Economic Evaluation of Cattle and White-tailed Deer Response to Aerial Spraying of Mixed Brush

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Highlight: The combined economic effects, based on returns for lease hunting of white-tailed deer in conjunction with lifestock production, were calculated following partial treatment (80% sprayed in alternating strips) and complete treatment of mixed brush in South Texas with aerial sprays of 2,4,5-T and picloram at 1 lb/acre. Both approaches were economically feasible based on a 10% discount rate over a 9-year projected treatment life, except when the brush was completely sprayed and cattle prices were $0.255/lb. However, when cattle prices were less than $0.495/lb, partial treatment by aerial spraying was preferred, in an economic sense, since returns from lease hunting where 20% of the brush was left untreated for wildlife habitat more than compensated for reduced cattle returns.

One of the major deterrents to maximizing range forage production in the South Texas Plains is a heavy infestation of mixed brush (*Prosopis-Acacia*). Therefore, effective brush management is usually the first consideration for range improvement. Evaluation of alternative brush control methods generally involves comparing only benefits of increased beef production, and perhaps labor and feed cost reductions, to the cost of the control measure over the expected life of the practice.

Although landowners cannot legally sell wildlife in Texas, they may charge a fee for the privilege of hunting. In recent years, the demand for hunting has increased, and the revenue generated from white-tailed deer (*Odocoileus virginianus*) hunting in Texas has become an important component of ranch income (Berger 1974; Forrest 1966). The level and magnitude of returns from hunting ultimately depend on hunter success. Hunter success depends largely on how well the ranch manager can manipulate the habitat to provide adequate food and cover for deer. Therefore, there is increasing interest in the potential impact of range improvement practices on wildlife habitat (Beasom and Scifres 1976). Consequently, objective evaluation of brush control alternatives must include economic impacts that may occur from changes in hunting returns.

Cattle returns also relate to the level of proficiency with which the ranch manager can manipulate the habitat to provide adequate range forage for utilization by cattle. Cattle production and profits characteristically increase following brush control on rangelands in South Texas (Durham 1975). However, Beasom and Scifres (1976) reported that white-tailed deer numbers decreased significantly following complete treatment of South Texas brushland with aerial sprays.

Land managers contemplating range improvement programs in areas such as South Texas may desire to include alternatives to effectively manage for increased cattle production while maintaining adequate white-tailed deer numbers. Since increased cattle production and maintenance of white-tailed deer numbers may be inversely related when brush control exceeds threshold requirements for adequate wildlife habitat, economic trade-offs between increasing livestock production and reduced hunting potential must be quantified. Thus, the question, "Does deer hunting contribute more to ranch profits than the profits arising from increased livestock production following brush control?" now faces many ranch managers.

The purpose of this study was to evaluate the economic returns from livestock and white-tailed deer following complete and partial treatment of rangeland with aerial sprays.

Procedures

Livestock production data and estimates of changes in deer populations for this study were obtained from previous research conducted in South Texas (Beasom and Scifres 1976; Scifres et al. 1976; Durham 1974) and from personal communications with the ranch manager.[1] These data were utilized as a basis for estimating annual costs and returns from livestock and white-

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[1] Personal communications with Mr. A. J. Durham, San Perlito, Texas.

tailed deer associated with aerial spraying for brush control.

Commercial aerial application of 1 lb/acre of 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid] + picloram (4-amino-3,5,6-trichloropicolinic acid) (1:1) in alternate strips was compared to areas completely treated and those left untreated. Sprayed strips were approximately 600 ft wide separated by untreated strips of 100 ft wide (approximately 80% of the area sprayed when lateral displacement considered). Treatments were randomly allocated to the study areas located in close proximity to insure equal access to all treatments by white-tailed deer (Beasom and Scifres 1976).

The treatments were analyzed for economic feasibility by estimating (1) net present value and (2) the internal rate of return.[2] The decision criteria utilized in this study for economic acceptance of partial or complete treatment by aerial spraying required the investment in brush control and any additional breeding livestock to result in a positive net present value over the life of the treatment when the discount rate was 10%. Similarly, the criterion of acceptance for the internal rate of return was 10%.

Annual cost and return estimates were developed for each treatment for three livestock price situations and were expressed on per acre basis. Livestock sale prices, selected on an arbitrary basis, were $.255, $.355, and $.455/lb.

Investments included in the analyses were (1) brush control and (2) additional breeding livestock. Brush control and additional breeding livestock investments were $9.50 and $6.92/acre, respectively, for complete treatment. For the partial treatment, the investment costs were $7.60/acre for brush control ($9.50/acre × 80% of the area treated) and $5.44/acre for breeding livestock.

[2] The net present value is the sum of annual costs and returns discounted to the present at a specified interest rate. The internal rate of return is that rate which results in a net present value of zero for a given investment.

The increased forage resulting from brush control was utilized by a cow-calf operation. Added cows were assumed to cost $200/head with a salvage value estimated at $175/head. The increased number of cows produced an average of 350 lb of beef per cow with added variable costs (not including interest on the cow) of $25.18 per cow (Durham 1974). Other cost reductions, principally labor, resulting from brush control were estimated from actual ranch records[1] and totaled approximately $1.00/acre for both the complete and partially sprayed pastures (Durham 1974).

The impact of each treatment on white-tailed deer numbers was reported by Beasom and Scifres (1976). White-tailed deer numbers were converted to dollars by assuming a 25% annual harvest rate, and utilizing a value of $300/buck and $50/doe (Table 1).

White-tailed deer moved to areas unsprayed during the first two years of treatment, but numbers had stabilized and were similar in all treatments by the end of the third year following treatment (Beasom and Scifres 1976).

Cattle numbers were increased as a result of brush control by aerial spraying (Durham 1974; Scifres et al. 1976). Actual carrying capacities were utilized for 1973 through 1975 and projections were made for 1976 through 1982.[1] The partially treated area was estimated to carry 80% of the added number of cattle that the complete treatment supported (Table 2). This was considered to be conservative since cattle had improved accessibility to the 20% not treated; and, thus, greater utilization of existing forage was obtained.

Economic feasibility of the complete and partial brush control treatments was determined by examining the accumulated net present value (PV) and internal rate of return (IRR) over the projected life of the treatment. Economic preference of treatment (complete or partial) was accomplised by comparing the net present values and internal rates of return. Generally, when investment capital is not limiting, the brush control approach selected (either partial or complete spraying) must (1) be economically feasible (given the PV or IRR criteria established) and (2) produce the greatest net present value of the two choices. When capital is limited, the selected project must be (1) economically feasible and (2) produce the greatest internal rate of return.[3]

Risk and uncertainty (associated with brush control, cattle and white-tailed deer responses to the brush control, cattle price fluctuations, and use of credit reserves or cash for investment in brush control) are not considered in this study. The ranch manager must evaluate his risks and determine if income risks increase or decrease from partial or complete aerial spraying of brush. For South Texas, it could be hypothesized that a combination of cattle and white-tailed deer to produce a given level of income would have less income risk than the production of that income from cattle only.

Increased net revenues from increased cattle production and labor savings were estimated for the three cattle price alternatives and represent the net cash flow arising from weaned calf sales and labor savings less variable cash costs (Table 3).[4] This flow of funds must be sufficient to recover the investment of brush control, depreciation on the added breeding animals, and

[3] Assumptions which apply to this study situation include the following: (1) investment opportunities are mutually exclusive and (2) net cash inflows can be reinvested at a selected discount rate, present value method or the internal rate of return depending on which criteria are being utilized. As cattle prices increase and internal rates of return increase, assumption (2) may become less acceptable.

[4] For this situation, labor savings represented an actual cash outflow reduction. For other situations that involve only owner-operator labor, reductions in cash outflow would not occur and the decision to include labor reductions as a benefit would depend on the opportunity cost of the owner-operator's labor.

Table 1. Estimated value ($/acre) of white-tailed deer following partial (80%) and complete spraying of mixed brush in South Texas.[2]

Time of census[b]	Treatment[c]	Value ($/acre)		
		Bucks	Does	Total
Feb. 1974	None	1.78	.96	2.74
	Partial	.86	.66	1.52
	Complete	.29	.54	.83
Feb. 1975	None	1.73	.74	2.47
	Partial	1.23	.53	1.76
	Complete	.61	.21	.82
Aug. 1975	None	.55	.29	.84
	Partial	.67	.42	1.09
	Complete	.46	.35	.81

[a] Deer numbers are assumed to be equal during the 4 to 10 years remaining life of the treatments.
[b] Census couns were utilized nearest to the hunting season, except for the last count that represents the most recent.
[c] Brush control treatments were 1 lb/acre of a commercial 2,4,5-T + picloram mixture applied in strips so that 80% of the area was treated (partial treatment) and in solid block (complete treatment).

Table 2. Annual stocking rate increases (AUM/acre) resulting from partial (80%) and complete spraying of mixed brush in South Texas.

Year	Partial[a] treatment	Complete[a] treatment
1973	.300	.384
1974	.240	.288
1975	.228	.288
1976[b]	.276	.366
1977	.276	.366
1978	.276	.366
1979	.276	.366
1980	.204	.252
1981	.084	.108
1982	0	0

[a] Partial treatment represents 80% of the area treated in alternate strips and complete treatment represents 100% of the area treated with 1 lb/acre of a commercial 2,4,5-T and picloram (1:1) mixture.
[b] 1976 to 1981 represent projectons of increased cattle carrying capacities.

Table 3. Estimated annual net cash flow estimates ($/acre) from increased cattle production at three livestock prices ($/lb) following partial (80%) and complete aerial spraying of mixed brush in South Texas.[a]

Year after treatment	Complete treatment[b]			Partial treatment[b]		
	$0.255/lb	$0.355/lb	$0.455/lb	$0.255/lb	$0.355/lb	$0.455/lb
1[c]	3.29	4.51	5.72	2.90	3.89	4.88
2	2.86	3.84	4.81	2.53	3.31	4.11
3	2.78	3.71	4.65	2.50	3.27	4.04
4[c]	3.12	4.23	5.34	2.75	3.66	4.58
5	3.12	4.23	5.34	2.75	3.66	4.58
6	3.12	4.23	5.34	2.75	3.66	4.58
7	3.12	4.23	5.34	2.75	3.66	4.58
8	2.21	3.03	3.84	1.91	2.56	3.21
9	1.02	1.38	1.74	.92	1.22	1.52
10	0	0	0	0	0	0

[a] The annual cash flow estimates are gross livestock sales plus labor savings less variable cash costs and do not include the original investment in the brush control treatment, purchases or sales of added breeding livestock, or changes in hunting revenue.

[b] Complete treatment represents 100% of the area treated with 1 lb/acre of a commercial 2,4,5-T and picloram (1:1) mixture. Average treatment costs are $9.50/acre and the added breeding livestock investment is $6.92/acre. The partial treatment represents 80% of the area treated in alternating strips. Average treatment cost is $7.60 ($9.50 × .8)/acre and the added investment in breeding livestock is $5.44/acre.

[c] Year 1 is actually the year of treatment; year 4 through 10 represent projections.

lost revenue from hunting, and yield a 10% annual return on the total investment; i.e., the sum of the net present value over the life of the brush control alternative must be positive for brush control to be economically feasible.

Given these investments, the livestock cash flows (Table 3) and economic impacts from hunting (Table 1), the net present value and internal rates of return for each treatment were estimated for the three livestock price situations (Table 4). The final year of the net present value analysis represents the total accumulated net present value over the life of the treatment (Table 4). The first through eighth years represent an accumulated net present value for given points in the lives of the treatments.

Results and Discussion

Net present values indicate that brush control by aerial spraying was economically feasible for all cattle price and treatment situations, except when cattle prices were $.255/lb and the brush was sprayed completely (Table 4). The net present values for the brush control alternatives may be compared, for a given cattle price situation, to determine which treatment would be preferred. Using the criteria established for this study, the preferred treatment for the three livestock price situations is partial treatment in alternating strips.

As cattle revenues increase relative to hunting revenues, the economic advantage of partially spraying in strips diminishes. For example, at cattle prices of $.255/lb the partially sprayed pasture produced $2.50/acre more total net present value than complete treatment. At cattle prices of $.455/lb, the partial spray treatment produced $.41/acre more total net present value (Table 4). The break-even price between the treatment in alternating strips was approximately $.495/lb. The proper decision regarding type of treatment to use accordingly depends on the relative prices of beef and hunting returns. Given the past 5 years' average livestock prices and the value of hunting, it will be difficult for a landowner, in South Texas in this case, to justify complete spraying of rangeland if deer hunting produced $1.00 to $2.00/acre net revenue.

When capital is assumed to be unlimited, partial treatment in strips would be preferred in all situations presented in Table 4. However, if cattle prices were expected to average $.495/lb or more over the life of the treatment, complete spraying would be preferred.

Given a situation of limited investment capital, partially spraying in alternating strips yielded greater internal rates of return for all price situations and would therefore be the preferred treatment in South Texas (Table 4).

The time required for a brush control project to produce the minimum rate of return, as established by the manager in the present value analysis, is of additional importance. For example, when livestock prices were $.355/lb, a positive net present value occurred the sixth year following complete treatment of the mixed brush. This may have implications for the land manager who faces uncertainty regarding the projected life of a given brush control alternative, i.e., given two projects with similar net present values and internal rates of return, the preferred treatment would be one which produced a positive net present value in the shortest time period.

Table 4. Accumulated net present value ($/acre) of hunting and livestock production at three livestock prices ($/lb) resulting from partial or complete aerial spraying of brush in South Texas based on a 10% discount rate; and associated internal rates of return (%).

Year after treatment	Total present value ($/acre)					
	Complete treatment[a]			Partial treatment[a]		
	$0.255/lb	$0.355/lb	$0.455/lb	$0.255/lb	$0.355/lb	$0.455/lb
1	−14.01	−12.91	−11.81	−10.63	−9.73	− 8.82
2	−12.90	−10.99	− 9.09	− 9.01	−7.46	− 5.90
3	−11.55	− 8.94	− 6.33	− 7.47	−5.34	− 3.20
4	− 9.41	− 6.05	− 2.68	− 5.59	−2.84	− .80
5	− 7.48	− 3.42	.63	− 3.89	− .56	2.76
6	− 5.72	− 1.03	3.65	− 2.33	1.51	5.35
7	− 3.43	1.82	7.08	− .38	3.93	8.23
8	− 1.36	4.27	9.91	1.34	5.95	10.56
9	− .20	5.58	11.37	2.30	7.04	11.78
Internal rate of return (%)	9.7	17.4	24.7	14.0	21.9	29.5

[a] Complete treatment represents 100% of the area treated with 1 lb/acre of a commercial 2,4,5-T and picloram (1:1) mixture. The partial treatment represents treatment of 80% of the area in alternate strips.

[b] The fourth through ninth years represent projections of livestock and white-tailed deer responses to treatment.

Conclusions

Returns from lease hunting of white-tailed deer were generally reduced, due to a negative response based primarily on reduction in production of forbs preferred by white-tailed deer (Beasom and Scifres 1976) regardless of whether the brush was partially sprayed in alternating strips or completely sprayed as compared to no treatment. However, application of the herbicide in strips had less adverse affect on white-tailed deer returns than did complete spraying of brush. Livestock returns from the area treated completely were greater than from the area treated in alternating

strips. Net present values, given the cattle price range used in this study, for the complete aerial spray ranged from −$.20 to $11.37/acre and for partially treating the brush in alternating strips ranged from $2.30 to $11.78/acre. Internal rates of return ranged from 9.7% to 24.7% and from 14% to 29% for the complete and partial spray treatment, respectively.

Given the net present values estimated for the two treatments, the internal rates of return, and the length of time required for a positive net present value, it can be concluded that (1) complete and partial treatment of mixed brush by aerial spraying are both economically feasible (with one exception concerning the complete treatment and $.255/lb sale price of livestock) and (2) the partial treatment of brush would be preferred, in an economic sense, to complete spraying in South Texas when cattle prices are less than $.495/lb (partial treatment is preferred at all price levels if capital is limiting). This analysis indicates (1) the importance of considering the impacts of fee hunting on selection of a brush control program and (2) that brush control is a viable alternative to increase profits from ranching in South Texas.

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