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CONSERVATION AND SUSTAINED YIELD

E. M. Gould, Jr.

The conservation movement in America has been called a house divided because although its members might be united in their concern over the future of civilization and the environment that supports it, they have seldom agreed on what was needed and how to do it. "By the turn of the century conservationists could be divided into two groups: those who favored a planned and scientific use of natural resources; and lovers of nature who wished to preserve the natural landscape unspoiled, as nearly as possible, by civilization." (Ekirch, 1963).

Foresters have been one of the most influential groups specifically trained to plan the long-run scientific use of a natural resource. Until recently they have had little sympathy with the idea that unspoiled nature could make a valued contribution to the quality of our civilization. The increasing use of forests for outdoor recreation, however, has brought this aspect of wild land use forcibly to the attention of forest administrators, so they are beginning to recognize that the intangibles sought after by "preservationists" may have practical validity in the operation of an affluent society.

In addition to this enforced involvement with amenities, a rather peculiar development in forest management theory promises to create more common ground between "conservationists" and "preservationists". Enough experience has now been accumulated with sustained yield forest management procedures to show that something is radically wrong with them, and the adaptations being proposed will probably be equally useful for rationalizing plans to meet the objectives of both wings of the conservation movement. If a theory of management capable of handling both tangible production goals and intangible amenity objectives should materialize, a new basis for united conservation action might be created.

A brief review of developments in forest management theory will help clarify the trend that gives hope for an accommodation within the ranks of conservation. Sustained yield forestry in its original form was based essentially on a biological model of timber production derived from the observation that trees, and the forest, are born, mature, and die. The first guiding principle was that the accumulation of useful wood in a forest gradually increased with age and then leveled off before the onset of senility. At some stage in maturation, production per acre would reach a peak; and harvesting done then would capture the greatest amount of timber. Thus the key to maximum wood productivity lay in judging the point when mean annual increment in a forest stand culminated and then using this as the rotation age.

The second guide to management, usually couples with rotation length, aimed at creating an even flow of harvested products over time. This constant supply was to be achieved by never cutting during any period a volume greater than was grown during the same period. This principle is analogous to the old New England idea of living off your interest and never dipping into capital. In this respect sustained yield fitted in nicely with popular notions of a thrifty and virtuous life.

If it is accepted that achieving maximum physical production, spread evenly over time, will generate the greatest human satisfaction, then sustained yield theory is admirably explicit about which forest facts to measure and how to respond to this information. The fully developed concept seems not only neat and consistent, but also deceptively simple to operate. About all that is required to achieve a stable balance with nature is for man to control himself, use his wits, and adjust his consumption of wood to what the forests produce.

If we think of the forest as a dynamic population of trees, then sustained yield shows how to manipulate this population by controlling the death rate. Of course, in practice this simplified model of biological reality had to be elaborated, because it turned out that the reproduction of harvested acres was not always automatic. As a minimum it became necessary to control the birth rate as well as the death rate. Because much of this birth control involved promoting the prompt establishment of favored species foresters had to adjust the composition of the forest population in early life, which suggested the desirability of continuing control into later life (Cline, 1929; Goodlett, 1960. Thus the door was opened to try increasing the growth of preferred individuals through control of the whole maturation process. The final result was the advocacy of intensive management so that forestry was equated to high level-sustained yield requiring the use of labor, capital, and organizational skill to control the birth, death, and maturation rates, along with the composition of the population of forest trees.

Any successful effort to apply this complex biological model of sustained yield required extensive knowledge of the natural processes at work in the forest. The information available to foresters at the turn of the century was simply not complete enough to provide the reliable control needed. It was soon discovered, at the Harvard Forest and elsewhere, that the results of many forest practices were sufficiently unpredictable to make any manager uncertain about the efficacy of his control measures.

This was the first fly in the ointment, and fifty years of research have been unable to remove it completely. The biological model of sustained yield could not be applied with certainty because scientific knowledge was too incomplete. Although this defect might be remedied in time, prudent men would meanwhile lay more flexible plans than the original theory contemplated, in order to avoid severe loss when things turned out other than as they expected.

If faulty information about regular biological processes had been the only source of uncertainty foresters had to cope with, the situation might have been tolerable. However, there still remained a whole series of irregular natural forces like fire, storm, insects and diseases that could periodically wreak havoc in the forest. Although damage is only occasionally disastrous, experience suggests that such losses can be pervasive enough to vitiate human efforts to closely control even the forest death rate.

The U. S. Forest Service estimates that nationally about a quarter of the annual drain on sawtimber is caused by uncontrolled natural forces. (U.S.D.A., 1958). Although this may be an acceptable level of slippage in forest plans if spread out evenly over the whole country, much of the loss is catastrophic in nature and concentrated in area. Thus too many individual forest holdings suffer unplanned losses frequently enough to cancel out human efforts to control their forest populations. The 1938 hurricane neutralized fifty years of management effort at the Harvard Forest, for instance, and research on the frequency of tropical storms suggests that there is at least a fifty - fifty chance of a similar performance in this century. No New England forest planner can safely ignore this possibility. (Gould, 1960).

An even more serious source of uncertainty in rationalizing sustained yield forest management is the long-term difficulty of reconciling a purely biological theory with the fluctuating character of man's needs. The technology used to process raw materials into a form that will satisfy human wants has changed radically as we have devised new and better means of conversion. New wants have also created new products (some would say, "and vice versa"), and the form of the raw material required has changed accordingly. Thus plywood, chip boards, and particle boards have invaded the lumber market; paper, plastic, and metal have almost completely displaced wood for containers. The net effect is to make any current standard for judging good quality trees a highly uncertain guide to future demand.

Local forest product markets have also been upset by advances in the field of transportation that bring distant supplies of wood into local competition. This trend seems likely to continue in the future, so that broader and broader areas must be taken into account in judging probable future supply against anticipated future needs.

In addition to technological changes in production requirements, our urbanizing and affluent society is making more diversified demands on forest land than ever before. Each new estimate shows that the supply of wood is more plentiful than before while the amenities that help make a productive life worthwhile are increasingly scarce.

(U.S.D.A., 1958; ORRC, 1962). Although the techniques for maintaining or creating outdoor recreation opportunities and attractive living space are not clear, these intangible values espoused by the "preservationists" seem to be rising in the scale of social preference.

All these factors -- imperfect biolgoical knowledge, rapid developments in the techniques of processing and distributing wood products, and the increasing importance of amenities and other forest values -- create too much uncertainty about the future for prudent forest managers to ignore. It seems obvious that even a complex biological theory of sustained yield is an inadequate model of the world in which foresters actually work. If we are to make "wise use" of our woodlands foresters need a conceptual framework that is closer to reality, one that accords a central role to man's technical ingenuity; and this frame of reference must be coupled with a theory of planning that will enlarge his capacity to rationally cope with pervasive uncertainty.

Foresters and conservationists interested in the rational use of wild land may get several clues to success from our long experience with farm land. Perhaps the most significant fact is that in farming we have come up with no single plan of action that is suitable for the myriad individual situations found in the real world. No single prescription can be applied across the board or for a very long time, not only because resources and objectives vary significantly, but also because the general situation is too fluid and our understanding too imperfect. Relevant problems and possibilities develop so fast that the most promising alternative to simply drifting from day to day seems to be planning -- planning undertaken not to create a single master plan to which all must conform, but rather a process engaged in on a continuing basis to weigh emerging ends and means rationally, and to adapt current operations to cope with our evolving concepts of man and his environment.

The way specific farm problems have been handled also has some significance for forestry. It is likely that the major step toward improving the biological base that supports today's phenominal food production rates was made in prehistoric times when people first brought plants together for cultivation instead of gathering wild crops. Concentrating plants in one place set the stage for men to watch growth throughout the annual life cycle, thus beginning an endless series of observations that built up a folklore about production processes. Modern agricultural research has been able to make tremendous strides toward removing uncertainty about farm production because a critical mass of information was accumulated by tinkering with and hungrily watching more than 2,000 generations of wheat and other crops since Cato the Elder wrote <u>De Agricultura.</u>

By way of contrast, in the same period only about twenty generations of trees have passed, and only two or three have been studied with much interest. Although systematic research can considerably speed our accumulation of knowledge it is likely that foresters should plan to cope with inadequate biological information for some time to come.

The chance to learn about plants and animals, and thus improve agricultural production, is only part of the story behind present progress, however. The move toward cultivation and the obvious gains to be had from more intensive management of the biological populations involved could only be realized if the human civilization surrounding agriculture was developed at the same time. Thus man had to learn about his own nature, and experiment with methods of organizing his efforts by creating such social institutions as ownership and tenure, exchange and marketing systems, distributing and processing facilities, credit institutions, procedures for disseminating knowledge, and the like.

Evidence supporting the need for coordinated application of both the natural and social sciences to agriculture is plain throughout the world. Progress toward a better diet in India, for instance, is probably not impeded as much by lack of biological knowledge as is by difficulty in changing social institutions ill-suited to modern technology. History records our long experience with a wide variety of human institutions, and our inventiveness has not yet exhausted the possible adjustments that will facilitate production on the land and also channel social change so that uncertainty about the future will be reduced.

Compared to agriculturists, foresters have attempted rather minor institutional changes, and most of these have merely affected the amount of land in public ownership. This restraint flows in part from preoccupation with a theory of sustained yield forestry that focuses on adjustments in land management as the primary means available for acheiving production goals. A broader concept of forestry might suggest greater scope for management, as it has in agriculture.

Although, as the name implies, agriculture was originally concerned primarily with production on the land, the field has gradually been expanded to include the activities of processing and distribution that connect the farmer and the consumer. A galaxy of associated activities like credit, education, and research have also been recognized as additional parts of what might be called an agricultural system. Awareness of the interrelated nature and full extent of this system has helped men find solutions to many specific problems. Thus we have been able largely to control deleterious erosion on farms through the S.C.S., and improve the economy of production and the level of farm living by other specific programs.

This ad hoc, but partially coordinated, approach to problems has built an American agricultural system that is the most productive the world has ever seen. It has all been done without any serious threat to the future productivity of the land, in fact there seems little reason to expect anything but further increases in abundance. In effect, "sustained yield" of farm products has been achieved by continually tinkering with whatever part of the agricultural system seems likely to respond and alleviate the problem of the moment. On the whole, this method of searching for working solutions to parts of the overall problem has been very successful in dealing with the uncertainties inherent in the system.

Foresters might take their cue from agriculture and visualize the scope of their legitimate interests as embracing a whole system of related events that starts with the biological activities of production on the land and only ends when human wants have been satisfied. Adopting such a broad conceptual framework for forestry will first of all help point up problems that should be given urgent attention, and suggest the part of the forestry system which, if changed, is most likely to produce early and satisfactory results. A typical problem of the moment is the rising cost of lumber and the increasing inaccessibility of high quality sawtimber. At the same time the total volume of wood is increasing, but most of it is in trees of low quality because their size, form, or species are not suitable for present milling technology. Silvicultural change of these tree characteristics will take a long time, but a manufacturing technique is already available for cutting or chipping this wood into small standard pieces and gluing these into forms so engineered that they could largely replace lumber in a short time.

A move in this direction could do away with incipient shortages for decades to come, and reduce transportation costs because suitable raw materials are available near population centers. But to gain the full efficiency promised by such a technical breakthrough will require coordinated changes in other parts of the forestry system. To realize all possible economies a method of mass producing component housing parts will have to be coupled with construction procedures that tailor these parts to the varied needs of consumers. Changes will also be needed in trade union attitudes, local building codes, financing schemes, and other institutional parts of the forest system that might inhibit lowering the cost of housing to consumers.

Along with a broad enough view of the scope of forestry to identify relevant problem areas, managers need a method of planning that will help them search for solutions. As previously stated, the uncertainties of the real world seem to call for a stream of management decisions designed to cope with the unfolding situation, rather than a single rigid plan of action. Foresters need to respond readily to new information about ends and means in a variety of ways that will take full advantage of the possibilities revealed by the social as well as the natural sciences.

Many of the analytical procedures developed by operations research promise to help forest managers handle the technical phases of a continous planning process. Once forestry is defined as a broad system of activities, relevant data can be analyzed rapidly to give managers a better information base for decisions than has been possible heretofore. In addition, the more elaborate analyses made possible by computers can more clearly define the residual uncertainties attached to each solution so that managers can more effectively concentrate on this facet of decision making.

Although managers can devise plans that are flexible enough to meet unforseen contingencies, it is axiomatic that this flexibility always entails some cost -- either in direct outlay, or in reduced achievement if the unplanned event does not materialize. Foresters, in common with other resource managers, must make a subjective evaluation of the relative losses and gains of flexibility. People go through this process every day in balancing the likelihood that they will need insurance against their capacity to carry the premiums.

Making difficult judgments of this kind, that involve uncertainty about the future, entails subjective evaluation of intangible possibilities. Considerations of this nature are little different from assigning a fair and proper weight to the subjective values inherent in wilderness, an attractive landscape, natural areas, and the other objectives of the "preservationists". It seems likely that a continuous planning process that improves the capacity of forest managers to cope with uncertainty will at the same time improve their facility to integrate and compare amenity values and product values. If this theory develops, forestry based on multiple working hypotheses may be able to play a central role in promoting rational conservation in all facets of our environment.

Literature Cited

Cline, A. C. Forest Weeding. Massachusetts Forestry Association, Boston, 1929.

Ekirch, A. A. Jr. Man and Nature in America. Columbia University Press, New York, 1963

Goodlett, J. C. The Development of Site Concepts at the Harvard Forest and Their Impact Upon Management Policy. Harvard Forest Bulletin Nc. 28. Petersham, 1960.

Gould, E. M. Jr. Fifty Years of Management at the Harvard Forest. Harvard Forest Bulletin No. 29. Petersham, 1960.

Outdoor Recreation Resources Review Commission. Reports. Washington, 1962

U. S. Department of Agriculture. Forest Service. Timber Resources for America's Future. Washington, 1958.