INFLUENCE OF FIRE ON WILDLIFE HABITAT IN THE GREAT BASIN: A POSITION STATEMENT BY THE NEVADA CHAPTER-THE WILDLIFE SOCIETY, AUGUST 16, 1998.

INTRODUCTION

Various opinions arise concerning the historical role of fire in shaping vegetational communities. Recently, certain management agencies have shifted their attitude toward favoring prescribed fire as a management tool; this has resulted in controversy concerning the historical role of fire and the effects of recent and future fire on different habitats. This position statement outlines documented information relevant to the effects of fire on Great Basin vegetation and wildlife.

Fires have been in the Great Basin for eons. Lightning provided, and continues to provide, a natural ignition source. Native Americans set fires by accident and on purpose to enhance vegetation and to send long distance communications. Today, society is experiencing stewardship issues concerning the values and effects of wildland fires. At times fires (whether natural or man-caused) have been deemed tragic and destructive; e.g., loss of life or private property, decrease in food and cover for wildlife, and an aid to the increase of noxious alien plants. Conversely, ecologists have recognized that periodic fires have and can play a role in developing healthy, secondary plant succession leading to diverse communities of plants and animals. Fires are the most ubiquitous agent of disturbance that releases energy and renews or regenerates wildlife habitat (Payne and Bryant 1994). Aldo Leopold (1933) advised us over 60 years ago that the influences of axe, gun, plow, and fire can be beneficial or detrimental to wildlife—depending on how they are applied. How well modern society understands and manages fire as a component of landscape stewardship is the key to maintaining or enhancing healthy wildlife habitats.

Wildlife includes all free-roaming terrestrial vertebrates in their natural associated habitat (Giles 1978, Bailey 1984). Emphasis in this position statement has been given to mammals and birds because more data were available relative to their response to fire than other vertebrates. Great Basin refers to landscapes in the Intermountain West with drainages terminating in closed watersheds and not the ocean, primarily located in northern Nevada, southcentral Oregon, eastern California, and western Utah (Grayson 1993). Secondary plant succession occurs where the original vegetation has been disturbed, for example, on land affected by fire or drought (National Research Council 1994).

Maintaining healthy vegetation communities is a major objective of rangeland management and predominant stands of decadent vegetation can be classified as a threshold of unhealthy rangeland status (National Research Council 1994). Extensive landscapes in the Great Basin are dominated by old-aged shrubs. Many of these areas can be classified as habitats in deteriorated condition. An example is the half-million-acre Sheldon National Wildlife Refuge in northwestern Nevada which presently is covered with more than 90 percent shrublands with old-aged shrubs (Gregg 1997). The current condition of these rangelands appears to be the result of 2 factors occurring during the last century: (1) extensive livestock grazing, which markedly reduced fine fuels that supported fire and allowed accelerated growth of shrubs, and (2) intensive fire suppression activities (responsible for protection of shrubs from fire) (U.S. Fish and Wildlife 1994). Over the long term, the return of fire disturbance is essential in order to stimulate and increase a greater diversity of successional stages rich in grasses, forbs, and shrubs upon which endemic wildlife is dependent.

The relationships of fire to wildlife in the Intermountain West are documented in recent scientific reviews (Payne and Bryant 1994, Riggs et al. 1995). Past scientific or technical literature assessing the relationship between fires and wildlife for the Great Basin has been limited; however, recent reports are addressing this matter (Gruell 1995, 1996; Miller et al. 1998). Published literature regarding the effects of fire on specific wildlife species as well as groups of species, was utilized in compiling this position statement.

Recognizing the need for a current assessment of the values and practices of fires to wildlife, the Nevada Chapter-The Wildlife Society (NC-TWS) is presenting this position statement to: (1) assess the influences of wild and prescribed fires on wildlife habitats in the Great Basin, and (2) develop positions relative to the impact of fire on wildlife. It will not cover the subjects of fire behavior or management practices such as planning, suppression, or rehabilitation. These may be addressed in future reports.

FIRE EFFECTS ON GREAT BASIN VEGETATION

Historical Perspective

Various studies have demonstrated that fire was common on western rangelands at the time of European contact (Cooper 1961, Burkhardt and Tisdale 1976, Shinn 1980, Payne 1982, Gruell 1986, Bunting 1987). Fire intervals varied because of differences in fuels, lightning and human ignition sources, topography, and local climate (Arno 1980, Martin 1982). Because of lack of fuel continuity, fire occurrence appears to have been negligible in valleys dominated by salt-desert shrub. Landscapes dominated by Wyoming big sagebrush (*Artemesia tridentata wyomingensis*) apparently burned infrequently because of the wide spacing of shrubs and sparsity of grasses. The infrequency of fire in major valleys is supported by the observations of early travelers who remarked about the dominance of shrubs (Vale 1975, Billings 1994). In contrast, fires were common on elevated landscapes supporting herbaceous fuels (Baker 1925, Martin 1982, Kauffman 1990, Gruell 1998).

Quantification of fire frequency in rangeland settings typical of the Great Basin is limited by scarcity of recorder trees including ponderosa pine (*Pinus ponderosa*) and Jeffrey pine (*P. jeffreyi*). Where these species are present, on the east slope of the Sierra Nevada, analysis of the scars from three regions has shown a historic fire return interval of approximately 8 years (range 1-32 years) during the period 1593-1990 (Rice 1990, Stephens 1996, Taylor 1996). Fire-scarred pinyon (*Pinus* spp.) and juniper (*Juniperous* spp.) provide a less definitive record because older trees bearing fire scars are restricted to sites that did not readily burn (Young and Evans 1981, Gruell 1996). Close fire intervals on fire susceptible sites are suggested, however, by the presence of fire scars on Jeffrey and ponderosa pine growing in association with pinyon or juniper (Gruell 1998).

Historically, fire influenced secondary plant succession by suppressing shrubs and trees, and promoting the growth of grasses and forbs (Clements and Clements 1939, Young et al. 1978, Wright et al. 1979, Arno 1985, Gruell 1986). Because of recurrent fire, landscapes were most likely composed of communities in different successional stages (Young et al. 1978).

Post Settlement Vegetation Changes

The role of fire in rangelands underwent a marked change following Euro-American settlement. Relocation of Native Americans from their ancestral territories removed a major ignition source and the possibility of extensive spreading fires was checked by the sparsity of fine fuels left after intensive livestock grazing (Harper 1986, Gruell 1997). Livestock grazing and the absence or reduction of fire caused compositional shifts in upland plant communities that resulted in a decline in herbaceous vegetation and an increase in fire-sensitive woody shrubs and trees (Blaisdell 1953, Blaisdell et al. 1982, Winward 1991, Miller and Rose 1995). Large increases in density and distribution of pinyon and juniper has been widely reported (Cottam and Stewart 1940, Christensen and Johnson 1964, Tausch et al. 1981, West 1984, 1988; Eddleman 1987, Miller and Wigand 1994, Eddleman and Jaindl 1994, Gruell 1997b). In the absence of fire, curlleaf mountain-mahogany (*Cercocarpus ledifolius*) increased greatly on deep soils (Scheldt 1969, Dealy 1975, Gruell et al. 1985). Big sagebrush (*Artemesia t.* spp.) and antelope bitterbrush (*Purshia tridentata*) thickened and reproduced on sites that were formerly grassy (Gruell 1966, 1986, Young et al. 1976).

A significant increase in fuels during the twentieth century has resulted in the occurrence of large, high intensity wildfires. Where present, cheatgrass (*Bromus tectorum*) has changed succession by providing a fine textured early maturing fine fuel. Cheatgrass affects succession by inhibiting the establishment of perennial seedlings through moisture competition (Young et al. 1978, Melgosa et al. 1990). In various xeric sagebrush-bunchgrass communities, the invasion of cheatgrass has reduced the fire interval from an estimated 30-70 years down to 10 years or less. The larger and more intense wildfires have occurred in major valleys and foothills occupied by cheatgrass. Despite aggressive suppression efforts, wildfires in pinyon-juniper woodlands have increased in size and intensity (Gruell 1998). Mountain brush and riparian communities burn infrequently, owing to accumulative growth and increased fuel moisture.

Fire Effects on Vegetation

Mountain Brush. The composition and distribution of shrubs in the mountain brush type varies greatly depending upon site characteristics. Northerly aspects and deep, moist soils often support a variety of species. Common species include aspen (*Populus tremuloides*), serviceberry (*Amelanchier* spp.), chokecherry (*Prunus virginiana*), snowberry (*Symphoricarpos* spp.), current (*Ribes* spp.), Woods rose (*Rosa woodsii*), rubber rabbitbrush (*Chrysothamnus nauseosus*), mountain maple (*Acer glabrum*), snowbrush ceanothus (*Ceanothus velutinus*), and oaks (*Quercus* spp.). These and other species respond to fire by resprouting from underground stems (rhizomes), dormant buds, root collars, root crowns, lignotubers, or burls (Miller 1988) and from seeds. Initial response can vary considerably depending on the location of reproductive tissue and fire severity (Rowe 1983, Humphrey 1984).

Periodic fire is considered essential for the long-term maintenance of the distribution and abundance of aspen (Schier 1975, Brown 1985, Kauffman 1990). Fire in aspen stimulates vegetative regeneration, fosters germination of seeds, and maintains a diversified age structure of stands across the landscape (Brown and DeByle 1989). Fire that kills parent stems releases energy to roots, which is followed by sprouting of suckers and regeneration of stands (Jones and DeByle 1985). A few species including snowbrush ceanothus require heat stratification to germinate dormant seeds stored in the soil (Noste 1985). Post-fire response of mountain shrubs is characterized by an increase in cover and density (Humphrey 1984).

Riparian/Wetland. Most shrubs and trees associated with riparian zones have the capacity to regenerate from root crowns and rhizomes. Common species include willows (*Salix* spp.), dogwood (*Cornus* spp.), aspen, and cottonwood (*Populus* spp.). Fire appears to have a negative effect on these species in the short-term, but long-term benefits are soon apparent (Stroud et al. 1995). Willows in good vigor sprout profusely when top killed by fire. They also have the potential to regenerate from wind blown seeds that come in contact with moist mineral soil (Stickney 1982).

Herbaceous Plants. Herbaceous forbs and grasses regenerate from meristematic tissue, basal buds, taproots, or rhizomes. The location of these reproductive organs with respect to the soil surface, the length of time the fire burns, and fire severity are significant determinants of whether a plant survives a fire (Miller 1988). Studies of fires that burned at varying intensities have shown a wide range of responses (Blaisdell 1953, Mueggler and Blaisdell 1958, Nimir and Payne 1978, Young and Evans 1981, Wambolt and Payne 1986). Tap-rooted species such as arrowleaf balsamroot (*Balsamorhiza sagitata*) and lupine (*Lupinus* spp.) are stimulated by fire. Fine bladed Idaho fescue (*Festuca idahoensis*) and needle grasses (*Stipa* spp.), with reproductive buds above the soil surface, are often killed by intense burning. Bluebunch wheatgrass (*Agropyron spicatum*), bluegrass (*Poa* spp.), squirreltail (*Sitanion hystrix*), and Indian ricegrass (*Oryzopsis hymenoides*) are species slightly damaged by fire (Britton and Ralphs 1979, Wright et al. 1979). Various studies have shown that on sites where perennial herbs were well represented, post-burn production increased significantly and was above pre-burn levels 10 or more years following burning.

Sagebrush. Most sagebrush species are readily killed by fire (Blaisdell 1953). Following fire, sagebrush reproduces from seeds stored in the soil and from seeds of surviving plants. Reoccupancy of the site is much slower following a high intensity fire that leaves few living plants. Sagebrush produces copious amounts of seeds, yet it still takes 25-50 years for it to reach dominance (Young et al. 1989). Mountain big sagebrush (*A. t. vaseyanna*) may reoccupy a burn in a short period of time because it grows on more mesic sites and produces great amounts of viable seeds that accumulate in the soil. Basin big sagebrush (*A. t. tridentata*) and Wyoming big sagebrush have a slower re-establishment period because they occupy sites that are drier (Wright et al. 1979).

Bitterbrush and Cliffrose. Antelope bitterbrush is fire sensitive (Nord 1965, Wright et al. 1979). Losses of bitterbrush to high intensity summer wildfires are of concern due to its importance as a browse plant. Because of genotypic variations, post-fire response can be quite different (Wright et al. 1979, Bunting et al. 1985). Plant mortality seems to be influenced by one or more factors including fire intensity (Blaisdell 1953), phenology (Mueggler and Blaisdell 1958), soil moisture (Nord 1965), and soil texture (Driscoll 1963). Mortality decreases as site fuel loading and fire severity is reduced. Moderate intensity late summer/early fall wildfires tend to be less destructive to bitterbrush communities because the plants have already set seed that are dispersed by rodents (Clements and Young 1997). Re-establishment following intense burning is largely contingent on seedling germination in dispersed rodent caches (Vander Wall 1994). Decumbent forms at higher elevations sprout more readily after top removal than do open or columnar forms found in semi-arid settings (Bunting et al. 1985). Desert bitterbrush (*P. glandulosa*) and cliffrose (*Cowania mexicana*) are also fire sensitive, being severely damaged by high intensity fire. Like antelope bitterbrush they also re-establish by seed dispersal.

Curlleaf Mountain-mahogany. Curlleaf mountain-mahogany, an important browse species, is a weak sprouter (Wright et al. 1979). High intensity fires have the potential of inflicting heavy mortality on mountain-mahogany stands, particularly those that contain dead trees that have contributed to fuel loading. Young mahogany may sprout from undamaged auxiliary buds on the stems or from adventitious buds beneath the bark. It does not sprout from basal caudex or rhizomes. Unlike many shrubs, mahogany has a thick bark. This allows it to survive light fires when mature. Sprouting may occur after light burning, but reproduction is highly variable and almost entirely dependent on establishment of seedings in mineral soil (Gruell et al. 1985).

Pinyon and Juniper. Post-fire plant succession in Great Basin pinyon-juniper woodlands often starts from a depleted understory base (Everett 1987). Initial response following fire is unpredictable because of unknown soil seed reserves, plant immigration, and postfire climatic conditions. The usual successional path is dominance of annuals during initial stages of succession. Root or shoot-sprouting shrubs, forbs and grasses such as green ephedra (*Ephedra viridia*), snowberry, Great Basin ryegrass (*Leymus cinereus*), and lupine can rapidly assume aspect dominance of some sites following fire (Everett 1987). Koniak (1985) found highest plant cover of perennial (grasses, forbs, and shrubs) on north and east aspects. A high cover of annuals occurred on south and west aspects. As succession advances, plant composition changes from shrub dominance to tree dominance (West and Van Pelt 1987). Closed stands that displace understory result in a loss of forage production and a woodland that is virtually fireproof (Blackburn and Bruner 1975, Clements and Young 1997).

Management Implications. The influence of modern wildfires contrast sharply with the historic role of fire. Modern wildfires are more intense owing to the buildup of woody fuels. The presence of cheatgrass can markedly influence succession following wildfire by converting landscapes that were historically covered by saltbrush and sagebrush-bunchgrass to annual grasslands. This can result in more frequent ignitions and close-interval fires.

The effect of fire on vegetation varies greatly because of differences in pre-burn floristics, plant vigor, growth form, and season of burning (Wright et al. 1979, Everett 1987, Miller 1988). Livestock utilization levels also influence the success of plant regeneration following fire. Over the long-term, fire is a rejuvenating agent on sites supporting plants that reproduce vegetatively. Fire can benefit sagebrush-bunchgrass, mountain shrub, and riparian communities by creating a mosaic of successional stages. Thinning and removal of sagebrush and replacement of decadent shrubs and deciduous trees with vigorous shrubs, trees, and herbaceous vegetation is beneficial to wildlife. Large high-intensity wildfires are less beneficial since they produce less edge and require a longer recovery time.

The increased density and canopy closure of pinyon-juniper woodlands is a major resource management challenge. Excessive livestock utilization and thickening of the tree cover has resulted in the loss of both herbaceous and browse plants. Many stands will not burn except under extreme temperatures and high winds. When the trees are 4-6 feet in height and still contain an understory they burn more readily.

Wildfire will continue to occur and may increase because of major increases in fuel. This is apparent in localities where livestock grazing has been eliminated or substantially reduced. In localities where the potential for plant recovery is high, there is opportunity to reduce woody fuels and rejuvenate vegetation by use of prescribed fire. Where native plants have been displaced by exotics, fire treatment is not a viable option unless the area can be successfully artificially revegetated.

WILDLIFE RESPONSES TO FIRE

Although fire can injure and kill wildlife, behavioral mechanisms generally tend to minimize this impact. The most important influences of fire on wildlife result from impacts on vegetation communities. Forage availability, plant growth form, and plant species distribution are interdependent habitat elements. The effect of fire on these elements impacts wildlife habitat choices. Animal physiologic make-up and behavioral plasticity interact with vegetation and climate in the post-fire environment to determine how animals adapt to habitat change (Riggs et al. 1995). Small mammals respond quickly to burned habitat. Vegetation at ground level may be little or great depending on pre-burn conditions (Ward 1977).

Wildlife species such as mule deer (*Odocoileus hemionus*), who depend on trees and shrubs for protective cover, may react negatively to their loss of cover when burned. However, mule deer find the increase in quantity and quality of forage in the burned areas to be an attractant (Stager 1977). In the later successional stages when shrubs or trees have restored cover, habitat conditions peak. Successional changes which lead to old, even-aged tree and shrub communities adversely impact habitat. Fire rejuvenates depleted habitats (Gruell 1996).

Pronghorn

Within the Great Basin, pronghorn (*Antilocapra americana*) occupy sagebrush-steppe ecosystems of low rolling topography with few slopes more than 30 percent in grade. Their population density reflects the quality and quantity of vegetation. Habitats with ground cover averaging 50 percent, rich in species of grasses, forbs, and shrubs, are preferred habitats (Kindschy et al. 1982). Characteristics of vegetation relate to habitat quality because the plants provide nutritional needs, water for physiological requirements, and protective cover for fawns from predators. Often the ecological stage of vegetation regulates the occupation and abundance of pronghorn in habitat sites (Yoakum 1996). Year-long food habit studies disclose that pronghorn have preference ratings of 4.7 for forbs, 1.5 for shrubs, and 0.2 for grasses (Yoakum 1990, Lee et al. 1998).

Yoakum (1996) reported that wildfire conversion of extensive tall, dense shrubland consisting predominantly of big sagebrush led to pronghorn reinhabiting a site where none had been observed for greater than 75 years. Wildfires followed by artificial seeding changed the vegetation to favor pronghorn. Shrub densities decreased, herbaceous forage plants increased and there was a decrease in vegetation height and density.

Based on studies, Yoakum (1996) developed the following management guides:

(1) Vegetation communities with plant composition of approximately one-third each of grasses/forbs/shrubs should be maintained and protected from fires.

(2) Extensive rangelands dominated by decadent shrubs can be managed with fire to create a mosaic of plant classes in various growth stages.

(3) It is unlikely that ecosystems with a healthy production of native herbaceous vegetation will need artifi-

cial seeding following fires. Seeding of productive areas can be politically motivated and wasteful.

(4) Extensive wildfires that limit forage availability, repetitive fires that follow with the invasion of undesirable alien plants, and the loss of shrubs vital for winter survival are not desirable.

(5) Sites lacking a healthy stand of herbaceous plants prior to a fire can be artificially seeded. Plant species should include a variety of grasses, forbs, and in some cases preferred shrubs. Dryland alfalfa (*Medicago* spp.) is a species adapted to semi-arid rangelands and is a preferred forage for pronghorn (Kindschy et al. 1982). Grasses preferred by pronghorn are fine textured species as opposed to coarse bunchgrasses. Species that remain succulent into the autumn should be considered.

(6) Rangelands needing restoration should consider the 10 basic principles of big game habitat restoration advocated by Plummer et al. (1968) and Yoakum et al. (1980).

(7) Successive prescribed fires that provide a mosaic of successional stages for vegetation provide greater diversity of preferred forage species.

(8) Vegetation should be monitored in 3 to 5 year intervals to determine if the vegetation meets the requirements of pronghorn for the ecosystem, and whether vegetation status remains static, or is increasing, or decreasing.

The influence of fire on pronghorn habitat was reported for the North Eccles Ranch area in Elko County, Nevada. This site was slated for the translocation of pronghorn to augment a small, stable population. However, a series of fires burned patches of the rangeland, followed by years of precipitation favorable for plant growth. These environmental factors changed the vegetation by increasing succulent, nutritious herbaceous forage and pronghorn more than doubled during a 10-year period (Ray Lister, personal communication 1998).

Disturbances such as fires that improve and maintain optimum habitat requirements of the pronghorn should be the management goal (Yoakum 1978, 1980, Kindschy et al. 1982, Yoakum et al. 1995, Lee et al. 1998).

Mule Deer

Mule deer occupy a wide range of habitats from open montane and subalpine coniferous forest, forest edges, woodlands, and shrubsteppe rangelands (Bradley et al. 1992). Habitat cover requirements include thermal (often provided by trees and tall shrubs) and escape (often shrubs of less height and density). Canyons and ravines in mixed topography supplement and enhance vegetation escape cover (Leckenby et al. 1982). Preferred food includes various forbs, shrubs, and some grasses (Bradley et al. 1992).

Many Great Basin mule deer populations peaked in the 1950s. These populations have since declined. Decreases in mule deer abundance can be explained partly by habitat changes attributed to plant succession resulting in shrubs becoming old and decadent, and a decrease and depletion of understory vegetation. At lower elevations, repeated wildfires have resulted in the conversion of native shrub/grass habitats to environments dominated by exotic annual grasses which are missing important habitat components. These changes had significant negative impacts on mule deer (Clements and Young 1997).

Mule deer may also respond positively to wildfires. In the early successional stages following a one square mile fire on a sagebrush and bitterbrush dominated western Nevada winter range, mule deer were found to forage 1/4 mile into the burn. Utilization of antelope bitterbrush was concentrated at the edge, however, approximately 150 yards inside and outside the burn (Tausch and Tueller 1972). This pattern of use in recently burned areas is typical.

Stager (1977) completed a study of 11 wildfires, ranging in age from 2 to 115 years, in Great Basin pinyon-juniper woodlands. Burns 2-4 years old were in grass-forb stage of succession. Deer did not penetrate the burns but concentrated within 100 yards of the burn edge in the unburned woodland. In the 16 and 17-year-old burns no differences were found in the distribution of deer within or outside of the burned areas. Sagebrush had re-invaded these sites, but antelope bitterbrush, a favored mule deer forage, had not yet recovered from the fires.

Stager (1977) reported that on burns older than 24 years, in shrub-dominated stages of succession, signs of mule deer were distributed throughout the burned areas. In most cases, distribution was greater in burned areas than in undisturbed woodland. The attraction to the burned areas was still obvious in the 115 year-old fire.

Many recent burns do not provide the thermal and escape cover that deer require. Shrubs necessary for winter food are often absent (Stager 1977). Summer forage, however, is usually enhanced by burning. Stager (1977) found the younger-aged burns ranging from 2 to 24 years, had significantly higher forb cover than did the surrounding areas. Salwasser (1979) reported forbs provided needed nutritious preferred forage during the pregnancy and lactation period beneficially affecting fawn production and survival.

Forbs are an important component of the spring and summer diet of mule deer (Kufeld et al. 1973, Spalinger 1980). Short (1971) found forbs to be high in crude protein and with high digestibility coefficients. Forb quality and quantity were considered to be important factors in influencing the productivity of two mule deer herds studied in Utah (Pederson and Harper 1978). The herd on summer range with forage that was 52 percent forbs had greater carcass weights and greater fawn productivity than a rangeland with only 12 percent of the forage being forbs.

Improved forage quality is a factor favoring fire in depleted or stagnated mule deer habitats, but this benefit may be compromised by the lack of cover in areas that are burned. Unless the lack of cover is offset by surviving trees, snags, or landscape features such as steep topography (Leckenby et al. 1982, Riggs et al. 1995), the size of the burn is an important factor. Large burned areas may receive mule deer use of the edge, but because of size, they may not be fully utilized (Stager 1977).

High intensity wildfires often occur on mule deer winter ranges where shrub habitat is replaced by exotic annual grasses. In many cases where conversion has occurred, the habitat reburns at a frequency that prevents the establishment of shrubs.

Bighorn Sheep

In the Great Basin, a healthy forb, grass, and open shrub community is the most desirable vegetation habitat for bighorn sheep (*Ovis canadensis*). They avoid tall dense stands of trees and shrubs (Van Dyke et al. 1983). Preferred habitat requirements for desert bighorn are usually rugged and steep arid terrain typified by rock, broken areas having ledges and caves. Vast regions of low growing vegetation generally free of visual obstruction are needed. Food habit studies disclose that diets average 40 percent grasses, 20 percent forbs, and 40 percent shrubs. Bighorns consume about 4 pounds of air-dry forage per day. Fires are a disturbance factor that have maintained or enhanced vegetation diversity and aids in the improvement of nutritional forage quality (Wilson et al. 1980).

On the Desert National Wildlife Range adjacent to the Great Basin in southern Nevada, 44 percent of bighorns surveyed were in burned pinyon-juniper woodlands. The burns encompassed only a small part of the range, but resulted in stands of early succession herbaceous vegetation (Graf 1981). Graf concluded fires could be used to increase herbaceous vegetation at the expense of trees and shrubs, thus improving forage for bighorns.

Fires at Hart Mountain National Antelope Refuge in south-central Oregon appeared to have influenced distribution of bighorn sheep. Approximately 1,500 acres of bighorn habitat was prescribed burned during spring and fall of 1994. Thirty-three percent (5/15) of the rams harvested during September 1994 were taken within the area burned the previous spring. The number of rams harvested from the burned area has increased each year. Fifty-five percent (10/18), 93 percent (14/15), and 100 percent (12/12) of sheep harvested on Hart Mountain were associated with the burn during 1995, 1996, and 1997, respectively (U.S. Fish and Wildlife, Lakeview, Oregon, unpublished data).

Wild or prescribed fires that convert shrub and tree dominated habitat to herbaceous and shrub environments are a compatible ecological forces benefitting this species.

Rabbits and Hares

Pygmy rabbits (*Sylvilagus idahoensis*) are a sagebrush obligate lagomorph. They inhabit dense stands of sagebrush and other shrubs on deep alluvial soils formed by streams and rivers. In Oregon, Weiss and Verts (1984) reported greater shrub cover and height at sites inhabited by pygmy rabbits. These sites provide forage, escape cover, and conditions favoring burrow construction. Sagebrush is consumed throughout the year and is the primary food source during winter (Green and Flinders 1980). Summer diets are more diverse with grasses making a third of the composition (Green and Flinders 1980, Zeveloff 1988).

Pygmy rabbits are colonial and tightly clumped in distribution, which makes the species vulnerable to habitat disturbance, such as fire, that removes shrubs at the colony site. Pygmy rabbits are susceptible to rapid declines and possible local extirpation. Furthermore, fragmentation of shrub communities may pose a potential threat by limiting dispersal into favorable habitats (Weiss and Verts 1984).

Cottontail rabbits (*S. nutalli* and *auduboni*) are widely distributed in the Great Basin. They inhabit shrub-covered hills, are often associated with rocky ravines, and show a preference for willows along river bottoms (Chapman et al. 1982). Cottontail diets consist of a variety of plants. Typically, sagebrush is the primary diet during the fall and winter, whereas grasses dominate the diet during spring and summer (MacCracken and Hansen 1984).

In the Great Basin, white-tailed jackrabbits (*Lepus townsendi*) prefer open grasslands, grassy higher slopes, and ridges up to and above timberline. Lim (1987) reported that grassland was the most used habitat by a multiple of 4 over shrubland or meadowland. Black-tailed jackrabbits (*L. californicus*) occur throughout the Great Basin in sagebrush habitats. Jackrabbit diets consist of a variety of grasses, forbs, and shrubs in early spring. Grasses are favored in late spring and early summer and shrubs provide the most forage in the late autumn and winter (Currie and Goodwin 1966).

Fire in sagebrush dominated rangelands in the Great Basin can be expected to improve habitat for cottontails and jackrabbits. The goal should be to manage for healthy rangelands, including a mosaic of successional stages that provide a greater mixture of grasses, forbs, and shrubs.

Columbian Sharp-tailed Grouse

Columbian sharp-tailed grouse (*Tympanulchus phasianellus columbianus*) have nearly disappeared from their historic Great Basin range. The subspecies was common in northeastern and northcentral Nevada (Linsdale 1936). Sharp-tails were extirpated by the early 1960s (Wick 1955, Alcorn 1988). Across most of their historic range, investigators have cited habitat modification from excessive livestock grazing, conversion to farmlands, herbicide treatments, invasion of conifers, deforestation of riparian zones, and urban development as reasons for the sharp-tailed grouse decline (Hart et al. 1950, Yocom 1952, Buss and Dziedzic 1955, Marshall 1969, Starkey and Schnoes 1976, Zeigler 1979, Leatham and Roberson 1980, Bredehoft 1981, Evanich 1983, Oedekoven 1985, Marks 1986, Giesen 1987, Klott 1987, Marks and Marks 1988). Historical documents suggest that sites dominated by a mosaic of perennial grass and deciduous shrubs and trees were preferred habitats.

Generally, sharp-tailed grouse occupy a diverse shrubsteppe with a significant grass and deciduous shrub component (Giesen and Connelly 1993). Sagebrush, serviceberry, and snowberry are shrubs they favor. Summer brooding habitat is most often categorized as the mountain brush zone with a diversity of forbs and bunchgrasses. Interspersion of various habitat types was considered important with most summer observations occurring in close proximity to a habitat edge. Critical components of winter habitat are specific. Grouse appear to be highly associated with riparian or mountain shrub communities.

Giesen and Connelly (1993) suggested that small, well designed prescribed fires could be used as a management practice for Columbian sharp-tailed grouse on sites where dense sagebrush communities could be enhanced with openings containing grasses and forbs. Winter habitats with crown sprouting shrubs can be enhanced with prescribed burning. Rogers (1969) reported that grouse used small openings created by fire in dense sagebrush.

Sage Grouse

Historically, sage grouse (*Centrocercus urophasianus*) were widely distributed and were associated with sagebrush throughout the Great Basin (Gabrielson and Jewett 1940, Klebenow 1985, Roberson 1986). Sage grouse populations have declined and in some areas have been extirpated (Crawford and Lutz 1985, Klebenow 1985). Conversion of native rangelands associated with human settlement, livestock grazing, introduction of exotic plants, and mining all have been cited as contributing factors in the reduction of sage grouse populations (Rogers 1964).

Some sage grouse populations are relatively sedentary, others travel long distances between summer and winter habitats (Dalke et al. 1963, Berry and Eng 1985, Connelly et al. 1988). Sage grouse habitat requirements include a diversity of vegetation types throughout the year. Low sagebrush (*A. t. arbuscula*) is important for breeding and brood-rearing and big sagebrush is critical for nesting, brood-rearing, and winter cover. Both low and big sagebrush are an important food source throughout the year. The importance of sagebrush as the primary component of sage grouse habitat is well documented (Braun et al. 1977). Virtually every study that examined the effects of sagebrush removal in sage grouse habitats concluded that sage grouse were detrimentally affected (Rogers 1964, Klebenow 1970, Martin 1970, 1976; Pyrah 1971, Wallestad 1975). However, a diverse and healthy herbaceous understory is important as well. A variety of annual and perennial forbs are an important dietary component of pre-laying hens (Barnett and Crawford 1994) and chicks (Peterson 1970, Drut et al. 1994). Tall (greater than 7 inches) residual grass cover is an important component of nesting habitat (Wakkinen 1990, Gregg et al. 1994, DeLong et al. 1995).

Prescribed fire may be used as a management practice to open dense stands of shrubs, create habitat mosaics, and increase availability of some forbs and grasses (Klebenow 1970, 1972; Wright et al. 1979, Winward 1985, Kauffman 1990). Reintroduction of fire may create diverse stands in different seral stages in juxtaposition that improves brood habitat in the short-term by increasing forb availability (Crawford et al. 1992). This also improves nesting habitat in long-term by promoting favorable understory conditions (Klebenow 1985, Pyle and Crawford 1996). Prescribed fire, however, is not a viable sage grouse habitat management tool under all circumstances. Shrublands invaded by cheatgrass or other noxious species would not likely respond favorably to treatment with fire without artificial postfire seeding. Fischer et al. (1996) did not find a favorable short-term response by sage grouse broods when a xeric Wyoming sagebrush community in Idaho was treated with prescribed fire.

Waterfowl and Waterbirds

Wetlands are unique environments characterized by shallow or fluctuating water levels and an abundance of aquatic and emergent vegetation. Although wetlands comprise a small component of Great Basin habitats, they provide important habitat for a variety of waterfowl, waterbirds, and other wildlife. Ducks, geese, and swans use wetlands in the Great Basin primarily during migration and winter. Some species use available wetlands during spring and summer for nesting and brood-rearing. Shorebirds, sandhill cranes (*Grus canadensis*), and other birds associated with wetlands are common during spring and summer.

Prescribed fire has been used to improve wetlands for wildlife. Prescribed fires in wetlands are conducted annually at Sheldon National Wildlife Refuge and Hart Mountain National Antelope Refuge in the northern Great Basin to enhance habitat for waterbirds (D. Dearborn, personal communication 1998). As in all fire-influenced habitats, fire in wetlands creates greater diversity and edge between age groups of vegetation (Vogl 1967, Stroud et al. 1995). Prescribed fires in wetlands typically are conducted when water levels are at or above root horizons, when water or soil is frozen, or when air temperatures are low. These fires are effective in reducing dense stands of dead vegetation, removing encroaching cattails (*Typha* spp.), and encouraging more productive and palatable regrowth (Schlichtemeier 1967, Stroud et al. 1995). This benefits waterfowl by promoting growth of desirable food plants, providing open areas for feeding and loafing, and enhancing nesting habitat by providing more water-vegetation edge. For example, prescribed fires in wet meadows are used to manage habitat for grazing species of waterfowl, such as Canada geese (*Branta canadensis*), by providing succulent and palatable vegetation.

Some wetland sites may have to be protected from fire. Heron and egret nesting colonies in hardstem bulrush (*Scirpus acutus*) rely on residual vegetation from previous years for nesting substrate. Live stems may be important later in the nesting season. Burning would have removed the dead stems leaving no nesting substrate for the birds. If suitable nesting habitat is limited, the nesting sites should be protected from fire (Giles and Marshall 1959, Bray 1984).

Song Birds

The variety of song bird species are individually adapted to combinations of plant community and structural condition for feeding, reproduction, or both (Maser et al. 1984). Fire in shrub and woodland ecosystems results in a conversion of multi-layered ecological habitat niches into a single layered forb dominated community (Ward 1977). A mosaic of burned and unburned sites results in ecotones that provide foraging opportunities for a broad range of ground, foliage, and aerial feeders. Burning can create habitat for snag dependent species (Mason 1981).

Species diversity and abundance of birds increased after prescribed burning in the pinyon-juniper woodlands in eastern Nevada (Mason 1981). The type of bird species changed from primarily canopy feeders to ground, aerial, and nectar feeders following burning. The most important variable affecting the type and number of species that responded to burning was the amount of vegetation that became established after the burn. Major species included common bushtit (*Psaltriparus minimus*), Brewer's sparrow (*Spizella breweri*), mourning dove (*Zenaidura macroura*), rufous-sided towhee (*Pipilo erythrophthalmus*), mountain chickadee (*Parus gambeli*), chipping sparrow (*S. passerina*), purple finch (*Carpodacue purpureus*), and common nighthawk (*Chordeiles minor*).

Following sagebrush-grassland wildfires in the vicinity of Reno, Nevada, the grass and forb dominated areas contrasted with adjacent unburned shrubland (Klebenow and Beall 1977). During the nesting season, grassland inhabitants that used the burns included horned larks (*Eremophila alpestris*) and western meadowlarks (*Sturnella neglecta*). Mourning doves, western meadowlarks, sage sparrows (*Amphispiza belli*), Brewer's sparrow, sage thrashers (*Oreoswcoptes montanus*), and loggerhead shrikes (*Lanius ludovicianus*) were found in the unburned shrublands. By late summer, the burns were widely used by seed eaters. Mourning doves, in particular, shifted their habits and were most abundant in the burns, whereas they were seldom found there during the nesting season. The seeds of many forbs were available in the burned areas in comparison to the unburned.

In Idaho, Peterson and Best (1987) reported no response by sage sparrows or sage thrashers to prescribed burning in a sagebrush community despite nearly 50 percent reduction in sagebrush. Brewer's sparrows declined immediately after fire, but recovered dramatically 32 years after the burn.

Other Small Mammals

Small mammals have been classified as fire-neutral, fire-negative, or fire-positive species (Kauffman 1990). Response to fire is dependent on the ecological niche occupied by a species, (Maser et al. 1984). For example fire eliminates habitat for woodrats (*Neotoma* spp.), a woodland species. and creates habitat for Great Basin kangaroo rats (*Dipodomys ordii*), a grass-forb successional species (Bradley et al. 1992). The rapidity with which small mammals recolonize disturbed areas depends on several factors including the presence of refugia, and the size and severity of the disturbance (Kaufman 1990). Immediate impacts are relatively short because of vegetation recovery and rapid reproduction by small mammals (Riggs et al. 1995).

Fire does not likely change species richness, but relative abundance can be altered (Riggs et al. 1995). This is not always the case, however. For example, a prescribed fire in a pinyon-juniper woodland in Nevada increased abundance but slightly decreased species diversity in rodent populations (Mason 1981). The most important factor affecting the type and number of species that responded to burning was the amount of vegetation that became established after the burn.

MANAGEMENT CONSIDERATIONS

Fire was a common occurrence in the Great Basin at the time of Euro-American settlement. Research suggests it has been occurring at low intensities in light fuels for thousands of years. The role of fire was drastically reduced through the removal of light fuels by heavy livestock grazing, elimination of Native American ignitions, and aggressive fire suppression. The absence of fire and improved livestock grazing management has resulted in a marked increase in the yearly occurrence of wildfire. Most fires are suppressed, but those that take place during hot, windy weather reach large size and burn at high intensity, despite aggressive fire suppression responses. From all indications, large high-intensity wildfire will continue to occur and may increase because of major increases in fuel.

Fire is a natural disturbance agent in plant succession. Plant response to fire depends on pre-burn floristics, fire characteristics, and time since fire. Wildfire often burns at high intensities, whereas prescribed fires are ignited under moderate conditions to permit fire control. Fire has the potential to greatly alter wildlife habitats by altering plant composition and production. High intensity wildfire in sagebrush-annual grass rangelands is considered detrimental to most wildlife species because it promotes fire frequency and the dominance of exotic annual grasses. Over the long-term wildlife habitats that can be enhanced by fire are those with good productivity potential with deep soils and good native plant components. Prescribed fire applied at low to moderate intensities can benefit wildlife habitats. The ultimate benefit of fire on wildlife depends on the conversion of vegetation, providing more nutritional forage and better cover. By providing a mosaic of successional stages in an area, forage nutrition can be enhanced and healthy habitat needs met in the long term even for species that favor the later successional stages. For example, deer and pronghorn prefer a mosaic of shrub communities in various stages of plant succession. These provide shrub production for winter use and herbaceous plants for spring and summer nutrition to support fawn production and survival.

Death or injury of wildlife by fire is not considered an important consideration except in extreme cases. Losses may occur during erratic, high intensity, fast moving wildfires. Being adapted to fire, small mammals escape in underground burrows, large mammals move to safe areas, and birds take flight. Wildlife losses during prescribed fire are insignificant owing to low fire intensity. Loss of nests may occur when prescribed fires are conducted during spring.

POSITION STATEMENT

As wildlife professionals, the Nevada Chapter of The Wildlife Society endorses the concept and practice of ecosystem management. Landscape planning across political and administrative boundaries is advocated with the use of scientific management data to achieve productive wildlife habitats supporting diverse, healthy, wildlife populations. Therefore, based on scientific and managerial findings, the Nevada Chapter of The Wildlife Society's position relative to the influences of fire on wildlife habitats in the Great Basin is:

(1) Fire is a critical natural disturbance agent that influences native plant succession and wildlife habitat condition. As a management tool, prescribed fire needs to be reintroduced in the Great Basin for purposes of enhancing the condition of wildlife habitat.

(2) Many Great Basin wildlife habitats are dominated with old-aged shrubs as a result of the absence of fire and other factors. A program that encourages a mosaic of plant communities in various successional stages can enhance the environmental health of these habitats.

(3) Many Great Basin wildlife species are adapted to herbaceous, open shrub habitats that historically supported a variety of perennial grasses, forbs, and shrubs. Decadent and homogenous shrub habitats can be rejuvenated and made diverse through application of prescribed fire, thus improving the quality of plants preferred by wildlife.

(4) Wildlife species that are adapted to later stages of vegetation growth now find many of these habitats in nutritionally poor condition. Over the long-term, a carefully applied program of prescribed fire can rejuvenate these habitats by providing a mosaic of young, more vigorous plant communities.

(5) Use of prescribed fire is not a viable alternative on deteriorated rangelands dominated by exotic annual grasses and forbs—unless followed by artificial seeding of perennial plants with wildlife value.

(6) Wildfires that remove wildlife habitat creating large vegetational monotypes or occurring in plant communities that do not recover readily through successional change may be damaging to wildlife populations.

(7) Some wildlife habitats are limited and fragmented in their distribution. These habitats meet the requirements of certain species. Examples are colony-nesting birds such as those associated with certain plant species and pygmy rabbits associated with big sagebrush and other shrubs in dense thickets. These habitats should not be intentionally burned without the development of a management program that provides linkage and alternative habitats.

(8) In any management program, the use of prescribed fire must be evaluated to insure that management objectives are met and to reveal new insight in the dynamics of fire on wildlife habitat.

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