MANAGING WILDLIFE HABITAT WITH FIRE IN THE ASPEN ECOSYSTEM

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ABSTRACT: Much of the nearly 7 million acres (2.86 million ha) of aspen in the western United States is seral to conifers. Also, most aspen stands are old, in excess of 60 years. Proper treatment of these aspen forests will retain the aspen and can produce optimum wildlife habitat. Optimally, all age and size classes of aspen should be present on the landscape. Fire is often the most economical and, ecologically, the most natural treatment applicable in the many acres of unmerchantable but burnable aspen community types in the West. Fire of sufficient severity will kill the old stand, cause profuse aspen root suckering, and increase forage production. Currently, baseline data are being gathered for developing fire prescriptions and describing the fuels in Wyoming and Idaho aspen types. The effects of fire on the aspen plant community, especially on its value as wildlife habitat, is also being assessed.

INTRODUCTION

In the interior western United States there are 7,067,200 acres (2 859 944 ha) of aspen (*Populus tremuloides*). Of this, some 2,664,200 acres (1 078 163 ha) are noncommercial (Green and Van Hooser 1983). In addition, many millions of acres of aspen occur in the western provinces of Canada and Alaska.

Wildlife managers generally agree that the aspen forest type is especially valuable habitat for a variety of upland species of birds and mammals, both game and nongame (Gullion 1977b). In the interior West, aspen takes on a particularly important role for wildlife, because it is the only upland hardwood tree species and it frequently is found in groves in the coniferous forests or as isolated stands in mountain grasslands and shrublands. In the conifers, the aspen groves may be the only source of abundant forage; in the grasslands they may be the sole source of cover.

I recently reviewed the literature and contacted several sources to compile a listing of birds and mammals that occupy the aspen type in the West (DeByle in press). Some 134 species of birds and 55 species of wild mammals were included. Among the game birds, there are six species of ducks, two forest grouse (blue and ruffed), two pigeons (band-tailed and mourning dove), the sharp-tailed grouse, and the wild turkey (*Meleagris gallopavo*). Among the larger mammals, there are moose, elk, white-tailed deer, mule deer, snowshoe hare, cottontail rabbit (*Sylvilagus nuttallii*), bison (*Bison bison*), raccoon (*Procyon lotor*), mountain sheep (*Ovis canadensis*), mountain lion (*Felis concolor*), black and grizzly bears (*Ursus americanus and U. arctos*), and several furbearers.

Aspen is a seral forest type on the majority of sites. It is a relatively short-lived tree (about 100 to 125 years in the West) that readily gives way to longer lived and more shade-tolerant conifers. If a conifer seed source is present, the typical aspen stand responds approximately as shown in the model developed by Bartos and others (1983). Herb biomass peaks first, then shrubs (fig. 1). As long as aspen dominates, there is a large herbaceous or shrub biomass in the understory, but as conifers take over, this source of forage and low cover largely is lost.

Most of our western aspen stands have reached maturity because they have been protected from wildfire and have not been marketable for most of this century. In a Colorado survey, Shepperd (1981) measured an average age of 80 years, with stands younger than 50 years difficult to find. Single-aged stands predominated, but two-aged and all-aged stands were frequently found.

Treatments are needed to retain aspen on sites where it is seral. And, whether seral or not, treatments are needed if we wish to have a variety of aspen age and size classes represented on the landscape. In the natural setting, wildfire probably was the most common cause of widespread even-aged regeneration, although insect and disease outbreaks may have played a role, too. In the managed forest, clearcutting, herbicides, or prescribed fire may be used to effectively treat aspen stands by killing the overstory and triggering abundant aspen regeneration.

Aspen regenerates by producing root suckers in large numbers after the parent tree is top-killed. Such vegetative reproduction over several generations has produced a mosaic of aspen clones (groups of genetically identical stems) on the landscape (Barnes 1966). In the West, regeneration by seed is rare because a continuously moist, mineral soil seedbed is required throughout the first growing season (McDonough 1979).

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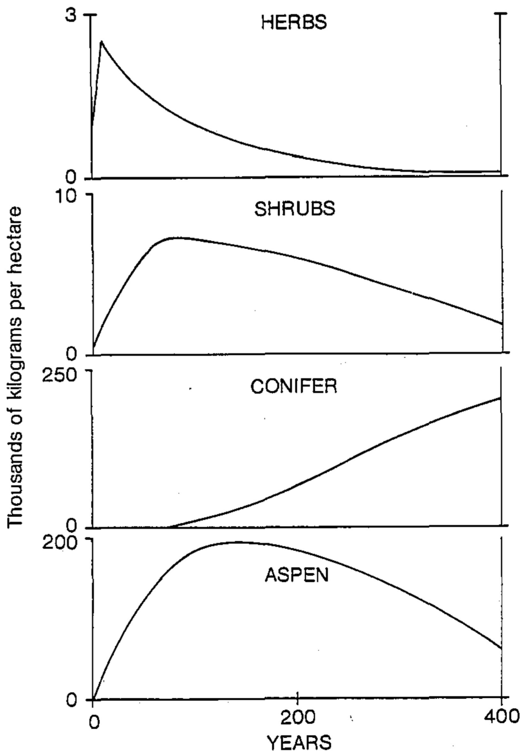

Figure 1.--Expected biomass of four vegetation components through time after a severe fire in aspen on a typical mesic site in the West. A conifer seed source is assumed. (From Bartos and others 1983, fig. 29a, p. 27.)

Sudden top-killing of an aspen stand upsets the hormone balance in the roots. Auxins, produced in tree crowns, are no longer supplied, and cytokinens, produced in roots, are no longer moved into the crowns. The lack of auxins, an increase in cytokinens, and warmer soil temperatures help stimulate abundant sucker production from roots near the soil surface (Schier 1981a, 1981b). If, say, the parent stand consisted of 200 stems per acre (494/ha), by the end of the second growing season after fire or clearcutting, there often will be some 40,000 suckers per acre (98 842/ha). Suckering response varies widely, due to genetic and site factors as well as the density of aspen roots near the soil surface. A good rule of thumb is 10,000 suckers per acre (24 710/ha) will produce a satisfactory forest stand--if roundwood products are being grown on the site.

The concern that high densities of young aspen will produce a stagnated stand is not justified because aspen is self-thinning. Disease, insects, browsing animals, snow breakage, and shading of these intolerant aspen suckers all take their toll. By maturity, a stand of 200 stems per acre (494/ha) again might be expected. During the 70- to 100-year interim, from a dense stand of young suckers to a mature stand of aspen trees, a progression of habitats will have been made available for a variety of wildlife species.

CASE STUDIES

There are many references in the literature about the effects of fire, usually wildfire, on aspen regeneration. There are far fewer on the effects on wildlife populations, and many of these are somewhat speculative. Usually the effects on plant communities are measured and the effects on associated wildlife are inferred.

Scotter (1972) points out that fire is at least partly responsible for maintaining extensive stands of aspen and other seral species in the boreal forest region but that the influence of fire on the animals cannot be easily evaluated--some members are benefited while others are disadvantaged. For optimum elk or moose habitat, both Gruell and Loope (1974) and Spencer and Hakala (1964) describe the benefits of fire in the aspen type. In the North, both Lutz (1956) and Viereck (1973) feel that fire may be deleterious on caribou (*Rangifer tarandus*) winter range because fire destroys lichens; on the other hand, it benefits moose and snowshoe hares because they depend upon the successional plant communities, notably aspen, that are produced. Much further south, Patton and Avant (1970) found that fire is an effective tool for producing deer and elk browse in the mixed aspen-conifer forests of New Mexico.

Those animal species that depend upon the forage or cover produced in a young aspen community will benefit from fire. They include some of the more important (game) species of wildlife--moose, elk, deer, ruffed grouse, and snowshoe hare. Others may do well in old, sometimes derelict, aspen stands--cavity-nesting birds for example. For these, fire is not necessary for habitat management if the aspen on the site is stable or climax. Other species of wildlife, such as red-backed voles (*Clethrionomys gapperi*), red squirrels (*Tamiasciurus hudsonicus*), and pine martens (*Mustela americana*), do best in coniferous forests. Fire to set back succession and retain aspen will be deleterious for these species. If diversity of habitats and a diversity of wildlife species are wanted, fire can play an important role in maintaining the mosaic of plant communities and age-size classes within these communities on the overall landscape. If edge is wanted, fire again is a tool to provide maximum edge between the patches in this mosaic. Thus, we must be specific what we want before prescribing fire or any other treatment.

The Role of Fire in Habitat Management of a Few Key Species

Elk.--The wapiti, or elk (*Cervus elaphus*), are grazing animals that prefer grassland, shrubland, and recent burns over the mixed forest community (Rounds 1981). They choose aspen over coniferous communities in summer and winter (Ackerman and others 1983), although conifers may be used for hiding (security) and thermal cover during times of harassment or severe weather (Thomas 1979).

Elk prefer grasses, then forbs; as curing or loss of herbaceous material occurs, they use deciduous browse species first and coniferous browse last. Aspen is avidly sought from among the browse species (Kufeld 1973; Nelson and Leege 1982). The aspen suckers themselves, however, will extend their crowns above the reach of elk in 6 to 8 years if growing in the open and not browsed (Patton and Jones 1977). In summer, the combined values of good forage and cover in the aspen forest make it especially valuable to elk; at this time they may select aspen stands over adjacent clearcut areas that have even more palatable forage (Collins and Urness 1983).

To provide optimum habitat for elk, Thomas (1979) recommended that 60 percent of the land area be managed to provide forage. Good forage is provided by the herbaceous and shrubby understory in the aspen as well as by aspen suckers less than 6-1/2 ft (2 m) tall. Peak production of this component is reached within a few years after burning (Bartos and others 1983).

In the Jackson Hole area of western Wyoming a combination of factors is causing the demise of aspen on big game winter ranges. Fire protection has permitted large areas of aspen to reach maturity and to begin the successional process toward conifers (Gruell and Loope 1974; Gruell 1979), and concentrations of big game, especially elk near winter feedgrounds, in some instances are eating every sucker that arises (Beetle 1979; Weinstein 1979). If nothing is done, aspen over large areas will disappear within a century (Krebill 1972). If protection can be provided from browsing elk (DeByle 1979), then fire can be used to regenerate the declining aspen stands. Somewhat similar conditions occur in and near Rocky Mountain National Park in Colorado (Olmstead 1979).

In recent years fire has been used on an experimental basis in the Jackson Hole area (Bartos 1979; Bartos and Mueggler 1979, 1981). They found that understory production decreased in the first postburn year, then increased to well over that on the unburned sites in the second and third postburn growing seasons. On one site in the second year there were 3,211 lb/acre (3 600 kg/ha) produced, about double that found before burning. Most of this was fireweed (*Epilobium angustifolium*)--a species palatable to cattle and elk. Production of aspen suckers was greatly increased by burning, enough to replace the parent stand where browsing pressure is not too great. On the sites where elk browsing pressure was greatest, there were 5,665 to 8,094 suckers per acre (14 000 to 20 000/ha) present in the declining aspen stands before burning; this density nearly doubled in the second postburn year, but by the end of the third postburn year, sucker densities had returned to near preburn levels (Bartos and Mueggler 1979, 1981). Even though over 1,000 acres (405 ha) was burned, elk use of aspen was deterred only one winter. Elk browsing the third winter averaged 44 percent of current annual growth and eliminated the height growth from the previous summer (Basile 1979).

Under current browsing pressures on heavily used areas, the small increase in sucker numbers after burning is not expected to regenerate these aspen stands.

Moose.--The largest member of the deer family, the moose (*Alces alces*), extensively uses the aspen ecosystem. They are primarily browsers, especially in winter (Peek 1974). Forbs are also extensively used when available in spring and summer. Usually moose first select willow (*Salix* spp.) and then aspen as browse. The typical understory forbs and shrubs in the aspen type as well as young aspen are favorite moose forage.

Moose can utilize larger saplings than can deer or elk. Their height of reach is 8 ft (2.4 m), and they will break down saplings up to 4 inches (10 cm) in diameter to reach higher browse (Telfer and Cairns 1978).

Moose have a high tolerance for cold; they will occupy willow bottoms without much thermal cover early in winter. As winter progresses and snowpacks deepen, however, they move into densely forested uplands with less snow (Rolley and Keith 1980). Moose in Alberta selected aspen stands less than 33 ft (10 m) tall as preferred habitat (Rolley and Keith 1980). In Montana, Gordon (1976) described ideal upland moose habitat as having a good distribution of aspen and associated trees and shrubs in a mosaic of age classes. Conifer patches for hiding cover also are desirable, perhaps essential.

In Minnesota, Irwin (1975) found that moose selected deciduous forest stands, especially postburn communities that produce large amounts of preferred forage, during the summer-fall period. Willows and the sprouts of aspen, birch (*Betula* spp.), and maple (*Acer* spp.) were the most important browse species used.

Seral aspen being replaced by conifers in south-central Montana were burned to enhance winter moose habitat (Gordon 1976). Aspen suckers increased to 27,400 per acre (67 700/ha). After the second growing season they averaged 3 ft (91 cm) tall, and both they and willow sprouts could be utilized. Gordon found that the heaviest use of aspen and shrubs was adjacent to the unburned area, where cover was quite dense.

From work done in Alaska (LeResche and others 1974), Minnesota (Irwin 1975), Wyoming (Gruell 1980), and elsewhere (Gullion 1977b) it is evident that regeneration of young vigorous stands of aspen, willow, and associated shrubs, usually after fires, improves moose habitat and results in a moose population increase. After this browse grows out of reach, the moose population drops. LeResche and others (1974) noted that fire-induced seral communities in Alaska have the greatest moose densities.

Deer.--Mule and white-tailed deer (*Odocoileus hemionus and O. virginianus*, respectively) are common throughout the range of aspen in the West.

The mule deer predominates in the States with the most aspen. Deer herds in these States are migratory--they spend summers at high elevations within the aspen zone and winters on steppe and brushlands at lower elevations, usually below the aspen. Thus aspen is largely summer and fall range for deer in the West. During these seasons both thermal and hiding cover are abundant in the aspen type. Leckenby and others (1982) rated aspen communities on the shrub-steppe western range second only to riparian zones in value to mule deer. Deer prefer to feed in the aspen forest rather than in forage-rich clearcut openings, and they commonly bed down in the aspen forest as well (Collins and Urness 1983).

In spring and early summer deer prefer herbaceous forage, primarily forbs. As these cure, deer shift increasingly to browse; by winter their diets are three-fourths browse (Kufeld and others 1973). Aspen is among the top eight species of preferred browse for mule deer. Hungerford (1970) noted that aspen sprouts became a key food only after new growth matured, usually in July. Upon leaf fall in autumn, deer consume large quantities of aspen leaves (Julander 1952). In addition to the aspen itself, deer forage upon many of the common understory shrubs (snowberry, serviceberry, barberry, pachistima, chokecherry, rose, willow) and forbs (yarrow, aster, milkvetch, fleabane, geranium, peavine, lupine, knotweed, cinquefoil, dandelion, valerian, vetch) in the aspen forest type (Collins 1979; Kufeld and others 1973).

The impact of deer on aspen regeneration can be greatest in late summer and autumn. They will readily take young, succulent aspen sprouts on recent burns and clearcuts. They also browse on aspen up to a 5-ft (1.5-m) height, and therefore can have a significant impact on aspen suckers younger than 4 or 5 years or those suppressed by browsing to heights of less than 5 ft. Mueggler and Bartos (1977) noted that deer browsing prevented aspen regeneration in small clearcuts and in the uncut aspen forest, but nearby large burned areas regenerated successfully. They felt that burns or clearcuts less than about 5 acres (2 ha) would concentrate deer use and would be less likely to successfully regenerate than would larger areas.

Deer on their summer range will benefit from having plenty of aspen habitat available, especially if it contains an abundance of understory forbs and shrubs. Since both aspen suckers and the aspen understory are in greatest abundance within a few years after burning (Bartos and others 1983), it appears that management to provide an array of aspen age classes on the range would provide the best overall habitat. The burn units should be of adequate size, however, to prevent overbrowsing of the aspen regeneration. Perhaps 10- to 40-acre (4- to 16-ha) units burned or clearcut at intervals of 40 to 80 years would provide optimum deer habitat.

Snowshoe hares.--Snowshoe hares (*Lepus americanus*) are present throughout much of the aspen range in the West; however, they are more common in the associated coniferous forest types. In the Rocky Mountains, winter hare habitat is lacking in most pure aspen stands due to deep snowpacks. In northern Utah, Wolfe and others (1982) found 85 percent of winter use by hares was in vegetation types that had cover densities of at least 40 percent immediately above the snowpack. Sometimes aspen with a very dense understory of tall shrubs fits this criterion, but usually only conifers provide this much winter cover.

During the summer growing season, snowshoe hares disperse somewhat from coniferous winter cover (Wolff 1980). The aspen type then provides adequate cover and excellent forage. Aspen is nutritious and choice food for hares (Walski and Mautz 1977), although new suckers may not be as palatable as twigs on the mature growth because of their high terpene and resin contents (Bryant 1981). In Alberta, Pease and others (1979) found aspen to be among the six most common browse species. During summer the hares shift largely to a diet of succulent plant material (Wolff 1980). Since the aspen type has much more herbaceous and shrub cover than most coniferous types, in summer it probably is the more desirable habitat.

The aspen type, if well interspersed with dense conifer patches, provides adequate snowshoe hare habitat in the West. Marginal habitat is provided with aspen and a dense understory of tall shrubs if this understory is not covered with deep winter snowpacks. It is doubtful that even the peak density of aspen suckers and shrubs on most aspen burns or clearcuts in the West provides adequate snowshoe hare habitat in winter (Wolfe and others 1982). Perhaps the best recommendation for management is one developed in Michigan (Conroy and others 1979), where clearcuttings managed for hares were recommended as small and shaped so adequate canopy cover remained within 200 to 400 yards (about 200 to 400 m) of all parts of the opening. In the western United States and adjacent Canada, perhaps small irregularly shaped clearcuts or burns and encouragement of small but dense conifer patches throughout the aspen forest will provide maximum snowshoe hare habitat in the aspen type.

Ruffed grouse.--The ruffed grouse (*Bonasa umbellus*) has a wide range across North America (Aldrich 1963), is associated with hardwood and hardwood-conifer mixed forests, and is primarily a bird of the aspen and associated forest types. Gullion (1977a) opined that there is an obligatory relationship between ruffed grouse and the aspen type wherever snow covers the ground between November and April. Aspen is heavily used as food and as cover; it provides a highly nutritious food source (Gullion and Svoboda 1972), protection from the weather (Bump and others 1947), and escape from predation (Gullion and others 1962). Wherever aspen and grouse ranges overlap in the West, the grouse selects aspen habitat during part or all of the year, as shown by Phillips (1964, 1967) and Landry (1982) in Utah, Stauffer and Peterson (1982) in Idaho, and Rusch and Keith (1971) and Doerr and others (1974) in Alberta.

Management for optimum ruffed grouse habitat must center on the aspen ecosystem and nearby dense, brushy vegetation. For Idaho and Utah conditions, Stauffer and Peterson (1982) recommended a diversity of habitat structure within 40- to 50-acre (16- to 20-ha) units. Drumming (breeding) sites should have 200 to 450 trees per acre (about 450 to 1 100/ha) that provide 80 to 95 percent tree cover and at least 2,500 small stems (shrubs and aspen sprouts) per acre (about 6 000/ha). Hens with broods prefer 50 to 75 percent tree cover, about 600 to 2,800 small stems per acre (1 500 to 7 000/ha), and openings with abundant herbaceous cover more than 20 inches (about 50 cm) tall. Winter cover should have large mature aspen for food and perhaps some conifers for cover. For Minnesota conditions, Gullion (1977a) recommended practices that maintain heavily stocked, fast-growing aspen stands in a variety of age (size) classes within the daily range of grouse. The value of conifers was questioned because they harbor avian predators. Stauffer and Peterson (1982) and Landry (1982) both emphasized the importance of a dense shrub layer in aspen or mixed aspen stands for our western conditions.

Even-aged management of 10-acre (4-ha) units on rotations of about 60 years perhaps will produce the best ruffed grouse habitat in the montane West. One unit should be treated (burned or clearcut) every 15 years within each 40- to 50-acre block, thus producing the diversity of habitat needed within the range of individual grouse. Clearcutting units as small as 10 acres is the most feasible treatment; then burning within a year afterward may provide the best brood habitat (Sharp 1970). Larger areas that are being taken over by conifers may be burned to set back succession, then later put into the rotation system of small 10-acre units (Stauffer and Peterson 1982).

Sharp-tailed grouse.--The sharp-tailed grouse (*Tympanuchus phasianellus*) in the parklands aspen habitat will use aspen trees in the winter and spring, but they prefer and select grassland and grassland-low shrub cover throughout most of the year. During winter, small aspen and shrubs offer sharp-tailed grouse protective cover and food. The grouse feed on aspen buds in winter and spring (Hamerstrom 1963; Moyles 1981). Aspen is useful as small thickets of young growth (3 to 6 ft or 1 to 2 m tall) and as larger patches of taller trees for winter use (Evans 1968; Hamerstrom 1963). During much of the year, aspen, except as a shrub, seems to be of little or no importance and is perhaps even a detriment to the sharp-tailed grouse. The presence of aspen near breeding arenas discourages use by these grouse (Moyles 1981). Moyles cites evidence that invasion of grassland by aspen reduces sharp-tail habitat.

It appears that the sharp-tail is a bird characteristic of early successional stages in the aspen ecosystem. Sharp-tails use frequently burned areas in which aspen regeneration is mostly shrub-size except for some scattered stands of mature trees that have escaped the fires. As extensive stands of trees return to this setting, the sharp-tail gives way to the ruffed grouse. Fire in relatively short intervals, say 20 years, could be used for management of sharp-tail grouse habitat. Large units of several hundred acres could be burned if patches of large aspen trees were protected.

OUR CURRENT RESEARCH

In 1981 the Intermountain Forest and Range Experiment Station commenced a prescribed fire study in the aspen on the Bridger-Teton and Caribou National Forests in western Wyoming and southern Idaho, respectively. There are two primary objectives: (1) to develop prescriptions for the use of fire to regenerate aspen and (2) to determine postfire plant succession and production. The research focuses on aspen sites that are being invaded by conifers or are susceptible to such invasion. Facets of the study include:

1. Probabilities of achieving weather conditions meeting specific prescribed fire conditions.

2. A method for predicting water contents of live herbaceous fuels.

3. A classification within the aspen ecosystem of fuels and their flammability.

4. The relation of overstory tree mortality to fire severity as evidenced by visible bole damage and fuel consumption.

5. The relation of aspen sucker populations to overstory mortality.

6. Vegetation response to fire, both with and without postburn grazing.

Adjunct to this research are two cooperative studies being conducted by Utah State University and the Intermountain Station. In the first study, forage quality is being assessed for several plant species on burned and unburned aspen sites during the first and second years after prescribed fire. In the second study, tame elk are being used to determine habitat selection, foraging behavior, and dietary nutrition during the second and third postburn years on burned sites and in the surrounding habitat.

A progress report that covered all facets of the primary study was given at the end of the 1982 field season (Brown and DeByle 1982). Research continues; however, data gathering and analyses for predicting fire weather (facet 1), for estimating water contents of live fuels (facet 2), and for developing a fuel classification (facet 3) are essentially complete. The fuel classification scheme was outlined by Simmerman (1983) and will be expanded into a more definitive publication in the near future. The results from the cooperative studies, when combined with the results from facets 4 and 5, should be of considerable interest to managers of wild ungulate habitats.

On most of the mid- to high-elevation aspen range in the West, the deep snowpacks do not melt away until spring greenup. Spring burning is not possible under these conditions, hence, we concentrated on developing prescriptions for autumn burns. Summer generally is dry in northern Utah, southern Idaho, and Wyoming. Fuels cure through late summer and autumn. As autumn approaches, the probability of major precipitation from a frontal storm system increases. To predict the probabilities of such storm systems, we analyzed the long-term weather records for several stations. Two prediction lines are shown in figure 2. The solid line represents the accumulative frequency of a storm that temporarily prevents burning; subsequent drying, however, would return prescribed burning conditions that season. The dotted line essentially predicts the end of the burning season. For example: in half of the years a frontal storm that delays burning for several days can be expected by mid-September, and the burning season will end, probably with a snowstorm, by approximately October 25.

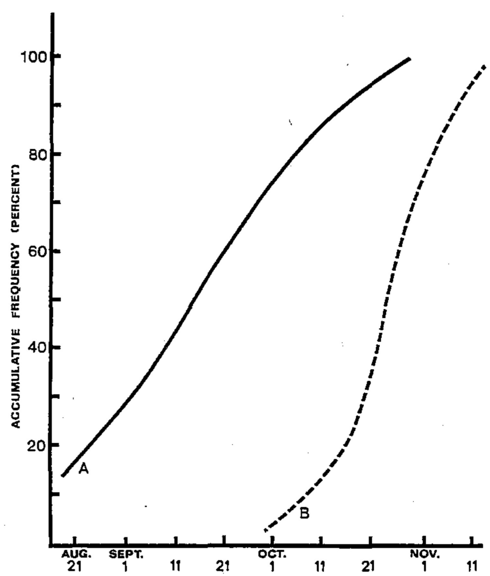

Figure 2.--Cumulative frequency curves of estimated dates before first major interruption of the prescribed burning season (curve A) and the last date of the prescribed burning season (curve B).

Fuel classification in the aspen ecosystem is based primarily upon understory characteristics (community types) and, to a lesser extent, upon successional status, amount of downed woody fuels, and grazing. Some of the major classes and their potential for prescribed burning are:

Overstory	Understory	Potential for prescribed fire
Aspen	Shrub	Good
Aspen/conifer mix	Shrub	Good
Aspen	Tall forb	Fair
Aspen	Shrub (grazed)	Fair
Aspen/conifer mix	Forb	Fair
Aspen	Low forb	Poor
Aspen	Tall forb (grazed)	Poor

NEEDS

It is generally accepted that managing western wildlands to provide an optimum amount of aspen on the landscape will benefit some key species of wildlife. It is generally accepted that managing this aspen to provide an array of age and size classes, perhaps in even-aged units of a few acres each will provide the best habitat for these key wildlife species. For most wildlife species, however, far too little is known about habitat needs to do a top-quality job of intensive aspen management to produce optimum habitat.

Several key wildlife species for which habitat management in the aspen type could be important have been used as examples in this paper. It is apparent that moose, elk, deer, snowshoe hare, and ruffed grouse will benefit by having an optimum amount of aspen in a variety of size classes on their range. Just how much is needed in relation to the mix and juxtaposition of other habitats is not known. For some species in some environments, aspen perhaps is all that is needed--an example is ruffed grouse in northern Minnesota (Gullion 1977a). For others, such as snowshoe hares in the montane West (Wolfe and others 1982), aspen alone will not provide satisfactory habitat. For still other species, aspen forest plus some other habitat variable is needed. Beavers (*Castor canadensis*), for example, use aspen (or willow) along streams and rivers. In addition, many species are migratory, such as most passerine birds, and use the aspen forest only during part of the year, but often during the all-important breeding season. These species are equally dependent upon habitats elsewhere for their year-round welfare. Manipulating the aspen type will not provide optimum habitat for this total mix of wildlife species.

Wildlife managers first must choose what key wildlife species are to be encouraged. Then they must determine what those species habitat needs are. Habitat needs must not be confused with preferences for some particular habitat components; instead, focus must be kept on what each species requires to maintain health, vigor, and an acceptable rate of reproduction (Peek and others 1982). The managers also must ascertain what the trade-offs are--what wildlife species are going to be placed in a disadvantageous position through some particular habitat management strategy. This is a difficult job, perhaps impossible with our present level of knowledge of habitat requirements for many species.

If the chosen key wildlife species are deer, elk, and moose (they usually are in the montane forested habitats of the West), perhaps enough is known about their preferences and some of their needs to make reasonable habitat management recommendations. Aspen clearly is preferred by these ungulates. On most of their ranges, aspen should be encouraged. A mix of habitats, consisting of mountain brush, meadows, conifers, and aspen may be best, but the proportions can only be speculated upon. Aspen on up to one-half of the range of these ungulates is perhaps most acceptable. Management of this aspen in even-aged units of 5 to 60 acres (2 to 24 ha) each on a rotation of 60 to 100 years will probably supply the greatest variety of habitats within the aspen type and will ensure a considerable amount of edge around these units. With this management strategy, fire becomes a feasible option for killing 60- to 100-year-old aspen stands, at least those with a shrubby understory, thereby triggering abundant even-aged aspen regeneration.

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