APPENDIX 6—WILDLAND FIRE MANAGEMENT

GENERAL RISK CATEGORIES

General Risk Category A

Category A includes areas where fire is not desired at any time and where mitigation and suppression are required to prevent direct threats to life or property. In addition, Category A includes areas where fire has never played a major role historically in the development and maintenance of the ecosystem (e.g., vegetative communities such as blackbrush ecosystems and shadscale ecosystems), and some areas where fire return intervals were very long (such as spruce communities). Other examples are very mesic sites and very xeric sites.

Emphasis will be placed on those actions that will reduce unwanted ignitions and reduce losses from unwanted wildland fires.

Emphasis will be placed on prevention, detection, and rapid suppression response and techniques. Non-fire fuel treatments will be used.

General Risk Category B

Category B includes areas where wildland fire is not desired because of current conditions. It includes areas where fire may naturally have performed an important role in the ecosystem function, but because of current resource concerns and potentially high economic impacts from unplanned ignitions (including in some wildland/urban interface areas), considerable constraints and mitigation measures are required. Sagebrush ecosystems, for example, can fall into this category because of encroachment of cheatgrass or a prolonged lack of fire that leads to large monotypic stands of sagebrush that will not burn as they would have historically.

The appropriate management response is usually aggressive suppression response and techniques.

Response will emphasize prevention and mitigation programs that reduce unwanted fire ignitions and resource threats.

Fuels reduction is a major means of mitigating the potential risks and losses. Fire and non-fire fuels treatments are used to reduce the hazardous effects of wildfire. Prescribed fire projects are often complex and costly because of stringent contingency planning. Hazardous fuel treatments may consist of multiple non-fire treatments before fire will be used.

General Risk Category C

Category C includes areas where wildland fire use is desired, but significant constraints must be considered for its use. Ecological, social, or political constraints must be considered prior to wildland fire use. These constraints could include air quality, threatened and endangered species considerations (e.g., effect of fire on survival of species), or wildlife habitat considerations. Resource considerations will be described for each Fire Management Unit in the annual update of the Fire Management Plan.

In multiple wildland fire situations, Category C areas would generally receive lower suppression priority than category A or B areas.

Fire and non-fire fuels treatments will be used to reduce the hazardous effects of wildland fire. Prescribed fire treatments for hazard reduction are a lower priority than in the category A or B areas.

General Risk Category D

Category D includes areas where wildland fire use is desired, and there are few or no constraints. In these areas, fire is an integral component in maintaining or achieving the desired vegetative condition for affected lands, and there are fewer mitigation requirements or resource constraints. Wildland fires may be managed to meet resource management objectives under an approved Fire Management Plan.

Areas in this category would have the lowest suppression priority in a multiple fire situation.

There is generally less need for hazardous fuel treatments in Category D areas. If treatment is necessary, however, all fire management activities may be used.

FIRE ECOLOGY OF MAJOR COVER TYPES

The way in which fire affects vegetation is an important component of this appendix; it is that direct relationship that influences many of the effects on other resources. The existing vegetation communities reflect evolutionary processes, natural disturbance, recent climatic trends and patterns, historic fire management, (e.g., suppression), and other land use practices (e.g., livestock grazing) that directly affect fuel loading, community composition (e.g., invasive concerns such as cheatgrass, knapweeds, tall peppergrass), and fire return intervals.

Historically, fire played an essential role in the landscape that helped define species composition, structure, and productivity (Bradley et al. 1992, Paysen et al. 2000). Therefore, many plants that make up these communities are adapted to withstand wildfire through a variety of anatomical or physiological mechanisms. However, over the past century, aggressive fire suppression efforts, introduction of exotics (e.g., cheatgrass), juniper encroachment, and some land management practices have altered the fire ecology and dynamics of successional processes across the Richfield Field Office (RFO). Therefore, current-day fire return intervals for many vegetation communities have changed in comparison with historic patterns because of a drastic decrease in fire occurrence and size (Brown 2000). Understanding the fire ecology of the major vegetation cover types is important to reintroducing wildland fire into the environment and restoring natural fire regimes, as well as to understanding the impacts from the proposed decisions. The remainder of this appendix addresses the fire ecology of the dominant vegetation cover types in the RFO.

Desert Shrub

Desert shrub composes nearly half of the vegetation acreage of the RFO, including most of the lower elevation public lands east of Capitol Reef National Park. Located primarily on the valley floors, this vegetation community is most common on well-drained, sandy to rocky soils; however, it can tolerate saline and alkaline soils. Desert shrub is characterized by salt-tolerant succulent shrubs including greasewood, seepweed, ephedra, shadscale, four-wing saltbush blackbrush, and threadleaf rubber rabbitbrush. A single or a few species dominate large areas, creating homogeneous landscapes. There is very sparse vegetation in the interspaces in intact native communities. Biological crusts are usually present and cover most of the interspaces between shrubs in intact, native species-dominated salt desert shrub communities. Cheatgrass expansion into this vegetation type poses a serious threat because it provides a continuous understory of fine fuel and reduces fire return intervals in otherwise non-fire-adapted communities.

Fire Ecology

The desert shrub community is not a fire-adapted community because most shrub species are fire sensitive. Even low-intensity fires can kill most species because most do not resprout or resprout weakly. A lack of continuous cover (e.g., fuels) has made historic fire rare to non-existent. Historically, these communities did not burn often enough or in large enough patches to support dominance of fire-adapted plants. Saltbush communities, however, are considered fire tolerant primarily because saltbush and many of its grass associates resprout vigorously and recover quickly (Evers 1998). In areas with a high percentage of cover of desert grasses, low-intensity fires may have been more common than in more shrub-dominated areas.

Fires in blackbrush were historically infrequent, and this vegetation community is characterized by Fire Regime V and Condition Class 2. This ecosystem is at moderate risk of losing key ecosystem components because of fire.

Recent experience on Utah Bureau of Land Management (BLM) land has shown that blackbrush does not respond favorably to fire. In addition, most of the blackbrush in Utah has suffered substantial dieback because of recent ongoing drought conditions. Burning has promoted succession to grassland by destroying the biological crust that stabilizes the soil. The biological crust provides important soil microflora apparently required for blackbrush survival or reestablishment (Paysen et al. 2000). Frequent large fires can be problematic from a management standpoint because recovery can take more than four decades or, in some cases, not occur at all (Wright and Bailey 1982, Paysen et al. 2000). Fire frequently destroys blackbrush seed banks and mature shrubs.

Fire frequency in the desert shrub communities has been estimated at 35 to more than 300 years for the desert shrub vegetation type (USDA Forest Service 2004). Because of the risk of losing key ecosystem components and greatly increased fire regimes as invasive annual grasses (e.g., cheatgrass) dominate, desert shrub is typically classified as Fire Regime Condition Class 3.

Pinyon-Juniper

Pinyon-juniper woodlands make up more than 25 percent of the vegetation cover in the RFO. It is estimated that pinyon and juniper woodlands have increased 10-fold over the past 130 years throughout the Intermountain West (Miller and Tausch 2001). Forest Inventory and Analysis data collected in the RFO revealed that more than 67 percent of identified plots had a stand age of less than 150 years. Throughout the RFO, this age discrepancy is indicative of juniper woodland expansion to more than 60 percent of its historic range. This expansion is largely a result of historic fire suppression in range communities, primarily grasslands and sagebrush, as well as a reduction of fine fuels that allowed fire to regularly remove young trees from grass/sagebrush ecosystems.

Juniper is considered a climax species for a number of pinyon-juniper, sagebrush steppe, and shrub steppe habitats. Old-growth pinyon-juniper is often restricted to fire-safe habitats, e.g., steep, dissected, and rocky terrain. Old-growth pinyon-juniper can be characterized by large trees, the presence of extensive dead woody material, increased number of canopy layers, rounded canopies, large lower limbs, and large, irregularly shaped and deeply furrowed trunks (Miller et. al. 1999, Miller & Rose 1999).

Pinyon-juniper stands that are most likely to burn are characterized by small, scattered trees with abundant herbaceous fuel between the trees, or dense, mature trees capable of carrying crown fire during dry, windy conditions. Stands of moderate tree density, where overstory competition reduces the herbaceous fuel, and the trees are more widely spaced, are unlikely to burn. Closed pinyon-juniper stands do not have understory shrubs to carry a surface fire, and do not burn until conditions are met to carry a crown fire. Trees taller than four feet in open pinyon-juniper stands are difficult to kill unless there are heavy accumulations of fine fuel beneath the trees. Because of the lack of undergrowth to act as fuel on dry sites, fire may never have been as important an influence as climatic fluctuations in governing the rate of tree replacement of shrubland or grassland. Moister, more productive sites probably have had more extensive and frequent fires when drought periods occurred. The steady increase in crown fuels has allowed burning through areas with deep soils (formerly sagebrush communities) at higher than normal intensities. These sites have never experienced such intensities and therefore are not adapted to this new fire regime.

Fire Ecology

Most of the area where pinyon-juniper currently dominates was historically characterized by fires burning every 15 to 50 years (Miller and Tausch 2001). Pinyon-juniper in Utah is typically described by Condition Class 2 (elevations greater than 7,000 feet) or 3 (elevations less than 7,000 feet). Areas of Condition Class 3 are characterized by dense stands of pinyon-juniper, scarce understory, and high potential for cheatgrass invasion following fire. Condition Class 2 areas have encroaching pinyon-juniper but are less dense than Condition Class 3 and are at less risk of cheatgrass invasion following fire. Areas of old-growth pinyon-juniper have experienced fire frequencies of 200 to more than 300 years (Goodrich and Barber 1999) and would be classified as Fire Regime V. However, this old-growth component is estimated to be less than 10 percent of the current area classified as pinyon-juniper (Miller and Tausch 2001).

Surface fires readily kill thin-barked young pinyon and juniper trees and have been relatively frequent historically in areas on which juniper has now encroached. It is generally agreed that fire was the most important natural disturbance that impacted the distribution of juniper and/or pinyon-juniper woodlands before the introduction of livestock in the 19th century (Miller and Rose 1999). Burkhardt and Tisdale (1976) concluded that fire frequencies of 30 to 40 years would control juniper expansion into mountain big sagebrush communities.

Sagebrush

Sagebrush cover types compose about 16 percent of the RFO. Historically (e.g., presettlement) sagebrush steppe is estimated to have dominated as much as 30 percent of the RFO. Sagebrush has been lost because of juniper encroachment, historical seedings for forage production (e.g., crested wheatgrass), and cheatgrass conversion.

Because seral diversity applies to sagebrush, a considerable portion of the acreage listed under perennial grasslands (native) and areas with recent sagebrush seedings may be considered as representing the early seral component of sagebrush communities. Healthy sagebrush is a patchwork mosaic of seral communities that range from recovering perennial grass-shrublands following natural fire, to old growth, decadent sagebrush steppe with high canopy cover and reduced herbaceous understory. In the past 100 years, the extent of sagebrush has been greatly reduced because of conversion to irrigated agriculture, livestock grazing, juniper encroachment, cheatgrass conversion, and the deliberate eradication of sagebrush for range improvement.

Low-elevation sagebrush, generally found below 6,500 feet, is dominated by basin big sagebrush and Wyoming big sagebrush. Mid-elevation sagebrush occurs at mid to high elevations (greater than 7,000 feet), is characterized by dominance of mountain big sagebrush, and appears less vulnerable to conversion to annual grasslands than low-elevation shrub steppe. On the other hand, mid-elevation sagebrush steppe is more vulnerable to encroachment of juniper as a result of fire suppression compared with lower-elevation sagebrush. Grass and forb species associated with these low- and mid-elevation sagebrush communities assist with the spread of fire. When domestic livestock are heavily grazed in sagebrush communities, the understory becomes sparse and can prevent the spread of fire. Ignition probabilities have also declined substantially because of the lack of fine grass fuels.

Fire Ecology

Fire frequency in sagebrush varies for the different sagebrush species but is considered to be between 10 and 110 years depending on precipitation, elevation, and sagebrush species. Presettlement stand-replacing fire frequencies for low-elevation sagebrush are estimated to vary from 60 to 110 years (Whisenant 1990, Peters and Bunting 1994). For mountain big sagebrush, presettlement stand-replacing fire frequencies have been estimated to vary between 10 and 25 years (Houston 1973, Harniss and Murray 1973). Wyoming sagebrush communities burned about every 40 years. Sagebrush is considered to be in Condition Class 2 if it is above 6,500 feet and Condition Class 3 if it is below 6,500 feet because of the high risk of losing key ecosystem components resulting from cheatgrass invasion following fire.

The cold-desert climate, with cold, wet-to-dry winters and springs, and dry, hot summers predispose sagebrush communities to an evolutionary history with recurring fire. Wright et al. (1979) surmised that the interval between fires must have been sufficiently long for big sagebrush, which does not resprout and recolonizes from seeds, to regain dominance.

Most sagebrush species do not sprout after fire, and most plants are killed by low- to high-intensity fires. This is true of all three subspecies of big sagebrush common throughout the RFO. Generally, the herbaceous understory composition does not determine the intensity and severity of wildland fires; sagebrush itself is the primary fire carrier. The high canopy cover associated with late mature sagebrush stands likely facilitated stand-replacing fires historically. However, the prefire understory is an important determinant of post-fire response. Because sagebrush seeds generally are not transported far from the parent, unburned areas within large burn areas are often the most important source of seed material for natural recruitment and reestablishment of sagebrush.

Grassland

Grasslands in the RFO include native perennial grasslands and seedings of native species and exotic perennial grasses, primarily crested wheatgrass; and some cheatgrass is classified as grassland. Cheatgrass is discussed more extensively below.

Crested wheatgrass-dominated grasslands are the deliberate result of historic range improvement projects and post-fire seedings. Other perennial grasslands have expanded in portions of the RFO as a result of the eradication of shrubs, especially sagebrush species or by wildland fires on relatively good condition rangelands where cheatgrass did not invade or does not dominate. Native perennial grasslands are an intermediate successional stage that would eventually return to a diverse sagebrush steppe habitat if allowed to recover for extended periods (e.g., 20 to 70 years) without impacts from wildland fires. Native perennial grass species include Idaho fescue, bluebunch wheatgrass, needlegrass, grama grass, and Indian ricegrass.

Perennial grasslands dominated by crested wheatgrass and/or other non-native species are stable communities that do not trend toward recovery to sagebrush steppe habitat as quickly as native perennial grasslands. Historically, native perennial grasslands would have formed part of the seral mosaic of the sagebrush steppe habitat, although it is unclear how widespread they once may have been across the landscape.

Fire Ecology

Because native grasslands are often seral to sagebrush, fire regimes are similar. Perennial grasses respond vigorously to fires of various intensities by resprouting from basal growing points. The primary determinant of fire response in native perennial grasslands is fire residence time. Fast, high-intensity fires have a short residence time and seldom cause substantial mortality to native perennial bunchgrasses. Slow backing fires have a longer residence time and greater severity; mortality to native perennial bunchgrasses may be high under these conditions. With most natural ignitions, the predominant fire spread would be as a fast moving head fire.

Mountain Shrub

Mountain shrub occupies about 2 percent of the RFO and occurs as a transition vegetation type between mid-elevation sagebrush and conifer vegetation types. This cover type is found at moderately high elevations (7,000–8,500 ft.). Mountain shrub is usually found on north and east slopes that tend to be cooler and moister than south and west aspects. Mountain shrub is a highly diverse community: Gambel oak, chokecherry, serviceberry, currant, mountain snowberry, elderberry, and mountain sagebrush. With its characteristically high productivity and diverse herbaceous understory, it provides important biodiversity, wildlife habitat, and protective ground cover to the ecosystem.

The range of most mountain shrub species has been shrinking as a result of fire exclusion and overgrazing by ungulates. Pinyon-juniper and sagebrush have encroached into sites where fires would have historically prevented their spread into the mountain shrub community. The range of Gambel oak, however, is estimated to be greater today than it was historically (Brown 1958, Christensen 1949, Christensen 1957).

Fire Ecology

Stand-replacing fire frequency ranges from 25 to 100 years in mountain shrub (Loope and Gruell 1973), although return intervals may vary widely with changes in elevation, aspect, site moisture, and the associated forest or woodland type. Fire regimes in mountain shrub cover types vary depending on the dominant species. Condition classes also vary depending on the dominant species, although most mountain shrub communities are in Condition Class 2 because of some missed fire return intervals, moderate risk of losing key ecosystem components, and moderately altered vegetation attributes. However, some mountain shrub communities at lower elevations (below 6,500 feet) are classified as Condition Class 3 because of their high risk of cheatgrass invasion following fire.

All species of mountain shrubs resprout after fire except mountain sagebrush. Mountain shrub communities generally recover rapidly following wildland fire and are considered to be fire tolerant.

Ponderosa Pine

Ponderosa pine occupies less than 2 percent of the RFO, mainly located in the Henry Mountains. Ponderosa pine communities are naturally characterized by an open, savannah-like appearance in which widely spaced large trees are present with open understories that are periodically cleared by low-intensity ground-fires.

Historically, frequent low-severity fire probably restricted the accumulation of large downed woody fuels. Fine fuels (e.g., grasses and needles) were the medium through which historical fires spread because most large fuels (e.g., limbs and trunks) would have been consumed by the frequent fires. Historic land management practices, along with fire exclusion, have created stand conditions that were rare or non-existent prior to European settlement. The absence of disturbance has encouraged a conversion to a higher proportion of shade-tolerant species such as Douglas fir and white fir. These stands are in the mid- to mature-age classes, overly dense, and more susceptible to insect and disease epidemics (Fule et al. 1997). The steady accumulation of tree biomass has contributed to progressively declining herbaceous productivity. Ladder fuels are well developed and contribute to unwanted wildland fires outside the historical range of intensity and severity.

Fire Ecology

Mature ponderosa pines have thick bark, which protects them from serious damage from surface fires. It is considered to be the most fire-adapted conifer in the west (Bradley et al. 1992). Fire frequency for ponderosa pine communities ranges from 10 to 40 years, with low- to mixed-severity (USDA Forest Service 2004) fires. Ponderosa pine forests in the RFO are classified as Fire Regime I and Condition Class 3. These forests have typically missed up 5 to 10 fire cycles in the years of fire suppression and are at risk of stand-replacing canopy fires.

Mixed Conifer

Major forest community types of mixed conifer include Douglas fir, Engelmann spruce, and sub-alpine fir. These communities occupy more than 1 percent of the RFO and generally occur at elevations above 7,000 feet. These forest types do, however, have a high value for recreation, aesthetics, and special and status species habitat. Forest composition varies with elevation, exposure, and latitude. Fire frequency varies with summer dryness and lightning occurrence and also depends on slope, aspect, elevation, and natural fire barriers.

Because of selective logging practices over the last 100 years, favoring the removal of ponderosa pine and Douglas fir, and fire exclusion, these stands are now dense and even-aged. Once adapted to a more frequent fire regime, they are now predisposed to endure high-intensity fires from the development of ground and ladder fuels. Stand-replacing fires outside the historical range of intensity and severity are likely. Closed stands with dense Douglas fir understories present the highest fire hazard. Stands may have large amounts of downed twigs and small branchwood. Dense overstory trees and the presence of dead branches near the ground create a crown fire potential under severe burning conditions.

Fire Ecology

Fire frequencies range from 100 to 300 years, and these forests are often characterized by a combination of understory and complete stand-replacement fire regimes (Arno 2000). Because of the longer historic fire return intervals and well-functioning vegetation attributes, mixed conifer is classified as Condition Class 1 when associated with Fire Regime IV and Condition Class 2 when associated with Fire Regime III.

This mixed severity fire regime often results in a mosaic pattern of stand structure and fuels. Past stand burn mosaics tend to increase the probability that subsequent fires will also burn in a mixed pattern (Arno 2000). Dead woody fuels accumulate on the ground, often in a haphazard manner, and the greatest fuel loadings tend to occur on the most productive sites, which are predominantly stand-replacement fire regimes.

Aspen

Aspen-dominated communities occupy less than 1 percent of the RFO. Aspen communities can be climax or seral to conifer communities (e.g., Douglas fir) and are found between elevations of 6,500 feet and 10,500 feet. Aspen occurs as pure stands or in association with various conifers. Although conifer invasion is a natural pattern in many aspen stands, because of long-term fire suppression throughout the

RFO, it has resulted in increased representation and dominance by conifer in aspen stands, thus reducing the extent of aspen-dominated stands (Mueggler 1989). The absence of fire, coupled with excessive browsing of young aspen trees by livestock and wildlife, has led to rapid replacement of aspen communities by conifer forests (Bartos 1998). However, the presence of conifers does increase aspen stand flammability and therefore may be essential to carrying the fire to regenerate aspen on the site. Brown and Simmerman (1986) found that livestock grazing reduces fine fuels so that fire intensity and rates of spread may be as low as one-tenth that of ungrazed stands.

Areas with small amounts of aspen in a stand may indicate that the area was once dominated by aspen (Bartos and Campbell 1998). Throughout national forests in Utah, including the adjacent Fishlake National Forest, aspen-dominated landscapes have declined by about 60 percent (Bartos and Campbell 1998). Aspen in the RFO, either adjacent to Forest Service land or in the Henry Mountains, is intermingled with and adjacent to stands of mixed conifer stands. Conditions noted throughout Utah are not expected to be different than those in the RFO.

Fire Ecology

Fire frequencies range between 25 and 100 years with mixed severity (Loope and Gruell 1973). Aspen is characterized by Fire Regime IV and Condition Class 2. Fire regimes have been moderately altered, and vegetation structure has been moderately altered from the historical.

Pure stands of aspen are particularly susceptible to mortality of above-ground stems from fire of low intensity, even though aspen is well adapted to regeneration by sprouting after fire (Jones and DeByle 1985). Aspen stands do not easily burn and often act as natural fuel breaks during wildland fires. Fires in young aspen stands tend to be low-intensity surface fires unless there is a great deal of understory fuel. In older stands, during the warmest and/or driest months of the year, abundant fuel can lead to higher intensity fires.

Riparian/Wetland

Riparian areas occupy only a small portion of the overall landscape (less than 1 percent of the RFO), typically in narrow stringer communities along both sides of the rivers and streams and adjacent to springs. Native tree communities may be dominated by Fremont or narrowleaf cottonwoods with understories of shrubs (such as sandbar, whiplash, and Booth's willows) and herbaceous species.

Invasive species, such as tamarisk, tall whitetop, and Russian olive, along with greasewood, have become well established in the riparian communities and are slowly replacing the native vegetation across much of Utah.

Fire Ecology

Fremont cottonwood communities are characterized by a late seral stage (e.g., all mature to late-mature trees) with little or no representation of younger age-classes and are not typically fire adapted. Narrowleaf cottonwood is a somewhat fire-adapted species that may resprout from roots, provided the stands are not decadent and occur in areas where the water table remains reasonably high throughout the growing season. Willow species typically sprout vigorously following a fast-moving fire. Slow-moving fires are generally more damaging, presumably because of greater heat transfer to root crowns.

Although many riparian species may resprout following a fire, this community is not considered a fire-dependent ecosystem. Historically, fire in these riparian communities would have been infrequent, and vary from small size, with highly mosaic burn patterns as a result of the higher moisture content generally present in riparian areas/species, to stand-replacing burns likely to have occurred only in extreme drought periods. These riparian communities are classified as Fire Regime IV, with most areas presently in Condition Classes 2 and 3. Lower elevation riparian areas would be in Condition Class 3 because of the higher incidence and potential of invasive species.

Cheatgrass

The effects of cheatgrass on fire ecology raise the importance of addressing it in this appendix. Introduced from Eurasia in the late 1800s (USDA Forest Service 2004), cheatgrass is an opportunistic winter annual that germinates anytime between autumn and spring when temperatures and soil moisture are suitable. It outcompetes native grasses that grow dormant through winter and are slower to develop in the spring. This exotic species may be present in relatively undisturbed plant communities but easily becomes dominant if a site is disturbed. Cheatgrass has been less successful in dominating sites that are above elevations of 7,000 feet, but there are known populations of cheatgrass at higher elevations.

Fire Ecology

The establishment of cheatgrass fosters much more frequent fire return intervals. Shortened natural/historical fire rotations impact perennial vegetation by killing the tops of the plants and allowing little time (e.g., few growing seasons) between recurrent fires. However, the fire regime of cheatgrass-dominated sites is the historical fire regime of that site before it was invaded by cheatgrass. For example, where cheatgrass has invaded a salt desert scrub community, the fire regime would be Fire Regime V. Wherever cheatgrass threatens to dominate the landscape, the vegetation type is managed as Condition Class 3 because of the potential for loss of key ecosystem components (e.g., native species).

The presence of cheatgrass in a wildland community extends the time during which the community is susceptible to wildland fire ignitions. In the summer, cheatgrass dries out 4 to 6 weeks earlier than perennial grasses and forms a fine-textured, highly flammable fuel. Cheatgrass may also be susceptible to fire one to two months longer in the fall because perennial grasses may green up following periods of moisture in the autumn (Paysen et. al. 2000).

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