Tallgrass Prairie and Savanna Prescribed Fire Decision Support System

Developed by Dr. Brent Tegler, North-South Environmental Inc. with technical advice on prescribed burning from Fred Bruin, Fred V. Bruin Consulting and software development by Bruce Miller, Rules of Thumb Inc. Input. Editorial review was provided by Ontario Ministry of Natural Resources Staff Dave Heaman, Rick Carbino, Andrée Morneault, Wasyl Bakowsky and Mike Spaans.

1. INTRODUCTION

Operational experience in tallgrass prairie and savanna prescribed burning in Canada is limited as only a few areas across Ontario have conducted prescribed burns. The Tallgrass Prairie and Savanna Prescribed Fire Decision Support System tool captures the knowledge and experience of the people who have planned, carried out and evaluated these fires and serves as a means to preserve and distribute rare expertise.

The objective of the Tallgrass Prairie and Savanna Prescribed Fire Decision Support System is to assist land managers with the assessment of potential candidate sites for prescribed burning in tallgrass prairie and savanna ecosystems. The system uses both site and fire management characteristics and considerations to provide a qualified recommendation involving the application of prescribed fire. The Tallgrass Prairie and Savanna Prescribed Fire Decision Support System also provides information relevant to the planning for and conducting tallgrass prairie and savanna prescribed burns. The Tallgrass Prairie and Savanna Prescribed Fire Decision Support System integrates a large body of data and knowledge that was previously dispersed among various publications and experts.

The Tallgrass Prairie and Savanna Prescribed Fire Decision Support System software runs from a CD, operating with common internet browsing software such as Internet Explore or NetScape. The Support System prompts a user to answer a series of questions in each of the following three sections (these sections are described more fully below):

- Ecological Considerations
- Prescribed Burn Objectives
- Management Objectives

Based on the input a user provides to questions, the Decision Support System generates a comprehensive report with outputs that include specific information that provide a better understanding of the issues identified; management recommendations to deal with the issues and an evaluation of potential *Prescribed Burn Complexity*, *Anticipated Costs*, *Fire Intensity*, *Time Commitment* required to conduct a prescribed burn and *Internal and External Communication* considerations.

2. ECOLOGICAL CONSIDERATIONS

The most effective use of prescribed fire needs a good understanding of the ecological characteristics of a site, particularly those that pertain to the ecology of fire. Prescribed fire is an environmental management strategy used to **restore** and **maintain** fire dependent ecosystems such as prairie and savanna.

Restoration refers to the re-introduction of prescribed fire in environments where it is has been excluded for a long period of time (*e.g.* greater than 10 years). Restoration is often characterized by pre-engineering activities to prepare a site for the re-introduction of fire and special fire management methods related to the timing, frequency and intensity of prescribed fires.

Maintenance refers to the regular application of prescribed fire using methods (pre-engineering, timing, frequency, intensity) tailored to a site necessary for the long-term health and integrity of the ecosystem. The intention of this expert system is to assist site managers in assessing factors relevant to the initiation of prescribed fire program. Although this expert system assembles a considerable amount of important information for the site manager it does not result in the preparation of a "burn plan". Completion of this exercise will provide a user with a better understanding of the suitability of a site for fire management and an outline of the next steps that must be taken, such as site inventory, communications, and consultation with a Fire Management Technician or Prescribed Fire Contractor.

Six key ecological considerations have been identified to consider for prescribed burns:

i. **Knowledge of the site** - Knowledge about the current and historic conditions that characterize a site is vital to making good ecosystem management decisions. How much is known about the site that is being considered for a prescribed burn program? Is the history of past land use and/or ecological impacts known for the site? Is there an up-to-date and reliable inventory of plant and animal inhabitants, including rare species, invasive species and species that are characteristic of prairie and savanna? Is there an understanding of abiotic conditions such as past fires, soil conditions and site hydrology?

ii. **Indicator plant and animal species** – A good to excellent inventory of the plants and animals known to inhabit the site is used to assess the number of prairie and savanna species that are present, and to determine if provincially significant species are present. Based on the plant species present, a prairie indicator index is also calculated based on coefficients of conservatism developed by the Morton Arboretum in Chicago and later adapted for use in Ontario. The lists of indicator species have been developed by the Ontario Ministry of Natural Resources, Natural Heritage Information Centre as published in Tallgrass Communities of Southern Ontario: A Recovery Plan (www.tallgrassontario.org/)

iii. **Deer populations** – In southern Ontario the creation of suitable habitat in the form of farmlands, fields and woodlots and low numbers of large predators and low hunting pressure favours the growth and reproduction of deer herds. Where deer are hyper-abundant they can have significant negative impacts on native ecosystems through grazing and browsing pressures and this can interact negatively with a prescribed burn program.

iv. **Soil conditions** – Prairie and savanna sites in southern Ontario are often associated with freely drained sandy soils. Sandy soils tend to be drier sites with low nutrient status and a greater likelihood of wildfire occurrence. These factors retard the growth of woody vegetation, and favour prairie and savanna species which are adapted to drought and low nutrient levels. In addition, sandy soils may have been avoided during agriculture development, thus indirectly protecting prairie and savanna ecosystems. Historically, wet prairies occurred on poorly drained clay soils that eliminated woody growth due to annual flooding. Much of Ontario's wet prairie sites have been converted to agriculture through the creation of drainage canals and the tiling of agricultural fields.

v. **Site hydrology** – Knowledge of seasonal hydrology characteristics of a site is essential to understanding the availability of seasonally dry conditions necessary to conduct a prescribed burn. For some prairie and savanna site hydrology is also important because seasonal flooding plays an important role in eliminating woody growth to maintain wet prairies.

vi. **Soil seed bank –** Plant seeds present in the soil can have both positive and negative implications for prescribed burn programs. Knowledge of what species of viable plant seeds are present in the soil provides information that can be used to develop appropriate fire management strategies.

3. PRESCRIBED BURN OBJECTIVES

Goals and objectives provide an essential role in any resource management program. The goal provides direction and purpose for a program and indicates the general end point that the program should reach. Goals are not necessarily attainable but seek to identify the ideal state. Objectives, however, should be measurable and achievable. They serve to "operationalize" the goal. Objectives serve as a means to evaluate the success of a program, and provide the baseline against which a program is measured and evaluated. Monitoring should be considered an essential component of a prescribed burn program.

The following three objectives are considered the most common reasons for the initiation of a prescribed burn program. Each of these objectives is presented below with more detailed questions about the possible targets associated with each. Site managers should consider each objective and determine whether one, two or all three apply.

i. **To reduce the amount of woody plant growth in order to enhance the growth of sun-loving prairie and savanna species.** Past resource management policies have generally taken an aggressive approach to extinguishing fires when they occur in the environment. In prairie and savanna environments one of the effects of these policies has been an increased growth of woody plants that would normally be held in check or excluded from these sites by wildfire or historical aboriginal fire management practices. The increased shade

created by a tree and/or shrub canopy leads to an exclusion of prairie and savanna plants and their associated fauna.

Despite a long history of fire exclusion many of the original prairie and savanna plants and animals are present in smaller numbers or in the case of plants present as viable seed in the soil seed bank. The re-introduction of fire serves to effectively reduce the woody plant cover and the shade its canopy creates while stimulating the renewed growth of prairie and savanna species. Reducing woody plant growth is an inherent part of all fire management programs; the aggressive reduction of over-abundant woody growth is often one of the objectives in the initial phases of prairie and savanna restoration. Consider your site and determine if there is a need to reduce woody plant growth.

ii. **To blacken (burn) a high proportion of the ground surface in order to stimulate the early spring growth of prairie and savanna species.** The surface blackening that results from a fire creates environmental conditions that favour the growth of native prairie and savanna species. Blackening results in greater exposure of the ground to the sun and increased absorption of solar energy. Spring surface temperatures can be raised by as much as one degree Celsius (1°C). This seemingly small temperature increase contributes immensely to the success of the native species germination and plant growth; an important factor that contributes to their success when competing with "cool season plants" that are not prairie and savanna species. The degree of blackening of a site can be controlled and is measured in terms as the percentage of the ground surface that will appear black following a prescribed burn. A site that is 50% blackened means half of the ground will have some degree of blackness ranging from moderately black to fully black, while the remaining 50% will have little or no blackening meaning that the area has not been burned. The pattern o f blackening is variable. Un-burnt areas result when there are subtle differences in factors such as moisture (e.g., a wet depression), or fuels (e.g., suitable fuel to carry a fire is not present). Variation in the pattern of burnt and un-burnt areas will affect the pattern of vegetation present and may provide important refugea essential to the persistence of some prairie species (e.g. some arthropods). After selecting yes, you may, on the next screen, examine the advantages and disadvantages for different degrees of blackening to determine the degree of blackening that is most appropriate for your site.

iii. **To kill fire-intolerant invasive plants that are displacing fire-tolerant native prairie and savanna species.** Disturbed environments with a high proportion of non-native plants characterize the agricultural and urban landscapes of southern Ontario. Some non-native plant species are of concern because of their ability to invade neighbouring native plant communities leading to the displacement and elimination of native plants and the animals that live in association with them. Ontario's prairies and savannas are at risk, because the characteristic open, dry conditions if disturbed encourage the growth of the many non-native weedy plants present in Ontario that are adapted to disturbed conditions. The use of prescribed fire to control the growth of invasive plants must however, be undertaken cautiously, with a good knowledge of the response of non-native plants to fire. In some cases pre-treatment, such as hand cutting or the application of herbicides, may be required to obtain the benefits of prescribed burning. For some plant species, light prescribed fire may enhance their growth and it is only through the rigorous application of a series of intense and correctly timed prescribed burns that the target species can be eliminated or held in check.

A good knowledge of the plant species present in a site will make it possible to determine if one objective of a prescribed burn program is to control invasive plants. For each invasive plant selected, carefully review the information about its ecology, pretreatment requirements and response to prescribed burning to determine how these species can best be managed. Extensive information is often available and some references and websites have been provided to obtain additional information on invasive plants.

4. PRESCRIBED BURN MANAGEMENT CONSIDERATIONS

This section of the Tallgrass Prairie and Savanna Prescribed Fire Decision Support System reviews some of the technical factors to be considered for a candidate prescribed burn site. Before conducting a prescribed burn, careful planning is required and qualified fire management technical staff should be involved throughout the planning process. Users of this software should note that the completion of this Prescribed Fire Decision Support System does

not result in the development of a burn plan, nor should it be considered a replacement for a burn plan.

The use of prescribed burning is essential to the restoration and maintenance of prairie and savanna in southern Ontario. However, without adequate planning or implementation by qualified personnel, the use of prescribed burning can be dangerous. The reports generated from your responses to the following prescribed burn management considerations will provide important information about site factors that contribute to less and/or more complex prescribed burns. In some cases, recommendations are provided that may allow you to reduce the complexity of a burn program for the site.

Eleven prescribed burn management considerations are presented below:

i. **Time of Year** - The time of year selected to conduct a prescribed burn influences the intensity of fire behaviour because of a combination of weather and fuel conditions. This in turn has implications for the ecological effect of fire on plants and animals. The time of year selected for a burn will depend on several factors including ecological considerations, burn objectives, and various prescribed burn management considerations. A review of site factors with a fire management specialist will determine the most appropriate time of year for a prescribed burn. The information provided here for early spring, late spring and late summer or autumn burns identify some factors to consider in determining the appropriate time of year to conduct a prescribed burn.

ii. **Site Values** - Within a site or in areas up to one-half kilometer adjacent to a site, there may be ecological, social or economic values that may be adversely affected by direct contact with fire or indirectly through smoke or soot. In order to mitigate fire effects, the type, and location of site values should be noted. Site values include utilities (*e.g.* hydro poles, gas pipelines, telephone lines, *etc.*), structures, fences, agriculture, flammable materials, site improvements and ecosystem concerns (*e.g.* endangered species, special habitats).

iii. **Fuel** Types - Fuel types are the natural dead and living plant materials that provide the fuel for a prescribed fire. Natural fuel types include: **cured** grasses, sedges and herbs either standing or matted on the ground; tree and shrub leaf litter on the ground or drought wilted (cured) leaves that are still on shrubs and trees during late summer/fall burns; and living or dead standing coniferous (needle-leaved) trees. Living coniferous trees are a fuel type because of the presence of natural oils in the needles that make these trees flammable even when alive.

iv. **Smoke Management** - Smoke and its management can play an important role in the application of prescribed fire. The management of smoke in urban areas can create unique problems for the management team while rural areas may have little or no smoke management concerns. Different fuels in various states of burning create different amounts of smoke. In addition, weather plays an important part in the management of smoke and will have to be considered during the overall plan development. Burning in an unstable air mass promotes the lifting and venting of smoke and is therefore beneficial to smoke management. Burning in a stable air mass can cause smoke to sink to the ground when the heat of the fire is removed, thus creating smoke problems that may occur after a burn has been completed.

v. **Boundaries** - A boundary for prescribed burning is defined as an existing barrier, natural or constructed, that will stop or retard the spread of the burn. Existing boundaries and/or the need to create improved boundaries must be carefully considered when planning for a prescribed burn. Normally, a prescribed burn is ignited on the windward side of an area, a technique that allows a low intensity fire to back-burn away from boundaries effectively widening firebreaks. The presence of good natural and/or constructed boundaries is extremely important, as these will safely contain a fire within a prescribed burn site. Good boundaries that run continuously along all sides of a burn site will greatly reduce the risk of fire escaping outside the site. With reduced risk, the complexity and costs for a prescribed burn will also be reduced.

vi. **Slope Characteristics** - Site topography and slope characteristics can affect fire behaviour in positive and negative ways depending on the conditions within a site. While a site may have a variety of slope and topographic conditions, choose the predominant conditions present when providing the information below. Sites with an overall gently rolling topography are not difficult to manage for a prescribed burn. The rate of spread of the fire will be both positively and negatively affected by rolling terrain resulting in only small effects on fire behaviour. Weather and fuel are, therefore, the primary considerations for fire behaviour. In gently rolling topography slope and aspect may slightly affect fire behaviour on the site. Variable gentle slopes may have a small effect on fuel conditions and dryness across a site. As a result, the presence of gentle slopes may alter fire control lines and their positioning throughout the site.

vii. **Site Shape** - Site shape refers to the overall shape of the proposed burn. Site shape plays an important role in the ease of ignition and the level of effort required to maintain control of a prescribed burn. Site shape has safety related concerns for both ignition and fire suppression crews. It is always preferable that suppression be

kept to a minimum and shape plays an important role. Fire suppression is more difficult in irregularly shaped sites because of complex fire behaviours and difficulty in accessing site boundaries. Fire suppression staff may be faced with low and high fire intensities simultaneously on different areas of the perimeter. This, combined with more difficult access, will result in the need for more suppression staff to ensure control of the fire at all times.

viii. **Visibility** - Site visibility is defined as the ease of viewing the entire site from one location. Excellent site viewing is extremely important to allow the fire manager to observe the progress of a prescribed burn thereby allowing them to make sound management decisions as necessary. If a site cannot be viewed entirely from one location, the overall complexity and cost of a prescribed burn may be higher. The prescribed burn may require additional supervisors to manage ignition and suppression crews positioned on different areas of the site. If the fire boss for a prescribed burn does not have a clear view of the entire site, they will not have direct control of the operation at all times. The fire boss will have to rely on other staff to relay information to assist in the decisions of the operation of the burn.

ix. **Site Size** - Site size is major factor in determining the ignition method used for a prescribed burn. A key aspect of size is the length of perimeter that will have to be lit and then extinguished. Sites with longer the perimeters generally require more time for burn ignition and extinguishing. There are two accepted methods of ignition, hand ignition and aerial ignition. Hand ignition is carried out by a trained ignition team or teams and coordinated by an ignition boss. Normally, the hand ignition teams use drip torches as the ignition tool. Aerial ignition is a more complicated form of ignition requiring the use of a helicopter. The helicopter is equipped with a specialized ignition tool that is operated by a trained technician. An ignition boss also rides in the helicopter to oversee and control progress of fire ignition.

x. **Land Ownership** - As a part of the prescribed burn planning process, it is important to determine who owns or manages the on-site and off-site properties. This knowledge can have implications regarding the complexity of the prescribed burn planning process and it is important to effectively conduct communication efforts.

xi. **Population Density** – In urban, suburban or rural areas with high to moderate population density public open houses will be required to inform people of the prescribed burn planning process and to provide people with a basic understanding of fire ecology. Effective communication will reduce fears people may have about fire and dispel inaccurate information before problems arise. With knowledge of the long-term plans for a site, the community can participate in efforts to restore and protect prairie and savanna. In rural areas and areas of low population density there are usually fewer public concerns to address. There is still however, a requirement for effective communication to landowners, local residents and authorities, fire departments and utility managers. The early involvement of the local radio, television and the printed press may constitute the most cost-effective way to communicate information about the prescribed burn program to a dispersed local public.

The Tallgrass Prairie and Savannah Prescribed Fire Decision Support System is distributed at no charge. A CD with a copy of the software may be obtained by contacting Dave Heaman, Fire Science and Planning Specialist with the Ontario Ministry of Natural Resources (dave.heaman@mnr.gov.on.ca) or Brent Tegler, the developer of the software with North-South Environmental Inc. (btegler@nsenvironmental.com).