THE EVALUATION OF WILD ENVIRONMENTS IN ZIMBABWE : A LITERATURE REVIEW

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This paper is a synthesis of major international experience in the conservation of natural resources which has had little exposure in Zimbabwe but which has important implications as far as the future of this country, and indeed the world, is concerned. Comprehension of this knowledge is a prerequisite to the imperative changes in our economic view of man and his world which must come about if our society is to avoid the apocalypse.

The study of economics of natural resources was intimately mingled with that of economics in general until the middle of this century. Natural resource economics emerged fully as a sub-discipline of economics with the publication, in 1963, of Scarcity and Growth : The Economics of Natural Resource Availability (Barnett and Morse, 1963). This seminal work was researched and written in that marvellously optimistic era following the Second World War when advances in technology were taking place at a rate previously inconceivable. Barnett and Morse (1963) interpreting the spirit of their time, wrote

> "The traditional concerns of conservation economics - the husbanding of natural resource stocks for the use of future generations - may now be outmoded by advances in technology."

While known resources were being depleted, technology was making available increasing supplies of either previously non-economic resources or of completely new resources. The distinction between exhaustible and renewable resources was blurring, with technology emerging as the ultimate 'renewing' resource (Barnett and Morse, 1963). Scarcity and Growth was the first major comprehensive survey of the theory and data pertaining to natural resource use. The conclusions outlined above reinforced a similar position advocated by Schultz some ten years previously (Schultz, 1951) and Scarcity and Growth has been remarkable both for its intellectual contribution to the literature and for its influence on the resource economics profession (Krutilla, 1977).

The era was not without its non-conformists and dissidents. In the agricultural sphere, Rachel Carson's Silent Spring (1962) had a profound influence both on agricultural scientists and on the emerging study of ecology. In the economics literature, Galbraith's The Affluent Society (1958) and Boulding's "The Economics of the Coming Spaceship Earth" (1966) remain classics to this day. It was Boulding, (1966), who defined the major problem of our time; that of the need to face, and adjust to, the realities of a 'closed' economy.

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> "The closed earth of the future requires economic principles which are somewhat different from those of the open earth of the past ... [The open economy is characterised by] the illimitable plains .. associated with reckless, exploitative, romantic and violent behaviour ... The closed economy [on the other hand is one] in which the earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution, and in which, therefore, man must find his place in a cyclical ecological system ... The difference between the two types of economy becomes most apparent in the attitude towards consumption. In the [open] economy ... the success of the economy is measured by the amount of throughput from the factors of production ... By contrast, in the [closed] economy, throughput is by no means a desiderata and is indeed to be regarded as something to be minimised rather than maximised."

Boulding's closed earth is a unique and characteristic feature of the twentieth century and is the result of two phenomena in particular. Firstly, advances in hygiene and nutrition have pointed the way to the rapidly expanding human population of our time. Secondly, the end has come to what Walter Prescott Webb (1952) in his book The Great Frontier refers to as the 400-year boom in modern history. The boom was the result of European expansion into the Americas, Africa and Australasia:

> "When this great area was made available to the crowded and impoverished people of the Metropolis [by which he means Western Europe], they swarmed out like bees to suck up the nectar of the wealth, much of which they brought home to the mother hive. This sudden, continuing and ever-increasing flood of wealth precipitated on the Metropolis a business boom such as the world had never known before and probably can never know again."

Today our problem is that the economic growth which fueled the development of so much of the world is no longer, in itself, the key to the future prospects. In the 400-year boom just ended, economic growth has provided the solution to most of human economic welfare problems and consequently our institutions and our society are orientated towards the promotion of growth policies (Kelso, 1977). Our values and institutions of democracy, capitalism, private property and free competition have emerged from, and are consistent with, a boom era where nature's resources and dumps were regarded as infinite. In the land and environment-scarce world of the late twentieth century, the penetrating insights

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of Mill, a century ago (Mill (1865) 1965) as amplified by Galbraith and Boulding in this century, take on a new relevance. Where we are forced to live a limited and closed system, there are dangerous shortcomings in private ownership of, and competition for, the resources of nature. Economic growth, as a goal in itself, can become a danger and, on a world scale, an impossibility. Economic growth in one region simply robs another of its birthright. It is this issue which forms the kernel of the current dispute over resources and income distribution between the nations of the Northern and Southern hemispheres.

In Zimbabwe, political changes have brought us, after years of government policies apparently aimed at ignoring or shelving the difficulty, squarely to face with the problems of land scarcity. Land reform and redistribution are clearly important policies for the immediate future but simple mathematics involving available land area, population size and population growth must surely indicate that the answer lies elsewhere. Of the three prime facets of the economic growth policies of the last 400 years, industrialisation, emigration and exploitation of indigenous and foreign natural resources, only the options of industrialisation and local resource consumption remain to any significant extent. Zimbabwe must grow and develop, of that there can be no question. The need is to discover the institutions and methodologies for the development of Zimbabwe that truly reflect the realities of the closed system within which both the current generation, and those which follow, must live. On the institutional aspect, time does not permit a full discussion. I must resort again to quotation, this time from Kelso (1977):

> "Maximisation of the state of well-being of the society often requires a 'monopoly solution' of the natural resources problem.
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> Since monopolisation of natural resources by private individuals is politically unthinkable given our present social values, such monopoly solutions require collectivization solutions that range from private collectives such as co-operatives to quasi-public and truly governmental monopolies ... Rather than the perfect competition of conventional economic wisdom, natural resource problems often require the opposite - broadened collectivist, monopolistic solutions."

The modification of our legal, social, land tenure and other institutional systems is clearly a priority task and Zimbabwe is indeed fortunate in that it is moving toward a favourable political climate in which needed change can evolve. It is the methodological rather than the institutional aspects of development that form the substance of the

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remainder of this paper.

The concern for putting the environment to its best use goes well back into history. Many of the simple societies of this planet, from the Bushmen of the Kalahari to the crofters of St. Kilda, evolved sophisticated survival systems based on the skilled and sustained use of environmental resources. In modern times, national parks were established in the United States soon after the appearance of Mill's Principles of Political Economy. This model has subsequently been copied in many other parts of the world, including our own (Fisher & Petersen, 1976). But beyond this very important and significant step in preserving certain environments as national parks for the enjoyment of present and future generations, little attention, either nationally or internationally, has been paid to natural resources policy.

In this last field, the United States is the leader, albeit a rather reluctant one. Its role largely results from the vast land and resource holdings of the federal government. The U.S. Bureau of Land Management and the U.S. Forest Service administer about 650 million acres, making them amongst the largest of the world's public enterprises (Krutilla & Fisher, 1975, p.5) These land and resource holdings have been, and are, subject to increasing and conflicting demands on their use but it was not until 1964 that an attempt to resolve the complex issues involved was made. The Public Land Law Review Commission was established and reported, as follows, some six years later:

> "Although Congress has established goals in the statutes setting aside and providing for the administration of national parks, wilderness areas and wildlife refuges, it has not provided adequate goals for lands not having a clearly defined primary purpose. It is on these lands, primarily those managed by the Forest Service and the Bureau of Land Management, that the absence of goals has led to major problems." (1970, p.42).

However, as Krutilla & Fisher (1975) observe, the problem is not one of an absence of goals. Rather it is the lack of a procedure for the evaluation of the relative worth of competing goals, or combinations of goals, to which an area of the environment may be dedicated. It is to the techniques, and their limitations, that are and can be employed in policy analysis that the discussion now turns.

Economic analysis in development or project evaluation has a long and mixed history. The constitution of the state of Vermont, for example, requires explicitly that the benefits from the monies to be levied and expended be demonstrated to

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exceed the costs (Margolis, 1959). The practical procedures of modern cost-benefit analysis are without the scope of this paper but can be found in any one of the numerous texts on the subject (e.g. Little & Mirrlees, 1974). The objective here is to highlight the limitations of cost-benefit analysis, in situations where one use of an area is permanently and irrevocably destructive of other valuable or potentially valuable uses. Strip mining of an area of land may render the land permanently unsuitable for agriculture, recreation or other uses. In such instances, it is necessary to balance the net economic gains consequent on the mining activity against the opportunities of alternative uses foregone. It is certain that data needed to evaluate certain forms of land use will be difficult to acquire. The need therefore is to develop valid analytical procedures which can yield meaningful results in situations where data are limited. Such procedures are particularly necessary when one potential form of land use of an area is that of leaving it in its natural state.

Cost-benefit analysis, as currently applied by development agencies, starts from the premise that wilderness, wildlands and 'unimproved resources' have no value. Ely and Wehrwein, for example, write "while land as nature has no cost of production, land is not a factor of production, or even a consumption good until it has been modified or 'produced'" (1940, p 144). Nash (1967, pp 40-43) writing of the American wilderness, shows that in seventeenth and eighteenth century America, wilderness had a negative value in the minds of Americans, and that this view largely persists into the present day. A similar attitude is also the conventional wisdom in Zimbabwe.

Following directly from the belief that land in its natural state has no value, is the lack of recognition of opportunity costs in the form of amenity services precluded by the development of wildlands (Krutilla & Fisher, 1975). Where, as in past centuries, Zimbabwe consisted of small pockets of developed lands surrounded by vast tracts of wilderness, a zero, or near zero, value, at the margin, of wildlands was appropriate. This no longer holds true in the Zimbabwe of 1980, where National Parks and undeveloped forest and safari areas occupy a relatively small fraction of our total land area. The measurement of the value of preservation is a difficult task and, to date, the issue has largely been dodged by economists, policy-makers and legislators. In place of scientific analytical procedures, sentiment has reigned. Ambiguous statements urging the preservation of our 'national heritage' and the need to follow sustained yield policies without adequate definition of what these terms imply, have passed the responsibility for choosing between alternative development paths to the resource

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manager and the planner. These individuals, operating in the hard world of economic reality, have little choice but to use conventional cost-benefit procedures. Given that these procedures, as currently applied, are deficient with respect to the evaluation of the costs and benefits of preservation, it is hardly surprising that wildlands get short shrift. Sentiment invariably loses to economics in the longer term.

The practice of cost-benefit analysis suffers from two primary limitations (Krutilla, 1975). Firstly, for extensive, long-lived investments there is the formidable and exacting task of projecting the physical and human consequences of the proposed development. Frequently the agency responsible for implementing the project is also charged with preparing the project evaluation. Inevitably, there will be an institutional bias towards development. Krutilla (1975) writes:-

> "Other evidence exists in the general practice of the assiduous search for benefits, but the apparent occupationally induced myopia in perceiving costs. For example, take the widespread calculation of secondary benefits that was relied on to add something to the benefit total when primary benefits fell below the corresponding costs. This was done without apparently recognising that there were corresponding secondary costs - the secondary costs were completely neglected in the evaluations."

The second limitation of cost-benefit analysis lies in the tendency of analysts to concentrate on 'intermediate' rather than final goods produced from the project. For example, the primary output from a hydro-electric project is electricity, an intermediate good in the production of final capital or consumption items. The consumer of a given final product can be regarded as largely indifferent as to whether the energy used to produce the product came from hydro, thermal or nuclear sources. On the other hand, the consumer of the natural environment now drowned by the hydro lake may well be hard placed to find a satisfactory substitute.

> "The significance of final consumption services that are both incidentally provided, such as water based outdoor recreation on new impoundments, or destroyed, such as recreational activity supported by a free flowing stream or the peculiar habitat provided by the site inundated by the reservoir, where winter habitat is a limiting factor, appear not to have received the kind of attention accorded the intermediate goods purposes of development" (Krutilla, 1975).

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Development planning, should account, not only for the flow of services that result from the proposed development but also for those consequent on leaving the land in its natural state. The procedures for estimating the economic value of development activities in agriculture, forestry, mining and water development, are well established; those for estimating the amenity value of tracts of land are, if as yet incomplete, available and practical. They have, however, been little used outside the United States (see, for example, Clawson, 1959; Davis, 1963; Krutilla & Fisher, 1975).

This last fact is of some consequence since the recreational industries in a developed nation such as the United States are significantly different in purpose and emphasis from those in poorer countries. The methodologies developed in the United States cannot, therefore, be transplanted unaltered to Zimbabwe but require appropriate modifications to ensure they cater for local conditions and objectives. Of particular importance is the distorting effect that recreational industries based mainly on overseas visitors have on the local economy. Care must be taken in the analysis of a natural environment to ensure that environmental preservation does not lead to the cultural destruction so apparent in many of the small island nations of the Caribbean and Pacific.

With the above reservation in mind, it is neither sensible, nor tolerable, to fail to evaluate properly the preservation option in a world in which land, and in turn natural environments, are becoming scarce resources. While the development of technology may lead to the use of substances as natural resources that at present are of no or little value, the destruction of a natural environment, by such activities as mining, agriculture, or hydro development, is irreversible. We have a total stock of wildlands that have evolved through geological time i.e. each one we modify is lost forever. Certainly, modern transport has meant greater access to wild areas that previously were effectively closed to all but local inhabitants. However, the total stock of wildlands has not, and cannot be, increased by modern technology unless such artificial creations as Disneyland are considered to be adequate substitutes for lost natural environments.

The wildlands of the world, and of Zimbabwe, represent an asset in increasingly limited supply and for which demand can be expected to rise in line with improvements in per capita incomes. In the United States, wilderness recreation and recreation in undeveloped natural areas is the most rapidly growing outdoor activity. The rate of increase has been

in the order of 10 per cent annually over the past several decades without evidence of slackening (Stankey, 1972). There seems no reason to suppose that Zimbabweans, with increasing wealth and education, will not also demand access to the wild places of their heritage. It will be a tragedy for the future generations of this nation should these habitats have been unnecessarily destroyed in the cause of short-term economic gains. Decisions taken today which lead to major impacts on our future welfare or the welfare of future generations are taken under conditions of uncertainty. A 'right' decision cannot be guaranteed. However, when today's decision closes in perpetuity an option for the future, it is the duty of the current generation as trustees of the future to ensure the judgement should not be made lightly.

The matter of irreversibility is of such moment that some further emphasis may be in order, particularly as some find it an elusive concept. The concern here is with those decisions which are irreversible for society as a whole rather than those which are irreversible for individuals and in the short term. Consider, for example, a farmer who is in the process of choosing between market gardening and dairy production. In either case his decision must be taken in an environment of uncertain future prices, yields and weather conditions, and will result in an investment in appropriate capital facilities. Should, to his regret, his choice prove in time to have been incorrect, financial considerations may dictate that he has no option but to live with his decision. In the short term, his decision is fixed. While the consequences of the decision as far as the individual is concerned, are neither ephemeral nor trivial, they are of no great moment to society. In the long term, either that farmer, or his successor, can switch to the more appropriate production process. The land and its improvements are not irrevocably locked into a single option. The decision may be irreversible from the perspective of the individual, but society has not lost the option of future changes.

In biological terms, this situation is analogous to the loss of a single breeding pair of birds. While irreversible and of obvious concern to the deceased, it makes little difference to the welfare of society as long as the reproductive capability is retained within the population. However, the demise of the last viable breeding pair is a matter of far greater moment to society and represents a totally irreversible situation. Similarly, a misjudged investment decision, which involves the loss in perpetuity of a natural environment, results in the reduction of the options

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available to society and in a permanent welfare loss. (Fisher & Krutilla, 1974).

The discussion thus far leads naturally into consideration of the timing of any investment decision. In simple terms, conventional economic analysis is concerned with the efficient use of resources, efficiency being determined by the market for goods and services. Market exchange, with each participant pursuing his or her own private interest, is believed to lead to what is termed a 'Pareto' optimum. At this optimum, no one can become better off without someone else becoming worse. All 'slack' in the economy has been taken up and all resources are being put to the use to which society attaches the highest value (Kneese, 1976). In practice, the efficiency criterion is relaxed to permit changes that help some, even at the expense of others, as long as the gainers could (but not necessarily do) compensate the losers (Kaldor, 1939).

In development, the gainers tend to be the present generation and, in any case, today's decision-makers are placed in the difficult position of being arbiters for future generations. The evaluation of any project will depend on how it is perceived relative to some point in time. Cost-benefit analysis is a 'present-orientated' technique. Future costs and benefits are first of all listed, as discussed above, and then discounted to give a value for the project in 'present value' terms, to the present. The result is that costs and benefits further in the future are regarded as less valuable than those in the near future. While conservationists may be uneasy about this procedure, economists observe that this accords directly with the way people behave and value things (Page, 1977, p.146).

Fundamental to discounting is the choice of the appropriate discount rate. The higher the discount rate, the lower the value attributed to future costs and benefits. Concern with the welfare effects of inappropriate discounting dates back to Pigou's Economics of Welfare, published in 1932:

> "It is the clear duty of Government, which is the trustee for unborn generations as well as for its present citizens to watch over, and if need be, by legislative enactment, to defend, the exhaustible natural resources of the country from rash and reckless spoliation. How far it should, itself, either out of taxes, or out of state loans, or by the device of guaranteed interest, press resources into undertaking from which the business community, if left to itself, would hold aloof, is a more difficult problem. Plainly, if we assume adequate competence on the part of governments, there is a valid case for some artificial encouragement to

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investment, particularly to investments the returns from which will only begin to appear after the lapse of many years."

Projects with long lives and with benefits and costs realised at different times are highly sensitive to the choice of discount rate. For example, raising the discount rate used by the U.S. Army Corps of Engineers in 1962 from $2\frac{5}{8}$ percent to 8 percent would have resulted in a reduction by 80 percent in the number the dam projects approved that year (Ferejohn, 1972). Ideally, economists would like to use clearly defined discount rate which reflects the time preferences of the future as well as present generations. Such a rate, known as the social time preference rate is easier to posit than quantify and, indeed, may be impossible to define satisfactorily (Baumol, 1968).

The literature on discounting is vast and to a large extent theoretical rather than practical (see Ramsey, 1928; Pigou, 1932; Eckstein, 1958; Krutilla & Eckstein, 1958; Hirshliefer, 1961; Samuelson, 1964; Baumol, 1968, 1969; Arrow & Lind, 1970). However, the clear theme that runs through this debate, which continues inconclusively after half a century of academic effort, is that straightforward discounting inevitably favours the present generation and those projects which give early rather than long-term benefits. Project analysis, using conventional techniques, favours the short-term economic gain of the present generation; it suffers from what Pigou (1932, pp 24 - 27) terms a "defective telescopic faculty".

The problem of satisfactory discounting remains complex, although not insoluble. The discount rate presumably is related in some manner to the current market rate of interest. Hence there is a starting point from which an appropriate discount rate may be found. A low discount rate allows greater weight to be given to costs and benefits. However, it also will stimulate investment generally, leading to a more rapid depletion of exhaustible resources (Scott, 1955). On the other hand, we can expect that the commodity value of a development, say a hydro dam, and the amenity value of the preserved area to alter both relatively and absolutely over time. The value of hydro-electricity will be affected by future technological developments in thermal and solar power, energy transmission, mining techniques and other areas of applied science. The benefits from such a development can be expected to fall over time. Conversely, as we have seen, the amenity value of the unique area to be drowned by the dam can be expected to increase in time; this is a function of such factors as population size, per capita income and education. It would be reasonable, therefore, to use a different discount rate for the

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development as opposed to the preservation option. The difference in rates is arrived at, not through any arbitrary manipulation of the base discount rate, but rather through reasoned consideration of the expected changes over time in relative values. It may be this result that Pigou sought in his concern for the protection of limited resources of increasing scarcity value (Krutilla & Fisher, 1975).

Consideration of the discount rate, and its appropriate role in project analysis, leads directly to two other issues with respect to intertemporal exchange for which space permits only a brief discussion. The first concerns a development involving a depleting or depreciating resource. As the present value criterion slides through time, future generations are likely to value the development less. If the cost-benefit analysis of a hydro dam built today was repeated, say 50 years hence, 50 years of benefits would have passed and would not be included in the analysis. On the other hand, the amenity value of the destroyed resource may have increased.

> "Consideration of a concrete example, the construction of a dam and reservoir in the Hetch Hetchy Valley in Yosemite National Park, back in 1914, may clarify this point. Hetch Hetchy, which was considered by John Muir and others to be as fully a natural phenomenon as the lower Yosemite Valley, was flooded to provide water for the city of San Francisco. Given the dwindling supply of unspoiled environment as remarkable as Hetch Hetchy, it is not surprising that many people now wish it were possible to have the valley back in its natural state. They might be indeed willing to give some of their (greater) material wealth in exchange for a preserved Hetch Hetchy. Were it possible for them to compensate the water users of San Francisco in 1914, in addition to any who would prefer the dam today, they might choose to do so." (Krutilla & Fisher, 1979, p.69).

Where a development involves the irreversible destruction of a scarce amenity resource, and where future demand for the amenity is uncertain, there may be a significant benefit in retaining the option to utilize the amenity in the future. This benefit is referred to as the 'option value', and ideally should be included in the policy analysis. (Weisbrod, 1964, Cichett & Freeman, 1971).

I have attompted, thus far, to provide a review of the economic theory on which economic analysis of policy impacts in a closed economy needs be based. Necessarily the survey has been brief but the literature is comprehensively referenced for those that wish to pursue the theoretical aspects in

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greater depth. However, as an applied economist, my interest is in practice as much as in theory and the remainder of this paper is devoted to a brief summary of one instance of a policy impact analysis in practice. The example selected is that of the Hells Canyon case. This was analysed by Resources for the Future (RFF) for the Federal Power Commission in 1969 and reported in Krutilla & Fisher (1975, pp 84 - 150). The reasons for selecting this case from the multitude of environmental suits that have been brought in recent years can be summarised as follows:

1. The analysis was done as a 'Friend of the Commission' and not on behalf of either of the opposing sides.

2. The analysts concerned are respected resource economists and their study was based on explicit economic models and data analysis. Their findings have subsequently been widely reported in both legal and economic circles.

3. The case illustrates many of the theoretical points made previously in this paper.

4. Although the study was completed before both the passing of National Environmental Protection Act and the recent rise in energy costs, it remains valid even under the changed conditions of the 1980's.

5. The arguments presented for preservation were both accepted by the court at the time and subsequently have turned out to be valid in practice.

The lower Snake River lies between Oregon and Idaho where it passes through 200 miles in impressive geological formation known as Hells Canyon. The river, along this stretch, is one of the most scenic in the United States but also presents a series of ideal sites for hydro-electric development. The 1969 Hells Canyon case was concerned with three sites in particular, the sites being known as High Mountain Sheep, Mountain Sheep and Pleasant Valley. There were, by this stage, several hydro dams lower down on the river, and the issue to be resolved before a hearing of the Federal Power Commission, at the request of the U.S. Secretary for the Interior, was whether preservation of the reaches of the river was more in the public interest than the proposed development.

The strategy followed by the RFF team was firstly to conduct a conventional cost-benefit analysis of the development alternatives, taking thorough care to ensure that all costs and benefits were accounted for and were valid. Only if,

after this exercise, should one or more of the alternatives show a positive net value, would the more difficult evaluation of environmental opportunity costs be undertaken.

The first step of revising the cost-benefit analysis prepared by the developers resulted in the elimination, solely on economic efficiency grounds, of the Mountain Sheep and Pleasant Valley dams. The recreational benefits from these two dams had been grossly overestimated and no account had been taken of costs resulting from the diversion of visitors from existing, but under-utilized lakes lower on the Snake River. Consequently the original analysis had to be reworked excluding the separable benefits of recreation and the costs of recreation and related access facilities. The development then depended entirely on its value as a power facility. Further investigation revealed other errors in the initial analysis. No account had been taken of the fact that the hydro scheme was ultimately to form part of a thermal-hydro complex. Conventional hydro-electric evaluation procedures account for the expected gain in value due to technological advances of the thermal component in a mixed hydro-thermal system (Federal Power Commission, 1968). This adjustment had not been made, presumably as an oversight since the system was, in the early years, to be almost entirely hydro.

> "At a discount rate of 0.09 and an assumed rate of technical progress of 0.04/year, the failure to take technical change into account results in an overstatement of gross power benefits of approximately 7.5 per cent ... [or] an under-statement of the real costs of the hydro amounting to a present value of $18,770,000". (Krutilla & Fisher, 1975, pp 101-102)

The Mountain Sheep and Pleasant Valley dams could be shown to be non-economic using standard cost-benefit procedures under conditions of rigorous data analysis.

The High Mountain Sheep dam, however, showed a small positive net present value at discount rates between 8 and 10 percent. In this instance, a simulation model was constructed to mimic the expected recreational benefits from the area. This model took into account changes in demand as a result of expected future incomes and tastes, population growth patterns both locally and nationally and the carrying capacity of the area as a wilderness recreation area (it was assumed that once this carrying capacity had been reached, it would not be exceeded). Not surprisingly, all the data necessary for the model were not available and estimates, based on what data could be found, had to be made. In recognition of this, the model was tested for its sensitivity to changes

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in the key input variables. Krutilla & Fisher (1975, p.141) report:

> "While we have had to work with rather poor empirical data in some instances, the insensitivity of the outcome to rather large potential errors in some of the variables provides some reassurance in the case at hand. There is nothing in the results of analysis, whether immediate or final, that produces implausible results in any of the tests we were able to devise."

The model output was designed to answer the question, "what is the value of the initial year's benefits that would be required in order to equal the value of development benefits?" The solution to this problem is obtained by dividing the present value of a dollar's worth of initial year's preservation benefits (growing at the variable rate a_t and discounted at the rate i) into the net present value of the High Mountain Sheep project.

Formally this may be presented as:

$$b_o^P = \frac{\sum_{t=1}^{T} b_c^d (1+i)^{-t} (1+r)^{-t} - \left[C + \sum_{t=1}^{T^1} O_t^d (1+i)^{-t} \right]}{\sum_{t=1}^{T} b_o^{1P} (1+\bar{a})^{t} (1+i)^{-t}}$$

where:

b_o^P = the amount of initial year's preservation benefits growing at $\bar{a}$ and discounted at i, required for present value of preservation to equal present value of developmental benefits.

b_o^d = the initial annual benefits from development

C = the investment cost (including interest during construction)

O_t^d = the annual operating and maintenance costs

b_o^{1P} = one dollar's worth of initial year's presentation benefits

i = a constant discount rate

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r = a simplified representation of the combined effect of benefit change due to change in the role of the facility in the power system and the rate of benefit erosion due to technological progress.

$\bar{a}$ = an average annual rate (equivalent to the actually varying rate) of preservation benefit appreciation

T = relevant terminal year for developmental benefits

T^1 = relevant terminal year for preservation benefits.

The outcome from this model indicated that the initial year's preservation benefits needed to equal benefits from development ranged, according to variations in discount rate and other key input parameters, from $40 000 to $150 000. The value of $150 000 was then taken as representing the minimum amenity value of the canyon. If the preservation benefits could not be shown to exceed at least this figure, then the High Mountain Sheep dam could be regarded as the best public use of this unique environment.

Analysis of data from a recreation survey, a U.S. Fish & Wildlife Service Study and evidence from state wildlife biologists provided a quantitative picture of the present use of the canyon. These data were then projected to 1976 to obtain time comparibility with the proposed initial year of hydro-electric plant operations. The quantitative data used and the dollar values attributed to the various activities are shown in Table 1. The preservation benefits of some $900 000 clearly establish a case, on economic grounds, for the preservation option. It is of particular relevance that the evaluation of the amenity value of Hells Canyon is incomplete. Table 1 indicates that neither fish losses nor the option value of the unique environment have been quantified through lack of suitable data.

> "In this case and perhaps in numerous cases with which resource managers will be dealing, quantitative analysis can be very useful even in the absence of its capacity to capture all of the values potentially attributable to preserving rare natural environments. By the same token, the results of such analysis giving measurable benefits of preservation that exceed benefits from development may be sufficient for a decision, but are not essential for making a case for preserving some unique natural environment. That is, since only a part of the benefits from preservation currently can be evaluated quantitatively, it goes without saying

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that such results cannot be used persuasively, except in extreme cases, to establish that the environmental values precluded by development do not exceed developmental gains" (Krutilla & Fisher, 1975, p.135).

Here I must end my discourse. My theme, in common with economists from Adam Smith and Ricardo down to those of the present day, has been that of the efficient allocation of scarce resources. Conventionally, market mechanisms are used to measure scarcity and, in a world where substitution between resources is possible and where such resources can be exchanged through the market, this approach has proved sound and reliable. However, when dealing with public goods, for which a clear market value is difficult or impossible to establish, a market orientated approach is deficient. "A measure of a resource's scarcity should have just one essential property; it should summarise the sacrifices direct and indirect, made to obtain a unit of resource" (Fisher p.5). In the case of rare natural environments, scarcity may be better measured by examining the outcomes of a particular development policy. It is this approach which has been illustrated in this paper (Smith, 1976).

The economic analysis procedures outlined above are established, practical and represent a sophistication and improvement of conventional processes rather than a departure from them. Much of what passes for environmental impact assessment is a rubber-stamping of the status quo, and an attempt to alleviate the marginal effects of inappropriate development. It is based on dubious survey techniques, worse statistics and large volumes of paper. Consequently the conservation movement loses credibility. Resource managers, however, sympathetic to the environmental cause, ultimately are forced to take hard decisions based on available data. If the preservation option is not quantified, it can only be evaluated in emotional terms. And emotion, as already observed, is no obstacle to economics. The major positive contributions to natural resource economics in recent years have been reviewed in this paper. There are not solutions to all the problems but there are sufficient to do a far better and more comprehensive job on development policy evaluation than has been customary.

Wildlands are both irreplaceable and in increasingly short supply and there is an urgent need to uplift the living standards of the people of Zimbabwe. Inevitably, the immediate human needs of the people of Zimbabwe will come into conflict with longer term interests involving the natural systems of the world. There will be no simple answer, in each case of confliot, which can satisfy the diverse needs of the individuals concerned, both those living today and those yet to be born. The suggestion made here is that where development involves the destruction of a unique natural resource, the impact of

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that development be analysed, in the manner outlined in this paper, by an agency unbiased as to the outcome of the study. The analysis should be thorough, empirical and based on explicit data sources and economic models. It should also be open to public scrutiny and, if necessary, debate.

This is not an anti-development stance, a "back to nature" approach. Rather it is a request for the thoughtful development needed if this nation is to survive and grow in the closed economy of the future. It may slow certain development plans marginally but that is of minor consequence when the alternative is the irrevocable loss in perpetuity of a valuable natural resource. This approach to planning and development will help engender the spirit of co-operation, national identity and ecological consciousness vital to the peaceful evolution of Zimbabwe. I close with the words of that great Chinese philosopher, Lao Tsu:

> "Better stop short than fill to the brim.
> Oversharpen the blade, and the edge will soon blunt.
> Amass a store of gold and jade, and no-one can protect it.
> Claim wealth and titles, and disaster will follow.
> Retire when the work is done.
> This is the way of heaven."

TABLE 1

Opportunity Costs of Altering Free-Flowing River and Related Canyon Environment by Development of High Mountain Sheep Project[1]

Quantified losses	Recreation days 1969[2]	Visitor days 1969[3]	Visitor days 1976
Stream based[4] recreation	40,974[5] +	46,753[5] +	84000 at $5/ day = $420 000
Hunting[6]			
Big game	7 050	7 050	7000 at $25/ day = $175 000
Birds	1 100	1 100	1000 at $10/ day = $ 10 000
Diminished value of hunting experience	18 000[7]	18 000	29000 at $10/ day = $290 000

Total Quantified Losses ... ... $895 000 ± 25%

Unevaluated losses : Unmitigated anadromous fish losses outside impact area

Unmitigated resident fish losses - stream fishing downstream from High Mountain Sheep.

Option value of unique environment

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[1] Source : Krutilla & Fisher (1975, pp 136 - 137)

[2] "Recreation days" corresponds to definition as per Supplement No.1 Senate Document No.97; namely an individual engaging in recreation for any "reasonable portion of a day". In this particular study, time involved must be a minimum of 1 hour, as per letter from Monte Richards, co-ordination, Basin Investigations, Idaho Fish & Game Department.

[3] "Visitor day" corresponds to the President's Recreational Advisory Council (now Council on Environmental Quality) Co-ordination Bulletin No.6 definition of a visitor day as a 12 hour day. Operationally, the total number of hours, divided by twelve, will give the appropriate "visitor day" estimate.

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4 Source: "An Evaluation of Recreational Use on the Snake River in the High Mountain Sheep Area", Survey by Oregon State Game Commission and Idaho State Fish & Game Department in co-operation with the U.S. Forest Service, Report dated January 1970.

5 Not included in survey were scenic flights, nor trail use via Saddle Creek and Battle Creek trails.

6 Source: "Middle Snake River study; Idaho, Oregon & Washington" Joint Report of the Bureau of Commercial Fisheries and the Bureau of Sports Fisheries & Wildlife in Department of the Interior Resource Study of the Middle Snake, tables 10 and 11.

7 The figure 18 000 hunter days is based on expert evidence [details in original table]. The 1969 total of 18 000 hunter days is assumed to grow at 5 percent annually for deer hunting and 9 percent annually for elk hunting to give 29 000 hunter days in 1976.

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