Journal of
Environment
(JE)

Prescribed Fire as a Tool for Management of Grasslands

CARI Journals

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 4, Issue No. 3, pp 19– 40, 2024
www.carijournals.org

Prescribed Fire as a Tool for Management of Grasslands

Dr. John Oloo, PhD, CPM, CCM.

Department of Natural Resources Management, School of Spatial Planning and Natural Resource Management,

Jaramogi Oginga Odinga University of Science and Technology

https://orcid.org/0009-0006-3408-9463

Accepted: 30th Oct, 2024, Received in Revised Form: 14th Nov, 2024, Published: 22nd Nov, 2024

Abstract

Purpose: The purpose of this research was to investigate how prescribed fire as a tool can be used for the management of grasslands with specific questions: (i) What is the importance of prescribed fire? (ii) What is the importance of grasslands?

Methodology: The methodology used was systematic literature review and the findings were; prescribed fire is useful in: reduction of fuels, altering vegetation communities, improving wildlife habitat, releasing of nutrients, removing seed dormancy and helps in killing disease vectors while grasslands are useful in provision of *grass for ruminants, Grass for perfumes, alcohols and beverage*, Ecosystem services, Climate regulation, Erosion prevention, Tourism, recreation, and hunting, Cultural heritage, spiritual, and social cohesion.

Findings: In conclusion, based on the provisions of prescribed fire and grasslands, there is every need to use prescribed fire in grasslands management.

Unique Contribution to Theory, Policy and Practice: For managers intending to use this tool, I recommend that a smaller area of less than ten hectares of grassland should be used for experiment first and results observed. After that, then larger areas can be burnt because the manager would have gotten the necessary skills and competency. The objectives of using prescribed fire should be well stated.

Keywords: *Fire intensity, fire severity, grassland, prescribed fire*

INTRODUCTION:

The origin of fire is tied to the origin of plants. Plants are responsible for two of the three elements essential to the existence of fire: oxygen and fuel. The third element, a heat source, has been available throughout the history of Earth mainly through lightning (Pausas and Keeley, 2009). A story on native burning was written by Sharon Levy (2005), a freelance writer in Arcata, California. Levy wrote about Amelia Lyon, who was a member of the Hupa Tribe of northern California. Amelia practiced what generations of women in her culture did—maintaining the open oak woodlands near what is now Redwood National Park. Amelia tended the open oak stands by burning the undergrowth every year and thereby encouraging health and vigor in the standing trees, and more important. Other historical accounts suggest that the Takelma women (from the Rogue Valley of interior southwest Oregon) were responsible for the majority of the seasonal burns used for harvesting foods (Tveskov *et al*, 2002). They used fire to roast and collect sunflower and tarweed seeds, grasshoppers, and yellow jacket larvae, and to make it easier to locate acorns for collection while also suppressing boring insects. These regular fires in the oak or grass savanna also encouraged the growth of healthier basketry materials; the same was done at higher elevations to encourage the new growth of bear grass, the leaves of which are another important basket-weaving and regalia-making materially, generous acorn crops. Since her death in the late 1800s, the native tradition of burning ended.

In some instances, the Takelma used fire during warfare to scare away or hinder travel of competing tribes or to use the smoke to cover up an escape. They also used fire to burn potential enemy hiding places and to signal war activity to nearby groups (Tveskov *et al*, 2002, Pullen 1996, LaLande and Pullen, 1999). For the Takelma, fire was an essential tool for maintaining healthy food sources year after year. As a result of the tarweed seed, grasshopper, and deer-drive burns, overgrowth of brush and small trees was kept to a minimum, maintaining a larger open, oak savanna. The Takelman use of anthropogenic fire provided them with sustainable food resources, but also maintained a healthy habitat for large game animals, encouraged biological diversity, minimized fuels, and decreased the probability of catastrophic wildfires (LaLande, 2004).

While a fast-moving, wind-driven fire may be intense (lots of heat), a long-lasting fire that just creeps along in the forest underbrush could transfer more total heat to plant tissue or soil in a given area. In this way, a slow-moving, low-intensity fire could have more severe and complex effects on something like forest soil than a faster-moving, higher-intensity fire in the same vegetation. (Hartford and Frandsen, 1991). Development of the incipient fire is dependent on the characteristics and configuration of the fuel involved. If there is adequate oxygen, additional fuel will become involved and the heat release rate from the fire will increase; this is considered the growth stage. The flashover point is the sudden transition from a growth stage to fully developed fire. When flashover occurs, there is a rapid transition to a state of total surface involvement of all combustible material within the compartment. In the post-flashover stage, energy released is at its greatest but is limited by ventilation. When the available fuel is consumed or there is limited oxygen, the fire is then considered in decay stage. Prescribed fire is a planned fire; it is also sometimes called a "controlled burn" or "prescribed burn," and is used to meet management objectives. A prescription is a set of conditions that considers the safety of the public and fire staff, weather, and probability of meeting the burn objectives. After many years of fire exclusion, an ecosystem that needs periodic fire becomes unhealthy. Trees are stressed by overcrowding; fire-dependent species disappear; and flammable fuels build up and become hazardous. The right fire at the right place at the right time:

- Reduces hazardous fuels, protecting human communities from extreme fires;
- Minimizes the spread of pest insects and disease;
- Removes unwanted species that threaten species native to an ecosystem;
- Provides forage for game;
- Improves habitat for threatened and endangered species;
- Recycles nutrients back to the soil; and
- Promotes the growth of trees, wildflowers, and other plants, ((Hartin, 2008).

Prescribed burning is the intentional, controlled application of fire to a forest to accomplish the objectives of a landowner or land manager (US Forest Service, 1989). Prescribed burning includes fires designed for site preparation purposes and for forest understory maintenance (Figure 1). In this section, prescribed burning refers to a surface fire that burns under the canopy of an established stand of live trees (Carter and Foster, 2004). These types of fires may be used in either even-aged or uneven-aged forests. Weather conditions, fuel moisture conditions, and soil conditions must be considered to determine the likelihood that a fire would be (1) confined to the area of interest once lit; and (2) conducted with the intensity of heat and rate of spread that would meet its objectives (Ford-Robertson, 1971). Prescribed burning could be used to assist in the development of a forest with a preferred species overstory, a mid-story free of undesirable plant vegetation, and an understory composed of desirable herbaceous and woody plants (Haywood, 2009). In other words, prescribed fires can be used to promote or maintain the development of wildlife habitat characteristics.

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 4, Issue No. 3, pp 19– 40, 2024
www.carijournals.org

Figure 1: Prescribed fire in action in a young southern United States pine forest.

Prescribed burning activities are generally moderate- to low-intensity endeavors (as it relates to upward release of energy and subsequent damage to tree crowns) that are repeated 1–5 years in a forest following the first burn. However, the objectives of a landowner or land manager would suggest whether prescribed burning activities are even necessary. At times, prescribed fires are used to reduce fuel loads and thus act as a wildfire prevention tool. Other times periodic fires are needed to maintain forest types, such as the longleaf pine (*Pinus palustris*) forest type of the southern United States (Bruce, 1951). Prescribed fires can also benefit the growth of forests by controlling diseases such as the brown spot needle blight (McCulley 1948, Bruce, 1951). Prescribed fires should be designed to meet the specified silvicultural objectives without negatively affecting off-site social values. The smoke produced by fires may not only be a nuisance for nearby communities but may also increase the risk of accidents on roads and harm poultry farms. Within the area being burned, prescribed fires can result in a short-term increase in mineral nitrogen in the soil surface and an increase in phosphorous, the level of which is a function of the duration and intensity of the fire (Galang *et al*, 2010). However, over time, prescribed burning can prevent or reduce accumulations of nutrient capital that would otherwise occur naturally (Carter and Foster 2004).

Although fires can occur at anytime of the year, dormant season fires are generally most common in grasslands. In tallgrass prairie, burning at the end of winter dormancy (i.e., early spring) is a common management practice. Spring burning generally increases total plant productivity by stimulating growth of the warm-season grasses, particularly in times (wet years) or locations (deeper soils) with adequate soil water available. This is due primarily to the removal of the large amount of plant detritus (up to 1,000 g m _2) that accumulates in the absence of the fire and the changes in microclimate and soil resource availability induced by the removal of detritus (Knapp and Seastedt, 1986).

According to www.wlf.louisiana.gov those sites where prescribed burning can be safely used, landowners should consider how prescribed burning will help them meet their management objectives and develop a plan that will enable them to effectively use this tool. Landowners should consider the following in their plan:

1. Establishment of fire breaks - Firebreaks can be plowed as needed, but many landowners should consider permanent fire breaks that can be planted with a cover crop that will serve as a food plot and reduce soil erosion.

2. Burning rotation - For most landowners in Louisiana, prescribed burning should be conducted on a two to three year rotation. There are some situations where annual burning is warranted and others where longer rotations are needed.

3. Size of burn units - Landowners should usually avoid burning their entire acreage in the same year. Burning a portion of the property every year will create a patchwork of cover types and provide better habitat for wildlife.

4. Timing of burns - Traditionally, prescribed burning was conducted during the late winter. However, burning can be conducted nearly year round. Results from burns vary according to time of year, for instance February burns will impact vegetation differently than a May burn.

5. Impacts on timber resources - While pines are fire resistant, some are less resistant than others. Longleaf pine is the most fire resistant and can be burned within a couple of years of establishment. On the other hand, loblolly and slash pine should not be burned until they are 10 12 years old.

6. Fuel accumulation - Land that has not been burned in several years may have a high accumulation of fuel. These sites can and should be burned to reduce the risk of wildfire, but extreme care should be exercised. High accumulations of fuel can not only make the fire difficult to control, but can cause damage to valuable trees if proper precautions are not taken.

Grassland as an ecological land type is defined as “land on which the vegetation is dominated by grasses” (Forage and Grazing Terminology Committee, 1991). The ecological basis for these land types depends on climatic factors including temperature and soil moisture. Kinds of grasslands including meadows, prairies, rangeland, savannas, steppes, or tundra are often referred to as *natural grasslands*. *Grazingland* as a type of grassland use is an all-inclusive term and refers to “any vegetated land that is grazed or has the potential to be grazed by animals” (Forage and Grazing Terminology Committee, 1991). Kinds of grazingland include pastureland, grazeable forest land, and rangeland. Other grasslands include those managed principally for agricultural production, such as pasture, silage, and hay, as well as some lands set aside for conservation, such as the acreage in the Conservation Reserve Program.

With about 10,000 species worldwide, the grass family (Poaceae or Gramineae) is the fourth largest of the plant families. In the United States, taxonomists have described many species of grass ranging from the common lawn and pasture species Kentucky bluegrass (*Poa pratensis* L) to the giant river cane [*Arundinaria gigantea* (Walt.) Muhl.] native to gulf coast marshes (Barnes and Nelson, 2003). The vegetative parts of grasses have a uniform structure across species (Fig. 2; Chase, 1948). The basic vegetative structure of all grasses includes a stem with solid nodes and a leaf at each node. The stem section between nodes is termed the *internode*. Leaves are normally arranged alternately on the stem. The entire leaf consists of the leaf blade and the leaf sheath. At the junction of the blade and sheath there is a collar, sometimes with two points called *auricles*, and a thin papery structure on the inside called the *ligule*. Grass shoots are formed by repeating units (termed *phytomers*) of leaves, nodes, and internodes. Grasses spread by forming new shoots called *tillers* either from the base of the main plant stem or from lateral underground growth of stems, called *rhizomes*, or lateral growth aboveground of horizontal stems, called *stolons.* The reproductive parts of grasses are highly varied and specialized. The seed head or inflorescence of a grass holds the inconspicuous flowers in units termed *spikelets*. Within the spikelet are the individual florets or flowers of the grass. Different names are used to describe grasslands in different regions. In North America, grasslands are called **prairies**. In South America, grasslands are referred to as pampas and cerrados. In Africa, they are **savannas** and **veldts**; in Australia, they are **downs**; and in Asia and Europe, they are **steppes**. Different grasslands support different amounts of non-grass vegetation. For example, savannas generally have scattered trees, whereas trees are rarer in steppes and prairies. Figure 3 shows animals grazing in a prairie.

Figure 2: Orchardgrass plant illustrating the basic structural units of a grass

Source: Plant illustration is adapted from the USDA-NRCS PLANTS database (http://plants. usda.gov/); Britton and Brown (1913).

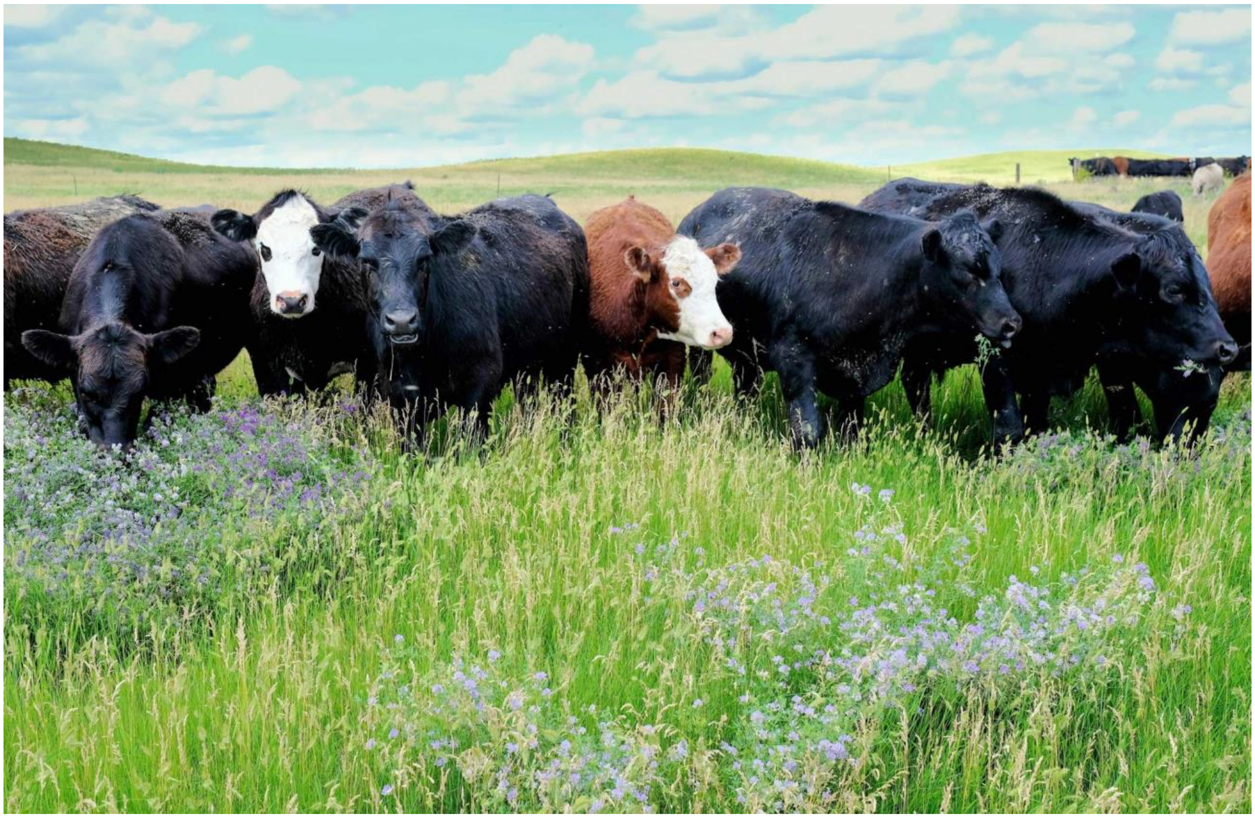

Figure 3: Cattle grazing on a prairie, South Dakota, U.S.A., 2018. Photo by Lars Plougmann (flickr, Creative Commons Attribution-ShareAlike 2.0 Generic license, image resized).

Three major types of grasslands can be distinguished within agricultural production systems: natural, semi-natural, and improved grasslands (Bullock et al. 2011, Lemaire *et al,* 2011). Natural grasslands forming the grassland biomes are natural areas mainly created by processes related to climate, fire, and wildlife grazing (Parr *et al*, 2014), but are also used by livestock. Semi-natural grasslands are the product of human management, require livestock grazing or hay-cutting for their maintenance, and will generally be encroached by shrubs and trees if taken out of production (Queiroz et al. 2014). Improved grasslands are pastures resulting from plowing and sowing agricultural varieties or non-native grasses with high production potential. They are usually artificially fertilized and maintained by intensive management (Suttie *et al,* 2005, Pilgrim et al. 2010). Grasslands have declined worldwide during the last century (Egoh *et al*, 2016), mainly due to conversion to arable land for production of animal feed crops and, conversely, lack of management and abandonment (Queiroz et al. 2014). In southern Africa (SA), more than 20% of the grassland biome has been cultivated, 60% is irreversibly transformed to other land uses (Fairbanks *et al*, 2000), and most of the remainder is used as rangeland for livestock (O'Connor and Bredenkamp, 1997). Over 90% of the semi-natural grasslands in northern Europe have been lost since the 1930s (Eriksson et al. 2002, Bullock *et al.* 2011, Pe'er *et al*, 2014). In North America, 80% of the central grasslands has been converted to cropland (Foley et al. 2005, Suttie *et a*l, 2005). Similarly, more than 43 million hectares of the Eurasian steppe have been converted into cropland, and 60–80% of the grassland area in SouthAmerica is degraded (Suttie *et al*, 2005).

Global surface temperatures have increased by 0.6 ± 0.2°C during the 20th century and are projected to increase by 1.5 to 5.8°C by the end of the 21st century (Intergovernmental Panel on Climate Change, 2007). Regardless of the potential causes of this warming, an increase in surface temperature will almost certainly influence regional precipitation patterns. Many climate-change predictions suggest that periodic droughts will become more common and extreme rainfall events more frequent. A combination of increased dry periods interspersed with larger individual rainfall events will result in extended periods of soil moisture deficit and greater variability in soil water content. Such a change may have important consequences for grasslands. For example, the timing of rainfall events may be more important than changes in rainfall amount in affecting important ecosystem properties like CO2 uptake and forage productivity (Intergovernmental Panel on Climate Change, 2007).

Recognition of ecosystem services that grasslands provide (e.g., soil and water conservation, carbon sequestration, wildlife habitat) will likely increase. It will require innovative management to balance the preservation of these services with the demands of a growing population seeking a

diet rich in animal products. Management practices that reduce the productive potential of grassland soils and thus undermine our ability to provide food and fiber for an expanding population must be avoided. New knowledge is needed to balance management intensification with preservation of grassland ecosystem services. Increased use of grassland-based agriculture in the United States makes sense from both economic and environmental perspectives. To ensure that we achieve a balance of productive use and preservation from grassland resources, we must invest in research and training to educate future students, producers, and the general public about the multifunctional nature of grasslands and the services they provide. By taking this approach now, we can better prepare for the management challenges that will face grasslands in the next 60 years.

According to Peter's et al, 2012, grasslands can be classified as follows:

(i) **Grasslands:** Land devoted to the production of forage for harvest by grazing/browsing, cutting, or both, or used for other agricultural purposes such as renewable energy production. The vegetation can include grasses, grass-like plants, legumes and other forbs. Woody species may also be present. Grasslands can be temporary or permanent. Two management categories can be identified:

Meadows: grasslands that have been harvested predominantly by mowing over the last 5 years1 or since the establishment of the sward if it is less than 5 years old.

Pastures: grasslands that have been harvested predominantly by grazing over the last 5 years2 or since the establishment of the sward if it is less than 5 years old.

(ii) **Permanent grasslands:** Grasslands used to grow grasses or other forage (self-seeded or sown and/or reseeded) and that have not been completely renewed after destruction by ploughing or spraying (herbicide) for ten years or longer. They can be agriculturally improved, semi-natural, natural or no longer used for production. European permanent grasslands can be dominated by:

- one or several grass species;
- one or several grass species and one or several legume species
- grasses, several forb species and possibly legume species;
- grass-like species and possibly forb species;
- shrubby zones (see ‘semi-natural grasslands’ for more information);
- grazed wooded areas (see ‘semi-natural grasslands’ for more information).

(iii) **Natural and semi-natural grasslands**: Low-yielding permanent grasslands, dominated by indigenous, naturally occurring grass communities, other herbaceous species and, in some cases, shrubs and/or trees. These mown and/or grazed ecosystems have not been substantially modified by fertilization, liming, drainage, soil cultivation, herbicide use, introduction of exotic species and (over-)sowing. The occurrence of natural grasslands is not related to human activities, in contrast to the latter

(iv) **Agriculturally improved permanent grasslands**: Permanent grasslands on good or medium quality soils, used with more frequent defoliations, higher fertilization rates, higher stocking rates and producing higher yields than natural and semi-natural grasslands. Agriculturally improved permanent grasslands can be dominated by:

- one or several grass species;
- one or several grass species and one or several legume species;
- grasses, one or several forb species and possibly legume species.

Agriculturally improved permanent grasslands are often classified, in terms of production, on the basis of the proportions of high-, medium- and low-productivity/quality grasses as well as on the proportion of legumes.

(v) **Permanent grasslands no longer used for production**: Areas of permanent grasslands, regardless of the grassland type and the previous use, upon which the produced biomass is no longer used for agricultural production purposes, but which are maintained in good agricultural and environmental condition by appropriate measures.

(vi) **Temporary grasslands**: Grasslands sown with forage species that can be annual, biennial or perennial. They are sown on arable land and can be integrated in crop rotations or sown after another grassland vegetation. They are kept for a short period of time, from a couple of months to (usually) a few years. They can be established with pure sowings of legumes, pure sowings of grasses or grass-legume mixtures.

(vii) **Rangelands**: Extensive, large-scale grazed grasslands. Rangelands can be fenced or not but they are usually not fenced, so a shepherd is often needed. Rangelands are dominated by grazed semi-natural vegetation. They may include natural and semi-natural grasslands, shrublands, steppes, tundras, alpine communities, marshes and the understorey of forestland.

(viii) **Grazed common lands**: Permanent grasslands where two or more persons have the right to let their animals grazing concurrently; in some cases these rights are not permanently vested in the same individuals but are allocated from time to time by a body with legal authority to do so.

It is estimated that as many as 800 million people worldwide rely directly on grasslands for their livelihoods, and virtually everyone uses grassland products (food, fiber, fuel) in their daily existence. In total, it is clear that grasses and grasslands have played an important role in the history of humans and will continue to do so in the future. Grasslands and other grass- and graminoid-dominated habitats (e.g., savanna, open and closed shrubland, and tundra) occur on every continent except Antarctica (though some grasses do occur there) and occupy about 30–40 % of Earth's land surface. They cover more terrestrial area than any other single biome type (White *et al*, 2000). Grasslands are truly multifunctional. Not only do they produce food and fiber for humans, but they also provide many ecosystem services on which humans depend. Such ecosystem services include soil erosion control, soil fertility improvement, water conservation and protection, wildlife habitat, pollution buffers, recreational uses, biofuel production, and an agricultural system termed *grassland agriculture* (Nelson and Burns, 2006; Havstad *et al*, 2009, this volume). Managing grassland multifunctionality will become increasingly important in the future because of a growing population, environmental concerns, and ever-tightening energy supplies.

According to Long (1999), properly managed prescribed fire can provide the following benefits:

(i) Reduces the risk of wildfire by decreasing dense understory shrubs, harvest residues and accumulated dead fuels.

(ii) Improves wildlife or grazing habitats.

(iii) Maintains successful forest regeneration.

(iv) Cycles nutrients for healthy ecosystems.

(v) Preserves fire-dependent species.

(vi) Controls insect and disease problems.

(vii) Improves forest access.

(Long, 1999)

RESEARCH QUESTIONS AND FINDINGS.

Question One: What is the importance of prescribed fire?

According to www.wlf.lousiana.gov, the following objectives are achieved by controlled burning:

(i) reduction of fuels

Arson, human carelessness and lightning will inevitably ignite wildfires. If fuel loads (dead vegetation, pine needles, brush) are high, these fires can develop into intense fires that damage forest resources and property. Regular prescribed burning removes accumulated fuels, thereby reducing the risk of intense wildfires. Prescribed burning is conducted when weather conditions favor a controllable fire. In contrast, wildfires usually occur when conditions favor rapid spread. Prescribed burning for fuel reduction may not significantly decrease the number of fires, but will reduce their severity. Prescribed burning must be repeated at regular intervals to maintain the protective effect of reduced fuels. In the long growing sea- sons of the south, it takes only four to five years for fuels to return to hazardous levels.

Photo by Wayne Adkins, USDA Forest Service, *forestryimages.org*

(ii) Altering Vegetation communities

Although not readily apparent, plant communities are constantly changing. If left unchecked, a longleaf pine forest will eventually become a hardwood-dominated forest and a prairie will become a forest. Fire is the process that halts this change and maintains our native plant communities. It does so by impeding the growth of invading plants such as sweet-gum or yaupon that are not adapted to fire and encouraging growth and development of those that are fire-adapted such as pines, grasses and many wildflowers. Prescribed burning also changes the structure and density of existing vegetation. For example, a prescribed fire may reduce the density of young sweet-gum trees in a pine stand. This increases the amount of sunlight that reaches the ground, encouraging growth of grasses and herbaceous vegetation

Photo by Dale Wade, Rx Fire Doctor, *forestryimages.org*

(iii) Improving wildlife habitat

Prescribed burning is one of the best tools for improving wildlife habitat in grasslands and pine-dominated forests. Shrubs and herbaceous plants experience a flush a new growth following a fire. This new growth is more nutritious and palatable to grazing and browsing wildlife than the "rough" vegetation that occurred before the burn. Many of the beneficial insects consumed by birds are more abundant following a fire. Fires promote flowers, seeds and fruit production which increases food for wildlife. Vegetative structure is an overlooked, but important component of habitat for wildlife and can be enhanced by prescribed burning. For many species of wildlife, periodic prescribed fire is crucial to their maintenance of their habitat.

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 4, Issue No. 3, pp 19– 40, 2024 www.carijournals.org

Photo by William M. Ciesla, Forest Health Management International,

forestryimages.org

(iv) Important considerations

Experienced practitioners of prescribed burning consider a wide variety of factors in order to safely conduct a prescribed burn. Some of those considerations include fuel load, fuel moisture, wind speed and direction, relative humidity, temperature, smoke dispersal in the atmosphere, and the location of the property relative to sensitive areas such as roads, schools, hospitals, etc.

(v) Other important considerations include:

(a) Establishment of fire breaks - Firebreaks can be plowed as needed, but many landowners should consider permanent fire breaks that can be planted with a cover crop that will serve as a food plot and reduce soil erosion.

(b) Burning rotation - For most landowners in Louisiana, prescribed burning should be conducted on a two to three year rotation. There are some situations where annual burning is warranted and others where longer rotations are needed.

(c) Size of burn units - Landowners should usually avoid burning their entire acreage in the same year. Burning a portion of the property every year will create a patchwork of cover types and provide better habitat for wildlife.

(d) . Timing of burns - Traditionally, prescribed burning was conducted during the late winter. However, burning can be conducted nearly year- round. Results from burns vary according to time of year, for instance February burns will impact vegetation differently than a May burn.

(e) Impacts on timber resources - While pines are fire resistant, some are less resistant than others. Longleaf pine is the most fire resistant and can be burned within a couple of years of establishment. On the other hand, loblolly and slash pine should not be burned until they are 10-12 years old.

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 4, Issue No. 3, pp 19– 40, 2024
www.carijournals.org

(f) Fuel accumulation - Land that has not been burned in several years may have a high accumulation of fuel. These sites can and should be burned to reduce the risk of wildfire, but extreme care should be exercised. High accumulations of fuel can not only make the fire difficult to control, but can cause damage to valuable trees if proper precautions are not taken.

According to Stubbendieck (EC148), benefits of Prescribed Fire Prescribed fire is not a "magic bullet" that alone will erase past management failures or make up for improper management in the future. However, prescribed fire can yield many benefits if it is used with other sound management practices. In grasslands, prescribed fire can increase grass nutritive quality, palatability, availability and yield, reduce hazardous fuels, suppress unwanted plants, and improve wildlife habitat. Grass quality, palatability and availability are improved because the fire removes dead plant material and improves access to new growth. If soil moisture is adequate, grass yields increase because baring and darkening the soil surface allows it to warm more quickly and stimulate earlier growth, and because competing weeds are suppressed.

Question Two: What is the importance of grasslands?

Grass for ruminants: In many countries of the world, pastoral rangelands are the primary and only resource on which both wild and domesticated herbivores depend. As the human population has increased, pastures has been converted into cropland, resulting in an overgrazing of the remaining grassland. The grassland area decreased in Western Europe with at least 8 million ha since the fifties. In the same period other traditional forage crops, like fodder beets and red clover almost disappeared, while the cultivation of the maize became more popular. Western European dairy farms are nowadays mostly based on the cultivation of two crops: grassland and maize. Man's understanding of the principles of herbivore nutrition and the laboratory techniques to determine them, together with the plant yield and quality production have advanced significantly and nowadays, in intensive production systems, the dietary requirements are calculated with high precision (*Luciene & Carlier, 2014)*

Grass for carbon sequestration: Other specific characteristics give grassland more importance. The capacity to store carbon and to act as a carbon sink, in comparison to arable land, its role in the prevention of erosion, the immobilization of leaching minerals are interesting additional effects in the frame of a sustainable agriculture and development of the countryside. Grasslands are able to sequester about the double quantity of C in the soil in comparison to arable land In this context is worthwhile to notice that permanent grasslands are sinks for carbon sequestration in comparison to arable land. Although livestock enteric fermentation, manure and the use of inorganic fertilizer account for the major share of agricultural greenhouse gasses (GHG) in most developed countries. In the EU, the contribution of agriculture in the total main GHG, carbon dioxide CO2 is only about

2%, it accounts for over 50% of total nitrous oxide N2O and nearly 45% of methane CH4 emissions. Besides, the global warming potential of CH4 and N2O are respectively about 20 and 300 times higher than that of CO2. So some agricultural activities, especially well fertilized grazed grassland and grassland renovation by ploughing the old sward may lead to high GHG emissions and transform grassland from a carbon sink to a carbon source. (Guo and Gifford, 2003; Mestdagh, 2003).

Grass for perfumes, alcohols and beverage: Well-known is the kind of brandy "Zubrowka bison grass wodka" from Poland with a stem of bison grass (sweet grass: *Hierochloe odorata* L.) as a characteristic in the bottle. Other coumarin rich grass species are used in the same way, like sweet vernal grass (*Anthoxanthum odoratum* L.) used in tobacco and herb pillows. There are twelve known varieties of vetiver grass; the most important is *Vetiveria zizanioides* Linn. For centuries the oil extract from the roots of *V. zizanioides* has been used in the perfume trade. Indigenous peoples have recognized vetiver for its medicinal uses, for thatching, mulch, and feed, and for soil and moisture conservation. It grows both on highly acidic (< pH 4) and alkaline soils (pH 11). Its roots will grow to depths of 3 - 4 meters. It is not affected seriously by pests or diseases. Each clump of vetiver is extremely dense, so dense that if con*Fig.*d correctly will act as a near perfect filter. The generic name Vetiver is a Tamil word meaning "root that is dug up" and zizanioides means "by the riverside". The genus *Cymbopogon* accumulates different kinds of essential oils. The essential oil of *Cymbopogon validus*, which chemical composition is reported by Chagonda *et al*, (2000), has been used as an astringent skin toner and anti-ageing for men and has antifungal and antiseptic properties. The predominant compounds, properties and uses of *Cymbopogon* species are described.The essential oil of lemon grass *Cymbopogon citratus* (West Indian lemon grass) consists mainly of citral. Further terpenoids in lemon grass oil are nerol, limonene, linalool and β-caryophyllene. The content of myrcene is low, but still enough to make the oil susceptible to oxidative polymerization. Naidoo (2006).

Ecosystem services

Besides having a high conservation value and supporting food production, grasslands may also be important contributors of Ecosytem services (ES) (Sala and Paruelo, 1997, Pilgrim *et al*, 2010, Bullock *et al.* 2011).. However, grasslands have remained under-appreciated in the framework of ES (Frelichov_a *et al*, 2014), and sometimes, grasslands have been combined with other rangelands that include shrubland, deserts and savannas (e.g., Sala *et al*, 2017). Similarly, grasslands have received substantially less attention in the multiple ES framework compared to other production systems, such as forest (Gamfeldt *et al*, 2013) and cropland (Robertson *et al*, 2014). Grasslands have also been largely neglected in global policy discussions concerning ES (e.g., IPBES, Diaz *et al*, 2015, Pascual *et al*, 2017), despite having been highlighted regionally in, for example, South Africa (Reyers *et al.* 2005; Egoh *et al*, 2016). Not only do grasslands have a local importance for the maintenance of biodiversity and food production, but they also affect

Journal of Environment
ISSN 2789-3863 (Online)
Vol. 4, Issue No. 3, pp 19– 40, 2024 www.carijournals.org

ecological processes at landscape (e.g., pollination), regional (e.g., water regulation, recreation), and global scales (e.g., climate regulation)

Climate regulation

The processes of carbon sequestration, carbon storage as soil organic matter, and fluxes of greenhouse gases in grasslands are intimately linked to each other. It is well established that carbon sequestration increases when grassland management is intensified by increased nutrient inputs, especially nitrogen (e.g., K€atterer *et al,* 2012, He *et al,* 2013). However, the climate mitigation effect of intensified management may be offset by increased emissions of greenhouse gases other than CO2. Permanent grasslands store large amounts of carbon in the soil (Soussana *et al,* 2010, Bullock *et al,* 2011;, Smith 2014), much more than croplands, and sometimes as much as forest soils (Burrascano *et al,* 2016). This carbon is rapidly decomposed and released as CO2 if grasslands are transformed into cropland or intensified by plowing and re-sowing (Soussana *et al*. 2007, 2010, K€atterer *et al*, 2012). Hence, grasslands and their management play a role as potential sinks in the global carbon cycle (Lal, 2004), both in NE and in SA. Plant species composition also influences carbon and nitrogen storage and dynamics in grasslands (e.g., Lemaire *et al*, 2011).

Erosion prevention

Permanent vegetation protects against soil erosion by reducing water runoff and stabilizing the soil. Permanent grasslands can, if not overgrazed or mismanaged, contribute greatly to soil erosion prevention, both in NE (e.g., Souchere *et al*, 2003, Verheijen *et al*, 2009, Pilgrim *et al*, 2010) and in SA, where high energy rainfall and steep gradients result in high erosion potential (Blignaut *et al.* 2010, Dlamini *et al*, 2011. Grasslands often show <10% of the soil erosion seen on croplands (Cerdan *et al*, 2010), although forested land has even lower erosion (Cerdan *et al,* 2010). Erosion prevention by grassland vegetation is strongly coupled to other services relating to water supply and regulation, carbon sequestration, and soil fertility (Hou *et al,* 2017). In NE, the location of grasslands in the agricultural landscape is of great importance. For example, Souchere *et al,* (2003) showed that in landscapes where grasslands had been converted to cropland water runoff (i.e., less infiltration), soil erosion and soil loss increased greatly, but also that a small increase in the amount of grasslands could, if well placed, contribute greatly to erosion control.

Tourism, recreation, and hunting

Natural and semi-natural grasslands are important parts of the cultural landscape in Europe (Emanuelsson, 2009). Some grasslands are protected as nature reserves or national parks and are often advertised as hotspots for local and national tourism (Everson and Morris, 2006, Fischer *et al,* 2008) in both NE and SA. In NE, much of the semi-natural grassland is protected (Bullock *et al*, 2011), but only a small percentage of the SA grassland area is under protection (Rouget *et al,* 2004). However, since many recreational activities are related to the broader landscape, it is difficult in NE to separate the role of semi-natural grasslands from that of improved grassland (UK

NEA, 2011) and the overall heterogeneity of the landscape. A cultural landscape containing grasslands can also be a tourist attraction in itself (e.g., South Downs National Park in England, the Swiss Alps, the SA Drakensberg grasslands) with the landscape potentially playing a significant role in a World Heritage context (Buckley *et al*, 2008). Many outdoor recreation activities such as bird watching, hiking, or hunting are linked to open landscapes (H€onigov_a *et al*, 2012), although in most cases the specific contribution from grasslands has not been examined. Nkambuleet al, (2016) report that local household members use SA grassland areas for recreation and cultural purposes

Cultural heritage, spiritual, and social cohesion

The extensive use and traditional management have made grasslands in NE highly appreciated for their cultural heritage (Fischer *et al*, 2008, Lindborg *et al*, 2008). Many are parts of agri-environmental subsidy systems both for their biological and for their cultural value. Grasslands are also associated with other cultural services such as spiritual, aesthetical, and social coherence (Bullock *et al*, 2011, Lamarque *et al*, 2011, H€onigov_a *et al*, 2012). Many semi-natural grasslands in NE are located on ancient sacred places such as burial mounds and have been kept open by livestock for thousands of years (Lindborg *et al*, 2008). Traditional management of grasslands in terms of hay-making has played an important role as social cohesion among villagers and still does (Stenseke, 2009).

CONCLUSION

In conclusion, prescribed fire is useful in: reduction of fuels, altering vegetation communities, improving wildlife habitat, releasing of nutrients, removing seed dormancy and helps in killing disease vectors while grasslands are useful in provision of *grass for ruminants, grass for perfumes, alcohols and beverage*, ecosystem services, climate regulation, erosion prevention, tourism, recreation, and hunting, cultural heritage, spiritual, and social cohesion.

RECOMMENDATION

For managers intending to use this tool, I recommend that a smaller area of less than ten hectares should be used for experiment and results observed. After that, then larger areas can be burnt because the manager would have gotten the necessary skills and competency. Prescribed fire is a necessary for the management of grasslands so long as the objective of its usage is/are well spelt out. Timing is important and windy periods should be avoided.

REFERENCES

Barnes, R.F, and C.J. Nelson. 2003. Forages and grasslands in a changing world. p. 3–23. *In* R.F Barnes et al. (ed.) Forages. Vol. 1. An Introduction to Grassland Agriculture and Forages. 6th ed. Iowa State Univ. Press, Ames.

Bullock, J. M., et al. 2011. Semi-natural grasslands. Pages 161–196 in UK NEA, The UK National Ecosystem Assessment. UNEP-WCMC, Cambridge, UK.

Burrascano, S., M. Chytr_y, T. Kuemmerle, E. Giarrizzo, S. Luyssaert, F. M. Sabatini, and C. Blasi. 2016. Current European policies are unlikely to jointly foster carbon sequestration and protect biodiversity. Biological Conservation 201:370–376.

Blignaut, J. N., et al. 2010. Restoring and managing natural capital towards fostering economic development: evidence from the Drakensberg, South Africa. Ecological Economics 69:1313–1323.

Buckley, R., C. Ollenburg, and L. Zhong. 2008. Cultural landscape in Mongolian tourism. Annals of Tourism Research 35:47–61.

Chagonda, L. S., C. Makanda and J. C. Chalchat (2000). The essential oils of wild and cultivated Cymbopogon validus (Staph). Flavor and fragrance. 15(2):100-104.

Cerdan, O., et al. 2010. Rates and spatial variations of soil erosion in Europe: a study based on erosion plot data. Geomorphology 122:167–177

Diaz, S., et al. 2015. The IPBES Conceptual Framework – connecting nature and people. Current

Dlamini, P., C. Orchard, G. Jewitt, S. Lorentz, L. Titshall, and V. Chaplot. 2011. Controlling factors of sheet erosion under degraded grasslands in the sloping lands of KwaZulu-Natal, South Africa. Agricultural Water Management 98:1711–1718.ion in Environmental Sustainability 14:1–16.

Donald L. Grebner, ... Jacek P. Siry, in Introduction to Forestry and Natural Resources, 2013.

Chase, A. 1948. The meek that inherit the earth. p. 8–15. *In* A. Stefferud (ed.) Grass: The 1948 yearbook of agriculture. U.S. Gov. Print. Office, Washington, DC.

Egoh, B., J. Bengtsson, R. Lindborg, J. M. Bullock, A. P. Dixon, and M. Rouget. 2016. The importance of grasslands in providing ecosystem services: opportunities for poverty alleviation. Pages 421–441 in M. Potschin, R. Haines-Young, R. Fish, and R. K. Turner, editors. Routledge handbook of ecosystem services. Routledge, London and New York, New York, USA.

Eriksson, O., S. A. O. Cousins, and H.-H. Bruun. 2002. Land-use history and fragmentation of traditionally managed grasslands in Scandinavia. Journal of Vegetation Science 13:743–748.

Emanuelsson, U. 2009. The rural landscapes of Europe: how man has shaped European nature. The Swedish Research Council Formas, V€arnamo, Sweden.

Everson, T. M., and C. D. Morris. 2006. Conservation of biodiversity in the Maloti-Drakensberg mountain range. Pages 285–291 in E. M. Spehn, M. Liberman, and C. K€orner, editors. Land use change and mountain biodiversity. CRC Press, Boca Raton, Florida, USA.

Fairbanks, D. H. K., M. W. Thompson, D. E. Vink, T. S. Newby, H. M. van den Berg, and D. A. Everard. 2000. The South African land-cover characteristics data base: a synopsis of the landscape. South African Journal of Science 96:69–82.

Fischer, M., K. Rudmann-Maurer, A. Weyand, and J. St€ocklin. 2008. Agricultural land use and biodiversity in the Alps - How cultural tradition and socioeconomically motivated changes are shaping grassland biodiversity in the Swiss Alps. Mountain Research and Development 28:148–155.

Forage and Grazing Terminology Committee. 1991. Terminology for grazing lands and grazing animals. Pocahontas Press, Blacksburg, VA.

Foley, J., et al. 2005. Global consequences of land use. Science 309:570–574.

Frelichov_a, J., D. Vack_ar, A. P_artl, B. Louckova, Z. V. Harmackov_a, and E. Lorencova. 2014. Integrated assessment of ecosystem services in the Czech Republic. Ecosystem Services 8:110–117.

Guo, L. B. and R. M. Gifford (2002). Soil carbon stocks and land use change : a meta analysis. Global Change. 8: 345-360.

Hartford, R.A. and W.H. Frandsen. 1991. When it’s hot, it’s hot . . . or maybe it’s not! (Surface flaming may not portend extensive soil heating). International Journal of Wildland Fire 2:139–144.

Hartin, E. 2008. Fire Development and Fire Behavior Indicators. CFBT-US, LLC. www. firehouse.com Date accessed: January 19, 2017

Havstad, K., D. Peters, B. Allen-Diaz, J. Bartolome, B. Bestelmeyer, D. Briske, J. Brown, M. Brunson, J. Herrick, L. Huntsinger, P. Johnson, L. Joyce, R. Pieper, T. Svejcar, and J. Yao. 2009. The western United States rangelands: A major resource. p. 75–93. *In* W.F. Wedin and S.L. Fales (ed.) Grassland: Quietness and strength for a new American agriculture. ASA, CSSA, and SSSA, Madison, WI. (This volume.)

He, N., Q. Yu, R. Wang, Y. Zhang, Y. Gao, and G. Yu. 2013. Enhancement of Carbon sequestration in soil in the temperature grasslands of Northern China by addition of Nitrogen and Phosphorus. PLoS ONE 8:e77241.

Hou, R., R. Yu, and J. Wu. 2017. Relationship between paired ecosystem services in the grassland and agro-pastoral transitional zone of China using the constraint line method. Agriculture, Ecosystems and Environment 240:171–181

H€onigov_a, I., et al. 2012. Survey on grassland ecosystem services. Report to the EEA – European Topic Centre on Biological Diversity. Nature Conservation Agency of the Czech Republic, Prague, Czech Republic.

Gamfeldt, L., et al. 2013. Higher levels of multiple ecosystem services are found in forests with more tree species. Nature Communications 4:1340.

Intergovernmental Panel on Climate Change. 2007. IPCC Fourth assessment report, working group III. Available at http://www.ipcc.ch/ipccreports/ar4-wg3.htm (verified 15 July 2008). Cambridge Univ. Press, New York

James Stubbendieck, Professor, Grassland Ecology; Jerry Volesky, Extension Range and Forage Specialist; and John Ortmann, Director of Science and Stewardship, The Nature Conservancy, Niobrara Project Office, Grassland Management, With Prescribed Fire, EC148

Knapp AK, Seastedt TR. Detritus accumulation limits productivity of tallgrass prairie. BioScience.1986;36:662–8.

K€atterer, T., M. A. Bolinder, K. Berglund, and H. Kirchmann. 2012. Strategies for carbon sequestration in agricultural soils in northern Europe. Acta Agriculturae Scandinavica, Section A - Animal Science 62:181–198

Lemaire, G., J. Hodgson, and A. Chabbi, editors. 2011. Grassland productivity and ecosystem services. CABI,Wallingford, UK.

LaLande, J. 2004. So, Just How Extensive was Anthropogenic Fire in the Pacific Northwest?: Southwestern Oregon as a Case Study. Eugene, OR. Paper presented at the Northwest Anthropological Conference. Copy on file at Bureau of Land Management Medford District

Lucien A and Maria c, (2014). Importance and functions of grasslands. Available online at www.notulaebotanicae.ro

Lindborg, R., et al. 2008. A landscape perspective on conservation of semi-natural grasslands. Agriculture, Ecosystems and Environment 125:213–222.

Long, A. (1999). Benefits of prescribed burning. Gainesville, FL: Florida Cooperative Extension Service. Retrieved from https://ufdc.ufl.edu/IR00001810/00001

O'Connor, T. G., and G. J. Bredenkamp. 1997. Grassland. Pages 215–257 in R. M. Cowling, D. M. Richardson, and S. M. Pierce, editors. Vegetation of Southern Africa. Cambridge University Press, Cambridge, UK.

Mestdagh I., Iantcheva A., De Vliegher A. and Carlier L. (2003). Conflicts of Grassland for forage production and environmental benefit. Grassland Science in Europe. 8: 487-490.

Naido, N. (2006). The essential oil from Cymbopogon validus. Ph D thesis Department of biotechnology at the Durban University of Technology, Durban, South Africa

Nelson, C.J., and J.C. Burns. 2006. Fifty years of grassland science leading to change. Crop Sci. 46:2204–2217.

Nkambule, S. S., H. Z. Buthelezi, and S. Munien. 2016. Opportunities and constraints for communitybased conservation: the case of the KwaZulu-Natal Sandstone Sourveld grassland, South Africa. Bothalia 46:a2120.

Pausas, J.G. and J.E. Keeley. 2009. A Burning Story: The Role of Fire in the History of Life. BioScience 59(7):593.Reference for fire management

Pascual, U., et al. 2017. Valuing nature's contributions to people: the IPBES approach. Current Opinion in Environmental Sustainability 26:7–16.

Parr, C. L., C. E. R. Lehmann, W. J. Bond, W. A. Hoffmann, and A. N. Andersen. 2014. Tropical grassy biomes: misunderstood, neglected, and under threat. Trends in Ecology and Evolution 29:205– 213.

Peeters A.1, Beaufoy G., Canals R.M., De Vliegher A., Huyghe C., Isselstein J., Jones G., Kessler W., Kirilov A., Mosquera-Losada M.R., Nilsdotter-Linde N., Parente G., Peyraud J.-L., Pickert J., Plantureux S., Porqueddu C., Rataj D., Stypinski P., Tonn B., van den Pol – van Dasselaar A., Vintu V. and Wilkins R.J. (2012). Grassland term definitions and classifications adapted to the diversity of European grassland-based systems. *1RHEA Research Centre, Rue Warichet 4 Box 202, 1435 Corbais, Belgium*

Queiroz, C., R. Beilin, C. Folke, and R. Lindborg. 2014. Farmland abandonment: Threat or opportunity for biodiversity conservation? Frontiers in Ecology and the Environment 12:288–296.

Pe'er, G., et al. 2014. EU agricultural reform fails on biodiversity. Science 344:1090–1092.

Pilgrim, E. S., et al. 2010. Interactions among agricultural production and other ecosystem services delivered from European temperate grasslands. Advances in Agronomy 109:117–154.

Reyers, B., J. Nel, B. Egoh, Z. Jonas, and M. Rouget. 2005. National Grasslands Biodiversity Program: grassland Biodiversity Profile and Spatial Biodiversity Priority Assessment. CSIR Report Number: ENV-S-C 2005–102

Robertson, G. P., K. L. Gross, S. K. Hamilton, D. A. Landis, T. M. Schmidt, S. S. Snapp, and S. M. Swinton. 2014. Farming for ecosystem services: an ecological approach to production agriculture. BioScience 64:404–415.

Rouget, M., et al. 2004. South African National Spatial Biodiversity Assessment 2004: technical Report. Volume 1: terrestrial Component. South African National Biodiversity Institute, Pretoria, South Africa.

Sala, O. E., L. Yahdjian, K. Havstad, and M. R. Aguiar. 2017. Rangeland ecosystem services: nature's supply and humans' demand. Pages 467–489 in D. D. Briske, editor. Rangeland systems. Springer series on environmental management. Springer, Cham, Switzerland.

Souchere, V., C. King, N. Dubreuil, V. Lecomte-Morel, Y. Le Bissonnais, and M. Chalat. 2003. Grassland and crop trends: role of the European Union Common Agricultural Policy and consequences for runoff and soil erosion. Environmental Science and Policy 6:7–16.

Sala, O., and J. Paruelo. 1997. Ecosystem services in grasslands. In Nature's services: societal dependence on natural ecosystems. Pages 237–251 in G. C. Daily, editor. Nature's services: Societal dependence on natural ecosystems. Island Press, Washington, D.C., USA.

Sharon Levy, Rekindling Native Fires, *BioScience*, Volume 55, Issue 4, April 2005, Pages 303–308, https://doi.org/10.1641/0006-3568(2005)055[0303:RNF]2.0.CO;2

Suttie, J. M., S. G. Reynolds, and C. Batello. 2005. Grasslands of the world. FAO, Rome, Italy.

Smith, P. 2014. Do grasslands act as a perpetual sink for carbon? Global Change Biology 20:2708–2711.

Stenseke, M. 2009. Local participation in cultural landscape maintenance: lessons from Sweden. Land Use Policy 26:214–223.

Soussana, J. F., T. Tallec, and V. Blanfort. 2010. Mitigating the greenhouse gas balance of ruminant production systems through carbon sequestration in grasslands. Animal 4:334–350

Tveskov, M., N. Norris, and A. Sobiech. 2002. The Windom Site: A Persistent Place in the Western Cascades of Southwest Oregon. SOULA Research Report 2002-1. Ashland, OR

UK NEA. 2011. The UK National Ecosystem Assessment: synthesis of the Key Findings. UNEPWCMC, Cambridge, UK.

Verheijen, F. G. A., R. J. A. Jones, R. J. Rickson, and C. J. Smith. 2009. Tolerable versus actual soil erosion rates in Europe. Earth Science Reviews 94:23–38.