower shrub mortality. Shrubs resprouting after a fire are usually subjected to increased browsing by wildlife and livestock. Added to the stress of resprouting and reduced carbohydrate levels, intense browsing can result in lower shrub vigor and increased mortality. Healthy resprouting shrub populations usually maintain adequate leaf material for resupplying the root system under "normal" browsing pressure (Armour and others 1984; Kauffman and Martin 1985).

Soil moisture, fireline intensity, and flame residence time have not been found to be significantly correlated with shrub mortality (Armour and others 1984; Clark and others 1982; Kauffman and Martin 1985). Managers frequently consider soil moisture at the time of burning a major concern in predicting postburn vegetation response. Thermal conductivity in soil increases with increasing levels of soil moisture (DeVries 1963). Snow (1980) suggested that the increased heat load transmitted through higher soil moisture levels would contribute to an increased mortality in oaks. But Frandsen and Ryan

(1986) have shown that reduced temperatures and heat loads can be expected with either increased duff, or increased duff and increased soil moisture levels under prolonged heating. Their data supported earlier recommendations to burn after rain had dampened both the duff and the soil if you wish to reduce the impact of prolonged heat on the mineral soil (Aufderheide and Morris 1949) and the biological systems established at that level.

The plant species attributes that influence establishment (vegetative and seedling regeneration) and persistence in a stand are summarized (table 1). The most common mode of vegetative propagation is resprouting from a root crown followed by resprouting from a rhizome. Reproduction from seed, from both onsite and offsite sources, often involves seed of short viability. Reproduction depends on seed transport by animals or means other than wind. Most of the shrubs are early seral components that are intolerant to shade. According to Rowe's classification, many species persist in the stand as endurers.

## SPECIES DESCRIPTIONS

### *Amelanchier alnifolia* Nutt.

**Biology**—Saskatoon serviceberry is an erect, deciduous shrub approximately 3 to 13 ft (1 to 4 m) tall (Blauer and others 1975). In Montana it is a common associate shrub species of all three habitat series, *Pinus flexilis*, *Pinus ponderosa*, and *Pseudotsuga menziesii* covered by this report (Pfister and others 1977), and a prominent shrub in most of the habitat types of the *Pinus ponderosa* and *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). Two growth forms have been reported in Montana (Lonner 1973), a dwarf form (less than 5 ft [1.5 m] tall) that grows from rhizomes, and a taller form whose stems were clumped. A geographical separation of these two forms was noted. The maximum age of sampled live populations of this species was 86 years.

Hemmer (1975) described three types of root systems of serviceberry: deep vertical taproots, lateral roots, and combination of the two types. Taprooted specimens were restricted entirely to talus slopes. Considerable portions of the root structure were found to reside in the mineral soil (Bradley 1984).

This species' response to burning is from a root crown, frequently producing multiple stems (Frischknecht and Plummer 1955; Klebenow and others 1976; Lyon and Stickney 1976; Mueggler 1965; Wright 1974). Most sprouts occur immediately below the fire-killed tissue (Bradley 1984).

Phenology of serviceberry indicates that leaf bud burst begins in early May and might extend until late May. Flowering will start in Montana at the end of May and sometimes continue through mid-June. Mature fruit can be found by the end of July or early September (Schmidt and Lotan 1980). Flowering and the presence of ripe fruit is slightly earlier in northern Idaho (Orme and Legee 1980).

Regeneration from seed appears to be minimal. Good berry crops occur at intervals of 3 to 5 years (Blauer and others 1975). Each berry contains from two (Holmgren 1954) to 10 (Hemmer 1975) small seeds, which average from 45,395 (Blauer and others 1975) to 82,000 cleaned seed per pound.



Dissemination is by animals that pass consumed seeds through their digestive tract. Grouse, some songbirds, and bears feed on the fruit (Hemmer 1975). Serviceberry is considered a key grizzly bear food (Madel 1982; Zager and Jonkel 1983). Large clumps of seedlings have been observed germinating from the same point on the ground where seed was cached by rodents. Planted seed has exhibited short viability (Holmgren 1954), and requires cold stratification (Brinkman 1974a; McLean 1967). The species' characteristics of fire resistance and life history place it in the onsite surviving parts "root crown" offsite seed, "other transport" categories.

**Fire Response**—Fire resistance of this shrub is excellent; it resprouts from surviving root crown tissue after being top-killed (Fischer and Clayton 1983; Frischknecht and Plummer 1955; Klebenow and others 1976; Lyon and Stickney 1976; Mueggler 1965; Wright 1974). Stem density increases the first year following fire (Gordon 1976; Merrill 1982). Merrill (1982) also found that the mean number of twigs, and the current annual growth on burned sites, exceeded nearby controls the first season. Aboveground biomass and mean heights exceeded the controls by the end of the second postburn season. The species classification adaptation to fire is classified as enduring (W).

**Use**—This is an important wildlife browse species and is considered fair to highly palatable (Blauer and others 1975). Serviceberry stems, especially new shoots, are heavily utilized by deer and elk (Crane and others 1983; Morris and others 1962). Big game browsing pressure may be sufficient in some regions to eliminate any potential increase in biomass after a fire (Arno and others 1985). The foliage is also consumed by livestock after more palatable grasses and forbs have been grazed (Blauer and others 1975; Morris and others 1962). The fruit is considered of high value as a key bear food (Mace and Bissell 1986; Zager 1980).

### *Arctostaphylos uva-ursi* (L.) Sprg.

**Biology**—Bearberry is a prostrate, mat-forming, evergreen shrub (Hitchcock and Cronquist 1973; Morris and others 1962). The shrub is common to all three habitat type series in western Montana (Pfister and others 1977), and of the *Pinus ponderosa* and *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). Constancy tends to increase in the moister habitat types within these series.

Bearberry has been reported to regenerate variously as a nonsprouter (Lutz 1956) or as a sprouter developing from runners (stolons) on or just below the soil surface (Berndt and Gibbons 1958). Sprouts can also be produced from undamaged root crowns (McLean 1969); however, this appears to be unusual. Rowe (1983) also reports strong sprouting from golfball-sized lignotubers in the mineral soil. Most roots are near the soil surface (Berndt and Gibbons 1958; Bradley 1984), with runners and fibrous roots extending laterally up to 3 ft (0.9 m) beyond the crown (McLean 1969).

In the Northern Rockies, bearberry flowering begins in late May and is finished by the end of June (Schmidt and Lotan 1980). The fruit contains four to 10 strong nutlets

(Hitchcock and Cronquist 1973), and ripens by the end of September (Schmidt and Lotan 1980). Seed is disseminated by gravity and transported by wildlife. As many as 58,000 nutlets are contained in 1 pound (USDA 1948). Germination of the seed has been reported to be as high as 50 percent after acid scarification and alternating warm/cold stratification (Berg 1974). On the basal end of each bearberry nutlet, there is a plugged channel which must be dissolved before the seedling can emerge. This plug has been dissolved experimentally by immersion in sulfuric acid. The hard outer shell (endocarp) of manzanita, a member of the same genus, has also been observed to crack after wildfires (Berg 1974). A similar process may aid germination of bearberry. Soil-stored seed has been reported to germinate after Alaskan wildfires (Lutz 1956), but this trait has not been reported elsewhere. Bearberry has been noted, though, as a successful reinvader of burned sites (Arno and others 1985). The species does not resprout, and seedling regeneration depends upon other transport of offsite seed.

**Fire Response**—Bearberry's fire resistance is low to moderate, the effects depending on fire intensity, duff moisture contents, soil conditions, and plant location (Fischer and Clayton 1983; McLean 1969; Volland and Dell 1981). The plant will be killed by light ground fire when the root crown is injured (McLean 1969). Vegetative reproduction is rare, especially after fires that remove the organic soil layer (Bradley 1984). Based on Rowe's classification, the shrub is an endurer of fires (VI).

**Use**—Bearberry is not browsed by livestock (Gullion 1964). Deer, elk, and grouse eat the mature fruits (Gullion 1964). The berry is considered an important food source for bears, particularly grizzly bears (Aune and Stivers 1985; Craighead and others 1982; Gullion 1964; Mace and Bissell 1986). The forage value is fair to good for deer and elk, and the plant is consumed as a winter browse (Gullion 1964; Morris and others 1962; Mueggler and Stewart 1980).

### *Artemisia tridentata* Nutt.

**Biology**—Big sagebrush is considered the most widespread and common shrub in Western North America (McArthur and others 1979). Several subspecies of big sagebrush are generally recognized (Beetle 1960; Beetle and Young 1965; Winward and Tisdale 1977). Mountain big sagebrush (*Artemisia tridentata vaseyana*) is the commonly occurring variety in this region and is the principal subspecies considered. It is a frequent associated species in the *Pinus flexilis* and *Pinus ponderosa* habitat type series in Idaho, but can also be found on the drier *Pseudotsuga menziesii* habitat types there (Steele and others 1981). In Montana, mountain big sagebrush is an associate of the *Pinus flexilis* habitat types, but occurs on only the driest portions of both of the other two series (*Pinus ponderosa* and *Pseudotsuga menziesii*) (Pfister and others 1977).

This is an aromatic, evergreen shrub with an erect growth form. Height varies from 1 to 5 ft (0.3 to 1.5 m), but usually averages approximately 3 ft (0.9 m). Mountain big sagebrush is a deep-rooted shrub that can extract large amounts of water from the soil (Sturges 1983).

Seedlings regenerate from a small, round achene (Hitchcock and Cronquist 1973). It may take more than 5,500 seeds to weigh a gram (Deitschman and others 1974a; Plummer and others 1968). Although seed production varies considerably, seed is usually so abundant that germination rates have little effect on establishment (Harniss and McDonough 1976). Seed is disseminated by wind and gravity.

In Idaho, mountain big sagebrush has been reported to start blooming as early as July; seed matures from September to October (Hanks and others 1973). This time period may vary with elevation and latitude. The survival classification (Lyon and Stickney 1976) would fit the following groupings: short viability of onsite seed and airborne offsite seed.

**Fire Response**—Mountain big sagebrush seed has been shown to germinate more readily following a light heat treatment (Chaplin and Winward 1982). Young plants can grow rapidly and reach reproductive maturity in 3 to 5 years. Big sagebrush is killed by fire; burned shrubs do not resprout (Wright and others 1979). Postburn regeneration is restricted to seedling establishment. Seed are neither highly dispersed nor long-lived in the soil. Seed retained in the low canopy are destroyed by fire. As a result the length of time for reestablishment can be dependent on many factors such as the distance downwind from parent plant seed sources, fire intensity on seed dropped to the ground, and the number of surviving adult plants. According to Rowe's system, sagebrush would be categorized as a DRT, an invading species.

**Use**—Sagebrush is considered an important food source and cover for upland game birds. Seed from the shrubs have been reported to form up to 62 percent of the annual diet of adult sage grouse in Montana (Wallestad and others 1975). Palatability of the shrub for big game and cattle varies widely. Of the three subspecies, mountain big sagebrush is considered the most palatable (Hanks and others 1973; Sheehy and Winward 1976). Powell (1970) reports that palatability is influenced by volatile oil content. These oils can kill rumen microorganisms, decrease the digestibility of forage, and increase plant toxicity. Robust growth forms tend to be avoided by grazing animals. This may be due to larger quantities of oils formed in rapidly growing plants (Cook and others 1954). Palatability is generally considered as very poor for cattle, poor for sheep, poor-good for deer, and poor-fair for elk (Mueggler and Stewart 1980). The shrub can be important winter browse for mule deer, but not necessarily bighorn sheep and elk (Kasworm and others 1984).

### ***Berberis repens* Lindl.**

**Biology**—Oregon grape is a low, evergreen shrub with compound leaves and spiny-tipped, hollylike leaflets (Hitchcock and Cronquist 1973; Morris and others 1962). In Montana this shrub may be found as an associate in all three series discussed in this report (Pfister and others 1977). In Idaho it is absent from the *Pinus flexilis* series (Steele and others 1981). In both areas it becomes greater in constancy in the moister habitat types. In both regions the shrub's constancy class can indicate a habitat type phase.

Vegetative growth is initiated from horizontally growing rhizomes (Bradley 1984; Fischer and Clayton 1983), which grow mostly 0.5 to 2 inches (1.5 to 5.0 cm) below the mineral soil (McLean 1969). Portions above the mineral soil are susceptible to fire damage (Bradley 1984). The shrub may or may not have a root crown close to the surface (McLean 1969).

The fruit is a glaucous, blue berry that may have from one to several seeds within (Hitchcock and Cronquist 1973). This berry is consumed by many forms of wildlife, including bears, which may aid in seed dispersal (Angell 1981). Good fruit crops are borne almost annually, and clean seed run 54,000 to 71,000 to the pound (Rudolf 1974). Seeds from this genus ordinarily do not germinate for 2 or more years after planting and require cold stratification to initiate germination (Free 1957). Seed of Oregon grape has maintained viability for 5 years in sealed containers stored in unheated sheds (Plummer and others 1968). Seedling establishment after fire has been reported (Bradley 1984), possibly originating from a short-term seedbank. The fire survival strategy for Oregon grape is through rhizomes (short viability of onsite seed) and other transport of offsite seed.

Phenological studies of Oregon grape in the Northern Rockies indicate that new leaves first develop from the end of April until late May. Flowering starts in early May and may extend to early August. Ripe fruit can be detected from late June until mid-September (Schmidt and Lotan 1980).

**Fire Response**—Fire resistance appears to vary from moderate to very susceptible (Fischer and Clayton 1983; McLean 1969; Volland and Dell 1981) and depends on fire intensity and degree of duff removal. Severe fires have also been reported as favoring Oregon grape (Wright 1972). In ponderosa pine forests in northern Idaho, Oregon grape was reported to be absent after high-intensity fires, but not harmed by low-intensity fires (Armour and others 1984). Substantial development in terms of increases in density and height have been noted in the second postfire growing season (Gordon 1976).

Under Rowe's (1983) system, Oregon grape would be classified as an endurer (VT).

**Use**—The shrub provides browse for sheep. Deer will browse it regularly in the fall and winter, even though it is mildly poisonous (Gullion 1964).

### ***Ceanothus velutinus* Dougl.**

**Biology**—In Montana, Morris and others (1962) associate evergreen ceanothus with the Douglas-fir and spruce fir zones. The greatest potential for establishing evergreen ceanothus is on south slopes, followed in order by west and east slopes (Noste 1985). In Montana, *Pseudotsuga menziesii* habitat types have more potential for ceanothus than *Abies grandis*, followed by *Abies lasiocarpa* and then *Thuja plicata* habitat types.

Evergreen ceanothus commonly grows in dense clumps or patches that are 2 to 6 ft (0.6 to 1.8 m) tall. Seeds (61,400 to 152,000/lb) (Reed 1974) are long-lived, remaining viable on forest sites for 200 to 300 years (Gratowski 1962), and they require a heat treatment to germinate





Figure 1—Ceanothus seedlings that germinated from stored seed activated by heat from the fire. No ceanothus was present before the burn.

(Dyrness 1973). The species resprouts from the root crown after being burned and is usually intolerant to shade.

Phenology of evergreen ceanothus in western Montana shows leaf bud burst beginning mid-April and extending into early June (Schmidt and Lotan 1980). Flowering starts after mid-May and continues until after mid-June. Fruit ripens from late-June to early August, and seed fall starts in early August.

Seed is disseminated by mechanical expulsion, gravity, and rodents, and the plant reproduces from onsite seeds. When reproduction is by seed, a large increase in an early successional stage can be expected.

**Fire Response**—The relationship between fire treatment and ceanothus response provides a basis for management (Noste 1985). Arno and others (1985) state that a medium or severe wildfire or broadcast burn on a Douglas-fir/ninebark habitat type with evergreen ceanothus seed in the soil will result in an evergreen ceanothus community. Stickney's (1980) data for larch/Douglas-fir forests of western Montana show 24 percent ceanothus cover in 6 years following a low-severity fire on a west slope, contrasted to 41 percent cover from a severe fire on a south slope. These values probably represent maximum potential for evergreen ceanothus establishment and growth.

Spring burning in seral shrubfields in the Douglas-fir/ninebark habitat type caused ceanothus to exceed its preburn coverage (11.5 percent to 12.7 percent) the first growing season, and nearly double (21.5 percent cover) during the third growing season (Noste 1985). A severe fall burn set evergreen ceanothus cover back to 0.2 percent the first year, but in the third year the cover was about half of the preburn coverage (18.5 and 10.4 percent). The severe fall burn killed 60 percent of the mature

plants, and provided seedbed conditions favorable for germination and establishment of ceanothus seedlings.

A burning treatment to exploit stress and increase the probability of mortality of ceanothus plants has been proposed (Martin 1982). The treatment combines preharvest underburn to weaken mature plants and germinate some seed, with a subsequent postharvest burn. Successive fires at relatively short intervals have been shown to retard shrub growth (Gratowski 1962; Isaac 1940).

Plants surviving from root crowns can be expected to decrease a minor amount following wildfire but regrow very quickly (fig. 1). Using Rowe's system, evergreen ceanothus uses the evader (SI) mode of persistence based on long-lived seeds stored in the soil.

**Use**—Evergreen ceanothus is of special interest to managers because it fixes nitrogen (Jurgensen and others 1979) and competes with tree seedlings (Gratowski and Lauterback 1974). It is an important wildlife browse species that provides a critical winter food resource for deer and elk (Klebenow 1962; Martinka 1976).

### *Cercocarpus ledifolius* Nutt.

**Biology**—Curleaf cercocarpus (curleaf mountain mahogany) is an erect shrub, or sometimes a small tree. It has the potential on some sites of obtaining heights to 23 feet (7 m). The plant has leathery, persistent leaves (Blauer and others 1975; Hitchcock and Cronquist 1973). It is not listed as being associated with the forest habitat type series being evaluated in Montana (Pfister and others 1977), but does occur in all three Idaho series with varying constancy. In the Idaho *Pseudotsuga menziesii* series it can be found in the drier habitat types; one habitat type is named after the species (Steele and others 1981).



The fruit is a plumose, hardened achene (Hitchcock and Cronquist 1973). The plume aids in wind dispersal of the seed over short distances during August and September (Deitschman and others 1974b). Gruell and others (1985) suggest that fire be excluded from these shrub communities if curleaf cercocarpus is the potential climax, and where stands are less than 50 years of age. They suggest that fire may be useful in stimulating communities of low vigor. Stands that are successional to conifers will depend on periodic fire to maintain the seral condition (Gruell and others 1986).

Fruit size varies considerably by ecotypes. Collections from Utah averaged 51,900 cleaned seed per pound. The seed can be stored dry for at least 5 years or longer. Most seed evidently is dormant and stratification is necessary (Deitschman and others 1974b). Germination was reported as high on mineral soil that was cleaned of litter and plant competition (Phillips 1970a). High seedling mortality, however, can be caused by summer drought and rodents.

For less severe fires, curleaf cercocarpus can be listed as reproducing by onsite surviving parts-stem sprouts, onsite seed-short viability, offsite seed-airborne. Fires that kill the canopy and consume the immediate seed source create dependence on an offsite seed source.

**Fire Response**—Curleaf cercocarpus has a relatively deep, well-developed root system. It is a weak sprouter (Wright and others 1979) and is prone to being damaged by fire. Mortality can be high after severe, high-intensity fires. The lower bark is thick, which aids in survival of low-intensity fires, with sprouts originating from adventitious buds on the stem (Gruell and others 1985). Rowe's life-form classification would categorize the plants as WTC resisters for low-intensity fires. Severe fires can change the status to DT avoiders.

The presence of curleaf cercocarpus has been related to fire protection by natural landscape features such as rock outcrops. Young stands have invaded deeper soil sites with the improvement of fire suppression techniques and the removal of fuels by livestock (Dealy 1975; Gruell 1983; Gruell and others 1985; Scheldt 1969).

**Use**—Forage from curleaf cercocarpus is highly palatable for both elk and mule deer (Mueggler and Stewart 1980; Smith 1952), and is considered a preferred browse (Kufeld and others 1973). It is rated as only fair for cattle and sheep (Mueggler and Stewart 1980). Stands of the shrub also provide cover for big game (Dealy 1971), but can become overutilized and deteriorate (South 1957). Stands with good seedling input, however, can tolerate the heavy use without experiencing excessive damage (Claar 1973).

## *Juniperus* L.

**Biology**—Common juniper (*Juniperus communis* L.) and creeping juniper (*Juniperus horizontalis* Moench) are decumbent to prostrate evergreen shrubs (Hitchcock and others 1969), with berrylike fruit borne on female plants. Leaves of the common juniper are needlelike and in threes, while those of creeping juniper are scalelike and in twos (Hitchcock and Cronquist 1973). Common juniper may be found as a frequent associate only in the drier

habitat types of the *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). In Montana, common juniper is of varying importance in all three series considered in this report (Pfister and others 1977). Creeping juniper is not listed as an associate in Idaho (Steele and others 1981), but is throughout the *Pinus flexilis* series and the *Pseudotsuga menziesii*/*Festuca idahoensis* habitat type in Montana (Pfister and others 1977). The two species will be discussed together because of the many similarities, with exceptions noted.

No inclination towards vegetative reproduction has been reported, though cuttings are a common technique for horticultural propagation of the genus (Free 1957). Reproduction is by seed produced in a small "berrylike" cone (Hitchcock and Cronquist 1973). Seed crop production is irregular (Johnsen and Alexander 1974). Fruit mature after growing 1 year on the shrub (Hitchcock and others 1969). The cones are eaten by gray fox, wood rats, pocket mice, robins, and Townsend's solitaires (Gullion 1964). Birds have been reported as important disseminators (Fischer and Clayton 1983; Johnsen and Alexander 1974). Warm temperatures, followed by cold stratification, are necessary to produce good germination (Johnsen and Alexander 1974). Fire survival strategy includes only other transport of offsite seed with accidental introduction after fire.

**Fire Response**—Both juniper species are susceptible to fire (Fischer and Clayton 1983). The species are reintroduced into a burned area after necessary onsite germination requirements are met. The shrubs classify as avoiders of fire, with highly dispersed propagules (DT species).

**Use**—Common juniper was rated as moderately valuable browse for deer; creeping juniper was rated good to excellent for mule deer (Morris and others 1962). But Mueggler and Stewart (1980) considered creeping juniper as very poor browse for cattle, sheep, and elk, and poor to fair for deer.

## *Linnaea borealis* L.

**Biology**—Twinflower is a creeping, evergreen, herblike shrub (Hitchcock and Cronquist 1973). In Idaho it is not recorded within the three habitat type series being investigated by this report (Steele and others 1981). Its presence is highly variable in the *Pseudotsuga menziesii* series in Montana. It ranges from no occurrence in some habitat types to 100 percent occurrence in the habitat designated by the species name (Pfister and others 1977).

The shrub has one-seeded, small, dry fruit (Hitchcock and Cronquist 1973). Nothing has been published on germination requirements and viability.

In terms of the survival strategies, twinflower is an off-site seed, other transport species. The root system is a shallow, fibrous network (McLean 1969). Growing points of roots are on or only slightly below the surface of the duff layer (Bradley 1984; Flinn and Wein 1977).

**Fire Response**—Lutz (1956) cites Sarvas' (1937) finding that twinflower is unable to resprout following fire. Archibold (1978) reported a single occurrence of sprouting. Rowe's classification would place the plant in the T, avoiders category.

**Use**—No evidence is available about twinflower's use by wildlife.

## *Pachistima myrsinites* Pursh

**Biology**—Myrtle pachistima is a low, evergreen shrub approximately 8 to 24 in (0.2 to 0.6 cm) in height (Hitchcock and Cronquist 1973). It can be found as an associate in the more moist habitat types of the *Pseudotsuga menziesii* series in Montana (Pfister and others 1977). The shrub is not listed for the three Idaho series (Steele and others 1981).

There is no evidence that the seed produced by the one- to two-seeded fruit capsules is stored in the soil. Nor does there appear to be evidence to suggest any mode of seed dispersal other than by gravity.

Phenology of the shrub indicates that leaf bud burst will occur between early April and early June. Flowering may start between mid-April and early July. Ripening fruit can be discovered from mid-July until early September (Schmidt and Lotan 1980).

Based on the available literature, this shrub can be categorized as an onsite surviving root crown fire response.

**Fire Response**—A taproot is the principal storage organ of this plant (McLean 1969). Regeneration following fire is by sprouts produced from the root crown. Rowe's classification would establish the shrub as a VT endurer.

**Use**—Grazing value is fair to good for big game (Morris and others 1962).

## *Physocarpus malvaceus* (Greene) Kuntze

**Biology**—Ninebark is a deciduous, erect-to-spreading shrub that can vary 1.5 to 6.6 ft (0.5 to 2 m) in height. In Idaho ninebark occurs with varying levels of constancy in the *Pinus ponderosa* and *Pseudotsuga menziesii* habitat type series (Steele and others 1981). In Montana it can be found in the *Pinus flexilis* series (Pfister and others 1977). In regional habitat type classifications the shrub obtains enough importance in the *Pseudotsuga menziesii* series to be designated a specific habitat type.

The fruit produced by ninebark is a several-seeded follicle (Hitchcock and Cronquist 1973), with the seed distributed primarily by gravity. Some movement by wildlife is also likely, but is undocumented. Germination capacity of the seed is low, even after the necessary stratification (Gill and Pogge 1974a).

Phenology for the shrub indicates that leaf bud burst may begin as early as mid-April in Idaho (Orme and Leege 1980), or early May in Montana (Schmidt and Lotan 1980). Flower production begins in late May in Idaho, early June in Montana. Fruit ripens in early August to late September (Schmidt and Lotan 1980).

Following fire, ninebark regenerates from root crown/rhizomes.

**Fire Response**—The shrub sprouts vigorously following a fire (Wright and Bailey, unpublished paper). Sprouts originate from horizontal rhizomes, of which a high proportion are situated in mineral soil. The greater the proportion buried in the mineral soil, the better the poten-

tial for shrub survival and sprout production following a fire (Bradley 1984).

Merrill (1982) found ninebark more abundant on burned sites than on unburned locations. He also found that twig densities increased through the third postfire growing season. Heights on burned and unburned sites were equal by the fourth season, while aboveground biomass at this time was only 64 percent of the untreated areas. Owens (1982) found that the current annual twig production for ninebark increased with a proportional removal by fire of the shrubs canopy.

Rowe's classification would place the shrub as a VI, enduring species.

**Use**—Wildlife use of the shrub is usually minimal because more palatable shrubs are commonly associated with it. But for at least 3 years following a fire sprouts of ninebark plants are frequently browsed by deer. Importance of ninebark increases on drier sites, and its importance as an available browse is also likely to increase.

## *Prunus virginiana* L.

**Biology**—Black common chokecherry is an erect shrub up to 32.7 ft (10 m) tall, with deciduous leaves (Booth and Wright 1966; Hitchcock and Cronquist 1973). In Montana chokecherry may be found as a frequent associate in all three habitat type series evaluated in this report (Pfister and others 1977). In Idaho, chokecherry is not found in the *Pinus flexilis* series (Steele and others 1981), but is present in the others.

The primary means of vegetative reproduction is sprouting from a root crown or occasionally from rhizomes (Chadwick and Dalke 1965). Chokecherry is a prolific sprouter (Chadwick and Dalke 1965; Frischknecht and Plummer 1955), with new sprouts susceptible to grazing injury by deer and cattle (Frischknecht and Plummer 1955; Gullion 1964). Chokecherry is typically clumped because of its sprouting capabilities, frequently exceeding 3 ft (0.9 m) in diameter, and may dominate the site (Chadwick and Dalke 1965).

Seed reproduction is accomplished via a 1-seeded drupe (cherry or berrylike) (Hitchcock and Cronquist 1973), with 3,010 to 8,400 cleaned seed per pound (Grisez 1974). The heavy seeds are disseminated by wildlife and gravity. Gallinaceous and passerine birds feed heavily on the ripe fruit (Gullion 1964; Morris and others 1962; Shaw 1974). Mule deer readily consume the cherries when ripe, their stomachs occasionally containing a quart or more and little else (Gullion 1964). Aune and Stivers (1985) indicated that the fruit is an important grizzly bear food on the eastern frontal range of the Northern Rocky Mountains. Deposited seed may germinate the first spring or remain dormant for two or more winters before germinating (Holmgren 1954). Characteristics of the shrub place it in the root crown—short viability of onsite seed—other transport of offsite seed fire survival strategy.

Phenology indicates that this wide-ranging species goes into dormancy between early September and late November, with bud burst occurring in early April through late May (Schmidt and Lotan 1980). Flowering (anthesis) occurs during late May to early June, with fruit ripening in late June to early July (Schmidt and Lotan 1980).





Figure 2—*Prunus virginiana* and other species of shrubs that regenerated vegetatively during two growing seasons following fire.

**Fire Response**—Chokecherry resprouts if top-killed (Chadwick and Dalke 1965; Fischer and Clayton 1983; Frischnecht and Plummer 1955) or from singed stems (Volland and Dell 1981), making the species resistant to eradication by fire. Cover value is reduced sharply the first year following fire, with some increase the second year (Gordon 1976). Chokecherry is an enduring (VI) species (fig. 2).

**Use**—Chokecherry is susceptible to grazing pressure, and may be potentially toxic if consumed in large amounts. Palatability is considered poor to fair for cattle and sheep, but good for deer and elk (Mueggler and Stewart 1980). The fruit is of medium value as a fall bear food (Mace and Bissell 1986).

### *Purshia tridentata* (Pursh) D.C.

**Biology**—Antelope bitterbrush is an intricately branched, long-lived, deciduous shrub with numerous ecotypes. This shrub is an associate throughout all three habitat type series in Montana (Pfister and others 1977) that are considered in this report. It is absent in the *Pinus flexilis* series in Idaho, but present in the other two series (Steele and others 1981).

The different ecotypes can vary in stature from prostrate to erect growth forms (Blauer and others 1975; Giunta and others 1978). The arborescent forms may attain heights up to 12 ft (3.6 m) but average 3 to 6 ft (0.9 to 1.8 m) (Hitchcock and Cronquist 1973). The shrubs develop a meandering, fibrous root system reaching depths of 15 to 19 ft (4.0 to 5.8 m) (Giunta and others 1978; McConnell 1961). This root system is host to symbiotic nitrogen-fixing species of mycorrhiza (Jurgensen and others 1979; Monsen and Christensen 1976).

The creeping or decumbent ecotypes reproduce vegetatively by layering (Blauer and others 1975; Giunta and others 1978). Soil moisture and plant size appear to be key factors associated with stem layering (Nord 1963). Sprouting from a root crown after top removal is a highly variable response. Ecotype variation in shrub height also appears to affect the shrub's ability to resprout. Prostrate forms of bitterbrush sprout more readily than taller growth forms (Driscoll 1963). Degree of plant injury (Blaisdell 1950; Driscoll 1963; Nord 1965), and environmental factors (Driscoll 1963), are other important factors in determining response.

Sprouting occurs from dormant adventitious buds or from a callus of meristematic tissue at or slightly below ground level (Blaisdell and Mueggler 1956; Driscoll 1963). The degree of sprouting is related to the amount of remaining undamaged tissue capable of producing sprouts and has frequently been related to fire severity. The percentage of sprouting plants appears inversely related to fire severity (Blaisdell 1950; Blaisdell 1953; Driscoll 1964; Nord 1959; Phillips 1970b) and the resultant tissue damage in the root crown. Environmental factors such as aspect, texture of the surface soil, and stoniness which might aid a thermal impulse being transferred into the soil and causing tissue damage would be detrimental to sprouting (Driscoll 1963). Soil moisture has been implicated as a factor affecting resprouting (Nord 1965). Bitterbrush rarely sprouts from the point of layering (Driscoll 1963) or lateral roots (Giunta and others 1978) after fire.

Seedling regeneration is accomplished by a one-seeded fruit (achene) (Hitchcock and Cronquist 1973; Giunta and others 1978). The seed is medium sized, with approximately 15,400 cleaned seed per pound (Blauer and others 1975).



Good seed crops appear to be common and can be predicted (Nord 1963, 1965). The fruit drops shortly after reaching maturity (Holmgren 1954; Holmgren and Basile 1959; Hubbard 1965; Nord 1965). The seed is disseminated by gravity, rodents, and birds (Nord 1965). Germination success (Nord 1965) is aided by high soil moisture (Nord 1965), stratification (Holmgren and Basile 1959; Monsen and Christensen 1976; Pearson 1957), soil disturbance (Edgerton and others 1975), and a litter-free site (Christensen and others 1974). As much as 85 percent of bitterbrush seed can be dormant, and stratification is usually necessary. Seed stored for 3 years (Deitschman and others 1974c) has proved viable.

Under natural conditions germination occurs in the winter, with emergence any time from February until late April (Ferguson 1972). Conditions for good regeneration from seed vary regionally, from excellent every 2 to 3 years (Edgerton and others 1975) to rare (Martin and Dell 1978). Competition for moisture with native vegetation causes high seedling mortality the first year (Hubbard 1956; Holmgren 1956; Sanderson 1962).

Rodents cache large quantities of the seed after it falls (Christensen and others 1974; Hubbard 1965; Sherman and Chilcote 1972; West 1968; Wright 1978). Cached seed not consumed has a good chance of germinating. A hot fire in the fall after the seeds have been cached aids germination by eliminating competing vegetation (Biswell 1973; Holmgren and Basile 1959). Bitterbrush seedlings account for much of the regeneration on severe burns (Blaisdell 1950). Seeds remaining above ground would be either destroyed (Biswell 1973) or if heated above 65 °C (176 °F) have reduced viability (Ferguson 1972).

Bitterbrush flowers for 1 to 2 weeks in early spring (Giunta and others 1978). Latitude and elevation are important factors influencing the period between flowering and seed maturity (Blauer and others 1975; Nord 1965). More northerly and higher elevation ecotypes have a later phenology than southerly or low elevation populations or ecotypes. Usually 50 to 75 days elapse between flowering and seed dispersal, but this period is often shorter in northern ecotypes (Giunta and others 1978). Some fruit may ripen in late June (Ferguson 1972), but most ripen from July until September (Blauer and others 1975; Deitschman and others 1974; Ferguson 1972; Hubbard 1965). Ecotypes that resprout are classified as root crown—short viability of onsite seed—other transport of offsite seed fire survival strategy (Lyon and Stiekney 1976). Ecotypes unable to resprout are in the short viability classification or in the onsite seed—other transport of offsite seed classification.

**Fire Response**—Fire resistance of bitterbrush varies by ecotype. Mortality or damage may range from very susceptible to moderately resistant. Plants without resprouting capability must regenerate from animal-dispersed seed. Regaining preburn status is a slow process and depends on soil moisture and competing vegetation.

Burned plants regenerate most often from dormant buds (Blaisdell and Mueggler 1956). Bitterbrush that resprouts grows rapidly (Blaisdell 1953), but still may take 9 to 15 years to reach preburn conditions (Pechanec and others 1954; Wright 1972). Slow recovery may be due in part to heavy use for browse by numerous species of wildlife and

domestic cattle (Gullion 1964). Grazing by livestock has been suggested as a technique for reducing competition to bitterbrush (Phillips 1970b). In general, prostrate ecotypes with the capability to layer show a greater tolerance to fire than erect growth forms (Blauer and others 1975).

The ecotype that resprouts is an endurer (VI) group plant, while the ecotype unable to resprout is a member of the avoider group. This shrub ecotype or form of the species provides an interesting contrast; it is essentially not a fire-resistant species, but is fire-dependent for survival (Sherman and Chilcote 1972).

**Use**—Bitterbrush is considered excellent browse for cattle and sheep. It is recognized as critically important deer browse year around and is heavily utilized by pronghorn antelope during the growing season. Bighorn sheep consume trace amounts, mostly in the spring (Gullion 1964). Elk also browse the plant heavily (Mueggler and Stewart 1980).

### *Rhus trilobata* Nutt.

**Biology**—Skunkbush sumac is a low, erect shrub up to 6 ft (1.8 m) (Hitchcock and Cronquist 1973). This species is not a prominent member of any specific habitat type series in either western Montana (Pfister and others 1977) or northern Idaho (Steele and others 1981). In Montana it has been observed in the *Pinus ponderosa* series and the drier portions of the *Pseudotsuga menziesii* series. It is listed here because of its occasional importance in these dry habitat types as a wildlife food source.

Skunkbush has the ability to resprout after being top-killed (Dwyer and Pieper 1967) but evidently shows no inclination to reproduce vegetatively in the absence of severe disturbance. The fruit is a reddish-orange, one-seeded drupe (Hitchcock and Cronquist 1973). There are 7,000 to 9,000 fruit per pound and an average of 20,300 cleaned seed per pound (USDA 1948). Germination and seedling establishment are rare in established skunkbush stands in Montana (Martin 1972). Skunkbush seed germinates poorly without pretreatment by scarification, acid, or hot water soaking. These techniques have been found necessary to crack or soften the hard seed coat. No literature is available on the time length of seed viability (Brinkman 1974b). The embryo inside is also dormant and requires a cold stratification. Several species of birds (Gullion 1964) and animals (Brinkman 1974b) eat the fruit and may disseminate the seed. Life history is too poorly understood to reveal a fire survival strategy.

**Fire Response**—The species has moderate fire resistance. Frequent or intense fires will restrict the species to protected sites or to areas of light fuel loadings, even though vigorous sprouting occurs after fire, presumably from a root crown (Dwyer and Pieper 1967). The absence of fire has allowed seedling establishment on favorable microsites. Comparison of early historical photographs with current site vegetation mosaics has shown an increase of skunkbush in the absence of fire (Gruell 1983). Based on Rowe's classification, the shrub is probably a VT species, and is a fire endurer.

**Use**—Skunkbush is rated fair to good (Gullion 1964) to very poor (Mueggler and Stewart 1980) as browse for

sheep and cattle. Bighorn sheep have been observed utilizing only trace amounts in the fall (Gullion 1964). Skunk-bush is rated fair to good as deer browse; palatability is only fair to poor for elk (Mueggler and Stewart 1980).

## **Ribes L.**

**Biology**—Four principal species of current or gooseberry occur in the three habitat type series being evaluated: squaw currant (*Ribes cereum* Dougl.); swamp gooseberry (*Ribes lacustre* [Pers.] Poir.); mountain gooseberry (*Ribes montigenum* McClatchie); and sticky currant (*Ribes viscosissimum* Pursh). All four species can be found in the dry forest habitat series of Idaho (Steele and others 1981). *Ribes lacustre* and *Ribes montigenum* have low constancy values in the *Pinus flexilis* and *Pseudotsuga menziesii* series in Montana (Pfister and others 1977). These individual species will be treated as a group in this text because of their similar growth form and habit. Differences will be noted where they occur.

These shrubs are deciduous, may be armed (gooseberries) or unarmed (currants) depending on species, and are generally low in stature. Their fruit is a many-seeded berry (Hitchcock and Cronquist 1973). Stored in sealed containers, seed can remain viable for long periods (Pfister 1974). Dormant seed of this genus is frequently found in seed stored in the forest soil and duff (Quick 1954). Seedlings are frequently present in the immediate postburn vegetation (Morgan and Neuenschwander in press; Quick 1962). Seed germinates in the spring; mineral soil provides the best seedbed (Pfister 1974). Seed is dispersed by gravity or by wildlife (Volland and Dell 1981). Species in this group will resprout from surviving root crowns following light surface fires, or will regenerate from onsite seed of long viability following fires that remove the organic soil.

**Fire Response**—The root system is a shallow series of roots radiating from a central root crown. New plants may occasionally sprout from the root system, but this is not common. A fire that removes the organic soil layer will likely kill most root systems. Fires that only top-kill the shrub will allow sprouting to occur from the root crown or from the base of the stems (Volland and Dell 1981).

Under Rowe's system, *Ribes* would be classified as a VI species after a light surface fire or SI after a fire that removes the organic soil. The shrub is an invader species.

**Use**—Grazing value is low for livestock or game (Morris and others 1962). *Ribes* fruit is considered of low food value for bears (Mace and Bissell 1986).

## **Rosa L.**

**Biology**—Roses are armed, deciduous, medium-sized shrubs of which there are several taxonomically similar species. The more common taxa include: Arkansas rose (*Rosa arkansana* Porter), baldhip rose (*Rosa gymnocarpa* Nutt.), nootka rose (*Rosa nutkana* Presl.), and Wood's rose (*Rosa woodsii* Lindl.). They are occasional associates in the various habitat types in the *Pinus ponderosa* and *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). None received mention in the similar classification system in Montana (Pfister and others 1977).

They all have similar abilities to resprout from undamaged or buried root crowns (Mueggler 1965), with some ecotypes spreading by root sprouts (Blauer and others 1975). Seed production probably starts in plants that are 2 to 4 years old (Gill and Pogge 1974b). Seeds are produced in hips, which may or may not persist (Morris and others 1962). Each hip contains 15 to 30 achenes; clean seeds average approximately 45,300 per pound (Blauer and others 1975). Rose seed is primarily disseminated by birds and mammals. Passage through the digestive tract may be necessary for germination (Gill and Pogge 1974b; Morris and others 1962; Shaw 1974). Mice, coyotes, and numerous species of birds feed on rose hips. Porcupines, beaver, pronghorn, mule deer, and elk are attracted by the leafy browse (Gullion 1964). Seed dormancy is broken by a warm period followed by cold stratification (Gill and Pogge 1974b). *Rosa gymnocarpa* seed has been reported in the seedbank of northern Idaho forest soil samples. But *Rosa* seedlings did not appear when duff was burned on these sites (Morgan and Neuenschwander in press).

Flowering is from late May until early September (Budd and Campbell 1950), with fruit production in July to mid-August (Gill and Pogge 1974b). The fire survival strategy is root crown—short viability of onsite seed—other transport of offsite seed.

**Fire Response**—Wild roses are moderately resistant to fire. Although roses can resprout following fire (Mueggler 1965), the shallow root crown is susceptible to injury. Repeated annual spring burns may greatly reduce both cover and frequency (Bailey 1978). Two years following a single fire, cover and volume may increase (Gordon 1976). Merrill (1982) found that for baldhip rose, mean number of stems and twigs and the current annual growth on burned sites exceeded that on nearby control sites the first post-burn year. Stem height on the burns exceeded height on the controls by the second year. Aboveground biomass on the burns exceeded that on the controls by the third season.

The fire survival strategy is classified as a tolerant sprouting (VT) endurer.

**Use**—The grazing value of rose is poor to fair for cattle and good for sheep. The shrubs are used lightly by deer, elk, and pronghorn antelope (Gullion 1964; Morris and others 1962). *Rosa arkansana* is rated fair-good for both deer and elk (Mueggler and Stewart 1980). Forms having few or no prickles will receive the heaviest grazing pressure (Blauer and others 1975). Rose hips are eaten by bears but are considered of low food value (Mace and Bissell 1986).

## **Rubus parviflorus Nutt.**

**Biology**—Thimbleberry is an erect, unarmed shrub that has for a fruit an aggregation of small drupelets (berry-like) (Hitchcock and Cronquist 1973). This shrub can be in the *Acer glabrum* and *Physocarpus malvaceus* habitat types of the *Pseudotsuga menziesii* series in Idaho (Steele and others 1981). In Montana thimbleberry can be found in many of the moist habitat types of the *Pseudotsuga menziesii* series, but seldom obtains a high constancy or percent canopy coverage (Pfister and others 1977).



Seeds of the genus have commonly been identified in seedbanks (Graber and Thompson 1978; Moore and Wien 1977; Omstead and Curtis 1947; Oosting and Humphreys 1940). Thimbleberry seed has been identified in forest soil and duff samples by Kellman (1970) and Morgan and Neuenschwander (in press). On sites that had been burned to remove forest slash, thimbleberry mainly reestablishes from seedlings (Morgan and Neuenschwander in press). The germination requirements of thimbleberry have not been examined. But in general, raspberries require warm and cold stratification (Brinkman 1974c). Seed germination is enhanced by a sulfuric acid bath (Heit 1967). But under natural conditions, the seed is slow to germinate because of a hard outer coat (endocarp) and a dormant embryo (Brinkman 1974c). Fruit is dispersed by gravity and possibly by wildlife (Morgan and Neuenschwander in press). In terms of fire survival, this shrub is reestablished from surviving root crowns and rhizomes, and onsite seed of long viability (Lyon and Stickney 1976). Both categories indicate a large potential contribution to postfire vegetation.

**Fire Response**—Thimbleberry has a root system composed of rhizomes. These can sprout and form large clones. Lyon and Stickney (1976) considered surviving rhizomes the principal mode of reestablishment after a fire. No information is available on rooting depth. If the roots are predominantly in the organic soil layer, they could survive a low-intensity surface fire. More intense fires that remove the duff and soil organic matter would destroy the established root systems, but prepare a seedbed for seed banked in the soil. High-intensity fires in northern Idaho brushfields were found to benefit thimbleberry (Hooker and Tisdale 1974), though no mention is made of the observed mode of regeneration.

Rowe's classification would describe the shrub as a VT, or an ST, evading species.

**Use**—Grazing value is low for livestock and big game; fruit is valuable for forest wildlife (Morris and others 1962).

## *Salix scouleriana* Barratt

**Biology**—Scouler willow, an important member of the upland site group, belongs to a genus that is difficult to identify to species level. Scouler willow is a robust shrub 6 to 35 ft (1.8 to 10.7 m) tall (Hitchcock and Cronquist 1973) that occurs on dry slopes within the *Pseudotsuga* habitat types in Montana (Pfister and others 1977) and into the more moist *Pinus ponderosa* habitat types in Idaho (Steele and others 1981).

Willow seeds are very small (6,500 per pound), are disseminated by wind or water (Brinkman 1974d), and are characterized by very short seed life and rapid germination (Zasada and Vierick 1975). Scouler willow resprouts from a root crown following fire, and from airborne seed established on severely burned postfire sites such as the Sleeping Child, Neal Canyon, and Sundance Fires (Lyon and Stickney 1976). Scouler willow fits in two fire survival groups: (1) surviving parts (root crowns), and (2) offsite, airborne, short-viability seeds.

**Fire Response**—In the West Boulder drainage of Montana, willow canopy of 35 ft<sup>2</sup>/acre increased more than

tenfold the first year following fire, and more than thirtyfold the second year. This response was in a moist-cool aspen-conifer stand, but shows the potential for willow species to respond to fire treatment. In Idaho, also on a wet site, browse availability below 7 ft (2.1 m) was increased from 5 percent to 100 percent by killing the 25-ft (7.6-m) crown and stimulating resprouting (Leege 1968). *Salix scouleriana* crown cover was 10 times greater under little overstory tree canopy than where tree canopy exceeded 55 percent ground cover, so is intolerant of shade (Mueggler 1965). Also on a wet site, Scouler willow percent frequency and cover increased on logged-piled-burned, single-broadcast-burn, and multiple-broadcast-burn treatments (Mueggler 1965).

In Douglas-fir communities, *Salix scouleriana* is greatly enhanced by fire (Wright 1972). Scouler willow is abundant after burning (Leege 1969; Mueggler 1965). *Salix scouleriana* increases in density following fire because root crowns or single plants produce multiple sprouts (Lyon 1966). According to Rowe's system, Scouler willow is an invader (DI) species. The vegetative resprouting response from a root crown suggests that the endurer classification also applies to willow.

**Use**—Willow generally has very high value for wildlife. Upland sites are heavily used by deer and elk, while streambottom willow is important browse for moose. Upland game birds, especially grouse, feed on willow buds (Morris and others 1962). It is also grazed by sheep and cattle.

## *Shepherdia canadensis* (L.) Nutt.

**Biology**—Russet buffaloberry (Canadian buffaloberry) is an erect, 3- to 12-ft (0.9- to 3.6-m) tall, deciduous-understory shrub (Hitchcock and Cronquist 1973; Morris and others 1962). It is an occasional associate in all three habitat type series considered by this report from both Idaho (Steele and others 1981) and Montana (Pfister and others 1977). Buffaloberry sprouts from surviving root crowns and from dormant buds located on the taproot (Fischer and Clayton 1983). Buffaloberry is a symbiotic nitrogen-fixing shrub.

Seed production begins at 4 to 6 years of age, with the possibility of good seed crops every year (Thilenius and others 1974). The small, hard seed shows poor, highly erratic, or delayed germination. Rowe (1983) refers to the species germination response as seed-banking. Cold stratification for a minimum of 60 days appears to be a requirement for embryo development (McLean 1967; Thilenius and others 1974). The fruit is eaten by birds (Gullion 1964; Morris and others 1962) and grizzly bears (Aune and Stivers 1985; Craighead and others 1982; Madel 1982), with dissemination likely by these animals and by gravity.

Leaf buds break dormancy from early April through late June, but usually start by mid-May (Schmidt and Lotan 1980; Thilenius and others 1974). Buffaloberry leaves will normally be retained until early or mid-October, but may drop as early as late August (Schmidt and Lotan 1980). Fire survival strategy may be classified as root crown—short viability of onsite seed—other transport of offsite seed.

**Fire Response**—This shrub is normally resistant to fire (McLean 1969), but can be eliminated by the treatment (Stickney 1980). As a result it is labeled as moderately resistant to burning (Fischer and Clayton 1983). This species persists in a stand as an enduring species (VT) (Rowe 1983).

**Use**—Buffaloberry rates very poor as a food source for domestic grazers. It is considered to be good browse for both deer and elk year around (Gullion 1964). The fruit is of high value to bears (Mace and Bissell 1986; Zager 1980).

### *Spiraea betulifolia* (Pall.)

**Biology**—White spiraea is a low, 1- to 3-ft (0.3- to 0.9-m) (Shaw 1974), erect, clonal, deciduous shrub (Morris and others 1962). This shrub is found in all three forest habitat type series of Montana (Pfister and others 1977) that were evaluated by this study. In Idaho it can be found in the *Pinus ponderosa* and *Pseudotsuga menziesii* series (Steele and others 1981).

This species has the capability to resprout from horizontal rhizomes (Bradley 1984; Fischer and Clayton 1983; Lyon and Stickney 1976; Tiedemann and Klock 1976). New sprouts originate immediately behind the fire-killed tissue (Bradley 1984). Most fibrous roots and rhizomes are located below the mineral soil surface. Roots from below the mineral soil surface are able to produce sprouts (Bradley 1984; McLean 1969) (fig. 3).

Small spiraea seeds borne in a follicle (Stickney 1974) germinate at low temperatures (McLean 1967). The literature revealed nothing on modes of dissemination. White spiraea seed has been recovered from forest soil and duff samples in northern Idaho. Seedlings were not a postfire response; therefore it was speculated seed was of

low viability (Morgan and Neuenschwander in press). The fire survival strategy is root crown/rhizome—onsite seed of short viability.

Spiraea is normally in bud burst in early May, but on occasion may be as early as mid-April (Schmidt and Lotan 1980). Flowering has been observed from late May until the end of August, but usually is complete by the end of July. Depending on the time of flowering, the fruit may ripen from late June to early September. Leaves are shed from early September, or early October.

**Fire Response**—Spiraea is highly resistant to removal by a fire treatment (Fischer and Clayton 1983). The potential to sprout in profusion after fire has been observed, particularly on west aspects (Tiedemann and Klock 1976). In the Selway-Bitterroot Wilderness, ID, Merrill (1982) found that white spiraea on burned sites had greater mean number of stems, aboveground biomass, current annual growth, and mean heights than unburned controls the first postburn season. These values stayed consistently higher for the 4-year length of his study. Normally, the species is slow to recover on drier sites, with only a few initial sprouts. This could be considered a moderate fire response (Volland and Dell 1981). This species resists fire in a stand as an enduring (VI) species.

**Use**—Browse value of spiraea is low for livestock, and low rating probably is true for wildlife utilization as well (Morris and others 1962).

### *Symphoricarpos albus* (L.) Blake; *Symphoricarpos oreophilus* Gray

**Biology**—Two species of snowberry occur in this region: *Symphoricarpos albus* (L.) Blake (common snowberry) and *Symphoricarpos oreophilus* Gray (western snowberry). Both species are similar in lifeform and response to fire



Figure 3—*Spiraea betulifolia* resprouting from a rhizome below the soil surface.



and are combined here for the ease of discussion. Little research has been done with *Symphoricarpos oreophilus*. Most of the text in this section, unless specified as *Symphoricarpos oreophilus*, is from studies on *Symphoricarpos albus*. Snowberry is a low, usually 3- to 6-ft (0.9- to 1.8-m), erect, deciduous shrub (Hitchcock and Cronquist 1973; Morris and others 1962). *Symphoricarpos albus*, however, does not occur in the Idaho *Pinus flexilis* series and is of low constancy in the *Pinus ponderosa* series. In the series dominated by *Pseudotsuga menziesii*, it is of scattered and variable importance (Steele and others 1981). *Symphoricarpos oreophilus* is not a common species in Montana and fails to appear on the habitat type constancy listing for that State. The other species does occur, with highly variable constancy in all three series (Pfister and others 1977).

Common snowberry is clonal, spreading by horizontal rhizomes (Bradley 1984; Lyon and Stickney 1976; McLean 1969; Pelton 1953). The rhizomes are most commonly found 2 to 5 inches (5 to 13 cm) below the mineral soil surface (McLean 1969). Bradley (1984) found averages of 59 percent and 81 percent of the rhizomes below the mineral soil surface on two sites in western Montana. A single aboveground stem may emerge from a rhizome that has grown some distance from the original root mass (Bradley 1984). These aerial stems and their associated rhizome may become independent of the parent system after the first growing season (Pelton 1953).

Sexual reproduction of common snowberry is by two seedlike nutlets per drupe (Hitchcock and Cronquist 1973; Pelton 1953). Seed crop frequency is normally good (Evans 1974). Fruit production increases with increasing stem diameter and to a minor degree stem age. The nutlets are capable of remaining dormant on the shrubs for up to 4 years, though normally the fruit will drop by the second spring or summer (Pelton 1953). Approximately half of the mature nutlets are defective (Pelton 1953), with 54,000 to 113,000 cleaned nutlets per pound (Evans 1974).

Dissemination of the common snowberry nutlets is by rodents, birds and mammals (Evans 1974; Pelton 1953), with many wildlife species utilizing the shrub as a food source (Gullion 1964). Dry fruits float and may be transported during flooding (Pelton 1953). Warm, then cold stratification is necessary (Evans 1974), with optimum germination on a moist media, at 0 to 10 °C temperatures (Pelton 1953). Only 1 percent of nutlets collected in the top 0.8 inch (2 cm) of soil were viable (Pelton 1953), but the species is listed as being seed-banking (Rowe 1983). Snowberry was found in the seedbank of forest sites from northern Idaho, but seed contributed little in postburn vegetation response. It was speculated the seed had low viability, and that seedbanks did not contribute to the postfire regeneration of this (*S. albus*) species (Morgan and Neuenschwander in press). Snowberry, a general increaser, survives fires by means of rhizomes, onsite seed of short viability, and other transport of offsite seed (Lyon and Stickney 1976).

Studies of shrub phenology indicate an early bud burst (Pelton 1953) between mid-April and late May. Flowering is delayed until early June to late August. The fruit is ripe by early September to early October. Leaf fall is usually completed during fruit ripening (Schmidt and Lotan 1980).

**Fire Response**—Fire resistance of this species is very high in the Intermountain West (Fischer and Clayton 1983). Regrowth after burning occurs from surviving rhizomes (Bradley 1984), even after severe fires (Lyon and Stickney 1976; McLean 1969). Vegetative response following burning is highly variable as reported in the literature. First postburn season stem density may be slightly lower than preburn (Pelton 1953); the same (Gordon 1976); or greater (Merrill 1982). Sprout height has been reported to be half to three-quarters of the preburn stem (Gordon 1976; Merrill 1982; Pelton 1953). Height increases with subsequent growing seasons (Gordon 1976) until finally equaling preburn height by the fourth year (Merrill 1982). But cover and volume measurements consistently exceed original preburn values the second year (Gordon 1976), as does biomass (Merrill 1982). Annual or very frequent fires may be detrimental (Pelton 1953). Rowe's classification suggests a fire adaptation classification as an endurer (VT) of fire.

**Use**—Snowberry is considered poor to fair browse for cattle, fair to good for sheep, and of no value for horses (Gullion 1964). It is heavily utilized by domestic livestock on overgrazed ranges (Morris and others 1962). Deer use is moderate to heavy, primarily in the summer and fall. Value as forage for elk is fair, and bighorn sheep consume it regularly in the summer (Gullion 1964).

## *Vaccinium* L.

**Biology**—Huckleberries are usually low, 4- to 12-inch (0.1- to 0.3-cm), creeping rhizomatous to erect shrubs (Hitchcock and Cronquist 1973). Several species are prominent in the habitat type series being evaluated. These include: dwarf huckleberry (*Vaccinium caespitosum* Michx.), globe huckleberry (*Vaccinium globulare* Rydb.), and grouse whortleberry (*Vaccinium scoparium* Leiberger). In Idaho, globe huckleberry and whortleberry are infrequent associates of only the *Pseudotsuga* habitat type series (Steele and others 1981). In Montana globe huckleberry can be found in the *Pinus flexilis* series, as well as joining the other three species in the *Pseudotsuga* series. Constancy and canopy coverage vary considerably with habitat type. Dwarf huckleberry and globe huckleberry are prominent enough on specific sites to be distinguished by habitat types named after the respective species (Pfister and others 1977).

Fruit from the shrubs is a many-seeded berry (Hitchcock and Cronquist 1973). The seeds are not dormant and will start to germinate approximately 1 month after being deposited on a suitable substrate. Some seed will exhibit delayed germination if not subjected to cold temperatures (Crossley 1974). The berries are an important wildlife food, especially for bears (Craighead and others 1982; Madel 1982; Zager and Jonkel 1983). There does not appear to be any evidence that this wildlife use is important to dispersal of the seed. Fire response can be classified for these shrubs as onsite surviving parts by rhizomes, and offsite seed by other transport.

**Fire Response**—Huckleberries have rhizomatous root systems. Vegetative growth is initiated from the rhizomes and lower stems when the plants are clipped or burned (Miller 1977, 1978). The ability to resprout evidently is not

severely affected by the season of treatment. Miller (1978) attributed this to the onset of seasonal bud dormancy. New sprouts may not bloom until the third growing season, with large berry crops until the fifth or later year (Minore and others 1979). Root systems for several species were found to grow in the mineral soil (Flinn and Wein 1977). Severe fire treatment from both slash and wildfire greatly decreased globe huckleberry for about 15 years before recovery (Arno and others 1985).

This shrub is classified as a VT enduring species.

**Use**—Dwarf huckleberry has a low grazing value for big game, but the fruit is valuable bird food. Globe huckleberry has a fair value for deer as summer range and is a valuable fruit for bears and birds. Whortleberry is fair to good browse for mountain goats and is possibly fair browse for deer and elk (Morris and others 1962).

Whortleberry fruit is also of high value as bear food (Mace and Bissell 1986; Zager 1980).

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## GLOSSARY

**Achene**—A dry indehiscent one-seeded fruit, the seed connected to the pericarp ripening wall of the ovary at only one point (sunflower).

**Berry**—A fleshy fruit formed from one compound ovary containing few to many seeds (grape).

**Clone**—Any group of plants derived from a single parental plant by vegetative reproduction.

**Deciduous**—Woody plants, or pertaining to woody plants, that seasonally lose all of their leaves and become temporarily bare-stemmed.

**Decumbent**—A stem reclining on the ground but turned upward near the end.

**Drupe**—A fleshy, indehiscent fruit, usually one-seeded, with a strong endocarp (plum).

**Druplet**—A small drupe.

**Endocarp**—The inner third layer of the ripened wall of the mature ovary in the fruit.

**Evergreen**—Plants, or pertaining to plants, that remain green the year around, either by retaining at least some of their leaves at all times, or by having green stems that carry on the principal photosynthetic function.

**Follicle**—A dry, one-celled, one-carpellate fruit split down one side (milkweed).

**Hip**—An aggregation of achenes surrounded by an urn-shaped receptacle (rose).

**Nut**—A dry, indehiscent, one-seeded fruit, with a hard coat.

**Nutlet**—A small nut; a very thick-walled achene.

**Prostrate**—A stem lying flat on the ground, often rooting at the nodes but otherwise not particularly differentiated.

**Rhizome**—A stem, generally modified (particularly for storing food), that grows along but below the surface of the ground and produces adventitious roots, scale leaves, and suckers irregularly along its length, not just at nodes.

**Runner**—A very slender stolon, sometimes limited to those which root only at the apex.

**Shrub**—A woody perennial plant differing from a tree by its low stature and by generally producing several basal stems instead of a single bole, and from a perennial herb by its persistent and woody stem(s).

**Stolon**—A specialized horizontal stem that trails on the ground and that forms new roots and shoots at its nodes.

**Taproot**—A thick, tapering root (carrot).

**Tuber**—An enlarged underground stem, usually rich in starch, and with many buds capable of vegetative reproduction of the plant (potato).

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This paper contains information from diverse sources on the regeneration capabilities, response to fire, and utilization of shrub species important or common to dry forest habitat types in Montana and Idaho. Response to fire is classified by reproductive strategies and how the species persists in the stand. Utility of the species for browsing by livestock and wildlife is included.

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KEYWORDS: plants, autecology, regeneration, seed, root-crown, rhizome, wildlife, forage browse, plant survival

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## INTERMOUNTAIN RESEARCH STATION

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