ENVIRONMENTAL MONITORING OF WEED CONTROL ON ABORIGINAL LAND: A CASE STUDY

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Summary. Environmental weeds on Aboriginal lands are an emerging issue in Australia. Control of noxious weeds on these lands has, until recently, suffered sporadic and inadequate funding. In 1991, a program commenced to prevent the spread of *Mimosa pigra* on Aboriginal land in the Northern Territory. In this paper, it is demonstrated, through examples, that comprehensive research and monitoring has helped ensure that environmental goals are being met efficiently with minimal undesirable consequences. It is argued that management must be integrated with research to maintain support for similar large-scale programs to control environmental weeds on Aboriginal lands in the future.

INTRODUCTION

Environmental weeds are a major concern for nature conservation (6) and are now emerging as an issue for Aboriginal people who, in the Northern Territory (NT), control more than 40% of the land. Aborigines on these lands continue to rely in part on the natural environment to provide traditional foods. Environmental degradation through weed invasion will further disrupt traditional practices of Aborigines and increase their dependence on outside assistance. Until recently, no specific funding has been available to deal with large outbreaks of noxious weeds on Aboriginal lands (1). *Mimosa pigra* and athol pine, *Tamarix aphylla* are two species of immediate concern (6), but other environmental weeds such as rubber vine, *Cryptostegia grandiflora* may become problems in the future (6).

Weed control on Aboriginal land is distinctive because these lands are typically remote, lacking in infrastructural support, and usually are not commercially productive. Therefore the technology and assumptions of weed control programs on agricultural lands are not necessarily applicable. This paper presents a case study of a program to control an infestation on Aboriginal land of one of Australia's major environmental weeds, *Mimosa pigra*. By 1991, dense mimosa stands had covered more than 20 000 hectares of Aboriginal land in the NT (1). The easternmost large infestation of mimosa is on the floodplains of the East Alligator River at Oenpelli, where it has doubled in area every 1.4 years through the 1980s to cover about 6000 ha by 1991 (7). It has blocked access to a major area for traditional food-gathering of the Aboriginal community at Oenpelli, and has impacted on an important breeding ground for Magpie geese, *Anseranas semipalmata*. Furthermore, it threatens adjacent river systems including those of the Kakadu National Park World Heritage Area. For these reasons, the Commonwealth Government provided substantial funding to control this infestation and build upon previous smaller-scale control attempts.

The program to control mimosa at Oenpelli is the largest single program ever undertaken in Australia to prevent weed spread and restore a wetland following weed invasion. It has a high public profile and has many potentially controversial aspects. Therefore comprehensive research and monitoring is integrated into the overall control program to ensure that it is effective, efficient, and causes minimal undesirable consequences. This paper describes some of the contributions that research and monitoring has made to the control program. Funding for this work was provided by the Commonwealth Government through the Northern Territory

Department of Primary Industries and Fisheries. It is argued that integrating research and monitoring with management is crucial to maintaining public support for large-scale control of environmental weeds on Aboriginal lands.

METHODS

Study site. The main infestation of mimosa discussed in this paper occurs on the eastern floodplain of the East Alligator River (EAR), approximately 10 km north of the Aboriginal community of Gunbalanya (Oenpelli) in the Northern Territory (133°00' E 12°15' S). The EAR forms the boundary between Kakadu National Park (KNP) and Arnhemland. The floodplains are usually covered with water between late December and May/June each wet season, and dry out in the latter half of each year.

Monitoring of strategy and tactics. Initially, from 1983 until 1992, control measures focussed on the main infestation. The effectiveness of this strategy was examined by assessing the importance of satellite outbreaks to the spread of mimosa. Records of new outbreaks of mimosa in KNP were obtained from Australian National Parks and Wildlife Service (J. Madison pers. comm., 1992), and the density of new outbreaks per square kilometre of floodplain was calculated. From the relationship between density and distance from the main stand, the number of new outbreaks on previously unsurveyed wetlands in Arnhemland was predicted.

Tebuthiuron was the main herbicide used in this program. A total of 62 t of tebuthiuron were applied in November 1991 at the time recommended in the proposal, i.e. "early in the wet season, after cracks in the black soil have sealed but before flooding (in order to) minimise the movement of tebuthiuron into the soil profile" (1). The recommendation is reconsidered through studies of the mobility of tebuthiuron in the local environment (3) and literature review.

Monitoring of environmental effects. Concentrations of tebuthiuron were measured in samples of floodwater using HPLC. In November 1991 and 1992, the species composition and abundance of native flora was assessed at 200 sites representing a range of habitats and mimosa control histories across the main infestation. The species richness and herbaceous cover of sites in areas in which mimosa has never occurred were compared with that of sites treated first in 1991 and sites treated in 1988/89 and again in 1991.

RESULTS AND DISCUSSION

Prevention of mimosa spread. There was a strong negative relationship between the density of new outbreaks in KNP and distance from the main stand (Fig. 1), indicating that outbreaks of mimosa up to 60 km from Oenpelli could be attributed to seeds being spread from the main stand. It was predicted from this relationship that at least 34 new outbreaks could exist in the 610 square kilometres of floodplains within 60 km to the north of the main stand. As a result, the strategy of the control program has now changed to reflect the importance of controlling satellites. A thorough search of some of these floodplains in September 1992 found 22 outbreaks of mature mimosa plants (R. Salau pers. comm., 1992). The densities of outbreaks on the surveyed floodplains were even greater than those predicted suggesting that secondary infestations have probably occurred.

The rapid increase in the size of the main stand of mimosa at Oenpelli was, in part, the factor that convinced the Federal Government to provide funds for its control. This led, however, to the initial over-emphasis on control of the main stand. Such a misplaced emphasis on the control of the main stand is typical of most programs aimed at preventing plant invasions (9). Whereas the highest priority should be given to preventing weed spread by controlling satellite outbreaks (9). Once such strategies are in place, one can return to the less pressing problem of how to rehabilitate the land beneath the main stand.

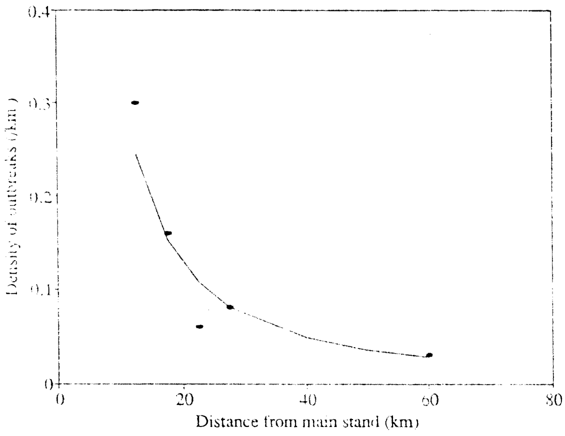

Figure 1. The relationship between the density of mimosa outbreaks in Kakadu National Park and distance from the main stand at Oenpelli: $Y = 8.4 * X^{-1.4}$ $r^2 = 0.84$.

<u>Herbicide application to the main stand of mimosa</u>. Research in the USA on a sandy loam soil concluded that tebuthiuron should be applied to dry rather than wet soils to prevent runoff water from removing tebuthiuron (10). Vertisols such as those in which mimosa grows, have notoriously low infiltration rates after crack closure (11). Consequently, the practice of applying tebuthiuron after crack closure, as recommended in the NT (1), is likely to produce severe losses of the chemical through runoff. The research component of this program drew attention to this problem and independently confirmed, under local conditions (3), the results of the work in USA. The research will therefore lead to improved efficiency in the use of this herbicide, and reduce any deleterious effects of dissolved tebuthiuron in floodwaters.

<u>Environmental impacts</u>. The concentrations of tebuthiuron in two water bodies to which the herbicide was applied directly in November 1991 were 635 µg/L and 2050 µg/L several days after application. Such levels are sufficient to reduce algal production and chironomid densities (12), but are well below LC_{50} values for fish (1). By March 1991, concentrations had fallen to below 40 µg/L, and it likely that tebuthiuron would have little direct toxic effects in the aquatic systems in the long-term.

On the floodplains, the cover and species richness of native flora was lower where mimosa had invaded than where mimosa has never occurred (Table 1). On sites which were treated with tebuthiuron first in 1988/89, the native flora has partially regained its richness of species, but the cover has remained low (Table 1). Thus despite two to three years of partial control of mimosa, revegetation has not proceeded adequately. Therefore active steps are required to hasten revegetation. Although pasture species such as Koronivia grass, ***Brachiaria humidicola*** can provide good competition for mimosa (8), they could also outcompete native species such as *Oryza sp.* and *Eleocharis spp.* on which Magpie Geese and other waterfowl depend (5). Given the high conservation values of the Northern Territory wetlands (4), and the value placed on waterfowl as a food resource by Aboriginal people (2), sowing of introduced pastures is inappropriate and techniques will need to be developed to revegetate the wetlands with native species.

Table 1. The effect of *Mimosa pigra* and its control on the cover and species richness of herbaceous plants on the Oenpelli floodplains.

Treatment	Herbaceous cover (%)	Number of herbaceous species
Mimosa absent	47[a]	4.1[a]
Mimosa present, treated 1989 and 1991	36[b]	3.2[b]
Mimosa present, treated 1991.	31[b]	1.9[c]

(different letters indicate significant differences; $p<0.05$).

Conclusions. The success of this program to control mimosa on Aboriginal land is vital because it is costing about $A6.5 million over several years and is in an environmentally and politically sensitive area. Research and monitoring of all aspects of the ecology, toxicology, environmental chemistry, logistics, and socio-economics has contributed to several major changes in direction of this program. These changes should lead to more rapid and cost-effective control of this weed, and restoration of the wetlands for use by the Aboriginal people.

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