THE EFFECTIVENESS OF DECLARED PLANT LEGISLATION - TWO BENEFIT COST EXAMPLES

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Summary. Declared plant legislation is a form of government intervention in weed control. The argument for such intervention is based on the failure or private land-holders to make socially optimal weed control decisions. Benefit cost analyses of government intervention in the control of saffron thistle, *Carthamus lanatus*, and blackberry, *Rubus* spp., in W.A. showed that, in the case of these weeds, the economic justification for such intervention was doubtful. The limitations of these studies suggest however, that the results should be treated with some caution.

INTRODUCTION

Government intervention in weed control via declared plant legislation has a long history in Australia. For example, Smith (19) reports that the principle legislation for declared plant control in N.S.W. is the Local Government Act, enacted in 1919. In Victoria, similar control was initiated under the Vermin and Noxious Weeds Act, of 1922 (14). Up until the 1960's this legislation appears to have been beset by inherent weaknesses. Trumble (21) points out that "in the 1950's weed control laws were characterised by a lack of sound scientific bases, haphazard or non-existent enforcement, and the absence of any significant co-ordinating capacity to deal with matters outside local boundaries." The forerunner to changes in the legislation is considered to be the establishment of the Victorian Vermin and Noxious Weed Destruction Board in 1958 (21).

A series of articles which appeared in the early 1970's (1, 12, 13, 15) drew attention to many of the weaknesses of the legislation at that time. These included the lack of a strong ecological basis, a burgeoning and somewhat *ad hoc* list of declared plants, costly control programmes and a relatively small number of successes. The authors indicated a need for a much stronger scientific basis for declaration. These articles were no doubt the catalyst for further significant changes to the legislation that followed in Australia. However, despite these changes, many of the weaknesses mentioned still exist.

Although implied by their criticisms, none of these authors explicitly considered the more fundamental question of government intervention in weed control. It would seem, as Johnston (9) states, that "the need for such intervention is widely accepted amongst biologists". Menz and Auld (11), in a paper on the control of galvanised burr, *Bassia birchii*, appear to be the first to explicitly consider this question. Earlier papers by Freebairn (3) and Johnston (8) also addressed this issue, but in relation to pests and diseases. These three papers used the welfare economics theory to provide arguments for such intervention.

I propose to begin this paper with the question of government intervention in weed control, and follow this with a description of two recent cost-benefit analyses of declared plants in W.A. aimed at evaluating the economic justification for such intervention. Finally, I will discuss the conclusions and the weaknesses of these studies, and mention future directions for research in this area.

THE ROLE OF GOVERNMENT IN WEED CONTROL

Various principles or rules of thumb for public pest control strategies have been developed concerning when and how governments should intervene, and the social responsibilities of individual land-holders (9). Menz and Auld (11) suggest that "in general terms, intervention takes place when society desires, and decides to enforce, a level of control different from that achieved by private owners/managers."

The question of government intervention in weed control is an example of what Johnston (9) calls the "government's essential policy problem." That is, "to determine those situations in which the government can produce a net social gain by influencing the supply of mixed goods given the policy instruments available to it and their cost...and to determine the optimum type and level of intervention".

In essence, the arguments for government intervention in weed control stem from the failure of private land-holders to make socially desirable investments in weed control, and from desired improvements in the distributional and equity effects of current strategies (3). That is, there is market failure, which is said to occur when markets fail to operate in an economically efficient way.

There are several sources of market failure which are described in detail by Johnston (9). With respect to weed control, the two most important sources of market failure are the presence of externalities and public goods (20). Let us consider each of these in turn.

Externalities. An externality exists when the action of a person or firm affects the well-being or production of others, in a way that is not reflected in the market place. Several examples of externalities can arise in weed control. For example, consider the land-holder who, acting in his own self-interest, does not control a particular weed on his property, thus allowing it to spread and infest other properties. These effects are external to the land-holder, and as such are not taken into account in the land-holder's decision making regarding weed control. However, they can impose an external cost on the adjoining properties by increasing the weed control effort required by these land holders. Because the land-holder does not consider the external costs of his actions, there is a divergence between the private and social costs of his weed control. The private costs are the actual costs of the spraying operation (chemical and application costs). The social costs are the sum of the land-holder's private costs and the external costs. This divergence results in a private level of weed control that is less than the level of control that is considered socially optimal.

Another example of an externality in weed control may arise from the spraying operation. In this case, drift from chemical application may damage crops on adjoining properties. As in the previous case, the land-holder does not take into account the effect of his actions on the costs incurred by the neighbour as a result of the crop damage.

Public goods. A case of government intervention can also be made with respect to the provision of certain services in weed control, such as the maintenance of quarantine restrictions; the selection and testing of biological control agents; and control over the use of pesticides. These services or goods are commonly called public goods, and have the following characteristics:

1. Consumption by one land-holder does not preclude simultaneous consumption

by another land-holder, and

2. Land-holders cannot be excluded from enjoying the benefit of the good.

Because of these characteristics public goods are likely to be undersupplied from a social point of view in the absence of government intervention. As an example, Tisdell (20) says a land-holder considering the introduction of biological weed control is likely to be motivated by his own self-gain, which will be less than the collective gain of society. Although the collective gain from a biological weed control programme may exceed the cost of its introduction, no individual land-holder could recoup these costs from his own gain. Therefore, in the absence of government intervention, the control may not be introduced.

An argument for government intervention may also exist in situations where the government can lower the transaction costs of control, capture economies of scale, or co-ordinate the control efforts of private individuals. The government may also be able to delay the development of irreversible situations and provide time for the conduct of research to determine optimal control policies. The government can also conduct extension programmes, which may change a land-holder's private weed control programme into a more socially desirable one.

It may be concluded than, that because of market failure, government intervention will result in a more socially desirable level of weed control.

CASE STUDIES

The Agriculture Protection Board of W A. (APB) typifies, in a broad sense, the nature of intervention by most state governments in weed control in Australia. Its activities are directed by the appropriate legislation, and are often the result of long standing practice and farmer pressure. Up until recently, there has been little or no attempt to evaluate these activities. This was the major motivation behind a study initiated in late 1985 aimed at evaluating, in an economic and social framework, a range of APB programmes.

The method being used in these analyses is benefit cost analysis, which can be defined as "an estimation and evaluation of net benefits associated with alternatives for achieving public goals" (18). Because it allows both the private and external costs to be taken into account, benefit cost anaylsis considers both the gains in profit to the land-holder and the costs or benefits accruing to others, from the weed control.

There have been few published studies of this nature in Australia, the most notable being Vere *et al.* (22), and the related comment by Edwards and Freebairn (4) on serrated tussock, *Narsella trichotoma*, control in N.S.W.; Hourigan (6) on hardheads, *Acroptilon repens*, control in Victoria; and the Industries Assistance Commission (7) on the biological control of Paterson's curse, *Echium plantagineum*, in Australia. The theoretical basis for these studies and the economics of weed control in general can be found in Tisdell (20), Lumley (10) and Roberts *et al.* (17).

In this section I will discuss two such benefit cost analyses, carried out by the APB: those of saffron thistle and blackberry. Both of these analyses were aimed at evaluating the economic justification for the APB's involvement in the control of these weeds. Details of these two studies are presented in Roberts and Crackel (16), and Crackel and Roberts (2).

1. Saffron Thistle

Background. Saffron thistle is found in both the agricultural and pastoral areas of W.A. In 1984/85 there was a total of 830 properties infested, of which 769 were in Zones 4, 7 and 8 in the agricultural areas (Fig. 1). This represented an area of infestation of 152,000 ha, of which two-thirds were in agricultural areas.

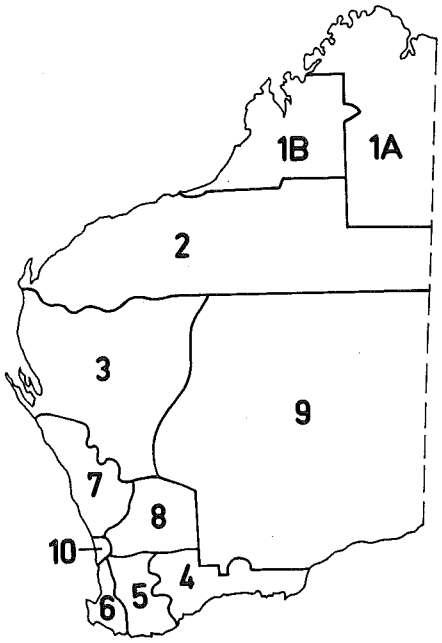

Figure 1. APB Zones in Western Australia

Saffron thistle is declared in W.A. under the Agriculture and Related Resources Protection Act (1976-1983). It is categorised for control in the heavily infested agricultural areas, and for eradication in the remainder of the agricultural areas. In the pastoral areas it is categorised for containment.

Expenditure on the control of saffron thistle in 1984/85 by the APB was about $276,000. About 60% of this was spent in the agricultural areas. This expenditure included the salaries of district officers, unit operators and temporary staff, plus contingencies, and the costs of materials. Income earned from operational work was not included.

Methodology. In the benefit cost analysis the net social benefit of the APB's involvement in saffron thistle control was estimated by comparing the costs and benefits accruing with and without the APB's control programme. The difference in net benefits between the "with" and "without" situations, is taken to represent the overall net social benefit (5) (Fig. 2).

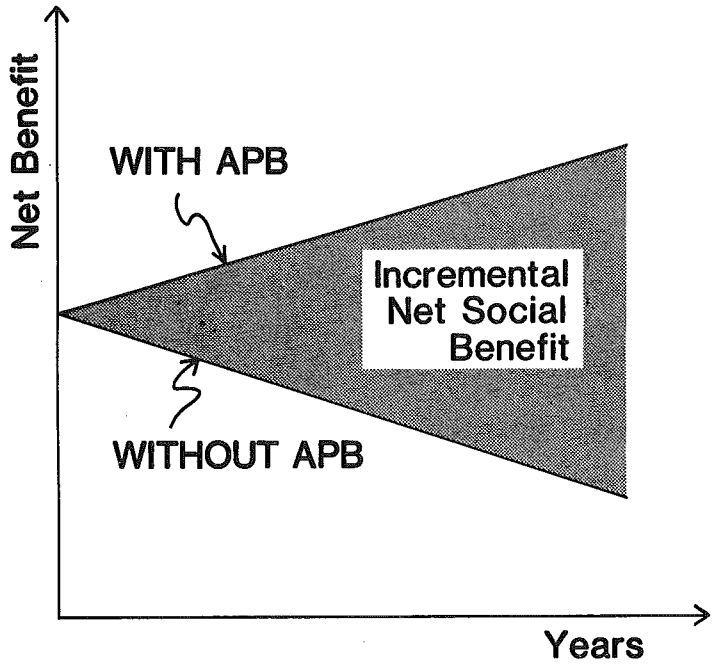

Figure 2. Comparison of the costs and benefits "with" and "without" APB control

It was assumed that cessation of the APB's control programme would lead to an increase in the rate of spread of saffron thistle. Thus land-holders could be faced with increased control costs. The cessation of the control programme was also taken to mean that there would be no farm inspections or control programmes prepared for land-holders. Farmers would also not be compelled to carry out any control on their properties. As well, there would be no compulsion for State or Local Government Authorities to carry out control on roadsides and other public land.

In the analysis the streams of benefits and costs accruing over the time period of the study, taken to be 10 years, were valued and discounted to present values. Because of uncertainty about the most appropriate discount rate to use, a range of discount rates was used in the analysis. Sensitivity analysis was used to test the robustness of the assumptions used in the base analysis.

Data for the analysis was obtained from two main sources, the APB's records, and from information gained at workshops held at three country centres. Participants at the workshops included farmers, APB staff and Department of Agriculture personnel.

Assumptions. The following assumptions were made in the analysis:

a. Rate of spread - assumed to be increasing at 1% in the presence of the APB. Because of the difficulty in predicting what might happen to the

rate of spread if the APB was not present, four rates of spread were used in this situation.

b. Levels of cropping - the area of crop in the infested areas was assumed to be in the same proportion as the area of crop for the zone, in the presence of the APB. This area was assumed not to change in the absence of the APB in Zones 7 and 8. In zone 4, where the level of cropping is much less, it was assumed to increase without the APB. This is in line with the recommendation that cropping is the best method of control.

c. Levels of control in the crop - depended on the prevalence of staggered germination in the crop. This assumption varied across zones.

d. Levels of control in the pasture - assumed to be relatively minor across all zones.

Benefits and Costs. The benefits of cessation of the APB's saffron thistle control activities were identified as:

a. Savings in costs to the APB.
b. Savings in costs to State and Local Government Authorities.
c. Savings in quarantine penalties by farmers.

The costs were identified as:

a. Greater costs of on-farm control by land-holders.
b. Loss in sheep production.
c. Loss in carrying capacity.
d. Loss in grain production.
e. Greater cost in grubbing light infestations.

Results. The results of the base analysis are given in Table 1. With one exception, that of an after-APB rate of spread of 10% in Zone 4, all benefit cost ratios are greater than one. In other words, the benefits of cessation of the APB's saffron thistle activities outweigh the costs. This result suggests that there is no economic justification for the current level of expenditure on the control of saffron thistle.

Sensitivity analyses showed that very significant losses in production due to saffron thistle, far higher than what might reasonably be considered plausible, would need to be experienced to alter the result. These analyses also showed that the spread of saffron thistle without the APB would have to be at a rate greater than the maximum used in the base analysis to alter the result. Finally, the result was shown to be relatively insensitive to changes in the level of control in pastures and on non-arable land. Thus, the results appear relatively robust with respect to the assumptions made.

Blackberry

Background. Blackberry is found in the south-west of W.A. The number of properties infested in 1985/86 was 2,100, which represented an area of infestation of 7,910 ha.

Blackberry is categorised for control in the heavily infested areas of zones 5 and 6, and eradication in the remainder of these zones. It has a prevention categorisation for the remainder of the state. Total expenditure on the control of blackberry by the APB in 1985/86 was about $304,000, and of this, $258,000 was on salaries and wages.

Methodology. The net social benefit of the APB's involvement in blackberry

Table 1. Discounted costs and benefits ($) over 10 years: Base anaylsis[a] (at 1984/85 prices)

Cost or benefit	Rate of spread assumption (%)[b]											
	Zone 4				Zone 7				Zone 8			
	3	5	7	10	3	5	7	10	3	5	7	10
Benefits												
Savings in costs of APB	237,197	237,197	237,197	237,197	907,278	907,278	907,278	907,278	320,216	320,216	320,216	320,216
Savings in cost to State and Local Govt. Authorities	48,835	48,835	48,835	48,835	186,792	186,792	186,792	186,792	65,927	65,927	65,927	65,927
Total benefits	286,032	286,032	286,032	286,032	1094,070	1094,070	1094,070	1094,070	386,143	386,143	386,143	386,143
Costs												
Increased cost of on-farm chemical control	90,738	116,049	143,992	191,441	35,553	74,803	118,134	191,711	21,750	45,762	72,270	117,282
Increased cost of grubbing light infest	19,278	40,561	64,057	103,954	71,325	150,067	236,996	384,605	21,068	44,328	70,005	113,606
Total costs	110,016	156,610	208,049	295,395	106,878	224,870	355,130	576,316	42,818	90,090	142,275	230,888
NPV	176,015	129,421	77,982	-9,363	987,192	869,200	738,940	517,754	343,324	296,053	243,867	155,254
Benefit cost ratio	2.60	1.83	1.37	0.97	10.24	4.87	3.08	1.90	9.02	4.29	2.71	1.67

[a]Discounted at a rate of 8% p.a.
[b]Assumed rate of spread without the APB

control was estimated using the same approach to that used in the saffron thistle study. In this study a 20 year time frame was used. Blackberry infestations in W.A. are found in three main locations: (i) farmland, (ii) pine forests, and (iii) hardwood forests, national parks and other public land. This study concentrated almost exclusively on the problem on farmland and in pine forests.

Assumptions.

a. Rate of Spread - blackberry was assumed to spread at an exponential rate if left uncontrolled. The actual rate of spread was governed by the assumptions on the level of control, with and without the activities of the APB.

b. Area Under Control
   i. Pine forests: area under control was determined by CALM's annual budget for blackberry control.
   ii. Farmland: area under control was assumed to decline following cessation of the APB's control activities.

c. Area Eradicated
   i. Pine forests: this was also determined by CALM's blackberry control budget.
   ii. Farmland: several eradication scenarios were used, three of which are reported in this paper. It was assumed that the annual area of eradication with the APB was 200 ha. This area was assumed to decline by either 100, 75, or 50% following cessation of the APB's activities.

d. Area of blackberry in pasture - the area of blackberry infestations in pasture was assumed to increase without the control efforts of the APB. Losses in pasture production were also assumed to increase.

e. Area of blackberry in pines and losses in pine production - both were assumed to remain unchanged following cessation of the APB's activities.

Benefits and Costs. The benefits of the APB's involvement in blackberry control were identified as:

a. Reduced loss in cattle production.
b. Reduced loss in pine production.

The costs were identified as:

c. Costs of the APB.
d. Costs of State and other Local Government Authorities.
e. Increased costs to CALM who would spend about 20% less on blackberry in the absence of the APB.
f. Increased costs of on-farm control.

Results. The results of the base analysis are shown in Table 2. As can be seen, the benefit cost ratios are all less than one, and in the context of this analysis, this indicates that the benefits of the APB's blackberry control programme are outweighed by the costs. That is, based on the assumptions made, there is no economic justification for the APB's intervention in blackberry control.

Table 2. Discounted costs and benefits ($) over 20 years: Base analysis[a] (at 1985/86 prices)

Benefit or cost	Changes in eradication[b]		
	100% decline in eradication	75% decline in eradication	50% decline in eradication
Benefits			
Reduced loss in cattle production	1,072,829	984,886	896,944
Reduced loss in pine production	36,185	36,185	36,185
Total Benefits	1,109,014	1,021,071	933,129
Costs			
Increase in costs of on farm control	-49,118	26,261	101,640
APB expenditure	527,616	527,616	527,616
Costs to Government Department and local shires	1,261,691	1,261,691	1,261,691
Increase in costs to CALM	252,338	252,338	252,338
Total Costs	1,992,528	2,067,907	2,143,286
NPV	883,514	1,046,836	1,210,157
Benefit cost ratio	0.56	0.49	0.44

[a] Discounted at a rate of 6% p.a.
[b] Assumed 200 ha eradicated 10% with APB

Sensitivity analysis indicated that the results were reasonably robust to changes in the assumptions. An increased loss in pasture production was the only change in the assumptions that caused the result to alter, and this was only in the case where eradication declined by 100% following cessation of APB activities.

CONCLUSIONS

The results of the two analyses suggest that there is no economic justification for the APB's intervention in the control of either saffron thistle or blackberry, and the consequent level of expenditure on each weed. These results can be interpreted as casting considerable doubt on the efficiency of the legislation which requires the APB to carry out its current control programme for these two weeds. The results also lend support to the arguments by Moore (12, 13), Quinlivan (15) and Amor and Twentyman (1), that many declared weeds need not be declared. From a policy point of view, the results present an argument for either un-declaring both weeds, or changing their categorization to one where much less effort is expended in control.

However, a word of caution is necessary. In both analyses, in particular the blackberry study, many of the external costs and benefits associated with each weed, were left out of the calculations. For example, in the blackberry study the loss in recreation and tourism due to blackberry infestations were not taken into account. Another example is the situation where a land-holder free of a particular weed has a preference for a weed-free farm. Therefore, even though the spread of a weed onto the property may not cause a direct economic loss, the land-holder may suffer a loss in utility, and this represents a social cost that should be accounted for in the study. In other words, both studies failed to properly account for many of the external costs and benefits that provide the reason for government intervention.

The valuation of these non-market costs and benefits and their mechanism in the benefit cost analyses is most important if the analyses are to give a true reflection of the economics of a particular weed. Research currently being carried out by the APB is aimed at developing methods of valuing these non-market items. Until then however, the results of the benefit cost analyses should be treated with some caution.

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REFERENCES

1. Amor, R.L. and Twentyman, J.D. 1974. J. Aust. Inst. Agric. Sci. 40, 194-203.
2. Crackel, L.J. and Roberts, E.J. 1987. "The Economics of Blackberry Control: A Cost Benefit Analysis", Agriculture Protection Board of W.A., Perth.
3. Freebairn, J.W. 1974. Government Intervention in Disease and Pest Control. Unpublished Paper, A.N.U., Canberra.
4. Edwards, G.W. and Freebairn, J.W. 1982. Rev. Mark Agric. Econs. 50, 193-210.
5. Gittinger, J.P. 1982. Economic Analysis of Agriculture Projects. (The John Hopkins University Press: Baltimore).

6. Hourigan, M. 1985. Hardheads Cost-Benefit Analysis of Funds Allocated to Research and Control, Department of Conservation, Forests and Lands, Melbourne.
7. Industries Assistance Commission. 1985. Biological Control of Echium Species. (AGPS: Canberra).
8. Johnston, J.H. 1975. Rev. Mark. Agric. Econs. 43, 3-39.
9. Johnston, J.H. 1983. Ph.D. thesis. Macquarie University, Sydney. 626. pp.
10. Lumley, S. 1986. Factors Influencing the Social Benefits and Social Costs of Pest Plant Control: A General Overview. Department of Conservation, Forests and Lands, Melbourne.
11. Menz, K.M. and Auld, B.A. 1977. Search 8, 281-287.
12. Moore, R.M. 1971. J. Aust. Inst. Agric. Sci. 37, 181-191.
13. Moore, R.M. 1975. J. Aust. Inst. Agric. Sci. 41, 119-121.
14. Parsons, W.T. 1984. Proc. Noxious Weeds Workshop, 7th Aust. Weeds Conf., Perth. p. 1.6.
15. Quinlivan, B.J. 1972. J. Aust. Inst. Agric. Sci. 38, 283-286.
16. Roberts, E.J. and Crackel, L.J. 1986. Saffron Thistle in Western Australia: A Cost Benefit Analysis.
17. Roberts, E.J., Crackel, L.J. and Hogstrom, A.W. 1986. Proc. Workshop on Economic Impact Weeds, Canberra. pp. 52-68.
18. Sassone, P.G. and Schaffer, W.A. 1978. Cost-Benefit Analysis: A Handbook. (Academic Press: New York).
19. Smith, L.W. 1984. Proc. Noxious Weeds Workshop, 7th Aust. Weeds Conf., Perth. p. 1.1.
20. Tisdell, C.A. 1985. Weed Control in a Social Context. University of Newcastle, Newcastle.
21. Trumble, H.P.C. 1978. Proc. 1st CAWSS Conf. pp. 431-442.
22. Vere, D.T., Sinden, J.A. and Campbell, M.H. 1980. Rev. Mark. Agric. Econs. 48, 123-138.