ECONOMIC FEASIBILITY OF USING BRUSH CONTROL TO ENHANCE OFF-SITE WATER YIELD

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ABSTRACT

A feasibility study of brush control for off-site water yield was undertaken in 1998 on the North Concho River near San Angelo, Texas. Subsequently, studies were conducted on eight additional Texas watersheds. Economic analysis was based on estimated control costs of the different options compared to the estimated rancher benefits of brush control. Control costs included initial and follow-up treatments required to reduce brush canopy to between 3 and 8%, and maintain it at the reduced level for 10 years. The state cost-share was estimated by subtracting the present value of rancher benefits from the present value of the total cost of the control program. The total cost of additional water was determined by dividing the total state cost-share if all eligible acreage were enrolled by the total added water estimated to result from the brush control program. This procedure resulted in present values of total control costs per acre ranging from $33.75 to $159.45. Rancher benefits, based on the present value of the improved net returns to typical cattle, sheep, goat, and wildlife enterprises, ranged from $8.95 to $52.12 per acre. Present values of the state cost-share per acre ranged from $21.70 to $138.85. The cost of added water estimated for the eight watersheds ranged from $16.41 to $204.05 per acre-foot averaged over each watershed.

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INTRODUCTION

Research on brush control and water balance began in the 1920s, but the idea of brush control as a possible means of alleviating water scarcity in drought-prone western states started to take hold in the 1970s (Gifford 1975). The control of brush species generally decreases interception of precipitation, reduces evaporation and transpiration losses, and increases water runoff and deep percolation (Lemberg 2000). Actual water yield, however, is dependent upon rainfall variations and many other landscape variables.

Past research has predicted that water yield is possible where deep-rooted brush species are replaced with shallow-rooted, deciduous, low-biomass, herbaceous species. Hibbert (1983) predicted that removing woody species from rangeland can yield an additional 0.3 inches of surface flow water for each inch of annual precipitation above 15 inches. Work by Weltz (1987), however, indicates that increased water production is likely to be limited to years with above-average winter and spring precipitation.

Over the past decade, brush control research has yielded a good deal of information on control efforts and their relationship to water production on rangelands. Weltz (1987) used the Ekalaka Range Hydrology Model (ERHYM-II) to study water budgets for south Texas rangelands. Arnold et al. (1996) did similar research with the Soil and Water Assessment Tool (SWAT). Carlson et al. (1990) studied water balances in the rolling plains using the Simulation and Production and Utilization of Rangelands model (SPUR). Dillon et al. (1991) examined the development and use of bio-simulation models for analyzing water production. Lemberg (2000) used the Phytomass Growth Model (PHYGROW) to assess hydrologic impacts of brush control in south Texas.

Studies of soil water budgets and aquifer regeneration were done by Recenthin and Smith (1967), who studied water yields and supplies in grasslands that had been reclaimed from brush. Gifford (1975) studied water budgets on sites where mechanical brush control was used. Water use by plants was studied by Sosebee (1980), Franklin (1987), and Knight et al. (1983). Sosebee studied mesquite's water use, Franklin studied the differences between water resources in grass- versus mesquite-dominated areas, and Knight et al. studied water balances in oak-infested areas. Thurow et al. (1987) studied rainfall and runoff in mixed grass and live oak mottes, and Thurow and Hester (1997) studied how different levels of juniper control affect water yield and runoff.

RECENT STUDIES

Early research, combined with successful demonstration projects on Rocky Creek of the Middle Concho River (Moseley 1987) and Seco Creek in the Medina River Basin (Newman 1992), led to a 1998 feasibility study of brush control for water yield on the North Concho River near San Angelo, Texas. The study was undertaken as a joint project of the Texas State Soil and Water Conservation Board (TSSWCB), Upper Colorado River Authority, Texas Agricultural Experiment Station, and Texas Agricultural Extension Service. Results indicated estimated cost of added water at $49.75 per acre-foot averaged over the entire North Concho basin (Bach and Conner 1998).

In response to this study, the 1999 Texas Legislature appropriated approximately $6 million to begin implementing the brush control program on the North Concho Watershed. A companion bill authorized feasibility studies on eight additional watersheds across Texas.

The eight watersheds ranged from the Canadian, located in the northwestern Texas Panhandle, to the Nueces, which encompasses a large portion of the south Texas plains (Fig. 1). In addition to including a wide variety of soils, topography, and plant communities, the eight watersheds included average annual precipitation zones from 38 to 66 cm and growing seasons from 178 to 291 days. The studies were conducted primarily between February and September 2000. Study results varied widely in estimates of brush control costs, expected water yield, and per unit costs of added water. Although the same estimation protocol was used in these studies, reasons for the wide variability in results are not readily discernable. Site-to-site variation in the large number of biophysical and economic characteristics used to develop the estimates may explain these differences.

OBJECTIVES

This paper reports the assumptions and methods for estimating the economic feasibility of a program to encourage rangeland owners to engage in brush control for purposes of enhancing off-site (downstream) water availability. Techniques for determining and categorizing vegetative cover using Landsat imagery and estimating increased water yield from control of the different brush type-density categories using the SWAT simulation model for the watersheds are described in other publications (Walker and Dugas 1998, Bednarz 2000). The data created by these efforts, along with primary data gathered from landowners and federal and state agency personnel, were used as the basis for this economic analysis.

This report provides details on how brush control costs and benefits were calculated for the different brush type-densities and illustrates their use in determining cost-share amounts for participating private landowners and ranchers, and the State of Texas. The SWAT model estimates of additional off-site water yield resulting from the brush control program are used with the cost estimates to obtain per acre-foot costs of added water gained through the program.

BRUSH CONTROL

The public benefit of additional water depends on landowner participation and proper implementation and maintenance of appropriate brush control practices. Rancher participation in a brush control program primarily depends on the rancher's expected economic consequences resulting from participation. With this in mind, the analyses described in this report are predicated with the objective of limiting rancher costs associated with program participation to no more than the benefits that would be expected to accrue to the rancher as a result of participation.

It is explicitly assumed that the difference between the total cost of the brush control practices and the value of the practice to the participating landowner would have to be contributed by the state in order to encourage landowner participation. Thus, the state (public) must determine whether the benefits, in the form of additional water for public use, are equal to or greater than the state's share of the program costs. Administrative costs (state costs) which would be incurred in implementing, administering, and monitoring a brush control project or program are not included in this analysis.

BRUSH TYPE-DENSITY CATEGORIES

For this study, the terms cover and density refer to the percentage of canopy cover (portion of total land area) occupied by the brush targeted for control. Land cover type categories identified and quantified for the eight watersheds included four brush types: cedar (juniper), mesquite, oaks, and mixed brush. Landowners statewide indicated they were not interested in controlling oaks, so oaks were not considered eligible for inclusion in a brush control program. Two density categories, heavy (>30% canopy cover) and moderate (10–30% canopy cover), were used. These categories were used to estimate total costs, landowner benefits, and the amount of cost-share that would be required of the state.

Brush control practices include initial and follow-up treatments required to reduce the current canopies of all categories of brush types and densities to 3–8% and maintain it at the reduced level for at least 10 years. These practices, or brush

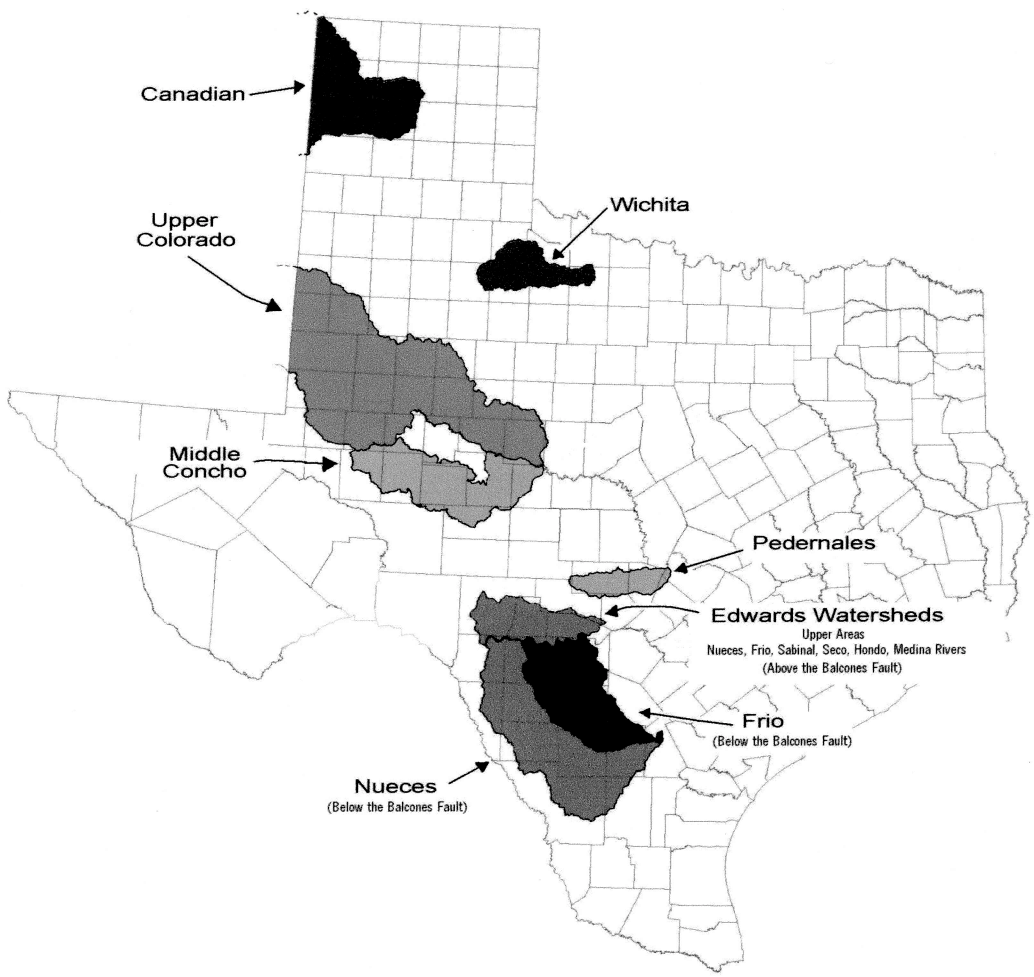

Figure 1. Map of Texas with eight watersheds designated for brush control—enhanced water feasibility study.

control treatments, differed among watersheds due to differences in terrain, soils, and amount and distribution of cropland in close proximity to the control areas. They also differed due to landowner preferences and practicality of application. An example of the alternative control practices, the time (year) of application and costs for the Wichita Watershed are outlined in Table 1. Year 0 in Table 1 is the year that the initial practice is applied, while years 3–7 refer to follow-up treatments in specific years after the initial practice.

Appropriate brush control practices, or treatments, for each brush type-density category and their estimated costs were obtained from focus groups of landowners and USDA-NRCS and Agriculture Extension Service personnel in each watershed. In the larger watersheds, two focus groups were used where it was deemed necessary because of significant climatic and/or terrestrial differences.

CONTROL COSTS

Estimated annual brush control treatment costs and the present value of those costs, assuming an 8% discount rate as opportunity cost for rancher investment capital, also are displayed in Table 1. Present values of control programs are used for comparison since some of the treatments will be required in the first year to initiate the program while others will not be needed until later years. Present values of total per acre control costs range from $33.75 for moderate mesquite that initially can be controlled with herbicide treatments, to $159.45 for heavy mesquite that cannot be controlled with herbicide, but must initially be controlled with mechanical tree bulldozing or root-plowing.

LANDOWNER BENEFITS FROM BRUSH CONTROL

As was mentioned earlier, one objective of the analysis is to equate rancher benefits with rancher costs. Therefore, the task of discovering the rancher costs, and, thus, the rancher cost-share, for brush control was reduced to estimating the 10-year stream of region-specific benefits expected to accrue to any rancher participating in the program. These benefits are based on the present value of increased net returns made available to the ranching operation through increases or expansions of the typical livestock (cattle, sheep, or goats) and wildlife enterprises that would be reasonably expected to result from implementing the brush control program.

For the livestock enterprises, increased net returns would result from increased amounts of usable forage (grazing capacity) produced by removing the brush and eliminating much of the competition for light, water, and nutrients within the plant communities. For the wildlife enterprises, improvements in net returns are based on an increased ability to access wildlife by paying hunters.

As with the brush control methods and costs, estimates of forage production and grazing capacity used in the studies were obtained from landowner focus groups, Experiment Station and Extension Service scientists, and USDA-NRCS range specialists with brush control experience in the respective watersheds. Because of differences in soils and climate, livestock grazing capacities differ by location; in some cases, significant differences were noted between sub-basins of a watershed. Grazing capacity estimates were collected for both pre- and post-control states of the brush type-density categories. The carrying capacities range from 70 acres per animal unit year (Ac/AUY) for land infested with heavy cedar to about 15 Ac/AUY for land on which mesquite is controlled to less than 8% canopy cover (Table 2).

Livestock production practices, revenues, and costs representative of the watersheds, or portions thereof, also were obtained from focus groups of local landowners. Estimates of variable costs and returns associated with livestock and wildlife enterprises typical of each area were then developed from this information into production-based investment analysis budgets.

Rancher benefits were calculated for changes in existing wildlife operations. Most of these operations were determined to be simple hunting leases with deer, turkey, and quail being the most commonly hunted species. For control of heavy mesquite, mixed brush, and cedar, wildlife revenues are expected to increase from $0.50 to $1.50 per acre due principally to the resulting improvement in quail habitat and hunter access to quail. Increased wildlife revenues were included only for the heavy brush categories because no changes in wildlife revenues were expected with control of the moderate brush type-density categories.

For ranchers to benefit from the improved forage production resulting from brush control, livestock numbers must be changed as grazing capacity changes. In this study, it was assumed that ranchers would adjust livestock numbers to match grazing capacity changes on an annual basis. Annual benefits that result from brush control were measured as the differences in annual net revenue (added annual revenues minus added annual costs) that would be expected with brush control as compared to without brush control. In some cases, ranchers preferred to maintain current levels of livestock, therefore realizing benefit in the form of reduced feeding and production risk.

The analysis of rancher benefits for each of the watersheds was done assuming a hypothetical 1,000 acre management unit for facilitating calculations. The investment analysis budget information, carrying capacity information, and brush control methods and costs comprised the watershed-specific data sets that were entered into the investment analysis model ECON (Conner 1990). The ECON model yields net present values for various range improvement alternatives. For this study, rancher benefits accruing to the management unit as a result of brush removal over the 10-year life of the projects being considered in the feasibility studies were analyzed. An example of the output resulting from this analytical process

Table 1. Wichita watershed example—brush control program methods and costs by type-density category.

Year	Treatment description	Cost/acre ($)	Present value cost/acre ($)
Heavy mesquite—chemical treatment			
0	aerial spray herbicide	25.00	25.00
4	aerial spray herbicide	25.00	18.38
7	individual plant treatment (IPT) choice	15.00	8.75
		Total:	52.13
Heavy mesquite—mechanical treatment[1]			
0	tree doze or root plow, rake, and burn	150.00	150.00
6	IPT choice or burn	15.00	9.45
		Total:	159.45
Heavy cedar—mechanical treatment choice[1]			
0	tree doze, stack, and burn	107.50	107.50
3	IPT choice or burn	15.00	11.91
6	IPT choice or burn	15.00	9.45
		Total:	128.86
Heavy cedar—two-way chaining[2]			
0	two-way chain and burn	25.00	25.00
3	IPT choice or burn	15.00	11.91
6	IPT choice or burn	15.00	9.45
		Total:	46.36
Heavy mixed brush—mechanical choice			
0	tree doze, stack, and burn	107.50	107.50
3	IPT choice or burn	15.00	11.91
6	IPT choice or burn	15.00	9.45
		Total:	128.86
Heavy mixed brush—two- way chaining[2]			
0	two-way chain and burn	25.00	25.00
3	IPT choice or burn	15.00	11.91
6	IPT choice or burn	15.00	9.45
		Total:	46.36
All moderate brush—treatment choice[3]			
0	chemical or mechanical and burn choice	25.00–45.00	25.00–45.00
7	IPT choice or burn	15.00	8.75
		Total:	33.75–53.75

[1]Tree doze, root plow, rake, and burn.

[2]Two-way chain and burn.

[3]Treatment choice between mechanical, fire, or chemical methods.

is shown in Table 3 for the control of moderate cedar in the Upper Colorado–West watershed.

Since a 1,000 acre management was used, benefits needed to be converted to a per acre basis. To get per acre benefits, the accumulated net present value of $11,895 shown in Table 3 must be divided by 1,000, resulting in $11.90 as the estimated present value of the per acre net benefit to a rancher. The resulting net benefit estimates for all of the type-density categories for all watersheds are shown in Table 4. Present values of landowner costs differ by location within and across watersheds. They range from a low of $8.95 per acre for control of moderate mesquite in the Canadian watershed to $52.12 per acre for control of heavy mesquite in the Edwards Aquifer watershed.

STATE COST-SHARE

If ranchers are not to benefit directly from the state's contribution towards the total control cost, they must invest in the implementation of the brush control program an amount equal to their total net benefits. The total benefits expected to accrue to the rancher implementing a brush control program are equal to the maximum amount that a profit-maximizing rancher could be expected to spend on a brush control program (for a specific brush-density category).

Using this logic, the state cost-share is estimated as the difference between the present value of the total cost per acre of the control program and the present value of the rancher participation. Present values of the state cost-share per acre of brush controlled also are shown in Table 4. The state's cost-share (across all the studied watersheds) ranges from a low of $21.70 per acre for control of moderate mesquite in the Wichita watershed to a high of $138.50 per acre for control of heavy cedar in the Edwards Aquifer watershed.

The costs to the state include only the state's cost-share for brush control. Costs that are not accounted for, but which must be incurred, include costs for administering the program. Under current law, this task will be the responsibility of the Texas State Soil and Water Conservation Board.

COSTS OF ADDED WATER

The total cost of additional water is estimated by dividing the total state cost-share if all eligible acreage were enrolled in the program by the total added water estimated to result from the brush control program over the assumed 10-year life of the program. The hydrological data for the brush control program water yields and the estimated acreage by brush type-density category (by sub-basin) were obtained from a hydrological study done tandem to this study by the Blacklands Research Center, Texas Agricultural Experiment Station in Temple, Texas (Bednarz 2000). The total state cost-share for each sub-basin is estimated by multiplying the per acre state cost-share for each brush type-density category by the eligible acreage in each category for the sub-basin. The cost of added water resulting from the control of the eligible brush in each sub-basin is then determined by dividing the total state cost-share by the added water yield over the 10-year period. The 10-year supply of water was adjusted for the delay in time of availability of the water gained, using a 6% discount rate, which is a comparable rate for other proposed state projects. The equation for determining the per acre-foot cost of water gained from brush control follows, and Table 5 provides a detailed example for the Wichita watershed.

$$CAW_i = TSCBC_i / TYSSWG_i ,$$

$$TSCBC_i = \sum_j TSCBC_{i,j} , \text{ and}$$

$$TYSSWG_i = \sum_t (YWG_{i,t} / (1+r)^t)$$

Where:

Table 2. Statewide grazing capacity in acres per AUY pre- and post- brush control by brush type-density category.

	Brush type-density category and brush control state											
	Heavy cedar		Heavy mesquite		Heavy mixed brush		Moderate cedar		Moderate mesquite		Moderate mixed brush	
Watershed	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Canadian	-	-	30.0	20.0	37.0	23.0	-	-	25.0	20.0	30.0	23.0
Edwards Aquifer	60.0	30.0	35.0	20.0	45.0	25.0	45.0	30.0	25.0	20.0	35.0	25.0
Frio–North	50.0	30.0	36.0	24.0	36.0	24.0	40.0	30.0	32.0	24.0	32.0	24.0
Frio–South	-	-	38.0	23.0	35.0	23.0	-	-	30.0	23.0	30.0	23.0
Mid Concho	70.0	35.0	38.0	25.0	50.0	30.0	52.0	35.0	32.0	25.0	40.0	30.0
Nueces–North	50.0	30.0	39.0	27.0	39.0	27.0	40.0	30.0	35.0	27.0	35.0	27.0
Nueces–South	-	-	41.0	26.0	38.0	26.0	-	-	33.0	26.0	33.0	26.0
Pedernales	45.0	28.0	28.0	15.0	40.0	22.0	38.0	28.0	24.0	15.0	34.0	22.0
Upper Colorado–East	56.0	24.0	32.0	18.0	48.0	21.0	44.0	24.0	28.0	18.0	36.0	21.0
Upper Colorado–West	70.0	35.0	38.0	25.0	50.0	30.0	52.0	30.0	32.0	25.0	40.0	30.0
Wichita	50.0	25.0	32.5	20.0	38.5	20.0	40.0	25.0	25.0	20.0	32.5	20.0

Table 3. Net present value report for the Upper Colorado River–West watershed, moderate cedar control[1].

Year	Animal units	Total increase in sales ($)	Total added investment ($)	Increased variable costs ($)	Cash flow ($)	Annual NPR ($)	Accumulated NPV ($)
0	0	0	0	0	0	0	-
1	4.2	1,423	2,800	520	-1,897	-1,757	-1,757
2	9.8	3,557	3,500	1,171	-1,114	-955	-2,712
3	10.1	3,557	0	1,171	2,386	1,895	-817
4	10.3	3,557	0	1,171	2,386	1,754	937
5	10.6	3,557	0	1,171	2,386	1,624	2,561
6	10.8	3,913	0	1,171	2,742	1,728	4,289
7	11.1	3,913	0	1,171	2,742	1,600	5,889
8	11.4	3,913	0	1,171	2,742	1,482	7,371
9	11.6	3,913	0	1,171	2,742	1,372	8,743
				Salvage[2]	$6,300[2]	$3,152[2]	$11,895[3]

Note: Includes grazing capacity changes with current management.

[1]The ECON model analysis is based on calculating the economic benefits which would be captured from capitalizing on the benefits of brush control with a production venture *without* paying the cost of the project; such determines the total benefit to the landowner/rancher. When the rancher is charged a cost to participate equal to his NPV of benefits, the project is determined to be of no net benefit (and likewise, no net cost) to the landowner/rancher.

[2]Salvage value is the accumulation of additional worth at the end of the project period. Cash flow is the sum of the total added investment, and annual NPV is the discounted cash flow salvage value.

[3]Economic analysis was done on a 1,000 acre basis, therefore, the accumulated NPV must be divided by 1,000 to find the per acre NPV, which would be $11.895. The accumulated NPV is the running total of annual (NPV) differences between increased sales and increased variable costs.

Table 4. Private (pvt)[1] and state shares of brush control costs by brush type-density category by watershed (dollars per acre).

	Brush type-density category											
	Heavy cedar		Heavy mesquite		Heavy mixed brush		Moderate cedar		Moderate mesquite		Moderate mixed brush	
Watershed	Pvt. costs	State costs	Pvt. costs	State costs	Pvt. costs	State costs	Pvt. costs	State costs	Pvt. costs	State costs	Pvt. costs	State costs
Canadian	-	-	10.37	40.33	10.44	54.93	-	-	8.95	26.10	10.48	23.43
Edwards Aquifer	43.52	138.5	52.12	98.49	45.61	105.00	23.27	93.75	20.81	43.71	23.88	40.64
Frio–North	30.69	79.81	39.76	90.18	39.76	84.57	10.44	92.29	23.43	60.56	23.43	60.56
Frio–South	-	-	38.71	75.95	41.6	72.32	-	-	21.07	55.57	21.07	62.92
Middle Concho	16.59	78.30	15.66	57.46	16.35	78.54	11.79	53.10	10.49	41.76	9.91	54.98
Nueces–North	30.69	79.81	34.49	95.45	34.49	89.84	10.44	92.29	19.73	64.26	19.73	64.26
Nueces–South	-	-	35.69	79.02	36.53	77.40	-	-	17.14	59.50	17.14	66.85
Pedernales	31.86	108.56	40.61	88.77	33.31	96.07	25.74	54.68	21.22	49.20	21.22	49.20
Upper Colorado–East	14.90	69.99	17.22	60.62	16.35	83.54	11.32	58.57	12.07	42.68	10.92	58.97
Upper Colorado–West	16.76	42.14	15.89	57.23	15.07	64.82	11.90	32.99	10.55	29.84	10.25	34.64
Wichita	18.79	68.82	18.70	87.09	21.80	65.81	15.13	38.62	12.05	21.70	19.09	34.65

[1]Private costs are rancher and/or landowner costs (or revenues, since initial costs to the rancher and the discounted stream of rancher revenues are equal).

CAW_i = cost of additional water for the i^{th} sub-basin (dollars per acre-foot),

$TSCBC_i$ = total state costs of brush control for the i^{th} sub-basin (dollars),

$TSCBC_{i,j}$ = total state cost of brush control in the i^{th} sub-basin for the j^{th} brush density category (dollars),

$TYSSWG_i$ = 10-year sum supply of water gained from brush control for the i^{th} sub-basin (acre-feet),

$YWG_{i,t}$ = yearly water gained from brush control for the i^{th} sub-basin in the t^{th} year (acre-feet), and

r = discount rate of 6% (.06).

The average cost of added water from brush control for the Wichita watershed is estimated at $36.59 per acre-foot. Sub-basin cost per added acre-foot within the Wichita range from $17.56 to $91.76.

As might be expected, there is a great deal of variation in the cost of added water between sub-basins in the watersheds. Likewise, there is a great deal of inter-watershed variation in the average cost of added water. For an example that contrasts dramatically with the results shown for the Wichita in Table 5, the Middle Concho analysis resulted in an estimated average cost across all its sub-basins of $204.05 per acre-foot. Most of the watershed analyses, however, resulted in cost estimates in the $60 to $100 per acre-foot range (Conner and Bach 2000). Although the cost of added water from alternative sources is not known for the watersheds in the study, a high degree of variation is likely, based mostly on population and demand. Since few alternatives exist for increasing the water supply, these values are likely to be competitive.

ADDITIONAL CONSIDERATIONS

Total state costs and total possible added water discussed above are based on the assumption that 100% of the eligible acres in each type-density category would be enrolled in the program. The assumption that 100% of landowners in the watershed would enroll was based on a standard participation for calculating water yields.

There are several reasons why this will not likely occur. Foremost, there are wildlife considerations. Although many wildlife researchers disagree on preferred brush canopies for deer and other species, most managers recommend maintaining no less than 10% brush canopy cover for wildlife habitat, especially for white-tailed deer. Since deer hunting is an important enterprise on almost all ranches in these eight watersheds, it is expected that ranchers will want to leave varying, but significant, amounts of brush in strategic locations (brush “sculpting”) to provide escape cover and travel lanes for wildlife. The TSSWCB consistently has encouraged landowners to work with technical specialists from the USDA-NRCS and Texas Parks and Wildlife Department to determine how brush sculpting methods can create a balance of benefits on their specific land holdings.

Another reason that less than 100% of the landowners will enroll is that a portion of the tracts where a particular type-density category are located will be so small that it will be infeasible to enroll them in the control program. Research work by Thurow et al. (2001) indicated that only about 66% of ranchers surveyed were willing to enroll their land in a similarly characterized program. Some landowners will not be financially able to incur the costs expected of them in the beginning of the program due to current landowner indebtedness.

Based on these considerations, it is reasonable to expect that less than 100% of the eligible land will be enrolled, and, therefore, less water will be added each year than is projected. However, it also is expected that participation can be encouraged and increased by designing the project to include the watershed-specific concerns of eligible landowners and ranchers.

Table 5. Cost per acre-foot of added water from brush control by sub-basin—Wichita watershed.

Sub-basin number	Total state cost ($)	Added acre-feet/year	Total added acre-feet/10 years	Cost per added acre-foot ($)
1	457,182.65	663.12	5,173.66	88.37
2	1,772,111.33	2,475.42	19,313.20	91.76
3	344,487.78	1,077.40	8,405.87	40.98
4	270,611.17	942.91	7,356.62	36.78
5	405,303.90	749.96	5,851.16	69.27
6	551,815.58	986.80	7,699.02	71.67
7	1,829,171.16	5,422.75	42,308.32	43.23
8	1,620,183.78	5,981.27	46,665.90	34.72
9	1,338,434.24	4,191.21	32,699.81	40.93
10	590,024.30	1,348.29	10,519.36	56.09
11	343,140.75	538.63	4,202.39	81.65
12	440,716.10	1,034.65	8,072.31	54.60
13	262,233.00	539.93	4,212.53	62.25
14	299,909.61	991.71	7,737.34	38.76
15	354,443.07	1,133.46	8,843.26	40.08
16	187,848.00	708.77	5,529.82	33.97
17	84,634.43	271.90	2,121.36	39.90
18	522,247.77	2,033.13	15,862.52	32.92
19	124,871.50	428.28	3,341.42	37.37
20	246,020.32	891.41	6,954.81	35.37
21	2,730,475.37	5,040.57	39,326.50	69.43
22	110,738.33	207.37	1,617.87	68.45
23	1,369,643.80	2,842.40	22,176.44	61.76
24	1,563,106.99	4,341.88	33,875.38	46.14
25	971,017.42	3,045.95	23,764.46	40.86
26	771,619.10	5,630.83	43,931.70	17.56
27	1,478,568.35	7,031.17	54,857.21	26.95
28	1,801,533.32	5,150.93	40,187.54	44.83
29	1,948,506.76	5,494.46	42,867.77	45.45
30	3,769,655.99	11,088.20	86,510.14	43.57
31	439,757.96	1,808.91	14,113.14	31.16
32	613,063.06	2,662.65	20,774.03	29.51
33	260,808.40	978.39	7,633.40	34.17
34	722,243.11	3,244.66	25,314.81	28.53
35	801,913.88	4,916.12	38,355.56	20.91
36	472,961.33	1,639.72	12,793.10	36.97
37	522,081.31	2,403.25	18,750.18	27.84
38	293,231.45	1,269.62	9,905.55	29.60
39	3,111,539.76	13,297.01	103,743.29	29.99
40	2,006,939.15	9,401.39	73,349.63	27.36
41	307,258.55	1,076.78	8,401.04	36.57
42	424,456.46	2,248.68	17,544.19	24.19
43	493,711.42	1,956.21	15,262.37	32.35
44	452,996.05	2,434.30	18,992.42	23.85
45	272,492.79	1,539.52	12,011.34	22.69
46	243,926.57	1,086.30	8,475.32	28.78
47	24,499.30	122.51	955.81	25.63
48	3,371,088.17	17,633.53	137,576.82	24.50
Total	$43,395,224.59	————	1,185,937.68	Average: $36.59

Note: Total acre-feet are adjusted for time-supply availability of water.

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