Evaluating the profitability of brush management and oak tree thinning for range improvement

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Clearing rangeland of dense brush thickets or stands of oak trees produces obvious benefits on the better soils: more and better feed for domestic and wild animals; improved water yield in the watershed; and reduced fire hazard. But there are also costs, which need to be weighed against potential returns before the decision is made to improve the land.

Weather and market conditions cause both physical production and product price to vary, but the costs of an improvement vary little, especially after they are incurred. This study estimates the annual costs of two range improvement practices, brush management and oak tree thinning, and discusses the comparison of these costs with potential returns when the returns are not known with certainty.

Improvement costs

At the University of California Hopland Field Station in Mendocino County, workers began clearing brush and thinning oaks in the 1960s to improve the carrying capacity of part of a 387-acre pasture for livestock and wildlife. The brush was crushed, burned, and later sprayed to discourage regrowth, and the cleared area was seeded with grass and clover, and fertilized. Over a seven-year period, 107 acres (28 percent) of the pasture were treated.

The trees were thinned using the cut-surface method, in which the herbicide, 2-4-D was placed in cuts on the tree trunk near the ground. Oaks with good potential for acorn production were retained. The area under treated trees also was seeded. Tree treatment began in the fall of 1961 on 47 acres, or 12 percent, of the pasture.

The usual analysis of investments involves estimating and comparing after-tax costs and benefits over the life of the investment by taking into account the time value of money. However, because the benefits of range improvements are more uncertain than the costs, we chose another approach — transforming the after-tax costs over time into an equivalent annuity. This equivalent annuity was then compared with expected benefits per year and variations in benefits per year. If the benefits outweigh the annual cost, the investment is sound (provided that the money is available and there are not other, more profitable investments).

An annuity is an amount received or paid each period, usually annually. An equivalent annuity is calculated from a series of values over time, and it is used because the costs usually are concentrated in the first years of the life of the improvement. An equivalent annuity expresses this uneven distribution as an annual cost spread over the life of the improvement.

Hopland example

Costs for range improvements at the Hopland Field Station are used as examples (table 1). We have taken the actual inputs and applied 1982 prices. The after-tax equivalent annuities are estimated to be $6.43 per acre for thinning trees and $20.16 per acre for brush management with a 20-year life for both improvements (table 2).

The equivalent annuity of the costs needs to be compared with the expected benefits of the improvement. For the comparison, the annual values of increased forage and other benefits need to be estimated. Different price and yield assumptions need to be used so that the stability or sensitivity of the decision in relation to uncertain prices and yields can be judged.

With yield information. In unpublished data from the 1960s, the Hopland Field Station showed an average yield increase of 0.36 animal unit month (AUM) per acre per year in the entire 387-acre pasture. This is assumed to be the result of the brush and tree treatments on 154 acres, which means that each treated acre contributes, on average, about 1 additional AUM per year when compared with untreated acreage. (However, brush clearing and tree thinning may produce different effects.) We are basing this example on the measured increase of 1 AUM per improved acre.

If the value of an AUM is expected to be $20 on range, the expected value of the improvement at 1 AUM per acre is $20 per acre. This expected benefit from grazing, $20, is greater than the equivalent annuity for tree treatment costs, $6.43, but not for brush treatment costs, $20.16. Hence, it appears the range should be improved by tree thinning. Other benefits, such as decreased fire danger, improved wildlife habitat, value of fuel wood, and hunting leases, need to be evaluated and used in this comparison also. These factors may make both improvements profitable.

Variations in these benefits also should be evaluated before a final decision is made. Table 3 shows different benefits per acre for variation in the value of an AUM and in the yield increase.

Without yield information. When an estimate of the physical yield is not available, the breakeven yield can be estimated for different values of that yield. These breakeven yields are then compared with the amount the rancher estimates to be possible. In this example, if the value of an AUM is $20, the breakeven yield for the tree treatment is 0.32 AUM per improved acre ($6.43 per acre divided by $20 per AUM); for brush treatment, the breakeven yield is 1.01 AUM per improved acre ($20.16 per acre divided by $20 per AUM). This annual breakeven yield can be compared with the yield estimates, and the improvement decision made.

Effect of yield deterioration. The value of the yield increase from a range improvement usually decreases over the life of the improvement (see example in graph). This effect could be evaluated by quantifying the expected yields in each year and estimating the net present value of the improvement. Different prices and yields need to be used in the analysis so that the sensitivity of the improvement decision to changes in both yield and price can be evaluated.

To evaluate the effect of yield deterioration using an equivalent annuity, the breakeven yields for different prices need to be estimated and then compared with expectations of how the initial yield increase and the subsequent deteriorations compare with the breakeven yields. If the breakeven yields are expected to be exceeded by expected yields in enough years to counteract any poor years, the improvement is deemed profitable.

As an example, the graph shows the estimated value of the yield increase in each year and an equivalent annuity of $20 per acre for brush control. With such information, the magnitude of the return in years when the value of the yield increase is above the equivalent annuity of costs can be compared with the magnitude when the value is below

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Range improvement, cont'd

the annuity. If the yield increase cannot be quantified, this will be a subjective evaluation.

The possible sale of firewood, now a profitable product for many ranchers, will affect the method of improving wooded ranges. After the wood is harvested, the area can be seeded for improved range capacity. The Hopland Field Station has had a one-time yield of 12¼ cords per acre with a conservative stumpage price of $5 per cord. Although the money from selling firewood may finance the seeding costs, the firewood and seeding should be evaluated separately for profitability. Costs of seeding after firewood harvest convert to an equivalent annuity of $1.09 per acre (table 2), which should be compared with expected benefits and variations as described.

The advantage of the equivalent annuity approach is the ease of adjusting the benefits to evaluate potential values of conversion, production, and livestock prices. Estimation of the net present value of these improvements and the subsequent sensitivity should give the same answer. The annuity method is suggested only in those instances where the yields and prices are not known and estimates of the benefits are very uncertain. In these cases subjective evaluation will be assisted by the relatively easy, equivalent annuity method.

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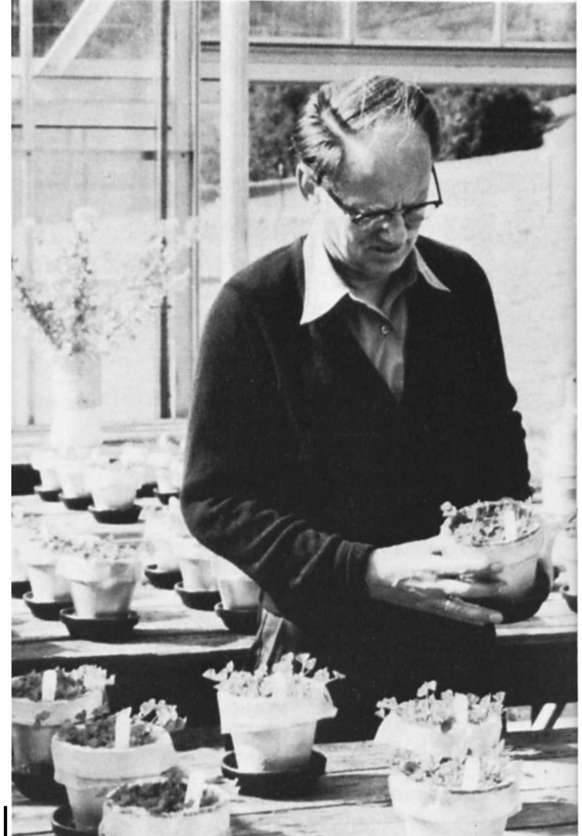

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Field Bindweed, cont'd

Flower and seed feeders. The bruchid beetle *Megacerus impiger* Horn frequently attacks seeds of all the California *Calystegia* spp. but only rarely is found in field bindweed seeds. The smut found in Greece also occurs in northern North America but is not found in California.

Stem and root feeders. No California organisms are associated with field bindweed stems, but the cecidomyid fly, *Lasioptera convolvuli* Felt, forms stem galls on western morning glory, *Calystegia occidentalis* (Gray) Brummitt. The sweet potato flea beetle, *Chaetocnema confinis* Crotch, like its European counterpart, *Longitarsus pellucidus*, feeds on roots in its larval stage and on leaves in its adult stage. It attacks both field bindweed and the native morning glories.

In spite of field bindweed's extensive system of roots and rhizomes, few organisms attack the underground portions of the plant in the Mediterranean, North America, or other areas where it has been studied. Organisms associated with other parts of the plant, however, occur in Europe and would be worth investigating as biological control agents where gaps in the fauna exist in California: late-season, specialized Lepidoptera; leaf beetles, gall mites, and fungus diseases of the leaves; seed-destroying organisms; and stem feeders.

In preliminary tests conducted in Europe on a variety of plant species in the Convolvulaceae and other plant families, the moth *Tyta luctuosa*, the leaf beetle *Galeruca rufa*, and seed beetle *Spermophagus sericeus* appeared to feed only on *Convolvulus* and *Calystegia* spp. Further tests conducted with the leaf beetle in the quarantine facility at Albany, however, indicated that this beetle could feed and reproduce on several North American sweet potato varieties.

The gall mite *Aceria convolvuli* Nalepa, from Greece, which attacks field bindweed buds and leaves, did not feed on American sweet potato varieties in laboratory tests, but tests on American morning glories are not complete. The powdery mildew appears to attack *Convolvulus* and *Calystegia* spp. Neither natural enemy has been thoroughly studied yet, but both organisms, or at least some closely related organisms, offer promise of being specific.

In conclusion, because some American sweet potato varieties and native North American morning glories (*Calystegia* spp.) are susceptible to attack by organisms associated with field bindweed, it will not be easy to find adequately host-specific biological control agents that may be used against this weed in California or any other area of North America.

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TABLE 1. Physical inputs for two brushland range improvement practices, Hopland Field Station.

Year*	Improv. prac.†	Labor used‡ Superv.	Labor used‡ Manual	Labor used‡ Trac. op.	Machinery and equipment§ Item	Machinery and equipment§ Hours	Materials** Item	Materials** Amount
		hours	*hours*	*hours*				
Brush crushed and burned, 107 acres								
1	a. Crush brush	2	8	18	D-7 w/dozer	18	—	—
	b. Burn brush	2	22	—	—	—	—	—
2	a. Crush brush	2	8	19	D-7 w/dozer	19	—	—
	b. Reseed	11	72	36	D-7 w/range drill	36	Amm. sulphate Seed	1.8 tons 417 lb
	c. Burn brush	5	46	—	—	—	—	—
3	a. Spray brush	6	61	—	Backpack mist blower	—	2,4-D ester 2,4,5-T	3 gal 3 gal
	b. Crush brush	8	14	33	D-7 w/dozer	33	—	—
	c. Reseed	18	133	47	D-7 w/range drill	47	Amm. sulphate Seed	2.3 tons 640 lb
	d. Burn brush	4	40	—	—	—	—	—
4	a. Spray brush	15	74	73	TD-9 w/spray rig	73	2,4-D ester 2,4,5-T	18.5 gal 18.5 gal
	b. Reseed	—	54	44	D-7 w/range drill	44	Amm. sulphate Seed	1.6 tons 493 lb
5	Brush sprout control	48	120	120	TD-9 w/spray rig	120	2,4-D amine 2,4-D LVE 2,4,5-T Oil	68 gal 48 gal 22 gal 17 gal
6	Brush sprout control	—	7	—	—	—	2,4-D LVE	0.5 gal
7	Brush sprout control	2	6	17	TD-9 w/spray rig	17	2,4,5-T 2,4-D LVE Oil	9.0 gal 9 gal 2.0 gal
Tree treatment, 47 acres								
1	Basal frilling	25	251	—	—	—	2,4-D amine	18 gal
2	a. Basal frilling	13	127	—	—	—	2,4-D amine	24.5 gal
	b. Seed under trees	2	24	—	—	—	Seed	100 lb
3	Seed under trees	1	14	—	—	—	Seed	58 lb
5	Basal frilling	17	174	—	—	—	2,4-D amine	12.5 gal

* Year starts July 1.
† Brush treatment started in 1962-63; tree treatments in 1961-62. No costs incurred for tree treatment in year 4.
‡ Labor costs: supervisory, $7/hr; manual, $4/hr; tractor operator, $5.50/hr.
§ Machinery costs: D-7 w/dozer, $40/hr; D-7 w/range drill, $50/hr; TD-9 w/spray rig, $20/hr. Calculated tractor net engine horsepower: D-7 = 108 and TD-9 = 52; equivalent to PTO horsepower times 1.16. Under load, continuous rated horsepower is 64 to 70 percent of rated net engine horsepower.
** Materials cost: 2,4-D amine, $12/gal; 2,4-D ester, $15/gal; 2,4,5-T, $25/gal; 2,4-D LVE, $15/gal; oil, $5/gal; seed (average cost of mix of harding grass, Palastine orchard grass, Blando brome, and rose clover seed), $2.61/lb; ammonium sulphate (16-20-0), $175/ton.

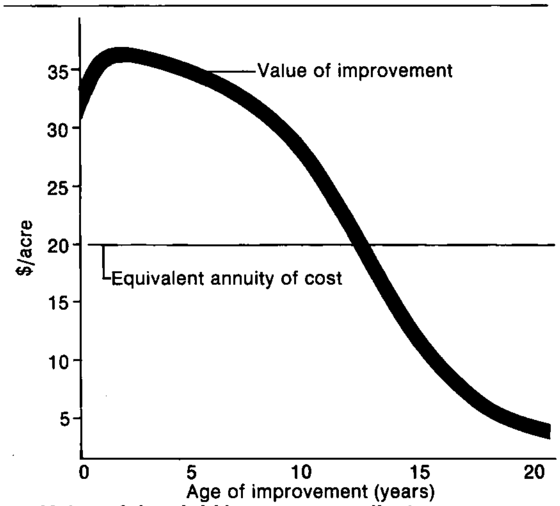
TABLE 2. Costs and the equivalent annuities of improvement practices, 1982 dollars*

Year	Pre-tax costs	(1-tax rate)†	Present value factor	Present value of after-tax cost
Crush and burn brush, 107 acres				
1	$ 968	.68	1.000	$ 658
2	4,900	.68	.893	2,975
3	7,556	.68	.797	4,096
4	7,231	.68	.712	3,500
5	6,059	.68	.636	2,618
6	36	.68	.567	14
7	842	.68	.507	290
Total	$27,592			$ 14,152
Equivalent annuity per acre:‡			7.469	$ 20.16
Tree treatment, 47 acres				
1	$ 1,401	.68	1.000	$ 953
2	1,268	.68	.893	770
3	215	.68	.797	116
5	969	.68	.636	419
Total	$ 3,853			$ 2,258
Equivalent annuity per acre:‡			7.469	$ 6.43
Seeding after firewood harvest, 47 acres				
1	$ 372	.68	1.000	$ 253
2	215	.68	.893	130
Total	$ 587			$ 383
Equivalent annuity per acre:‡			7.469	$ 1.09

* Based on improvements made at Hopland Field Station.
† The pre-tax cost is reduced by the decline in the tax bill due to incurring these expenses. In this case, a marginal tax rate of 32% is used.
‡ The equivalent annuity is the costs of the improvement transformed into an annual figure using a project life of 20 years and a discount rate of 12%. This rate is chosen to reflect interest and inflation rates at the time of the improvement. The factors used to transform the costs by year into the equivalent annuity are obtained from standard interest tables.

TABLE 3. Benefits per acre for various yield increases and values per AUM

Yield increase	Value per AUM $10	$15	$20	$25
AUM/acre	*$/acre*			
.50	5.00	7.50	10.00	12.50
.75	7.50	11.25	15.00	18.75
1.00	10.00	15.00	20.00	25.00
1.25	12.50	18.75	25.00	31.25
1.50	15.00	22.50	30.00	37.50



Value of the yield increase usually decreases over the life of the improvement.