WEEDS OF FORESTS AND NATIONAL PARKS - A REVIEW

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Summary. The present and future practice of weed control in forests and national parks is reviewed.

In forests weed control is subject to unique constraints including the long term nature of the crop, inhospitable terrain, extensive nature of the area, public ownership and labour availability. Weed control is an important factor in the maintenance of productivity of the declining forest resource. In native forests, growth of desired trees is emhanced by thinning. Experiments indicate that glyphosate, hexazinone, triclopyr and picloram are possible replacements to the 2,4,5-T currently used for stem injection. In man-made forests, weed control is fundamental to successful establishment, and weed control should be in accord with the dynamics of the weed-crop interaction. 2,4-D and 2,4,5-T have been used widely and effectively for many years, but public pressure against their use has stimulated a search for alternatives. In the 1980's, forestry researchers must continue the search for economic replacements for 2,4,5-T and address the weed problem of second rotation plantings.

Weed control in national parks faces problems similar to those in forestry but has the added constraint that it must be achieved without disturbance to the environment. In the 1980's weed control in national parks must address an appropriate definition of a weed, decide a control policy and apply an appropriate control measure in a positive manner.

INTRODUCTION

In reviewing Weeds of Forests and National Parks, we are examining a situation in which weed science is practised under conditions and contraints quite different from those faced by agriculture. Furthermore, while forests and national parks share many common weed problems, the approach taken to weed control and the methods used may differ greatly. The two facets of the topic will be discussed separately.

WEED CONTROL IN FORESTS

Closed forests currently occupy some 20% of the world's land surface. These forests are extensive and diverse with coniferous forests covering broad belt of the higher latitudes in the northern hemisphere. Mixed and broadleaf forests dominate in more temperate areas while the equatorial zone carries areas of tropical rainforest. From this immense resource of living material, man harvests a wealth of products. Each year the area of available productive forest is decreasing, while at the same time the demand for forest products is increasing. Weed control is one tool being used to correct this imbalance in supply by enhancing forest productivity. The degree of weed control applied depends largely on the production objective for which three categories can be defined:

1. Areas of natural forest may be exploited on the basis of a single harvest of all available wood products with subsequent conversion of the site to some non-forest use. Weed control plays no role in this form of forest production,
2. Areas of natural forest may be periodically harvested on a basis of maintaining productivity in perpetuity. Weed control plays a minor role in these forests,
3. Areas of forest or non-forest may be converted into intensively managed man made forests. Weed control is essential for initial establishment and survival in these forests.

The application of weed control to forest areas is influenced by many factors, several of which are unique to forestry and substantially limit the available options for weed control:

1. Production from a forest is long term in that a crop may require 20 to 100 years to grow to maturity. All costs of production have to face an interest penalty for long periods of time, and to be economic, weed control has to achieve gains greater than the compounded cost of application,
2. Production forests often occupy the less hospitable and less useable areas of the earth whilst agricultural interests occupy the more fertile and easily worked land areas. Forests inherit what is left. The terrain, soil types and accessibility of these areas restrict the means by which weed control may be achieved,
3. Forests tend to be large areas where extensive rather than intensive management is practical. Weed control must fit into this management philosophy,
4. Some 80% of the world's forests are publicly owned and government agencies are often responsible for forest management. In such areas, management is still primarily production orientated, but is affected by pressures such as end product price control, a need for multiple use of forest areas, a need to employ a large labour force and conservation requirements. Weed practice in such forests must be modified to conform to these other forces,
5. Some forest growers employ a large labour force while others depend on a high degree of mechanisation. This balance of man and machine dictates both the means by which weed control is achieved and the direction of research.

The Australian continent is not well endowed with forest, and only 5% of the land area carries potentially productive forest. A substantial area is held as national park, while private ownership makes a substantial area unavailable for forest production. Production forestry in Australia is dominated by government forest agencies who hold some 12 M hectares under state forest tenure. Several large companies have substantial forest holdings, while a further but progressively diminishing contribution is made by private owners. Products worth some $2000 M are harvested annually from these forests and forestry in its various forms is a major primary industry.

The practice of weed control in Australian forests is largely dictated by the type of management applied to an area. There are two broad categories -

natural forests and man-made forests.

The bulk of the Australian productive forest estate lies in natural forests. They are generally managed on the basis of sustained production in perpetuity. Such forests include the rainforests of northern Australia, the coastal eucalypt forests and the cypress pine forests of inland eastern Australia. Total productivity is dependent on having a large estate of forest which produces at a low rate per hectare per annum. Production is long term and the monetary resource available to practise weed control is low. Weed control is however practised in two forms. Firstly, the periodic harvesting operations are planned to liberate the forest so that the area is left in a state where a new forest can regenerate and secondly, the resultant regeneration is often subjected to a thinning operation. Desired trees are retained and the remaining competitors physically or chemically removed. The operation is cheap and effective and accrues a productivity advantage to the stand. For many years chemical injection was carried out using 2,4,5-T or mixtures of picloram and 2,4,5-T/2,4-D, but in recent years research has been directed at finding alternatives to 2,4,5-T. Experiments are indicating that herbicides such as glyphosate, hexazinone, triclopyr and picloram are possible replacements. These may ultimately prove to be effective against a wider range of species than past methods, and fewer injections per stem may be required to achieve a kill.

Man-made forests are less extensive in Australia and mostly occur as plantations. Intensively managed plantations are a means of achieving self sufficiency, and the Australian forest plantation estate is now some 750 000 ha. Annual planting (which includes second rotation areas) is of the order of 38 000 ha. All state forestry agencies and several private companies are involved in plantation establishment. Principal species grown are radiata pine (*Pinus radiata*), slash pine (*P. elliottii*), maritime pine (*P. pinaster*), Carribbean pine (*P. caribaea*), hoop pine (*Araucaria cunninghamii*) and several *Eucalyptus* spp.

The southern states of Australia grow radiata pine extensively, and the various forest agencies co-operate to a high degree in solving weed and other problems in this species. Queensland is almost alone in growing slash, Carribbean and hoop pine.

A typical sequence of events is as follows. A suitable site is selected for a plantation, and the useable products are removed, the site cleared, and the debris burnt. The site is prepared for planting by either mechanical and/or chemical means. The trees are planted and often fertilised. Weed control is applied in the first few years and involves various combinations of mechanical, physical and chemical methods. Intensive weed control ceases with canopy closure, which occurs between 5 and 10 years of age. Trees may be later pruned to produce clear wood, and limited weed control may be needed to provide access for this operation. The trees begin to compete with each other from the time of canopy closure onwards and various thinnings are carried out to maintain high wood volume production. The plantations are finally clear felled after 30 to 60 years and the site replanted.

Weed control is essential in the first few years for the survival, establishment and initial growth of the planted trees. In this phase three basic elements are important:

1. Tree growth is seasonal with the majority of the growth in the summer months. The major response to weed control is thus in this period of time,

2. The tree reacts to weed control in different ways depending on age. A high level of weed control is essential in the first year, and although the quantitative response is small this sound establishment is fundamental to future growth. The growth response in the second, third and fourth years is high and great gains can be made from weed control. However as the tree develops it becomes more dominant and the optimum level of applied control can be lowered. The growth advantage from weed control tends to cease with canopy closure and the trees become weeds unto themselves,

3. There is a changing spatial requirement for weed control. Trees are usually planted at wide espacements such as 3 by 3 m. In the first year the tree cannot fully utilise this available area and weed control can be confined to the area around the young tree. The area in which weed control is necessary progressively expands with time until canopy closure, after which weed control may still be required to remove noxious weeds and to provide access for forest operations.

The herbicides 2,4,D and 2,4,5-T have been widely used in most Australian forests and have proven to be cost effective. In recent years the controversy surrounding these herbicides has stimulated a great deal of research effort to find alternatives, and two basic philosophies have been adopted.

One line of research is investigating quite different approaches to the application of knockdown herbicides like 2,4,5-T. Systems being evaluated include the use of residual herbicides, various mechanical regimes and such tools as cover crops to eliminate or contain weeds. The second line of research involves a search for a direct replacement of 2,4,5-T, and the paper by Flinn and Minko falls into this category. The Forests Commission of Victoria establishes and maintains extensive areas of radiata pine plantation and in their paper Flinn and Minko outline past weed practice, initial trials on 2,4,5-T alternatives and two recent field experiments. The paper describes site preparation techniques and indicates that woody weeds are serious competitors of young pines.

Flinn and Minko indicate that hexazinone is a potential replacement for 2,4,5-T in radiata pine plantations. While the paper describes the weed control achieved by hexazinone, comment on the cost of treatment and the crop response would have been an advantage. Aerial application of 2 kg ha^{-1} hexazinone should be substantially more expensive than an equivalent application of 2,4,5-T. Radiata pine is affected visually by the treatment but the impact of this temporary defoliation on growth is not discussed. The aim appears to be total control of all woody weeds, and while the use of more expensive herbicides may be forced by restrictions on 2,4,5-T, the investigation of the cost effect of lesser levels of weed control appears warranted.

Forestry faces two major problems in the 1980's:

1. There is a need for an economic replacement of 2,4,5-T. The solution to this problem will depend on three keys. Firstly foresters must fully understand the dynamics of weed-crop interactions, since this knowledge is the base on which weed systems can be built. Secondly foresters must practice true weed management involving the application of integrated weed control systems. Set prescriptions must go

and be replaced by flexible weed science. This will demand training and an improvement in field expertise. Thirdly cost control is going to be largely dependent on changes in application technology. A revolution has occurred in the last few years and this will continue to the foresters advantage,

2. There is a need to successfully establish the second rotation. This phase is now beginning in earnest, and it may happen that the solution to a 2,4,5-T replacement may solve this problem. However there is evidence of a shift in weed species and this may demand new approaches.

WEED CONTROL IN NATIONAL PARKS

National Parks and similar areas are expanding in both area and importance in Australia and elsewhere. A primary objective within these areas is to preserve the natural habitats represented within the park boundary. Weeds in the form of plants foreign to that particular habitat, pose a substantial problem. These plants may have entered the park prior to declaration through disturbance by man or may enter with man as he uses a park area. All parks (particularly those of small areas) are subject to an invasion pressure from native and exotic plants existing immediately outside the park boundary. To maintain the prime objective of the park, weed plants need to be controlled.

The methods which can be used to control weeds in national parks are limited.

Weed control must not only effectively kill or eliminate the weed, it must do so without disturbing surrounding vegetation or without influencing natural regeneration on the site made vacant by weed removal. Control measures are usually very specific and physical means tend to be favoured. Chemical methods tend to be mistrusted by many because of concern that the herbicide may adversely influence the site in the short and/or long term.

The paper by Mowatt describes a common situation. Large-leaf privet (*Ligustrum lucidon*) and small-leaf privet (*L. sinense*) have invaded urban bushland in areas of New South Wales. These plants can develop into small trees and shrubs and are difficult to kill because they have the ability to reshoot and sucker. While small plants can be removed physically, large plants pose problems. Mowatt describes two experiments comparing physical and chemical methods of control. The first experiment examined a number of physical methods ranging from felling with or without black plastic coverage of remaining parts to stem removal and root cutting. The second experiment examined stem injection with hexazinone, glyphosate, triclopyr and dicamba. Simple felling is not successful but felling with coverage of remaining aerial parts with black plastic may succeed. Of the chemical treatments, triclopyr is the most effective to date. It is proposed to re-evaluate triclopyr and test glyphosate at higher rates. Mowatt states that chemical injection caused less site disturbance than the physical treatments. The paper concludes that chemical control may have a place in privet control.

The results presented in the paper do not appear to be conclusive and an assessment at 12 months is needed to confirm the promise shown by some of the treatments. The chemical treatments have an advantage in speed of application, lower labour requirement and less immediate disturbance. The only disadvantage mentioned is a possibility of a residual influence on the herbicide. More comment would be desirable on relative site disturbance and such comment

should include visual impact, soil disturbance, effect on surrounding vegetation and any influence on regeneration. Similarly the real possibility of any residual herbicide effects should be contrasted in the long term against the actual presence of black plastic. Glyphosate, which is proving effective for stem injection against other species, certainly appears more desirable than more soil persistent herbicides. The proposed experiments mentioned could attempt to quantify these elements and may find value in examining waist high injection of a lesser number of cuts with proportionately higher concentrations of glyphosate. This latter factor reduces both the labour component and the possibility of soil spillage.

Where weed control in National Parks may go in the 1980's is not possible to define. These comments can be offered

1. There appears to be a need to properly define the weed problem. In some cases, particularly in urban bushland, the term weed itself may need redefinition,
2. There appears to be a need to positively define if weed control is to be practiced at all. Weed control is ineffective in an environment of indecision,
3. If the first two points are positively addressed then the application of weed control should be forthright. In particular the use of herbicides needs to be rejected or supported on the basis of fact.