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The Economics of Forest Management for Multiple Uses: The Theory and Applications[1]

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多目的 山林經營의 經濟學的 考察： 그 理論과 應用[1]

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ABSTRACT

The concept of multiple-use forestry can be considered as a simple application of the economic theory which commands the efficient utilization of resources. This paper reviews two important branches of the economic theory—theory of the firm and the capital theory—and discusses various methodologies of measuring the non-timber benefits from the forest. In addition, an empirical analysis with an example of the Deogyu National Park is presented. For this purpose, the Clawson's Travel Cost Method was employed.

Key Words; Multiple-use forestry; Economics; Non-timber benefits; Deogyu National Park

要 約

山林의 多目的 經營은 資源의 效率的인 利用을 可能케 하는 經濟學 理論의 한 應用例로 볼 수 있다. 本稿에서 山林의 多目的 利用을 뒷받침 해 주고 있는 經濟學 理論 中 두가지 重要한 理論, 卽 企業理論과 資本理論의 山林經營的 解析과 그 適用上에 問題가 되고 있는 非木材 效用의 測定方法을 檢討하였다. 또한, 實證的 硏究로서 德裕山 國立公園의 山林休養 價値를 Clawson 의 旅行費用法에 의하여 計測하였다.

INTRODUCTION

It is commonly said that a forest can serve human-kind in a variety of ways. The typical phrase in this context may be found in a United States legislation, the Multiple-Use Sustained Yield Act (1960). It says, "The United States National Forests should be managed for multiple uses such as timber, outdoor recreation, range, watershed, and wildlife and fish." As in the utilization of other resources, the use of a forest is usually directed by the needs of society, under the objectives of its owner. In the real world, we are forced to allocate our resources among various ends in an efficient manner, because the resources are considered to be scarce relative to our endless wants. Some forest uses conflict with other uses whereas there are also complemen-

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tary relationships between uses (Teeguarden 1982). As demands for forest use become more intensive, and as such uses began to conflict more, it will become more difficult for optimum forest management to be practiced.

The problem can be specifically defined as finding the optimal output and input mix of forest management such that the forest in question can serve society or the owner with a maximum of goods and services. The main purpose of this study is to review the economic theories and some practical approaches for the multiple use management of forest lands. By reviewing the literature, the author has identified some of the problems in applying the theoretical models and the requirements of employing the practical approaches in multiple use management of forest lands. The results of an empirical analysis with an example of the Deogyu National Park is presented to demonstrate the applicability of a method known as the Travel Cost Method.

THEORETICAL MODELS

The economic theory is a rich source from which the solution for the multiple use problem can be sought. Essentially, there are two branches of economic theory which are relevant to our problem. They are the theory of the firm and the capital theory.

1. The Theory of the Firm

An earlier application of the theory of the firm into multiple use forestry is found in the articles by Gregory (1955) and Pearse (1969). Recently, Saastomoinen (1982) applied this model to forest management in northern Finland, where timber growing, deer raising, and outdoor recreation are considered as possible uses of the forest.

There are two distinguishable processes in the production of goods and services: single production and joint production. Single production is a process in which only one homogeneous item is produced with a set of inputs. Mathematically, representing the input vector by $X = (x_1, x_2, \ldots, x_n)$ and the level of output by q, the single production process can be defined as;

$$F(q, X) = 0. \quad (1.1)$$

This type of production process is commonly found in agriculture production, such as rice growing. This is also suitable to forest management for only one use; for example, when timber growing is the only objective of the forest owner. This is also possible when there is no demand for other forest outputs except the one considered as the sole product, or when the values placed by potential users on the other outputs are negligible compared to that of the main product. If we consider a large area of forested land as a management unit, and if each of the small units composing the area is suitable for single production of a specific output, the management of the forest can be also considered as multiple use forestry. This is the so-called Pearson (1944) approach or mosaic approach (Clawson 1975).

Secondly, joint production is a production process in which a set of different outputs are produced using a set of inputs. Mathematically, representing the output vector by $Y = (y_1, y_2, \ldots, y_s)$ and the input vector by $X = (x_1, x_2, \ldots, x_n)$, the joint production process can be defined as;

$$F(Y, X) = 0. \quad (1.2)$$

This type of production process is most suitable for forest management where demands for different forest outputs are to be met. In fact, this is the typical type of production process that multiple use forestry is concerned with. The problem is to find the optimal mix and levels of inputs and outputs in forest management.

The theory of the firm gives the basis for answering the problem under some restrictive assumptions. We assume that the production function defined in equation (1.2) has continuous first and second-order derivatives. If the owner of the forest in question would like to maximize the sum of net benefits from all outputs holding any value, the optimal solution for the problem can be found by the first-order condition;

$P_i/P_k = F_i/F_k = dq_k/dq_i = MRT_{ki}$

$i,k = 1,2,...,s$ (1.3)

where P_i, P_k are the prices or shadow prices for output i, F_i, F_k are the first derivatives of the production function F defined in (1.2), and MRT_{ki} are the marginal rate of technical transformation of output k for output i. This means that the rate of production transformation for every pair of outputs –holding the levels of all other outputs and all inputs constant–must equal the ratio of their prices.

For the K^{th} output and the J^{th} input,

$r_j/p_k = -dq_k/dx_j$

$j = 1, 2, ..., n; k = 1, 2, ..., s.$ (1.4)

That is, the value of the marginal product of each input with respect to each output is equated to the input price. Finally, for the inputs,

$r_j/r_k = -dx_x/dx_j = -MRS_{kj}$

$j,k = 1, 2, ..., n.$ (1.5)

The marginal rate of technical substitution for every pair of input–holding the levels of all outputs and all other inputs constant–must equal the ratio of their input prices (Henderson and Quant 1980).

There have been a number of studies, based on the concept of this model, dealing with the multiple use problem in forest management (for example, Muhlenberg 1964; Black 1963; O'Connell and Brown 1972; Saastomoinen 1982). Many of the researchers have expressed difficulties in obtaining necessary information such as data on input costs and output values, and the physical relationships of forest production which include input-output relationships as well as trade-offs between outputs (Teeguarden 1982, Lloyd 1969).

2. The Capital Theory

Perhaps the oldest application of the capital theory to forestry is the Faustmann problem which will be discussed later. The multiple use management of forest lands can be explained based on the capital theory with an assumption; forest management produces two outputs: wood products and vegetative states. The vegetative state of a standing forest provides a flow of social services or nontimber benefits to the potential users over the life of the stand (Kaiser and Norbury 1984). The social values are attributed to the capacity of a forest for providing wildlife habitats, outdoor recreation sites, forage, amenity, and of controlling water flows. Different users of the forest attach different values to the services, and these can be summed over all users to provide a single value for a vegetative state at any point in time. The analytical problem is to determine the optimum rotation length for the stand when both wood products and social goods are taken into account. In turn, the choice of harvest age determines the output mix since the vegetative state is a function of stand age. Since the multiple use problem can be seen as an application of the Faustmann model, we now begin with the traditional harvesting model.

1) The Faustmann model

The traditional economic problem in forestry is the timing of a sequence of harvests on a stand which is managed in perpetuity with prices, costs, interest rates, and stand productivity known and unchanging. Beginning with a single unstocked stand, a manager incurs per acre regeneration cost C. The timber grows according to the volume function V(T), giving saleable volume per acre as a function of harvest age T. At the harvest age, the manager receives revenue PV(T), with stumpage price P given net of any harvest costs. The land is regenerated and the cycle repeats. With prices, costs, the growth function, and the interest rate, i, known and unchanging over time, the selected harvest age should be the same in each subsequent rotation cycle. The problem is to find the rotation length T, to maximize the present net value of receipts from the current and all future harvest cycles. That is, representing the present net value of the stand, so-called SEV (Soil Expection Vlue), by S, we find age T which solves

$$S = \max [(PV(T)e^{-iT} - C) / (1-e^{-iT})] \quad (2.1)$$

The first-order condition for the maximization in problem (2.1) gives us;

$$PV'(T) - iPV(T) - iS = 0. \quad (2.2)$$

This means that the Faustmann harvest should be at the age T at which the marginal increase in value from further growth just equals the opportunity cost of delaying the harvest. This opportunity cost includes the potential interest income foregone on the delayed receipts of current harvest revenue plus the interest cost of delaying revenues from future harvest cycles.

2) The Hartman model

The Faustmann model does not reflect the value of amenity services provided by the standing forest. The lack of adequate market signals for nontimber forest outputs is the heart of the multiple use planning problem and presumably the justification for the public management of forest resources. Hartman (1976) reacted to Samuelson's (1976) discussion with a generalization of the Faustmann harvest problem. His analysis considers one single-aged stand and assumes that the value from nontimber services can be expressed as a function of stand age.

The benefit flow from an acre of standing stock of age n is represented by a (n). The integral, $\int (a(n)e^{-in})dn$ then represents the present value of these amenity services from a single harvest cycle of length T. Beginning with a single unstocked acre, the problem is to choose the harvest age T that will maximize the combined present values of timber and nontimber benefits from the current and future harvest cycles. The problem is given as;

$$S = \max [PV(T)e^{-iT} + \int (a(n)e^{-in})dn - C]/(1 - e^{-iT}) \quad (2.3)$$

with the net price P, volume V(T), cost C, and S as reviously defined for problem (2.1). The Hartman rotation age T must satisfy the first-order condition:

$$PV'(T) + a(T) - iPV(T) - iS = 0. \quad (2.4)$$

This is again interpreted as calling for a harvest at the age at which the marginal benefits of delaying the harvest just equals the opportunity costs. The benefits of delaying the harvest include the increment in value from timber growth, plus a(T), the flow of amenity benefits during the period of delay. The later term can be interpreted as a rental cost of using the land. It now reflects the value of the land for both timber and nontimber services. We harvest when the rate of increase in the total value of the land and its stock has just fallen to equal the discount rate i.

In general, the Hartman rotation age will be somewhere between the Faustmann rotation age and that which would maximize the present value of the returns from the stock amenity services alone. The solution age will depend both on the total amenity benefits of a harvest cycle relative to the net timber receipts and on the seperate relative growth rates in the amenity and timber values. When the amenity value of stock generally rises with stand age, the harvest solution will be greater than the Faustmann age. In fact, if the amenity flow is large and increasing with stand age, it may be optimal to leave the stand unharvested forever. In many areas where forage and increased water flow are important we might anticipate the amenity values to be declining with stand age, thus forcing us to choose shorter rotations.

Unfortunately, our knowledge tends to be weak with respect to the stand-age-dependent rate of change in amenity values. The difficulty is compounded once we realize that the value of a stand is likely to be dependent upon the treatment of neighboring areas of the forest. Due to the difficulty in valuing the amenity services, there are few studies in which optimal multiple use rotation have been calculated. Calish, Fight, and Teeguarden (1978) provided rough estimates of multiple use values for single Douglas fir stands as functions of stand age and solved for optimal rotation ages. Riiters, Brodie and Hann (1982), in a rather richer model, consider the choice of thinning intensity and rotation age on a single stand management for combined livestock grazing and timber harvesting. The consideration of grazing values tends to shorten rotations and leads to intensified thinnings.

3) The Bowes-Krutilla model

The richest and most realistic models can be built with the assumption that social value of the forest in a function of the mix of stand ages in an area rather than the ages of stands considered individually. Bowest and Krutilla (1985) have built such a model in a dynamic programming framework. In their mocel, the objective at any time period is to maximize the sum of harvest values and amenity services in theat time period and the value of the land in the next time period. In vector notation this is expressed as:

$$J(X_t) = \max\ [a(X_t) + b(H_t)]\, e^{-i} - C_t + J(X_t+1)e^{-i} \qquad (2.5)$$

The term in a(X) is interpreted as before with the exception that X is a vector containing the inventory of all of the stands in the forest. The term in H is acres harvested in each stand. The function b(H) values the harvest. If we limit harvest possibilities to clearcutting, then the valuation function becomes $P_t V(t)$, price times merchantable volume.

The harvest timing condition, expressed in continuous time, is given by;

$$\dot{P}_t V(T) + \dot{S}_t + P_t V'(T) + a_t(T) - i[P_t V(T) + S_t] = 0.$$

S_t represents the soil expectation value at time t. This is a more generalized version of the Faustmann solution.

The solution is sufficiently complex that few analytic conclusions are possible (Kaiser and norbury 1984). Bowes and Krutilla argue that the only even-flow steady state solution, if it exists, will involve rotations at the Hartman age. Further, multiple steady state solutions with cyclical steady state behavior in prices and harvests are possible. Simulation studies show that solutions are extremely sensitive to assumptions regarding prices, interest rates, and the initial distribution of stand ages. In some trials, if a forest has an initial endowment of mature timber, it will be optimal to save some. But, if the forest has no initial endowment of mature timber, it is not optimal to let any stand grow that long.

VALUATION OF NONTIMBER SERVICES

The application of theoretical models requires a manager to have a knowledge of values of nonpriced services of a standing forest. For example, the United States Forest Service uses estimates of average willingness to pay for its forest management planning (Kaiser and Norbury 1984). Methods that have been developed for deriving social values from forest production can be divided into five categories: opportunity cost, relative use value or intrinsic value, consumer expenditure, market value, and survey methods.

1. Opportunity Cost Method

This method has been used to try to value production opportunities. When evaluating the development of a site, the investment funds have an indefinite number of alternative uses. The opportunity cost is the returns that the capital or resources could produce if invested in any of the feasible opportunities, usually increased timber production. So far the Fedral Republic of Germany and Switzerland have been the most active using this approach (Gundermann 1981). Although the method does not indicate a benefit value, it does provide a baseline for comparing alternative investments.

2. Intrinsic Value Approach

Papanek (1981), in Czechoslovakia, developed a method using this approach, which employs quantitative and qualitative characteristics. Considering the resource productivity, suitability, and resource demands of a forest site, he analyzed the factors that influence timber production and other forest products including recreation. Factors considered also include production costs as well as those accepted by users. From these factors, a monetary value is awarded for each product and the forest site classified. The major problem with this approach is that it is relatively complicated and difficult for policy officials to follow and accept (Kaiser and Norbury 1984).

3. Consumer Expenditure Method

This approach is also severely limited to supplying only a baseline for comparison of projects. It attempts to measure the social value to the participant using dollars spent. This method has two major weaknesses. First, the gross expenditure does not measure the value of an additional opportunity to the consumer. Measuring only the gross change in expenditure gives no indication of how much the consumer is willing to pay for the product (Dwyer, Kelly, and Bowes 1977). A second weakness is that many expenditures may be ancillary to the actual use of the site.

To overcome some of these problems, a method was developed by researchers in North America using travel cost as a surrogate for price of recreaion opportunity (Clawson and Knetsch 1966). This method derives a demand function from differences in travel costs from different origins. For each origin, travel costs are incrementally increased and use estimated at each increment. A site demand curve is plotted using these estimates. Willingness to pay for the site is estimated by the area under this demand curve. The method's strengths include the fact that for each different location, recreationists face different prices and sites, actual behavior is used to place a value on benefits, and the method accounts for spatial differences in the market (Circchetti, Fisher, and Smith 1976).

Certain circumstances lend themselves to use of the travel cost method while other situations present problems. For the method to work, the following conditions should be met:

1) Sufficient variations in travel cost must exist among users,

2) the visits should be of single purpose, and

3) the changes being evaluated must be substantive enough to alter individuals' travel costs or number of visits at existing costs.

There are some weaknesses of the travel cost method. The method does not evaluate the effect of travel time and congestion on site benefits. Differences in user's income levels at varying origins also bias values. Using travel cost method where substitutes exist can lead to serious inaccuracies in predictions of use and estimates of benefits. Another weakness of travel cost method is that it evaluates only user benefits, thus excluding non-user benefits. At the same time, the analyst should evaluate any lost benefits resulting from site development.

4. Market Value Method

The market value method attempts to impute a value by comparing a proposed site with a comparable recreation site operated by private enterpreneuers. This method is conceptually logical, but it is, in reality, difficult or impossible to find similar sites and conditions. In addition, profit-oriented ventures are not often developed because of a large number of subsidized public facilities in many countries.

A notable study by Bishop and Heberlein (1979) utilized actual cash transactions to determine a market value for hunting permits. With an 80 percent response rate, willingness to sell hunting permits was determined to be $63 per permit for all hunters combined.

5. Survey Method

The survey method estimates site values by asking users a series of questions to determine their willingness to pay (or willingness to accept compensation) for use of a site. The technique uses a bidding game format requiring two surveys. The initial survey elicits the user's valuation of the area. Additional data are collected on variables that explain differences between individuals' valuations. An equation is developed that explains individual's willingness to pay or sell. Other users' valuations can be predicted from the equation if the values of the explaining variables are known for each user (Kaiser and Norbury 1984).

The survey method is most useful in instances when 1) the sites being evaluated are part of multiple destinations, 2) little changes in travel cost or number of visitors occur because of a small change in site quality, or 3) distances traveled or use is unknown (Dwyer, Kelly and Bowes 1977). However, this method assumes that consumers can assign accurate values and that a series of questions can accurately elicit value. The structure of the survey method may not meet these assumptions.

First, the consumers may not be able to assign values on the basis of description of hypothetical circumstances. This assignment is difficult because market prices for the opportunity generally do not exist (Bishop and Heberlein 1979). The availability of alternative uses also affects the value a user gives a site. The participant may not only have a difficulty identifying available alternatives, but also placing a value on such an alternative. (Kaiser and Norbury 1984).

Secondly, the interviewer must be certain that the repondent clearly understands the scale of the question. It should be clear to the respondent whether a question is evaluating a specific sits or the general availability of the opportunity over time (Kaiser and Norbury 1984).

The third bias in application of the survey method is the respondent's use of a game strategy. Two different incentives exist that distort responses. If people perceive that they will not actually have to pay and that their responses may influence the supply of a good, their responses may be what they would like to see done rather than how they would actually behave in the marketplace. Conversely, if they believe their responses will influence the fee charged, they may keep their responses lower than their actual value (Bishop and Heberlein 1979).

AN EMPIRICAL ANALYSIS: AN APPLICATION OF THE TRAVEL COST METHOD

The recreation demand for the Deogyu National Park was analysed by performing a field survey, and the recreational benefits were estimated by the Travel Cost Method. Among the 9,400 visitors to the Deogyu National Park during the 6 days randomly chosen from September 26 to October 10, 1982, 430 participants were selected for the questionaire survey.[1)]

The total demand curve for the Deogyu National Park was derived by plotting the visitors per population of each origin against the distance from the origin to the Park (See Figure 1). From this total

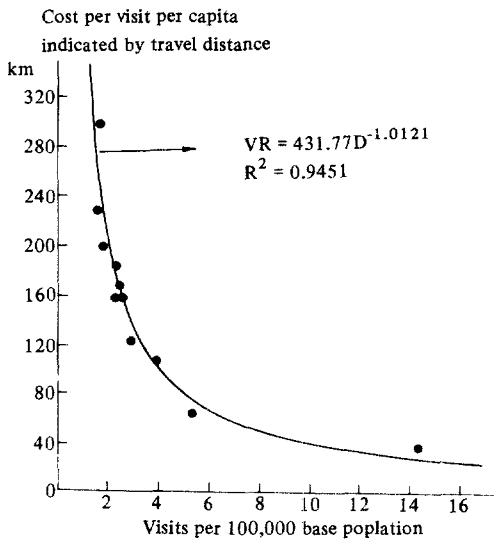

Fig. 1. Demand curve for whole recreation experience for Deogyu National Park

demand curve, the demand curve for the recreation resource was derived by plotting the changes in visitor per population against the marginal change in travel costs. The changes in travel distance were assumed to represent the changes in travel costs. The sum of each origin's demand for the Deogyu National Park can be considered as the demand for the recreation resources of the Park (See Figure 2).

The value of the recreation resources can be measured by the amount which the visitors are willing to pay for their recreation opporunity. This may be implicitly represented by the demand for the recreation resources. One way to approximate the value of the recreation resources is to measure the consumer's surplus. The consumer's surplus enjoyed by the users is represented by the area under the demand curve above the price.

The resource demand curve based on the survey is:

$$\log V = 4.0304 - 0.8167\Delta C$$

where V is visits under varying travel cost, and ΔC is marginal travel cost.

Integrating this resource demand curve gives

1) The detailed procedure and contents of questionaire are documented in the author's master thesis at the Seoul National University (1982).

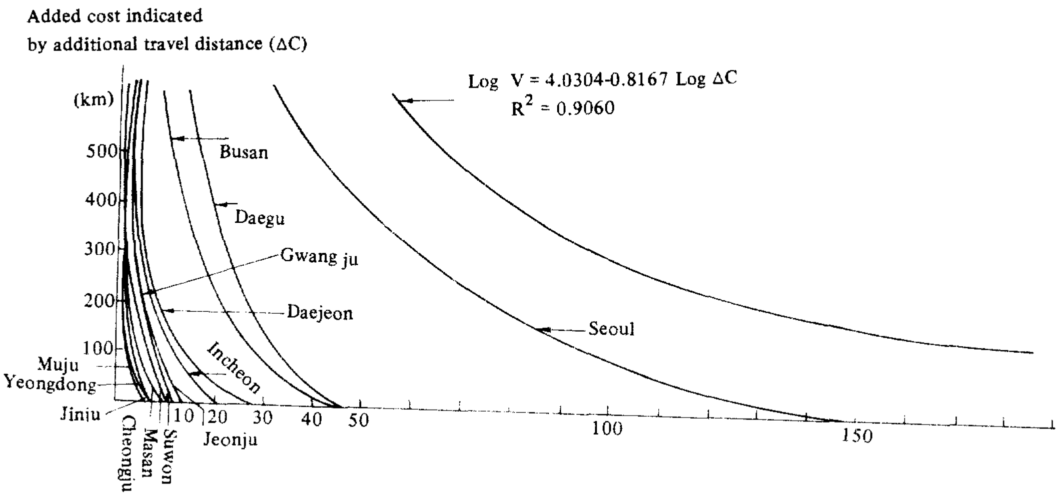

Fig. 2. Estimated visits under varying added costs, Deogyu National Park.

the total value of consumer's surplus. The value was estimated as 427,007 km. The feagure may be used as the basis of calculating the value of recreation resource by transforming the travel distance to monetary terms, and the number of vistors. For example, during the period of the survey, each visitor valued the recreational resources in the Deogyu National Park as equivalent to the cost of traveling 2,327 km.

CONCLUSION

As seen in the economic models of multiple use forestry, in order to manage the forest in an efficient manner, a forest manager needs to have a knowledge on the physical relationships among outputs as well as the estimates of nonpriced, social values of the standing forest. In determining the optimal harvest age, the social preference of time has a crucial role; what discounting rate should be used in multiple use forest investments. Due to the long period of time involved in forest production, any current management action will have a significant effect on the production capacity in the future. Thus, the unknown demand by future users should be concerned; forecasting the future demand for forest outputs is necessary for forest management planning.

These considerations give rise to the necessity of research on; 1) production functions of a forest for each output, 2) trade-off functions, or the relationships of the volume of one output to that of others, 3) determination of the values of each output, 4) measurement of the cost of inputs, and 5) time discounting preference of the users.

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LITERATURE CITED

1. Bioshop, R. C. 1979. Measuring value of extramarket goods: are indirect measures biased? American Journal of Agricultural Economics. 61(5): 926-930.
2. Black, P. 1963. Timber and water resource management. Forest Science 9(2): 137-145.
3. Bowes, M. D. and J. V. Krutilla. 1985. Multiple use management of public forest lands. In, Kneese, A.V. and J.L. Sweeny (eds.), Hand-

book of Natural Resources and Energy Economics, North-Holdand Publishing Co.

4. Calish, S., R. D. Fight, and D. E. Teeguarden. 1978. How do nontimber values affect douglas-fir rotation? Journal of Forestry 76(4): 217-221.
5. Cicchetti, C. J., A. C. Fisher, and V. K. Smith. 1976. An econometric evaluation of a generalized consumer measure: The Mineral King controversy. Econometrica 44(1): 1259-1276.
6. Clawson, M. and J. L. Knetsch. 1966. Economics of Outdoor Recreation. Baltimore: John Hopkins University Press.
7. Clawson, M. 1975. Forest for Whom and for What? Washington, D.C.: The Resource for the Future.
8. Dwyer, J. F., J. R. Kelly, and M. D. Bowes. 1977. Improved procedures for valuation of the contribution of recreation to national economic development. University of Illinois Water Resources Center Report No. 128, 218pp.
9. Gregory, G. R. 1955. An economic approach to multiple use. Forest Science 1(1): 6-13.
10. Gundermann, E. 1981. Evaluation of the recreation evaluation methods used in Western Europe. XVII IUFRO World Congress Proceeding, Division 4. pp. 513-518.
11. Hartman, R. 1976. The harvesting decision when a standing forest has value. Economic Inquiry Vol. 14, pp. 52-58.
12. Henderson, J. M. and R. E. Quant. 1980. Microeconomic Theory: A Mathemational Analysis. McGraw-Hill Book Co.
13. Kaiser, H. F. and F. L. Norbury. 1984. Multiple use of forest resources from the policy perspective. In, Papastavrou, A.C. et al. (eds), Policy Analysis for Foretry Development, Proceedings of the International Conference (IUFRO Division 4) held in Thesaloniki, Greece on August 27-31.
14. Lloyd, R. D. 1969. Ecnomics of multiple-use. In, Proceedings of a Conference on Multiple-Use of Southern Forests, held in Pine Moutain, Georgia, November.
15. Muhlenberg, N. 1964. A method for approximating forest multiple use optima. Forest Science 10(2): 209-212.
16. O'Connell, P.F. and H.E. Brown. 1972. Use of production functions to evaluate multiple use treatments on forested watershed. Water Resources Research Vol. 8, pp. 1188-1198.
17. Papanek, F. 1981. Forest function planning in Eastern Europe. XVII IUFRO World Congress Proceeding, Division 4. pp. 539-546.
18. Pearse, P.H. 1969. Toward a theory of multiple use: The case of recreation versus agriculture, Natural resources Journal Vol. 9, p. 562-575.
19. Pearosn. 1944. Multiple use in forestry. Journal of Forestry 42(4): 243-249.
20. Riiters, K., J. D. Brodie, and D. Hann. 1982. Dynamic programming for optimization of timber production and grazing in ponderosa pine. Forest Science 28, 517-526.
21. Saastomoinen, O. 1982. Economics of multiple use forestry in the Saariselka forest and feel area. Communicationes Instituti Forestalis Fenniae 104.
22. Samuelson, P. 1967. Economics of forestry in an evolving society. Economic Inquiry Vol. 14, pp. 466-492.
23. Teeguarden, D. E. 1982. Multiple Services. In, Duerr, W.A. et al (eds.), Forest Resource Management, Corvallis: Oregon State University Book Store.
24. The United States Congress. 1960. The Multiple-Use, Sustained-Yield Act.
25. Yeo Chang Youn. 1982. Studies on forest recreation demand and benefits of Deogyu National Park. Unpublished M.S. thesis, Seoul National University.