They have attained such high numbers that their combined feeding damage in many instances has allowed them locally to overwhelm and completely destroy their cactus hosts. The cochineal insects have now spread island-wide, largely via windborne, first-instar nymphs, but also by intentional transport of cochineal-infested pads by man and inadvertently by grazing animals.

Photos

Beginning in 1961, sequential photographs have been taken biannually during the spring and fall of selected prickly pear clumps located throughout the island. The relatively rapid and thorough destruction of cochineal-infested clumps is graphically shown in the photo sequences. Such destruction continues on the island at the present time. Apparently *Opuntia littoralis* and *O. littoralis* × *O. oricola* hybrids that more closely resemble the first-named species are more susceptible to attack by the cochineal insects. It appears that the susceptible species and hybrids have been brought under substantial control; whereas, only partial control of *O. Oricola* and hybrids resembling this species has been effected.

Sheep

Sheep eradication and restricted cattle grazing as practiced by the Stanton Ranch, which occupies over 90 per cent of the island, have significantly aided these biological control efforts. During the past decade, the island was laced with many miles of fencing, and the thousands of sheep trapped within the enclosures so formed were removed from the range. These efforts so reduced overgrazing that several species of annual grasses have been able to persist on formerly barren land, as shown by the terminal photographs in the photo sequences. Conservation of this grass cover has substantially curbed the further spread of the cacti.

During the late winter and the spring growth periods, these grasses also compete directly with the cacti for water, space, and nutrients. *Dactylopius* sp. injury has also undoubtedly reduced the competitive advantage of the cacti in favor of these grasses.

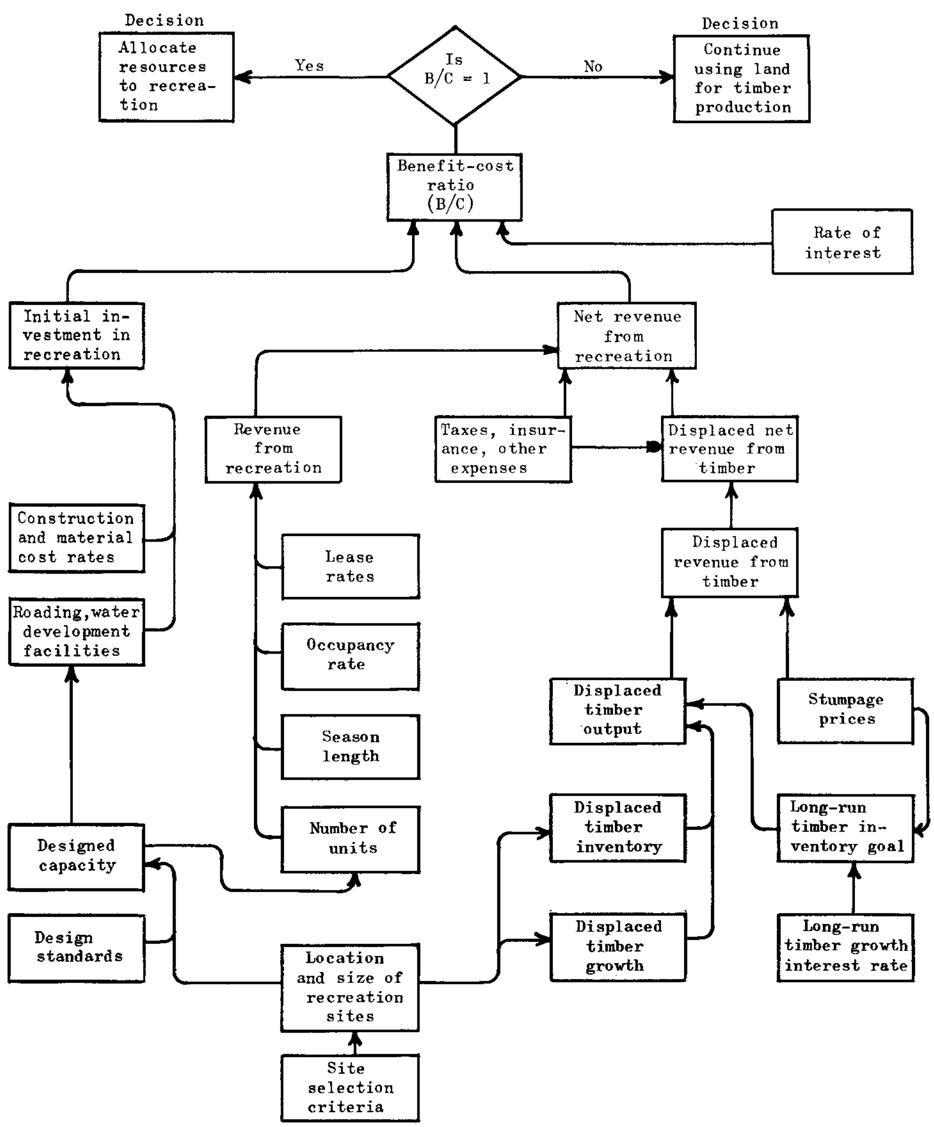
R. D. Goeden is Lecturer in Biological Control and Assistant Entomologist; C. A. Fleschner is Professor of Biological Control; and D. W. Ricker is Laboratory Technician IV, Department of Biological Control, University of Californa, Riverside.

D. E. TEEGUARDEN · K. R. WERNER

INTEGRATING FOREST-ORIENTED RECREATION WITH TIMBER GROWING

--a case study of economic factors

FLOW-CHART OF FACTORS INFLUENCING DECISION TO INTEGRATE RECREATION WITH TIMBER PRODUCTION



CALIFORNIA'S AFFLUENT, growing population is using more outdoor recreation services than ever before. Camping, for example, has increased at a phenomenal rate since the war and more people are investing in summer and weekend vacation homes in such areas as Lake Tahoe. Many forest owners want to know whether they can increase their incomes by adding recreation enterprises to their land management programs. The answer is not obvious. Developing the recreational resources of a forest may require a large capital outlay, even for a primitive campground. Also, income from timber production must be sacrificed if a tract of land is shifted to recreational use. The demand for recreational services must be evaluated in terms of possible cash receipts.

This study investigated the economics of integrating timber growing with the sale of two kinds of forest-oriented recreation services: vacation homesites and campground facilities. An analysis made of a 2,888-acre forest in El Dorado county was designed to answer four specific questions: (1) What factors should be taken into account in evaluating timber-recreation alternatives? (2) What additional investments are required to develop recreation resources? (3) How is a potential forest income affected by integrating timber growing with recreation management? (4) What are the important elements of uncertainty in the decision to add recreation enterprises? While the data are based on only one situation, the forest studied is comparable with many others in terms of size, accessibility, and physical environment—and the analytical procedure should be helpful to all forest managers concerned with timber-versus-recreation decisions.

Blodgett forest

The University of California Blodgett Experimental Forest was used for this case study of timber and recreation land-use alternatives. The forest lies on Sand Mountain Ridge, 14 miles northeast of Placerville between the middle and south forks of the American River. Elevations within the forest are from 4,100 to 4,600 ft and the terrain is gentle to moderate. Timber production potential is high, averaging nearly 1,000 bd ft per acre per year. Although recreational features of the forest are not as spectacular as those at higher elevations, they are considered to have potential economic significance. For years several undeveloped sites have been used for camping by transient vacationers, deer hunters, and fishermen. A recently completed reservoir nearby has increased local activity by recreationists, including travel on a paved road which crosses the forest in an east-west direction. Numerous summer homes have been built locally on private land and the demand for attractive sites is growing. Because vacation homes and campground developments appear to be the main land use alternatives to timber growing, it was decided at the outset of the study to restrict analysis to these two types of forest-oriented recreation enterprises.

In the study, the forest owner was assumed to be a private individual with an income subject to usual income taxes. It was also assumed that all net income not taxable as capital gains (and thus under federal law taxed at a 25 per cent rate) would be taxed at 50 per cent. (The analysis can be reworked with any rate using computational procedures developed in the study.) Second, it was assumed that the owner would be willing to invest in recreation development if the after-tax rate of return on a project were equal to at least 3.5 per cent. This is equivalent to 7 per cent before taxes if the investor's marginal income tax rate is 50 per cent, as assumed. Third, it was assumed in the study that the forest owner would discontinue timber harvesting in those areas allocated to recreation. Fourth, it was assumed that all benefits from recreation enterprises would be realized in terms of money revenues rather than from such intangible values as the improvement of public relations or control of recreationists for forest protection purposes. Finally, only benefits and costs over a 20-year planning period are included in the analysis.

The general method used in the economic analysis consisted of: (1) estimating the initial investment associated with each of eight possible recreation sites; (2) estimating the annual net revenue from each site; (3) estimating the foregone timber production revenue from each site; and (4) computing a benefit-cost ratio for each site—defined as the sum of discounted annual net revenues (minus foregone timber revenue) divided by initial investment. If this benefit-cost ratio is one or greater, an investment to develop the site for recreational purposes will earn at least 3.5 per cent after taxes. If it is less than one, the project would not be economically feasible and it would be better to continue with timber production than to add the recreation enterprise to the land management program.

The flow-chart illustrates how the many factors considered in the analysis influence the choice between recreation and timber production. Choosing any box and following the arrows allows a visualization of how each factor interacts with others. The chart also gives a picture of the research procedure, which involved computing or estimating each factor identified in the flow-chart.

Procedure

The first step in the study was to identify potential recreation sites. A preliminary survey of the forest was made using aerial photographs and maps. Then a ground reconnaissance was made. Each potential site was evaluated according to specific site selection criteria including four elements: ability to attract, availability of domestic water, terrain, and forest environment. A view, bodies of water, or the promise of successful hunting or fishing were considered aspects of ability to attract. For campgrounds, slope had to be less than 3 ft per chain (66 ft). For summer homesites the slope had to be 12 ft or less per chain. The term "forest environment" reflected a judgment of the overall aesthetic appeal of vegetation, terrain, and general surroundings, as opposed to the more limited criterion of ability to attract. Application of these criteria led to selection of six vacation home sites and two campgrounds (see table). Location and size of recreation sites plus considerations of design standards were the basic determinants of "designed capacity" of the site to support recreation activities of the kind planned. Designed capacity was in turn one of the determinants of recreation revenue through its effect on the number of units planned for a site. It also determined the roading, water developments, and facilities to be constructed. Given design standards and estimated capacity, a detailed plan of site development was prepared which included estimates of engineering and construction work required. These estimates were combined with estimates of construction and material cost rates to produce an estimate of the "initial investment" required to develop a recreation site. Estimated initial investments are shown in the table. Operating costs, taxes, insurance, depreciation allowances, and so on were estimated separately and deducted from recreation revenues in a separate calculation. Recreation revenues were treated as functions of the four factors identified in the flow-chart. Vacation homesite lease rates were $500 per year per unit; campground fees, $1 per day.

Foregone timber production revenues must be subtracted from recreation revenues if the benefit-cost ratio for a recreation development is to be properly estimated. To make this computation, maps of each recreation site were used to determine the area, displaced timber inventory, and displaced timber growth if the site were to be shifted from timber to recreational use. The potential timber output from the forest as a whole (with recreation developed) was then estimated using a special formula developed for this purpose. Subtracting the resulting figure from the figure of timber output in the absence of recreation gave an estimate of the displaced timber output caused by changing land use. Displaced timber output was converted to "displaced revenue" by multiplying output by stumpage prices for each year in the planning period. A constant price of $12.50 per thousand bd ft was assumed. Displaced net revenue was then estimated by deducting income and property taxes, insurance, and other expenses. The resulting figure — displaced net revenue from timber—was then subtracted from recreation revenue in order to adjust the latter for foregone timber returns. Finally, after-tax net revenue from recreation for each year in the planning period was discounted at 3.5 per cent, summed, and divided by initial investment to get a benefit-cost ratio. These steps were repeated for each recreation site considered in the study.

Conditions assumed

Under the conditions assumed, integration of timber production with recreation was considered economically feasible. However, the intensity of recreation management—how much of the resource is worth developing—depends upon many factors which interact in a complex manner (see flow chart). The average landowner should seek the help of specialists—foresters, farm advisors, and financial experts—before making additional capital expenditures to develop recreation resources.

The amount of existing timber inventory and growth, and the policy under which timber would be managed in the absence of recreation, are significant factors in a consideration of the economics of timber-versus-recreation.

To measure the consequences of alternative long-term inventory policies, the reduction in timber output was computed under three policies as indicated in the table: (A) reduction of inventory to a level yielding a 5 per cent before-tax rate of return on the last unit of inventory, 15,000 bd ft per acre; (B) reduction of inventory to a level yielding maximum mean annual growth, 25,000 bd ft per acre; and (C) maintenance of current average inventory, 43,000 bd ft per acre.

SUMMARY OF ECONOMIC ANALYSES OF RECREATION-TIMBER MANAGEMENT ALTERNATIVES FOR BLODGETT FOREST

Site	Type of development	Area	Units	Initial capital investment (est.)		Displaced annual timber output (Inventory policy)*			Benefit-cost ratio (Inventory policy)*		
						A	B	C	A	B	C
		Acres	No.	$ total	$ per unit	thousand board feet					
1	Vacation homes	142	18	35,784	1,988	203.2	132.2	113.6	1.21†	1.45†	1.78†
2	Vacation homes	42	5	12,241	2,448	115.5	94.5	45.4	0.37	0.57	1.40†
3	Vacation homes	37	6	11,545	1,924	32.0	13.5	25.4	1.34†	1.53†	1.58†
4	Vacation homes	31	5	9,033	1,807	63.0	47.5	31.1	1.08†	1.29†	1.82†
5	Vacation homes	31	3	5,747	1,916	48.2	32.7	25.7	0.82	1.15†	1.68†
6	Vacation homes	25	3	6,133	2,044	78.1	65.6	28.1	0.20	0.44	1.61†
7	Campground	58	13	11,287	868	95.4	66.4	45.2	−0.38	−0.07	0.49
8	Campground	28	10	2,773	277	76.0	62.0	30.2	−2.19	−1.58	0.82

* Inventory policies: (A) reduction of inventory to level yielding a 5% before-tax rate of return on last unit of inventory, 15,000 bd ft per acre; (B) reduction of inventory to maximum mean annual yield, 25,000 bd ft per acre; and (C) maintenance of current inventory, 43,000 bd ft per acre.

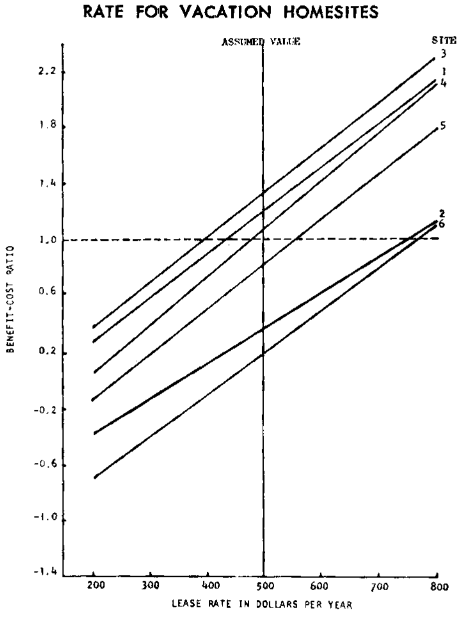
† Site economically feasible to develop for recreational purposes.

Conclusions

In this study, only three vacation homesites (in the table, 1, 3, and 4) were found profitable to develop, if current timber inventory was considered excessive and was to be reduced to a level specified in policy A over the 20-year period. In contrast, if inventory was already at a desired level (policy C), the impact of shifting land-use toward recreation was much less upsetting and all summer homesites could evidently be considered feasible to develop. None of the campground projects was found economically attractive, however.

Under timber inventory policy A, initial capital investment to develop the three profitable sites was $56,362, or an average of $1,943 per unit. Development would reduce timber output from 4,978 to 4,679 thousand bd ft, a reduction of 6 per cent. Under timber inventory C, initial capital investment to develop six summer houses was $80,483, with development reducing timber output from 2,257 to 1,988 thousand bd ft, a 12% reduction.

RELATIONSHIP OF BENEFIT-COST RATIO TO LEASE RATE FOR VACATION HOMESITES



Management income (defined as annual revenue minus all costs including depreciation, depletion allowance, and interest charges on investments) was increased from $20,696 to $23,823 as a result of developing sites 1, 3 and 4 under inventory policy A. Annual net cash-flow (defined as cash remaining in the business after all cash costs are paid) was increased from $37,561 to $42,373. These financial measures of incentive to develop recreational resources may be regarded as small by many owners in view of the numerous elements of uncertainty which surround such enterprises.

The foregoing conclusions are the result of the method of analysis and the assumptions noted. To evaluate the importance of the assumptions made, tests were conducted of the sensitivity of benefit-cost ratios to estimates of initial investment, lease rates, occupancy rates, and stumpage prices. The graph shows results of lease-rate test for vacation homesites. Note that none of the vacation homesites was profitable if lease rates were less than about $380 annually. On the other hand, if the lease rate is $550 or more, vacation homesite 5 was also profitable. A sensitivity index relating relative change in the benefit-cost ratio to small changes in an underlying factor was computed for each of the four factors indicated. These indexes revealed that in the case of vacation homesites the single factor producing the most uncertainty was the lease rate, followed by the occupancy rate, the initial investment, and the stumpage prices (a determinant of the revenue foregone from timber). In the case of campgrounds, uncertainty regarding these same factors was relatively unimportant because within a wide range of assumptions regarding costs and revenues, campgrounds failed to yield benefit-cost ratios of one or greater.

Does recreation pay? The answer is a conditional yes, within the context and assumptions of this case study. But the results do not give an unconditional, conclusive answer equally applicable to all forests. Some important elements in the decison to change land-use from timber to recreation have been identified, but the weight properly attached to these factors obviously will vary from one forest to another. Moreover, the analysis considers only those benefits which are calculated in money returns. To some owners other benefits may also be important. For example, a large industrial owner whose lands are open to public recreation may wish to operate campgrounds as a means of controlling the place and manner of the camping that would probably occur even in the absence of such facilities. Finally, given uncertainties surrounding factors which influence costs and returns, the element of risk may loom large in the minds of some landowners. For this reason alone, study results should be interpreted with caution. In the last analysis, the question, "Does recreation pay?" can be answered in any specific circumstance only through informed, carefully conducted advance planning.

Dennis E. Teeguarden is Associate Professor of Forestry; and Kenneth R. Werner was Research Assistant, University of California, Berkeley (now Forester, U. S. Forest Service, Mt. Shasta). *This report is based on a study supported in part by the U. S. Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley.*

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Fertilization method and nitrogen content of annual flowering plants

TOK FURUTA · JOHN RIBLE

LYLE PYEATT

UNIFORM NITROGEN CONTENT in the foliage is desirable for optimum growth of annual flowering plants (bedding plants). Two of many fertilization procedures suggested to maintain this uniform level, include the use of controlled release nitrogen fertilizers, and constant fertilization at each irrigation with a dilute fertilizer solution. Tests reported here, were to determine the ability of these procedures to maintain nitrogen uniformity during early growth under commercial conditions.

Seedlings of petunia Pink Satin and zinnia Giant Dahlia were grown in a lightweight mix of two parts sand, two parts perlite, three parts redwood sawdust and two parts peat. Single superphosphate, oyster shells, dolomite limestone, and iron sulfate were incorporated into the mix. Differential fertilizer treatments began 12 days after the transplanting of the petunia plants, and 17 days after the transplanting of the zinnia plants. These treatments were: (1) controlled release nitrogen only; (2) constant fertilization only; and (3) a combination of controlled release and constant fertilization. The controlled release nitrogen treatment was sulfur-coated urea applied as a top dressing. The product was 32 per cent N, 25.6 per cent sulfur coating, and it had a dissolution rate of 5 per cent. The constant fertilization treatment consisted of applying nitrogen, phosphorus, and potassium at each irrigation.

Medial leaves

Medial leaves were collected at the time of treatment and from all treatments five times during the experiment, beginning 10 days after treatment and ending 37 days after treatment. The leaf samples were analyzed for total nitrogen content, and soil samples were collected at that time.

At the time of the treatments, the zinnia and petunia plants had leaf nitrogen contents of 4.20 per cent. There was less variation in nitrogen content of the foliage of both species when the combination fertilization was used than when either method was used alone (see

TOTAL NITROGEN CONTENT OF FOLIAGE AND SOIL pH OVER A SIX-WEEK PERIOD, AS INFLUENCED BY FERTILIZATION PRACTICE

Plant	Fertilization program	Leaf nitrogen		Soil pH	
		Average	Standard deviation	Average	Standard deviation
		%	%		
Petunia	Constant fert, alone	4.9	0.54	7.1	0.21
	Controlled release, alone	5.3	0.35	7.1	0.21
	Constant fert, plus controlled release	5.7	0.30	7.0	0.20
Zinnia	Constant fert, alone	4.3	0.30	6.8	0.26
	Controlled release, alone	3.5	0.38	6.8	0.17
	Constant fert, plus controlled release	4.6	0.15	6.9	0.23