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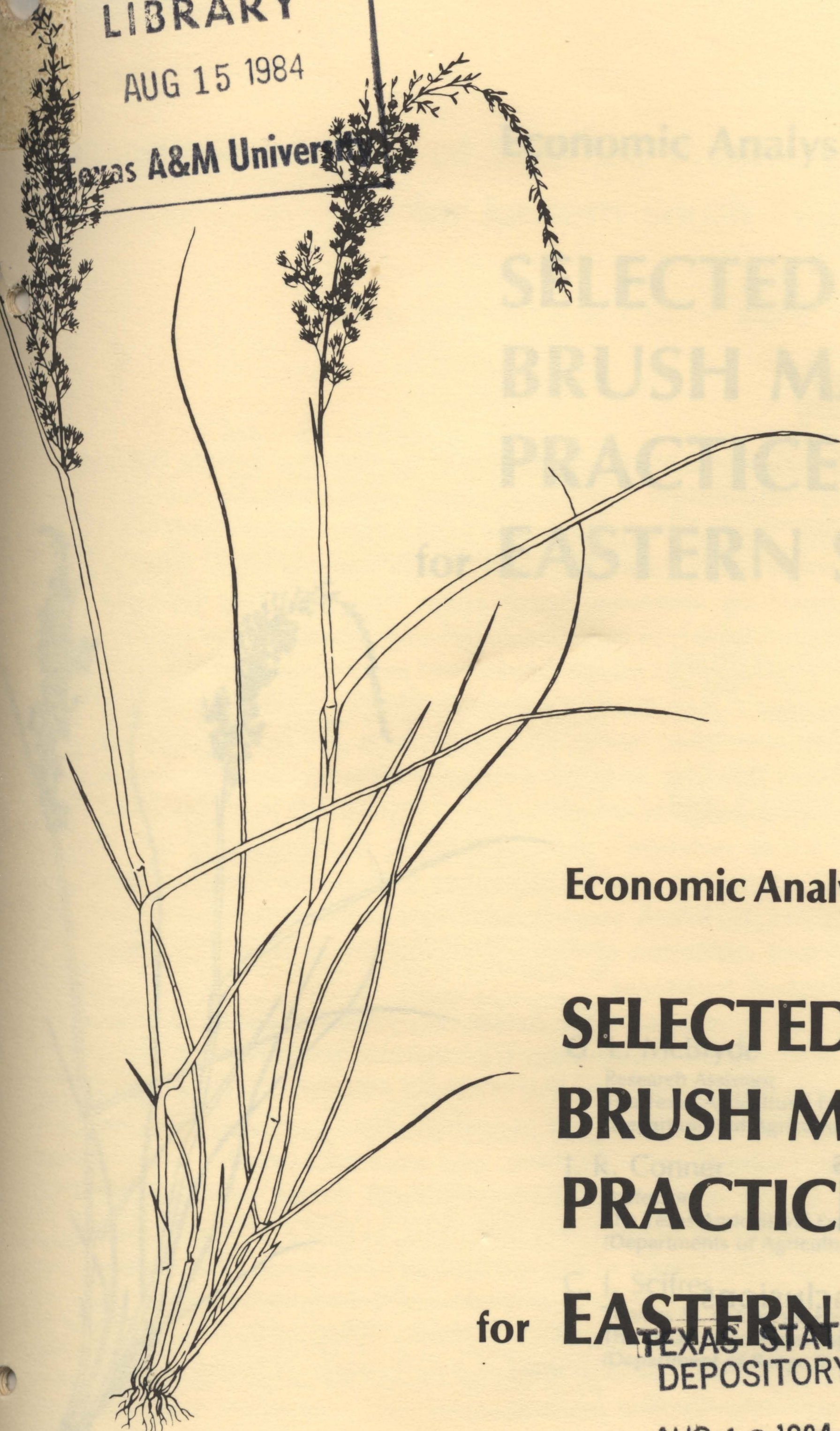

Economic Analysis of

SELECTED BRUSH MANAGEMENT PRACTICES for EASTERN SOUTH TEXAS

THE TEXAS AGRICULTURAL EXPERIMENT STATION / Neville P. Clarke, Director / The Texas A&M University System / College Station, Texas

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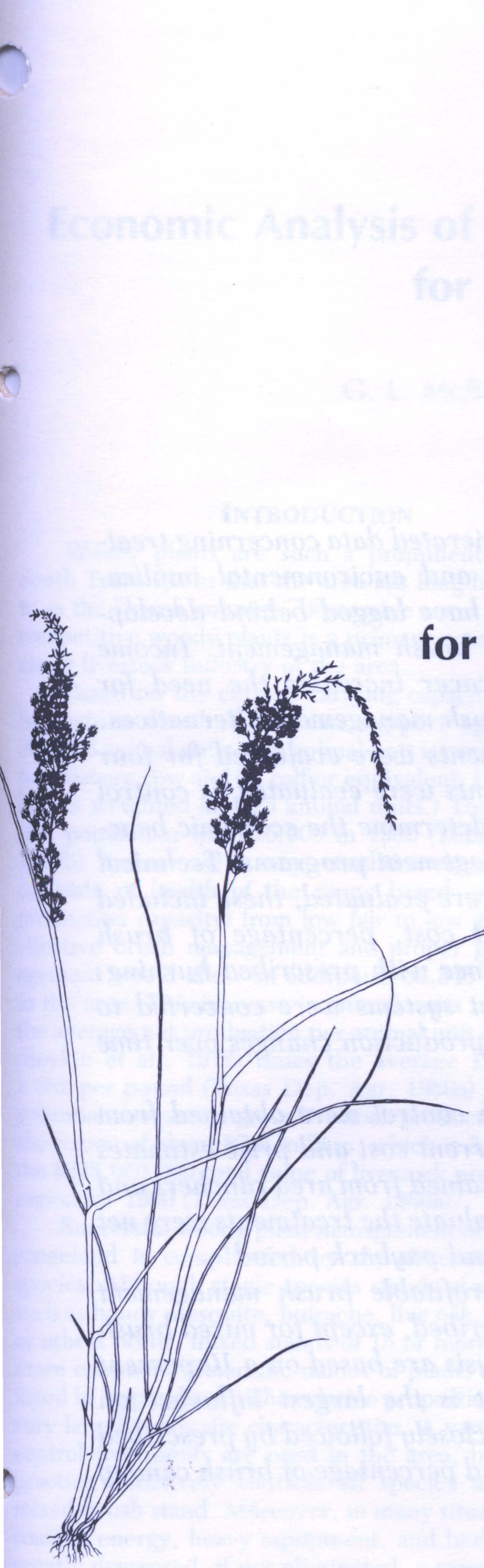

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Summary

Brush management research has generated data concerning treatment efficacy, application technology, and environmental implications. Economic evaluations, however, have lagged behind development of information in other areas of brush management. Income reduction caused by excessive brush cover increases the need for economic bases on which to compare brush management alternatives.

Responses to selected brush treatments were evaluated for four general brush types. Ten initial treatments were evaluated as control practices. They were then evaluated to determine the economic benefits of prescribed burning in brush management programs. Technical aspects of brush management systems were evaluated; these included forage production potential, treatment cost, percentage of brush canopy before treatment, and maintenance with prescribed burning. Forage responses to brush management systems were converted to livestock carrying capacities to develop production changes over time for each individual treatment.

Cost and price estimates for brush control were obtained from contractors active in the study area. Current cost and price estimates other than for brush treatments were obtained from area ranchers and retail firms. Economic indices used to evaluate the treatments were net present value, internal rate of return, and payback period.

Results of the analysis indicate profitable brush management alternatives exist for all brush types described, except for mixed brush on shallow sites. The results of the analysis are based on a 10 percent discount rate. Projected treatment cost is the largest influence on brush management profitability. This is closely followed by prescribed burning. Forage production potential and percentage of brush canopy cover are lesser contributing factors.

KEY WORDS: Range management/economic evaluation/livestock production.

Economic Analysis of Selected Brush Management Practices for Eastern South Texas

G. L. McBryde, J. R. Conner, and C. J. Scifres

Introduction

Woody plants are such a prominent part of the South Texas Plains that the area has long been referred to as the "brush country." Excessive cover of unusable, competitive woody plants is a primary constraint to the range livestock industry of the area.

Based on the current carrying capacity, rangeland in eastern South Texas can support approximately 364,536 animal units. (An animal unit is considered to be one mature cow and its calf or equivalent; i.e., a mature bull is weighted at 1.25 animal units.) The actual beef cow population was 375,000 in 1980 (Texas Dep. Agr. 1980b). An increase in range condition class (the ecological state of health of the range based on its natural production capacity) from low fair to low good through effective brush management and proper grazing management would allow an additional 33,545 animal units in the area. This increase in animal units multiplied by the average net production per animal unit of 33 pounds (Boykin et al., 1972) times the average 1980 price of $.652 per pound (Texas Dep. Agr. 1980a) represents a potential increase in gross livestock production value for the region of about $7.3 million, which is 3.2 percent of the $228,060,000 total value of livestock products in the region for 1980 (Texas Dep. Agr. 1980a).

Successful woody plant management of South Texas rangeland is complicated by the diversity of woody species. Although single-species stands of woody plants such as honey mesquite, huisache, live oak, whitebrush, or others occur, mixed stands of 15 or more species are more common. (Scientific names of plants involved are listed in Appendix A.) The relative proportions of species vary largely with site characteristics. A variety of brush control treatments are used in the area, but no single practice effectively controls all species in any given mixed-brush stand. Moreover, in many situations, rising costs of energy, heavy equipment, and herbicides have greatly decreased, if not eliminated, a reasonable profit margin from investments in brush management.

Information to assist producers in decision making for profitable brush management is either limited to single treatments or outdated with respect to market prices. Objectives of this study were to provide 1) a more extensive, updated analysis of the economic responses to brush management in eastern South Texas and 2) a basis for area ranchers to evaluate and implement profitable brush management opportunities.

Study Area

Brush control investments were analyzed for the eastern portion of South Texas. The study area includes Atascosa, Aransas, Bee, Cameron, Goliad, Jim Wells, Karnes, Kenedy, Kleberg, Live Oak, Nueces, Refugio, San Patricio, Willacy, and Wilson Counties (Fig. 1). The total area is approximately 7.7 million acres, of which about 4.6 million acres are rangeland (USDA 1970).

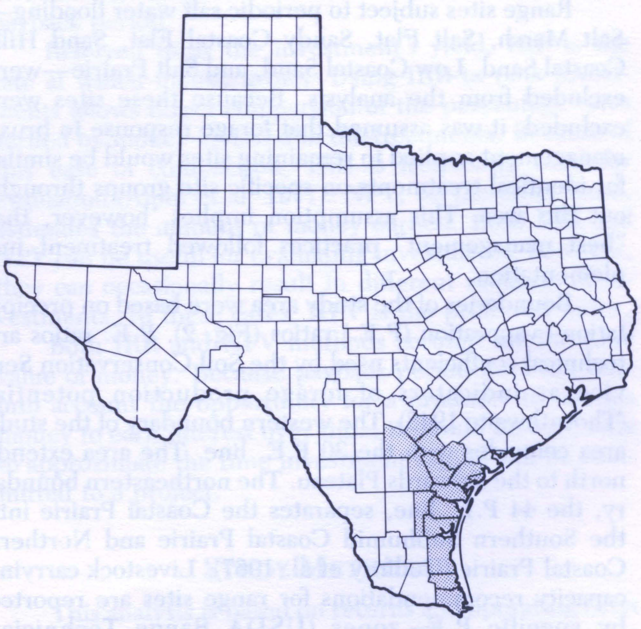


Figure 1. Counties with major portions in the study area which includes the southern portion of the Coastal Prairies and the eastern portion of the Rio Grande Plains resource regions, Texas.

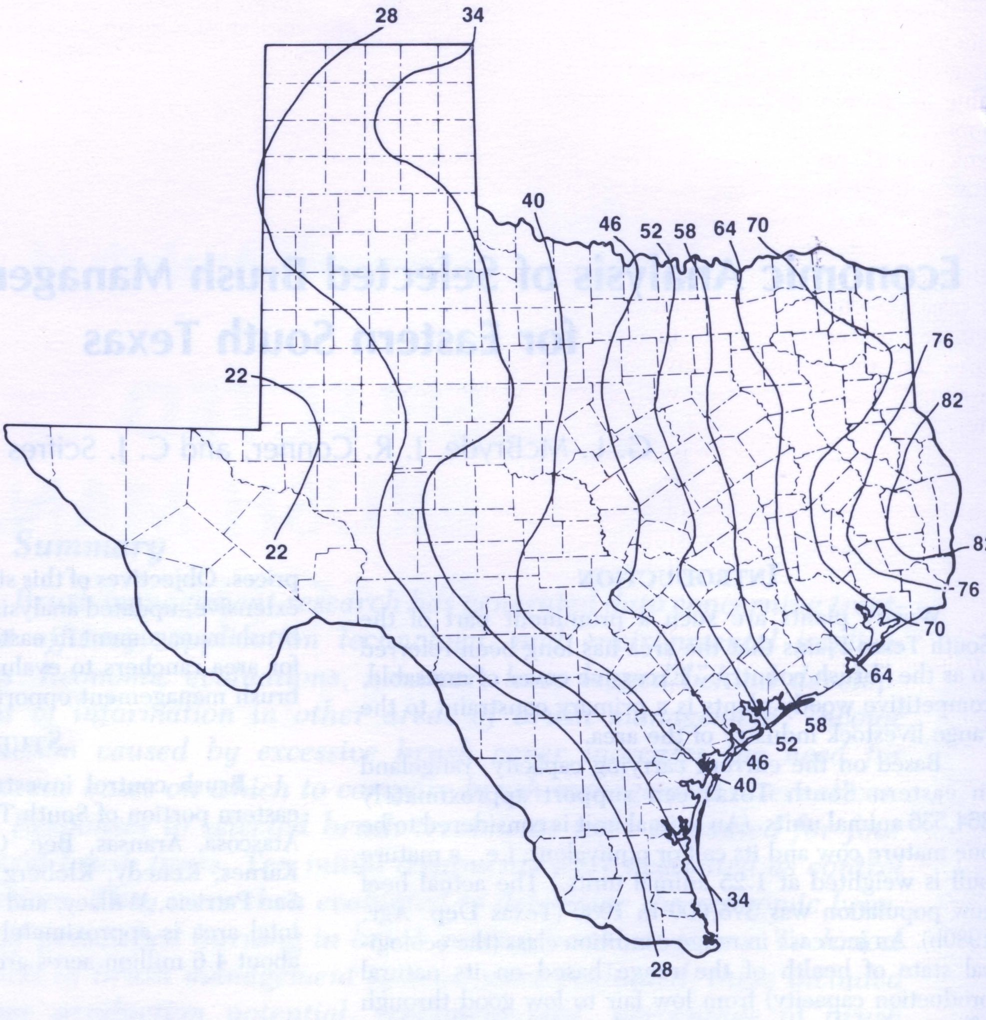


Figure 2. Annual precipitation–evaporation index for Texas (source: Soil Conservation Service, USDA, Temple, Texas).

Range sites subject to periodic salt water flooding—Salt Marsh, Salt Flat, Sandy Coastal Flat, Sand Hill, Coastal Sand, Low Coastal Sand, and Salt Prairie—were excluded from the analysis. Because these sites were excluded, it was assumed that forage response to brush management applied to remaining sites would be similar for identical treatments on specific site groups throughout the area. This assumption implies, however, that "best management" practices followed treatment implementation.

Boundaries of the study area were based on precipitation-evaporation (P.E.) ratios (Fig. 2). P.E. ratios are technical coefficients used by the Soil Conservation Service as indicators of forage production potential (Thornthwaite 1948). The western boundary of the study area coincides with the 30 P.E. line. The area extends north to the Edwards Plateau. The northeastern boundary, the 44 P.E line, separates the Coastal Prairie into the Southern Subhumid Coastal Prairie and Ncrthern Coastal Prairie (Godfrey et al. 1967). Livestock carrying capacity recommendations for range sites are reported by specific P.E. zones (USDA Range Technician Guides).

Three range site groups, based on soil profile depth and runoff moisture received, were established within the study area (Table 1). Four generalized but distinct and representative brush stands were considered to occupy these sites: mixed on deep drainages, mixed on deep upland sites, mixed on shallow sites, and huisache on deep sites. Each brush stand is defined by percentage of species composition (Table 2) and site group on which it occurs. There are two reasons for targeting the brush stands in this manner. First, it is necessary to know the proportion of each species in the brush stands to project the success of a specific treatment. Second, it allows contrasting other brush problems with those evaluated to determine how closely the investment yields may match.

Economic Procedures

In the budgeting process the first step is to determine yearly cash flows over the life of an investment. This is done by considering all costs of the new management and then the additional benefits the new manage ment generates and the years in which the costs and benefits occur (example given by Whitson et al. 1979). Range improvements generally have an initial cost of treatment followed by increased benefits from improved stocking rates, calf crops, and weaning weights. Thes improved production levels often last many years int the future.

These future yearly cash flows must then be discounted. Future cash flows are discounted because money has a time value. Each producer has his own time value for money based on his opportunity to use that money. For example, if a producer invests funds in a bank at a 10 percent rate of interest, those funds will grow over the investment period. How much they grow each year, as a percentage, is the investment's interest rate. The rate at which a producer should discount future cash flows from ranch improvements should then at least be equal to the available interest rate on an alternate use of those same investment funds. This ensures that the producer's investment in his ranch will grow at a rate competitive with other possible investments.

After the discount rate is established, it can be used to develop the net present value (NPV). The NPV, which indicates the worth of an investment in today's dollar value, is simply the sum of the discounted cash flows which occur over the life of the investment. If the NPV is zero, then the investment is earning the specified discount rate (investor's opportunity cost) and would be considered a favorable investment. If the NPV is greater than zero, the investment is producing additional value represented by the dollar amount of the NPV. Because all brush treatments are characterized by some element of risk, the producer may demand a higher discount rate to reflect this additional risk. As the producer chooses larger discount rates, he is demanding that his investment capital grow at a faster rate. Thus, a larger discount rate applied to the same investment will reduce the NPV.

Table 1. Representative range sites and soils used to generalize range site groups used in economic analysis of brush management methods in eastern South Texas.

Range site group and representative range sites	Typical soil series
Deep drainages	
Clayey bottomland	Aransas
Lakebed	Tiocano
Loamy bottomland	Sinton, Odem
Blackland	Lattas, Danjer
Ramadero	Papagua
Deep uplands	
Loamy sand	Comitas, Papalote
Claypan prairie	Christine, Laparita
Tight sandy loam	Floresville, Imogene
Gray sandy loam	Edroy, Opelita
Sandy loam	Czar, Delmita
Sandy	Sarita, Aluf-Hitilo
Saline clay	Monteola
Deep sand	Nueces
Shallow	
Shallow ridge	Pettus, Olmos
Shallow sandy loam	Dilley, Lacoste
Shallow	Flashing, Picosa
Gravelly ridge	Hindes

Source: USDA Soil Conservation Service county soil surveys.

Table 2. Generalized brush stands based on composition by canopy cover for each site group used in analysis of economic performance of brush management alternatives for eastern South Texas.

Site group	Major species*
Deep drainages	Mixed stand of whitebrush (35%); honey mesquite (25%); one or more of spiny hackberry, Texas persimmon, huisache and/or elms (25%); one or more of Texas colubrina, agarito, chittanwood, retama and/or pricklypear (15%).
Deep uplands	Mixed stand of honey mesquite (40–50%); one or more of spiny hackberry, twisted acacia, lime pricklyash, and/or blackbrush acacia (10–20%); one or more of Texas persimmon, *Condalia* spp., *Ziziphus* spp., Texas colubrina and/or desert yaupon (5–15%); mixture of guayacan, leatherstem, Texas ebony, Southwest bernardia, liveoak, catclaw acacia and wolfberry (5–15%).
Deep	Essentially 100% huisache.
Shallow	Mixed stand of guajillo, cenizo, twisted acacia and blackbrush acacia (90%); *Condalia* spp., desert yaupon, pricklypear, javelinabrush, and catclaw acacia (10%).

*Values in parentheses indicate relative proportion (based on canopy cover) of species in the brush stand.

The preferred method of evaluating investments would then consist of three steps: 1) estimate yearly net cash flows (income less costs) over the investment life; 2) discount the yearly net cash flows in the future years by an appropriate discount rate, then sum the discounted net cash flows for all years of the investment life to determine the NPV for the investment; and 3) select the investment with the highest NPV.

Two other methods are commonly used to evaluate investments. These are internal rate of return (IRR) and payback period.

Referred to as the investment's yield, IRR is the rate at which money grows. Using IRR to rank investments allows direct comparison of the percentage rates earned by money invested in the treatments. Because of this ease of comparison, IRR is frequently used for evaluation (Alpin et al. 1977). NPV, on the other hand, estimates the amount of money earned. Both IRR and NPV can be useful for evaluating investments; however, they can occasionally result in different rankings of investments. In these cases, NPV is the preferred index.

Both IRR and NPV methods account for the time value of money. Because payback period does not take into account the opportunity for a producer to use his money to earn interest over time, it should be used only to approximate the time investment capital will be committed to a project.

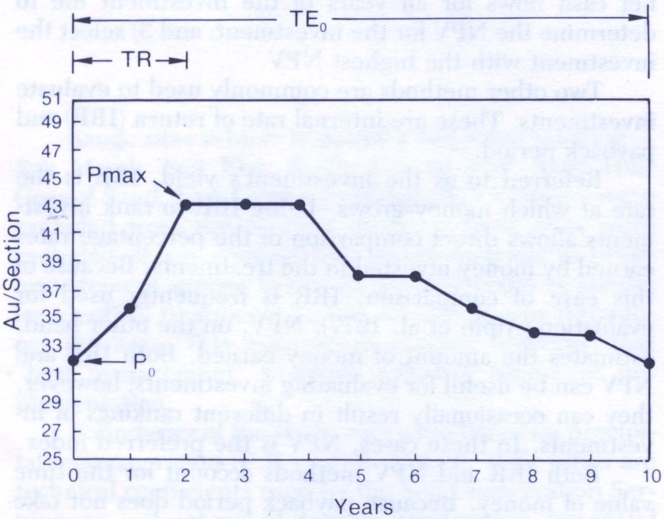
Study Methods

This analysis is based on returns and operating costs for a 300-head cow-calf operation. The analysis used a standard partial budget format with discounted cash flows to project NPV and IRR of investments in brush management practices. This procedure was used to evaluate the value of such a change in ranch operations on a yearly basis for the life of the investment. (Brush management plans, including prescribed burns, may be permanent changes. Should the change be permanent, value from the change would be calculated as a salvage value in approximately the 20th year after initial treatment.)

Technical data that affect the economic analysis were restricted in this study to those specific yield changes that affect the marketable product (pounds of beef). These included changes in carrying capacities, weaning weights, and calf crop percentages. Potential benefits from reduced labor costs or impacts on revenues from wildlife-related enterprises were not considered.

Estimates of yield changes are difficult to obtain because of the long time period that brush treatments affect production. Range forage responds to the increased availability of water, nutrients, and light soon after the brush has been removed or suppressed. This initial response allows a subsequent decrease in the number of acres required to support an animal unit. Also associated with the improved range condition class is an increase in more nutritious forage which promotes increased calf weaning weights (McGinty 1980). Improved nutritional levels also allow faster recovery of cows after calving. This in turn will increase the probability of cows successfully breeding and calving the following year.

Components of a typical response curve showing changes in carrying capacity are illustrated for a moderate canopy cover of mixed brush on the deep upland site



TE_0 = Length of time from treatment application until the effect is exhausted;

TR = Time required to reach maximum production;

P_0 = Original production;

Pmax = Maximum production.

Figure 3. Components of response curve following treatment of a moderate canopy cover of mixed brush on the deep upland site group with 2,4,5-T + picloram (1:1) at 1 lb/acre.

Table 3. Weighted carrying capacities by range condition class of generalized site groups used in economic analysis of brush management methods in eastern South Texas.

Condition class	Deep drainages	Deep upland	Shallow sites
	Carrying capacity (animal units/section)*		
Excellent	63.4	53.8	39.0
Good	48.8	42.4	31.1
Fair	38.8	33.5	25.6
Poor	36.4	30.2	27.7

*Carrying capacities were calculated by weighting the representative range site carrying capacity for each condition class by the percent acreage the site occupied in the study area. This is the same as calculating pasture carrying capacities for each condition class. For example, assume a pasture is 100 acres with two range sites. The two sites are clayey bottomland (25 acres) and blackland (75 acres). Carrying capacity values are obtained from Range Technician Guides for each condition class. The calculations would be as follows for good condition class:

Range site	% Acreage		Carrying capacity		% Contribution
Clayey bottomland	25	×	58.2 AU/Sec	=	14.5
Blackland	75	×	53.3 AU/Sec	=	40.0
			Pasture total carrying capacity		54.5

The carrying capacities can be calculated in this manner for all range condition classes.

group following aerial spraying with a conventional 1:1 mixture of 2,4,5-T [2,4,5-trichlorophenoxy] acetic acid) and picloram (3,5,6-trichloropicolinic acid) at 1 pound active ingredient per acre (Fig. 3).

Predicting production levels over time from alternate brush treatments was done by first assigning carrying capacity changes; then weaning weights and calf crop percentages were generated in response to the carrying capacity change. Weaning weights and calf crop percentages are considered to be directly related to range condition class; however, a major proportion of the increase in calf crops and weaning weights can be attributed to "best herd management" practices.

Initially, brush composition was defined as specifically as possible to allow estimation of treatment efficacy. Sites of uniform nature were then grouped into deep drainage, deep upland, and shallow site groups. The range condition class and corresponding carrying capacities (Table 3) were calculated as if for a pasture (USDA 1976). Carrying capacity associated with the initial range condition class represented pretreatment productivity (*Po*). Initial forage production increases in response to treatment are more likely to be associated with improved forage vigor than with a large percentage increase of desirable species. As desirable perennial species establish and/or increase in abundance, forage production tends to stabilize, with yearly variations largely a function of rainfall. As brush reinvades the treated site, forage productivity declines until the brush cover again reaches maximum growth. This adjustment may take place over two or more growing seasons as the brush stand matures.

Potential range condition classes with associated carrying capacities serve as useful indications of expect-

ed production improvement after the brush is treated. Carrying capacity indicated by excellent range condition class represents an upper bound of increased productivity from brush treatments. Actual maximum productivity (*Pmax*) obtained from an initial brush treatment will depend on treatment efficacy and condition of the range before treatment as well as weather and grazing practices after treatment. *Pmax* in this analysis is generally associated with the carrying capacity indicated by low-good to mid-good range condition class.

Production changes alone are not adequate to assess completely a treatment's economic worth; the year in which they occur is also important. The number of years from time of treatment required to reach *Pmax* was determined by inspecting each treated site group. Similarly, the time required for productivity to return to pretreatment production levels was established by observing the time elapsed from treatment until the range returned to its pretreatment condition class.

Cost-price data used in the analysis were current for 1982. Costs associated with a cow-calf operation are described in 1982 cow-calf budgets prepared by the Texas Agricultural Extension Service for the Coastal Bend region. Based on informal producer surveys, these budgets were modified to reflect an assumed higher level of management necessary to achieve yields described in the analysis (Table 4). Expenditures for salt and minerals were increased from $2.94 to $10.63 to meet needs for phosphorous supplementation. Liquid feed supplementation was included at a daily rate of 1.85 pounds per cow for 90 days. Veterinary costs were increased from $3.00 to $5.00 per cow to reflect a higher degree of herd health care. Operating input costs of $61.22 were added to labor costs of $64.00 for an annual variable cost total of $125.22 per cow (Table 4). Investment costs were assumed to be $550 per cow, and salvage values were set at $450 per cow. Bull investment costs were assumed to be $1,500. The avearge selling price of calves over the past 20 years in constant 1982 dollars—$70 per hundredweight—was used in this analysis.

Table 4. Operating inputs and costs for cow–calf production on rangeland in eastern South Texas.

	Cost/cow unit
Salt and mineral	$10.63
Vet medicine	7.00
Hauling and marketing	7.80
Liquid supplementation	13.57
Equipment fuel and lubrication	18.67
Equipment repair	3.55
	$61.22
Operator labor	
Equipment	$28.00
Livestock	36.00
	$64.00
Total cost	$125.22

The final cost items necessary for performing the economic analyses were initial and maintenance investment requirements for each specific brush treatment. Individual brush treatment costs were estimated at the following prices:

Treatment	Cost/acre ($)
1. Aerial spray 2,4,5-T + picloram (1:1) at 1 lb a.i./acre	21.50
2. Disc and seed with buffelgrass	23.00
3. One-way chaining	5.50
4. Rootplow	25.00
5. Root rake	26.00
6. Burn brush stacks	4.00
7. Seeding to buffelgrass	15.00
8. Oiling	22.00
9. Initial maintenance prescribed burn	6.00
10. Second and subsequent maintenance burns	3.25
11. Two-way chaining	8.00

Linking cost and price data with the yield response by year of occurrence allows for accounting of benefits and costs in the partial budget format. Discounting the net cash flow annually and summing generates an accumulated NPV.

Economic evaluation of brush treatments is predictive in nature; that is, not all parameters that influence the final outcome are known. This uncertainty necessitates the following assumptions:

I. Range response
   - A. Current production will not change without treatment.
   - B. Yearly precipitation is the long-term (25-year) annual average.
   - C. Other management practices are constant (e.g., grazing management systems).
   - D. Treatments perform at optimum levels based on research experience.
   - E. Herd management is adequate to obtain stated yields.

II. Financial
   - A. Yearly calf prices are the average of the last 20 years expressed in constant 1982 dollars.
   - B. A producer's opportunity cost of money is 10 percent.
   - C. Maximum pre-tax profit is the producer's economic objective.

These assumptions can introduce a positive or negative bias into the results and, before accepting the results, a producer should determine to what extent his financial or production position corresponds to these assumptions. For example, a producer with high range forage production but a rapidly developing brush cover would not be safe in assuming that, without treatment, current production will not deteriorate. However, an individual with rangeland in low range condition and dense mature brush would be safe in assuming that production will not change significantly without treatment.

Results

Deep drainage site group–mixed brush

Aerial spraying with 2,4,5-T + picloram at 1 pound per acre on either heavy or moderate canopy covers of mixed brush on deep drainage sites was considered feasible when followed by prescribed burning to maintain range improvement. Aerial spraying removes the brush canopy cover and thins the density of live brush plants; this normally results in relatively rapid release of

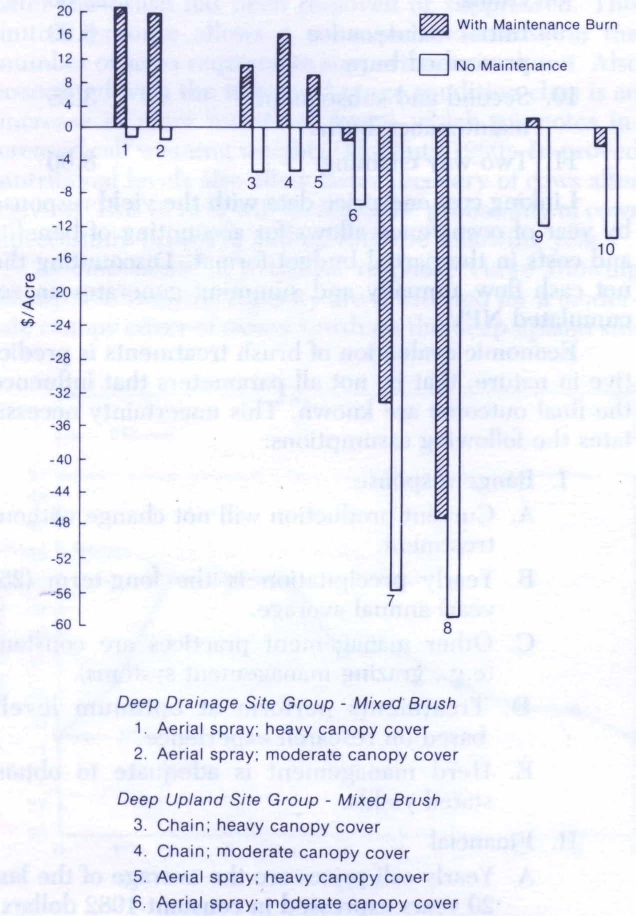


Figure 4. Net present values at 10% discount rate for application of selected brush management strategies in eastern South Texas.

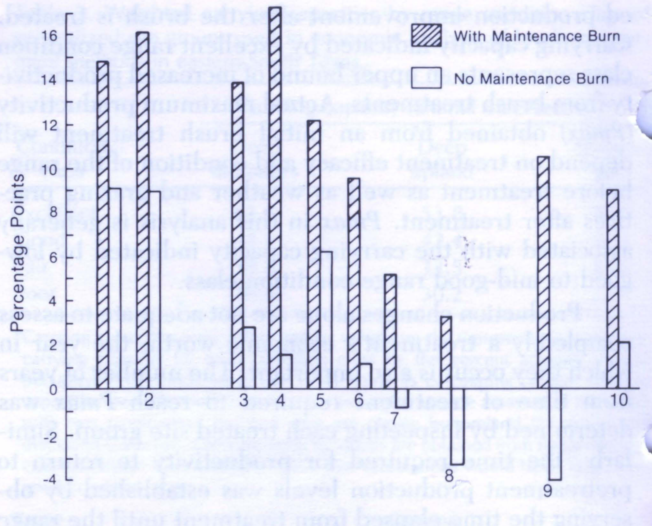


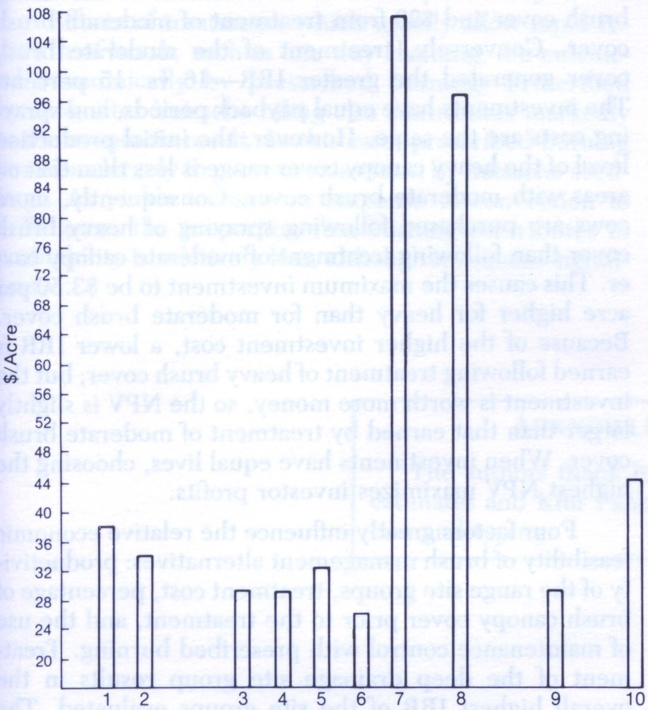
Figure 5. Internal rates of return for application of selected brush management alternatives in eastern South Texas.

herbaceous species (Scifres et al. 1977). The herbaceous cover, with proper grazing management, may be developed into a continuous load of fine fuel for prescribed burning. Prescribed burns, applied at 3–5-year intervals, suppress top growth of woody plants not severely damaged by the herbicide and retard reinvasion of the rangeland by woody plants (Scifres 1980). Positive NPV (Fig. 4) and a high IRR (Fig. 5) indicate that this brush management combination used on a deep drainage site group with mixed brush would be a profitable investment for a rancher in the study area. Under the conditions previously assumed, these treatments would require a maximum annual investment (treatment costs and additional cattle) of about $34 per acre for the moderate canopy cover of brush and $38 per acre for the heavy canopy cover (Fig. 6). The treatment sequence, with appropriate application and post-treatment management, would be expected to produce a positive accumulated net cash flow after 10 years (Fig. 7).

Aerial spraying alone (not followed by prescribed burning) failed to produce an IRR of 10 percent (Fig. 5) and thus results in a negative NPV (Fig. 4) when the brush canopy cover is moderate or heavy. Maximum annual investment requirements (Fig. 6) are the same as for aerial spraying followed by prescribed burning; subsequent investments would be expected to result in a positive accumulated net cash flow after 7–8 years (Fig. 7).

Deep upland site group–mixed brush

Using the NPV criteria, only two treatment investments appear feasible for controlling mixed brush stands on deep upland sites (Fig. 4). Chaining, followed by prescribed burning to eliminate woody debris and suppress brush sprouts, is feasible for both heavy and moderate canopy covers. Also, aerial spraying with 2,4,5-T + picloram followed by prescribed burning on sites with heavy brush canopy cover would be expected to produce an IRR greater than 10 percent (Fig. 5). Consequently, the treatment combination would produce a positive (NPV (Fig. 4) over the life of the project. This same treatment applied to moderate canopy covers of mixed brush would result in an IRR of just less than 10 percent (Fig. 5) and, thus, a slightly negative NPV (Fig. 4). The chaining–prescribed burning treatment sequence requires a maximum annual investment of about $30 per acre (Fig. 6). The chaining–prescribed burning alternative would be expected to produce positive accumulated net cash flows after 11 years when applied to heavy canopy cover of mixed brush and after 10 years when applied to moderate brush canopy covers (Fig. 7). The aerial spraying–prescribed burning sequence re-



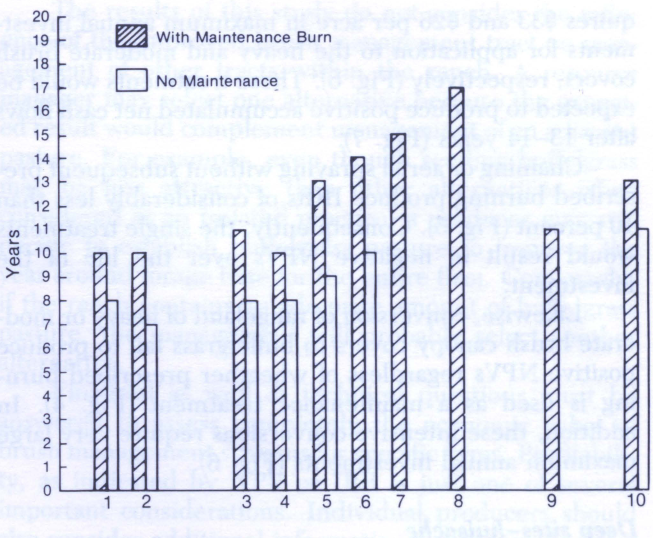
Deep Drainage Site Group - Mixed Brush
1. Aerial spray; heavy canopy cover
2. Aerial spray; moderate canopy cover

Deep Upland Site Group - Mixed Brush
3. Chain; heavy canopy cover
4. Chain; moderate canopy cover
5. Aerial spray; heavy canopy cover
6. Aerial spray; moderate canopy cover
7. Chain, root plow, stack, burn stacks, seed with buffelgrass; heavy canopy
8. Chain, root plow, stack, burn stacks, seed with buffelgrass; moderate canopy cover

Deep Site Group - Huisache
9. Oiling; 150 plants/acre

Shallow Site Group - Mixed Brush
10. Disc, seed, moderate canopy cover

Figure 6. Maximum investment ($/acre) including treatment cost and additional cattle necessary to increase stocking rates as a result of selected brush management alternatives in eastern South Texas.



Deep Drainage Site Group - Mixed Brush
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Deep Upland Site Group - Mixed Brush
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8. Chain, root plow, stack, burn stacks, seed with buffelgrass; moderate canopy cover

Deep Site Group - Huisache
9. Oiling; 150 plants/acre

Shallow Site Group - Mixed Brush
10. Disc, seed, moderate canopy cover

Figure 7. Years to recover investment after application of selected brush management alternatives in eastern South Texas.

quires $33 and $26 per acre in maximum annual investments for application to the heavy and moderate brush covers, respectively (Fig. 6). These treatments would be expected to produce positive accumulated net cash flows after 13–14 years (Fig. 7).

Chaining or aerial spraying without subsequent prescribed burning produce IRRs of considerably less than 10 percent (Fig. 5). Consequently, the single treatments would result in negative NPVs over the life of the investment.

Likewise, conversion of rangeland of heavy or moderate brush canopy covers to buffelgrass fail to produce positive NPVs regardless of wheather prescribed burning is used as a maintenance treatment (Fig. 4). In addition, these intensive conversions require very large maximum annual investments (Fig. 6).

Deep sites–huisache

A positive NPV (Fig. 4) and an IRR of about 10 percent (Fig. 5) indicate that individual plant treatments with fuel oil followed by maintenance with prescribed burning would be expected to be a profitable investment for deep sites infested with huisache in eastern South Texas. The oiling–maintenance burning sequence for huisache requires a maximum annual investment of approximately $30 per acre (Fig. 6) and would be expected to produce a positive accumulated net cash flow after about 11 years (Fig. 7). The treatment sequence has been effectively applied on blackland sites on the Coastal Prairie (Scifres et al. 1982).

Shallow site group–mixed brush

Conversion of mixed brush stands on shallow sites to buffelgrass resulted in negative NPVs (Fig. 4) regardless of whether prescribed burning was included as a maintenance treatment. Establishment of buffelgrass and maintenance with prescribed burning, produces an IRR of almost 9 percent (Fig. 5). Seeding increases the relative risk, however, and would reinforce use of the 10 percent discount rate as a cutoff point for implementing the treatment. The relatively high ($44 per acre) maximum investment requirement (Fig. 6) and long (13-year) payback period (Fig. 7) greatly reduce feasibility of this investment.

Implications and Conclusions

Economic indices presented here should be interpreted in light of a producer's specific brush and economic situation, and assumptions used in this analysis should be taken into consideration when evaluating results. Also, price and cost projections should be used to moderate the results. If a treatment is available to a rancher at less cost than indicated here, then the rancher could expect a better return.

This discussion has assumed the brush management investments to be mutually exclusive. That is, a given tract of land may be treated only once. Under this assumption, the producer would invest in the treatment with the highest NPV and exhaust all investment capital allocated to brush management or treat all of the brush on that particular acreage. Any remaining capital would then be invested in the treatment with the next highest NPV, so long as the NPV was equal to zero or higher. This study emphasizes the selection of profit maximizing investments. Investments with a negative NPV, calculated at a 10 percent discount rate (assumed to be the opportunity cost of capital), can be rejected.

An example of NPV and IRR resulting in different rankings occurs in the aerial spray–prescribed burning treatment sequence applied to the deep drainages with heavy or moderate brush covers. The two measures give conflicting results as to relative profitability. The NPV is $21.10 per acre yielded from treatment of the heavy brush cover and $20 from treatment of moderate brush cover. Conversely, treatment of the moderate brush cover generated the greater IRR—16 vs. 15 percent. The investments have equal payback periods, and spraying costs are the same. However, the initial production level of the heavy canopy cover range is less than that on areas with moderate brush cover. Consequently, more cows are purchased following spraying of heavy brush cover than following treatment of moderate canopy cover. This causes the maximum investment to be $3.50 per acre higher for heavy than for moderate brush cover. Because of the higher investment cost, a lower IRR is earned following treatment of heavy brush cover; but the investment is worth more money, so the NPV is slightly larger than that earned by treatment of moderate brush cover. When investments have equal lives, choosing the highest NPV maximizes investor profits.

Four factors greatly influence the relative economic feasibility of brush management alternatives: productivity of the range site groups, treatment cost, percentage of brush canopy cover prior to the treatment, and the use of maintenance control with prescribed burning. Treatment of the deep drainage site group results in the overall highest IRR of the site groups evaluated. The highest average IRR is 12.15 percent for deep drainages, contrasted to 7.02 percent for the same treatments applied to the deep upland sites. Other aspects being equal, early returns of investment dollars are preferred to late ones. The average payback period is 8.7 years following treatment of the deep drainages. Less productive sites required, on the average, longer times to recover the investment in brush management: 11.5 years and 12 years, respectively, for deep upland and shallow sites.

Severity of brush cover before treatment affects the economic worth of an initial brush management treatment. Treatment of heavy brush cover generally increases IRR by an average of 1.4 percent over returns from treatment of moderate covers.

Aerial spraying with subsequent burning of moderate brush cover on deep upland sites was rejected because it earned an IRR of 9.5 percent (Fig. 5), which is extremely close to the 10 percent return considered profitable. The same treatment on deep upland sites with a heavy brush cover earned a 12.2 percent IRR. Thus, the level of brush cover and its impact on pretreatment carrying capacity can strongly impact economic results. A producer should carefully consider projected yield responses as well as his specific current stocking rate and site potential for possible impacts that can alter the projected investment's earnings.

Prescribed burning had a greater effect on profitability than did site production potential. Treatment combinations which included prescribed burning resulted in an average IRR of 11.1 percent, contrasted to 2.4 percent where prescribed burning was not employed. In every case where the IRR exceeded 10 percent, maintenance burns were included in the profitable treatment scenario. Prescribed burning contributes an average of 8.5 percentage points to the IRR, regardless of initial treatment.

Effects of treatments which usually allow rapid regrowth of brush, such as one-way chaining, are enhanced economically by prescribed burning. Prescribed burning after huisache oiling also contributes markedly to the economic result. In this case, prescribed burning functions largely to prevent reinvasion by huisache seedlings. As yields increase in response to conversion to buffelgrass, the proportion that burning contributes to profitability is relatively less, although it remains significant.

The results of this study do not consider the influence of the improved brush management tract on management of other tracts within the ranch. A resource manager may select one alternative because the expected result would complement management of an adjacent pasture. For example, even though seeding buffelgrass may be less attractive than other alternatives when considered as an isolated practice, a producer may still decide to establish buffelgrass pasture to improve the year around forage base for the entire firm. Conversely, if the ranch contains an adequate amount of buffelgrass pasture, the management will probably select another alternative.

Financial as well as technical questions must be answered to assess completely the economic value of brush management systems for specific firms. Profitability, as indicated by NPV or IRR is just one of several important considerations. Individual producers should also consider additional information not analyzed in this report, including the financing capabilities of the individual producer and effects of the investment on annual income tax liability. Finally, an economically efficient brush management system may be accepted by one producer and rejected by another simply on the basis of individual risk-bearing preferences.

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Appendix A: Scientific Names of Plants Mentioned in Text and Tables

Agarito	*Berberis trifoliolata* Moric.
Blackbrush acacia	*Acacia rigidula* Benth.
Buffelgrass	*Cenchrus ciliaris* (L.) Link
Catclaw acacia	*Acacia greggii* Gray
Cenizo	*Leucophyllum frutescens* Berl.
Chittanwood	*Bumelia lanuginosa* Michx.
Desert yaupon	*Schaefferia cuneifolia* Gray
Elm spp.	*Ulmus* spp.
Guajillo	*Acacia berlandieri* Benth.
Guayacan	*Porlieria angustifolia* Engelm.
Honey mesquite	*Prosopis glandulosa* Torr.
Huisache	*Acacia farnesiana* L.
Javelinabrush	*Microrhamnus ericoides* Gray
Leatherstem	*Jatropha dioica* Sesse
Lime pricklyash	*Zanthoxylum fagara* L.
Live oak	*Quercus virginiana* Mill.
Pricklypear	*Opuntia* spp.
Retama	*Parkinsonia aculeata* L.
Southwest bernardia	*Bernardia obovata* I. M. Johnston
Spiny hackberry	*Celtis pallida* Torr.
Texas colubrina	*Colubrina texenis* Gray
Texas ebony	*Pithecellobium flexicaule* (Benth.) Coult.
Texas persimmon	*Diospyros texana* scheele
Twisted acacia	*Acacia tortuosa* L.
Whitebrush	*Aloysia lycioides* Cham.
Wolfberry	*Lycium berlandieri* Dunal

All programs and information of the Texas Agricultural Experiment Station are available to everyone without regard to race, ethnic origin, religion, sex, age, or physical or mental handicap.

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