U.S. FISH AND WILDLIFE SERVICE
TRANSMITTAL SHEET

PART	SUBJECT	RELEASE NUMBER
104 ESM	Habitat Evaluation Procedures Human Use and Economic Evaluation (HUEE)	1-85
FOR FURTHER INFORMATION CONTACT		DATE August 1985

EXPLANATION OF MATERIAL TRANSMITTED:

Attached are the revised Human Use and Economic Procedures (HUEE) for your use. This copy should be filed in the fourth Ecological Services Manual binder labeled ESM 100. The March 31, 1980 version of HUEE, Release 2-80, should be discarded.

This revision does not make any changes in HUEE procedures or in the forms used, but was prepared basically to delete all references to the old Water Resources Council's Principles and Standards for Planning Water Resource Developments. The HUEE procedures provide a means for determining both the extent of human uses of wildlife and the dollar value of these uses. They can be used to help evaluate any project effecting fish and wildlife resources. These procedures were developed and are intended for use in conjunction with the Habitat Evaluation procedures (HEP) (102 ESM).

This revision also incorporates a new Appendix A, Bio-Economic Analysis of Wildlife to replace the current Appendix A, that discussed Principles and Standards. Appendix A was prepared to provide a better understanding of HUEE and the concepts, methods, and data commonly used in bio-economic evaluation involving wildlife.

Associate Director - Habitat Resources

FILING INSTRUCTIONS

Remove: 104 ESM, all pages, dated March 31, 1980

Insert New Material: 104 ESM dated August 1985

Transmittal Memorandum: File this transmittal sheet in numerical order behind the subject index divider.

Human Use and Economic Evaluation (HUEE)

104 ESM

(Revised August 1985)

Division of Ecological Services
U.S. Fish and Wildlife Service
Department of the Interior
Washington, D.C.

Preface

Human Use and Economic Evaluation (HUEE) procedures provide means for determining both the extent of human uses of wildlife and the dollar values of these uses. These procedures were developed and are intended for use in conjunction with the Habitat Evaluation Procedures (HEP) (102 ESM). The HEP and HUEE together with the Habitat Suitability Index Models for Use with the Habitat Evaluation Procedures (103 ESM), provide a complete set of procedures for field staff to use in making assessments that involve wildlife resources.

The HUEE procedures are designed for use by field staff, principally biologists, assigned to evaluate the impacts of water and non-water resource development projects. These procedures may be applied in field studies without the assistance of economists or recreation planners. However, to apply advanced methods such as the travel cost method (TCM) or contingent valuation method (CVM), the assistance of a specialist, such as an economist or recreation planner is needed. This assistance may be obtained from the lead planning agency; other Federal or State agencies, specialists within the Fish and Wildlife Service, universities, or private consultants.

The HUEE procedures incorporate a concern for wildlife in that special attention is given to the levels of use which wildlife can tolerate, regardless of the method or methods applied.

More detailed information on bio-economic analysis of wildlife is provided in Appendix A. This information is useful for obtaining increased understanding of this evaluation process.

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Chapter 1. Introduction

Changes in habitat may increase or reduce wildlife populations available for human consumptive or nonconsumptive uses. HEP (102 ESM) is designed to display impacts on biotic resources and HUEE converts these impacts on habitat and wildlife species into effects on projected human uses of these populations.

Data produced in a HUEE analysis are used primarily to compare the effects of proposed actions on human uses of wildlife. These data also may be utilized in benefit/cost (B/C) analyses developed by a lead planning agency or project sponsor.

This manual provides technical information and data useful in completing a HUEE study. The concepts and procedures presented should be applied in conformance with agency guidelines and regulations. Thus, for example, a HUEE study of changes in potential use may be completed, technically, without considering access to wildlife but the respective agency internal and external directives should be followed to assure consistency of a given study with these directives.

The Unit Day Value (UDV) procedures presented in Appendix B may be used by a biologist to develop a systematic evaluation of the uses of wildlife However, the application of advanced methods such as TCM or CVM produces more statistically reliable values. The information and data developed by applying one or more advanced methods in a study are more extensive than with the UDV and provide substantial documentation. In addition, other values associated with wildlife such as values arising from the continued existence of these resources, irrespective of use, can be estimated by applying an advanced method (CVM). Such values cannot be estimated with the UDV approach.

HUEE Forms 1107 and 1108 (Appendix B), may be completed by biologists to provide data reflecting impacts on wildlife. These forms should be completed for all significant projects, whenever a B/C analysis is performed, to facilitate the incorporation of these impact data into the study. However, additional HUEE forms would be needed if demand is to be addressed.

Chapter 2. Relationship of Biological Productivity to Human Uses

Use and economic evaluations start with consideration of a unit of use, such as a day of deer hunting. This unit of use is subject to two conditions: (1) a human desire (or demand) for this type of hunting; and (2) the availability or prospect of availability (supply) of deer for harvest. Demand, therefore, originates with a human desire to use wildlife in some fashion. Supply, on the other hand, depends on the harvestable or usable population of deer. The biological productivity of the species constrains the number of animals available for both consumptive and nonconsumptive use. The population eventually will decline if the combination of consumptive (in this example, hunting) and non-consumptive uses (such as hikers observing deer) exceeds the capacities of the herd to sustain such uses. The capacity of the deer herd to sustain the various human uses constrains or limits the human uses.

Biological productivity (supply source) can be determined in various ways, including population data or prediction models. The most desirable method is to use sustainable yield numbers based on animal population data. In this case, the availability of harvestable animals can be determined directly from population data and the projected use calculated from information, such as the number of hunters per unit of animals or the number of fisherman days per unit of fish. Population data may be available for baseline conditions, but predictions of anticipated population levels are usually difficult to make. However, the same method for determining biological populations and harvest should be used for both baseline and future conditions because significant errors are otherwise likely to result, due to differing assumptions in population-predicting models.

Relatively few models are available for predicting animal numbers. An example is the National Reservoir Research Program which developed predictive models for fish populations in warmwater reservoirs (Jenkins 1976). Such models can be used to estimate baseline and future population levels. State and Federal agencies may provide local predictive models for selected wildlife species.

Predictive models will not be available, in most instances, for all species of interest. It is possible, however, to predict wildlife populations and harvest by use of Habitat Unit (HU) data derived from predictive habitat suitability index (HSI) models that are described in HEP (102 ESM). Some States (e.g. Missouri) have developed tables for converting HU data to population numbers for some common species. HU data must be converted to predicted supply before these data can be used in the economic analyses.

Chapter 3. Procedures for Evaluating Uses of Wildlife

3.1 Approach. One or more of the following methods or approaches may be selected for a HUEE study. For example, both TCM and CVM could be applied to provide extensive documentation if needed for a large or controversial project, assuming funds were available. An advanced method such as TCM or CVM might be selected if recreation is an important project component relative to other outputs and costs, or if specialized or unique recreation activities would be potentially affected.

The UDV approach could be used if less precise values are acceptable and substantial documentation is not needed, or if funds are limited. Finally, Forms 1107 or 1108 may be completed if only impacts on wildlife are to be considered without regard to human needs or demands for use of the resource being evaluated.

For many studies, value data or models from previous research can be used in a HUEE study. For example, "unit values" from a relevant TCM study may be used in a UDV approach. In this case, the "unit values" from the TCM study may be used instead of the values usually developed with the UDV (Appendix C). However, specialized assistance or advice is generally needed when considering the potential use of existing values or models developed by applying advanced methods in previous studies.

Overall, the method or approach selected should be based on a balance between the relative importance of the potentially affected wildlife and recreation, the advantages of the respective approaches, and cost considerations.

The objective, regardless of the method used, is to estimate the net willingness to pay for each potential increment of output. The net willingness to pay for recreation includes entry and use fees actually paid for site use, plus the dollar value accruing to the recreationist, above costs or expenditures. The change in total consumer and producer surplus or profit estimated for the project is compared with construction and other project costs. If the increased benefits exceed construction and other costs, the project has a positive benefit/cost ratio.

A. Travel Cost Method (TCM). The TCM is based on observations of the travel, behavior of users and the costs of travel. These two factors are combined to determine user willingness to pay for various recreational activities. The assumption is made that when other considerations remain equal, per-capita use of a recreation site decreases as time and out-of-pocket costs of travel to the site increase. A demand curve is derived, using the variable costs of travel and the value of time as proxies for price, that reflects the willingness of users to pay for additional increments of recreational activity. This method may be used to develop a site-specific study or a regional economic model. However, the TCM is not used if: (1) use is not estimated by a technique relating trip-generation to distance to the site; (2) there is insufficient variation in travel distances to allow parameter estimation (e.g., urban sites); or (3) the project site is typically only one of several destinations visited on a single trip.

B. Contingent Valuation Method (CVM). The CVM is used to estimate changes in the dollar value of recreation and is based on responses of users to various questions concerning resource use. Individual households are queried about their willingness to pay for changes in the quality and quantity of recreation opportunities at a proposed site. Individual values may be aggregated for all users in the study area. This method may be applied to a site-specific study or a regional model. Survey studies are expensive and regional CVM models should be developed, if possible, to make site-specific studies less costly. All survey forms used by Federal agencies are subject to the clearance procedures of the Office of Management and Budget.

C. Unit Day Value Method (UDV). The UDV relies on expert or informed opinion and judgment to estimate the average willingness of recreation users to pay for their activity. An approximation of the dollar value of recreation activities is obtained by applying, to estimated use, a carefully thought out and adjusted unit day value. The UDV has the simplest conceptual basis of the three methods but from it one develops the least reliable values.

D. Forms 1107 and 1108. Completion of these forms (Appendix B) would provide data showing potential impacts on the sustainable uses and value of wildlife. However, these forms do not consider human demands, if any, for use of this resource.

3.2 Biological Productivity Limits. The approaches described in Sections A, B, and C, above, can be utilized to determine baseline and future recreational uses of wildlife resources. Predicted uses cannot be sustained if they exceed the capabilities of the habitat and species to support that level of use. Environmental factors that can constrain use, e.g., habitat productivity, availability, stability, and species tolerance to human activities, should be considered.

Biological limits can be calculated by completing Forms 1107 and 1108 using incorporating data generated in a HEP analysis. Potential use data, combined with biological limits, assures the development of evaluations that reflect sustainable use in an area. The availability of wildlife for human uses on a sustained basis should be evaluated regardless of the method used.

4. HUEE Evaluation Process

A HUEE study focuses on the relationship between the availability or capabilities of wildlife to sustain use, which may be affected by a proposed project, and the demands or needs of humans for use of this resource. The concepts involved in the HUEE evaluation process are discussed with illustrative numerical examples.

4.1 Overview.. A HUEE study measures changes in uses of wildlife including recreational, commercial, scientific, and educational activities. Both consumptive and nonconsumptive uses are included (Figure 4-1).

There are two distinct "paths" or sequences in the HUEE evaluation process (Figure 4-2). The left hand series of blocks in the diagram lead to the estimation of supply, or the uses that the animal population can sustain. The adjacent series of blocks, beginning with Existing Human Use, reflects the potential needs or demands of humans for the various uses of the wildlife species.

Either Habitat Units (HU's) or animal population data can be used as inputs to estimate sustainable use levels. All potential human uses or demands are summarized and compared with the use sustainable by the species. Each proposed action is compared to the future-without-project conditions.

The relationship between potential uses and biologically based limits is shown in Figure 4-3. This example represents one configuration of use and productivity curves; the actual shape of these curves will vary by species from project to project. The shaded area on Figure 4-3 represents the amount of use that is sustainable during the life of the project. The important consideration is that after use and productivity are plotted, the data on use that will be projected or planned for the alternative and utilized in the valuation are represented by that area in Figure 4-3 defined by the lower limits of both use and productivity curves. Project-related changes in unused resources (supply surplus), or in the demand above that is supported by the resource on a sustained basis, do not enter directly into the HUEE analysis.

A. Sustainable Use--Supply. The HU's derived from HEP can be used in conjunction with these procedures as one method for setting limits based on biological productivity (a population productivity model is another method). The first step in determining this biological limitation using HEP data is to convert the data obtained in a HEP analysis into use-days. The two types of information needed for this conversion are: 1) the number of HU's required per animal for the species; and

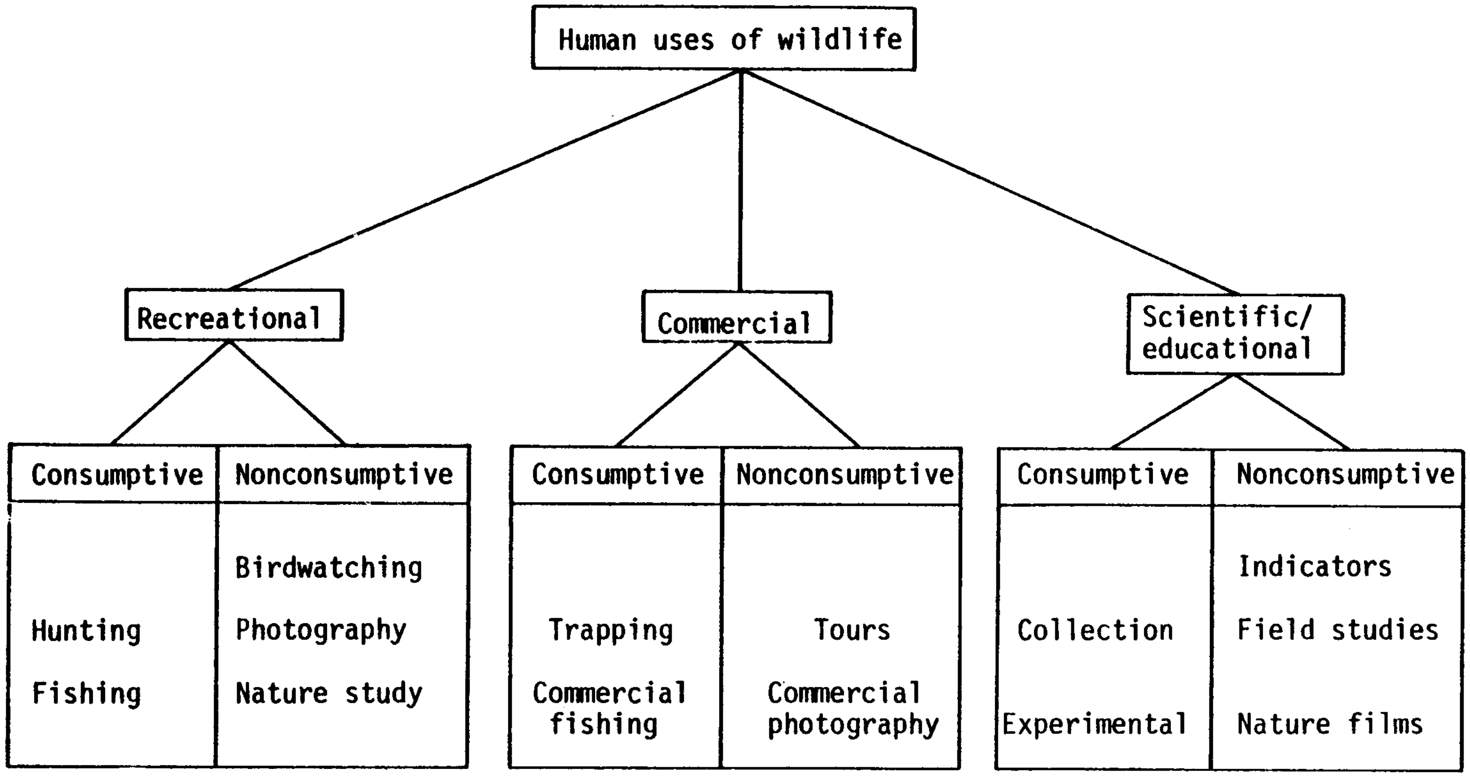


Figure 4-1. Categories and examples of uses of wildlife species.

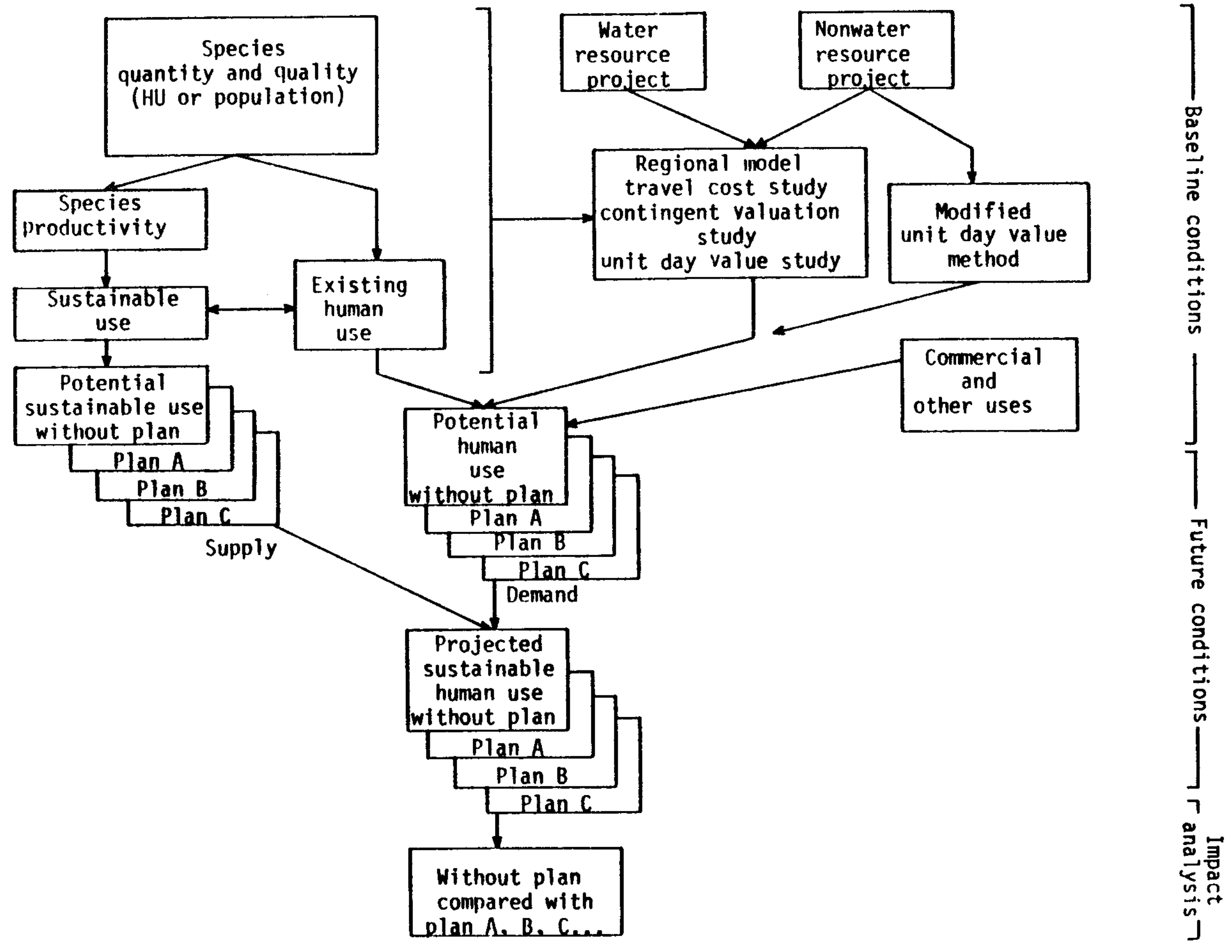


Figure 4-2. HUEE Evaluation Process.

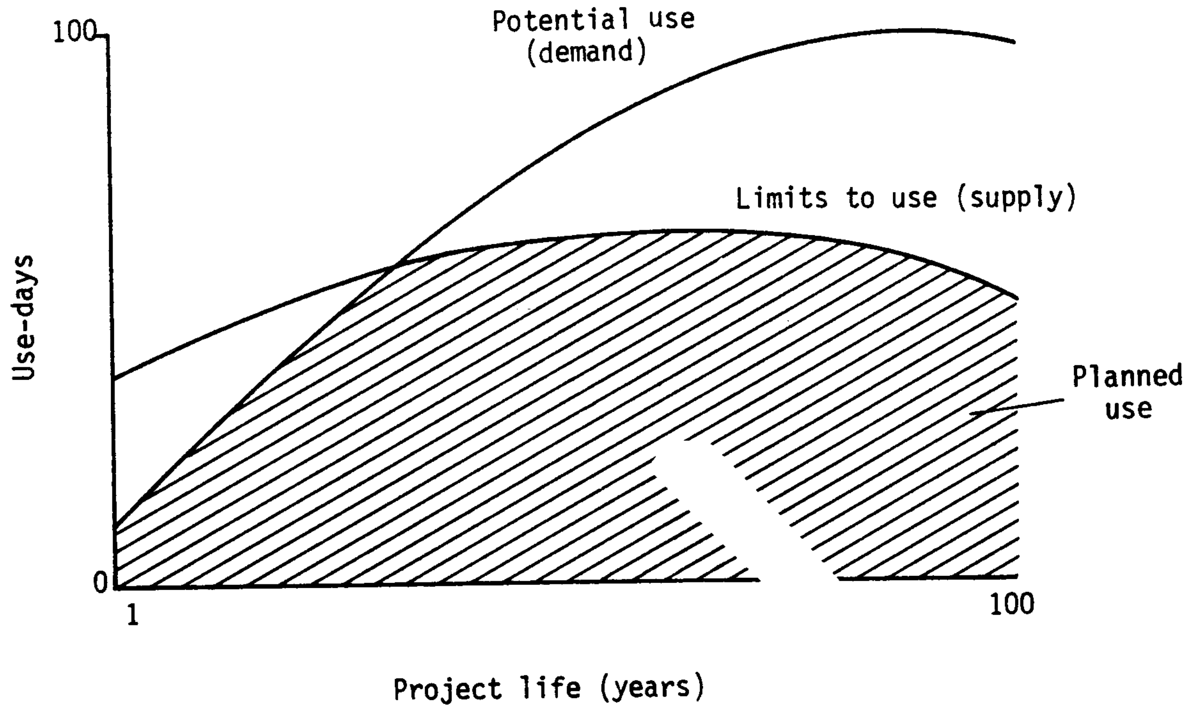


Figure 4-3. Biological productivity limiting human uses of wildlife.

2) the relationship between the species population and sustainable use. Additional population data required to develop this information should be sought from any appropriate source, but particularly the State wildlife agency.

In the HEP analysis the Habitat Suitability Index (HSI) is multiplied by the area of available habitat to obtain HU's. The number of animals per HU is multiplied by the total number of HU's to obtain the estimated population size. The relationship between these values is illustrated for white-tailed deer in Table 4-1.

Table 4-1. The use of HEP data to estimate the number of white-tailed deer an area can sustain.

Cover Type	Target Year	Available Area (Hectares)	HSI Value	Total HU's	Deer per HU	Total Population
Bottomland hardwoods	Baseline	1,000	0.75	750	0.12	88
	1	500	0.75	375	0.12	44
	20	500	0.15	75	0.12	9
	100	500	0.15	75	0.12	9

The link between the total species population and the amount of consumptive use that can be supported is the sustainable harvest rate and the use-days per animal. The harvestable population multiplied by the number of use-days of effort per animal yields the total sustainable number of use-days. This relationship is shown in Table 4-2.

The population data are converted to sustainable use level for baseline conditions and for each target year for proposed actions and without-project conditions. Values for intervening years are extrapolated from the target year data. These data can be graphed to form a sustainable use curve (Fig. 4-4). The area under the curve provides a measure of the total use that can be provided during the life of the project. The number of sustainable use-days that are generated by a given number of HU's should be determined by consulting with species specialists and by using data available from State wildlife agencies, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and other agencies.

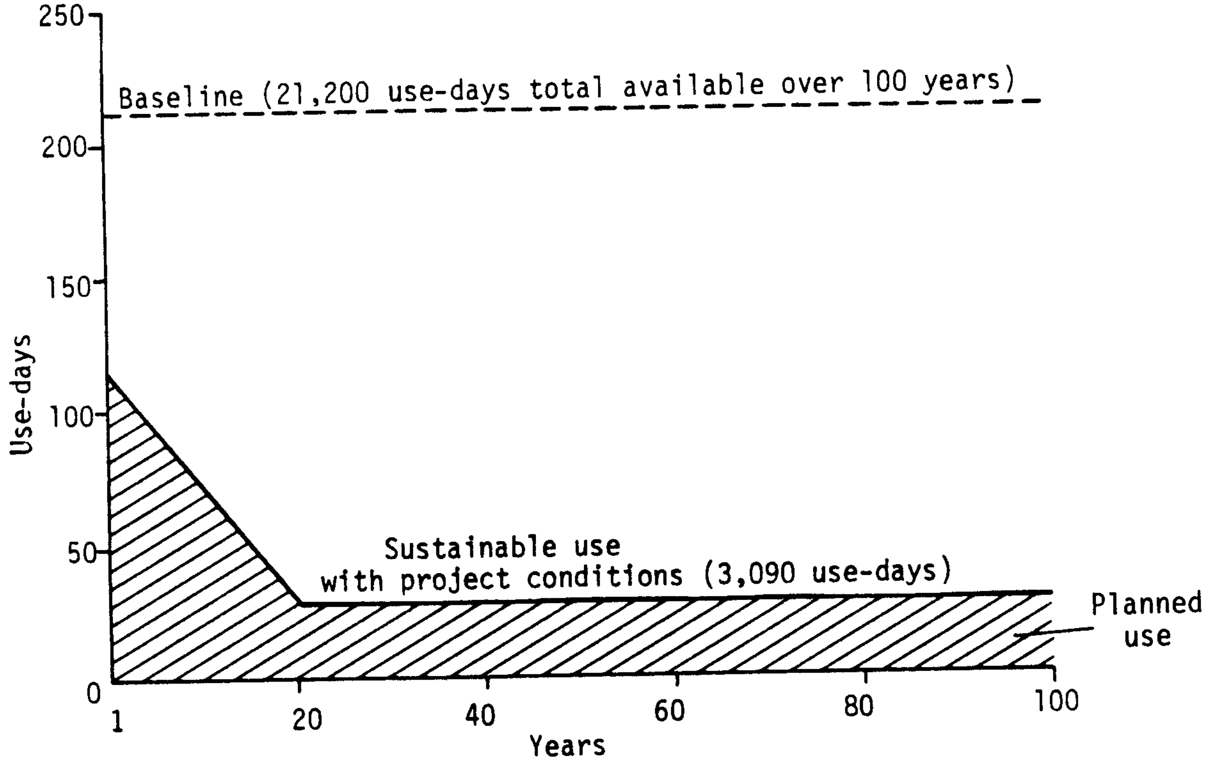


Figure 4-4. Number of use-days of deer hunting available (supply) during the project life. Without-project conditions are the same as baseline conditions in this example.

Table 4-2. The relationship of white-tailed deer harvestable populations to sustainable use.

Target Year	Total Deer Population	Harvestable Populations	Use-days Per Deer	Sustainable Use-days of Deer Hunting
Baseline	88	29	7.3	212
1	44	15	7.3	110
20	9	3	7.3	22
100	9	3	7.3	22

The sustainable use curve (supply) limits the amount of use (demand) that an area can sustain for a given activity. The sustainable limits (use curve) should be used to constrain the projected uses if a model or method is utilized that does not consider biological limits (Fig. 4-5). The projected or planned use that should be considered in the analyses is shown by the shaded area.

B. Potential Use--Demand. The potential use or demand curve for human use for each species must also be estimated for each target year. The same "Without Project" demand curve may be also used for all proposed actions since the desires for use of wildlife are unlikely to be significantly affected by most projects. A proposed action, however, may result in large population influxes or other demographic changes that would change the level of demand.

The potential use or demand curve estimates or projections of desired use days should be based on current and expected hunting trends in the project area, population trends and trends in other demographic variables (sex, age, income, etc.). Various approaches to projecting demand may be used including graphic techniques (drawing a line through historical data), or an electronic calculator.

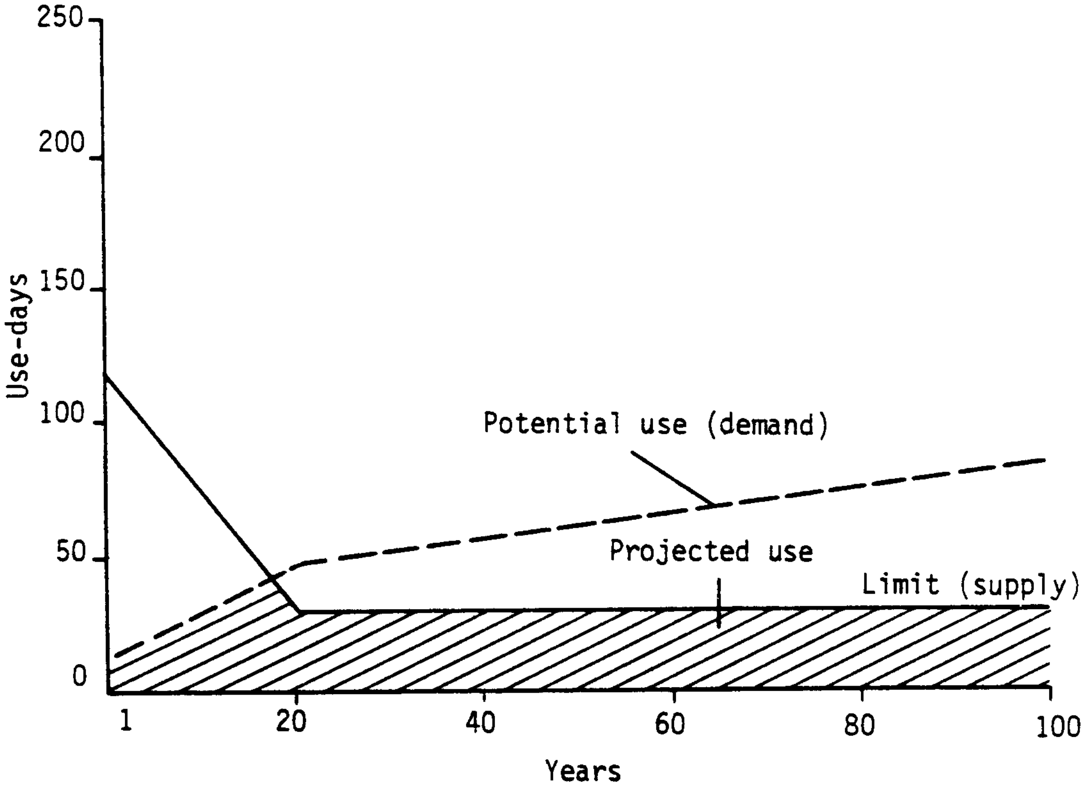


Figure 4-5. Determining projected use from potential deer use constrained by species productivity.

C. Planned or Projected Use. The lesser of Sustainable Use and Potential Use in any given year is termed Planned Use. This Planned or Projected Use is carried forward for each proposed action in the remainder of the analysis.

4.2 Outputs. The use-days and dollar values estimated for the life of the project are utilized to produce four sets of output data:

1) Average Annual Use (AAU);
2) Average Annual Worth (AAW);
3) Present Worth (PW); and
4) Average Annual Equivalent Value (AAEV).

The terms "worth" and "value" have identical meaning in the context of these output data. Annual Worth is the dollar value of an activity that takes place during one year. Cost, benefit, and externality values, after the beginning of the project life, are assumed to occur at the end of each year, even though they may actually accrue throughout the year. Costs and benefits that occur during project construction are assumed to occur at the beginning of each year because facilities must be in service the entire year before benefits or investment costs can accrue for that year. The evaluation combines changes in use and values that occur during project construction with those that occur during the operational phase of the project.

A. Average Annual Use (AAU). The AAU is estimated by activity for each proposed action and for conditions without the project. Use-days are determined for selected target years during the life of the project and interpolated to develop use data for the remaining years (Table 4-3). Use data are summed for the life of the project to determine the total use-days. The AAU, throughout the life of the project, is determined by dividing the total use-days by the number of years. Average annual use-day calculations are not usually applicable to commercial uses of wildlife.

B. Average Annual Worth (AAW). The AAU is multiplied by the unit value of one use-day for the activity to determine the AAW. For example, the AAW of 145 days of deer hunting, at $3.00 per use-day, equals $435.00 (Table 4-3). The $3.00 per use-day is selected from a range of values using weighted criteria and following the instructions for calculating unit dollar values for recreation (Appendix C). Alternatively, advanced methods can be applied to estimate the value of recreational activities.

Table 4-3. Determination of Average Annual Use and Average Annual Worth from target year data and unit value.

		Year	Days of deer hunting	Annual worth $
Target year		1	100	300
	Interpolated	2	105	315
		3	110	330
		4	115	345
Target year		5	120	360
	Interpolated	6	140	420
		7	160	480
		8	180	540
		9	200	600
Target year		10	220	660
Total		10 years	1,450 days x $ 3.00 =	4,350

Average Annual Use (AAU) = total days of hunting ÷ years = 1,450 ÷ 10 = 145 days of deer hunting per year during the life of the project.

Average Annual Worth (AAW) = AAU x Unit Value for one day of use = 145 days of use x $ 3.00 = $ 435.00.

The AAW also can be computed by summing annual worth data for the life of the project and dividing the sum by the number of years. Annual worth data are obtained by multiplying annual use by the unit value for one use-day for the activity.

The net annual profit for a commercial activity is considered the annual worth of the activity. Annual worth of commercial, recreational, or other activities are summed when corresponding uses, i.e., commercial and recreational fishing, occur for the same species. The combined annual worth is averaged over the life of the project to obtain the AAW. The combined annual worth data are used to calculate annual worth. (See Section 4.3 - Commercial, Scientific, or Educational Uses.)

C. Present Worth (PW). The PW is determined by discounting the annual worth for each year in the life of the project and then summing the discounted values. This calculation provides a value ($) for the activity that is directly comparable to values at the start of project operation. Annual worth is multiplied by a factor or factors from an Interest and Annuity Table (Appendix D) or discounted by use of a computer program to obtain PW data.

Table 4-4 illustrates the calculation of discounted annual values by using factors from an Interest and Annuity Table. Alternatively, annual values may be discounted by solving an equation such as:

$$PW = \sum_{t=1}^{n} AWt\ (1+i)^{-t} \qquad (1)$$

where
PW = Present Worth
n = number of years in the life of the project
t = year
AW = Annual Worth
$(1+i)^{-t}$ = discounting factor
i = discount rate

The equation solved for the above example of deer hunting, assuming a 6% discount rate for the project, is:

$$i = 0.06,\ n = 10,\ AW_1 = 300,\ AW_2 = 315,\ AW_3 = 330,\ \text{etc.}$$

$$PW = \sum_{t=1}^{10} AWt(1 + .06)^{-t} = \sum_{t=1}^{10} AWt \times 1.06^{-t} = \$3{,}061$$

Table 4-4. Calculating Present Worth of deer hunting over 10 years by discounting Annual Worth data

Year	Annual Worth $		Discount factor[a] $(1+i)^{-t}$		Discounted Annual Worth $
1	300	x	0.943396	=	283.02
2	315		0.889996		280.35
3	330		0.839619		277.07
4	345		0.792094		273.27
5	360		0.747258		269.01
6	420		0.704961		296.08
7	480		0.665057		319.23
8	540		0.627412		338.80
9	600		0.591898		355.14
10	660		0.558395		368.54
Total (Present Worth)					3,060.51

[a]Factors taken from 6% Interest and Annuity Table.

The discount rate used for the project should be obtained from the lead agency or project sponsor. The discounting process applies to costs or benefits incurred during the life of the project. Changes in the value of use that occur in the Prestart Period before project implementation are adjusted to PW by the addition of interest during the construction period (Appendix E - Prestart Analysis).

D. Average Annual Equivalent Value (AAEV). The AAEV is calculated by amortizing the PW over the life of the project; this spreads the project benefits evenly over time. The formula used to calculate the AAEV is:

$$AAEV = PW \frac{i(1+i)^n}{(1+i)^n - 1} \quad (2)$$

where AAEV = Average Annual Equivalent Value

PW = Present Worth

i = discount rate

n = years

The AAEV for the deer hunting data in Table 4-4 is:

$$AAEV = \$\ 3,061 \frac{0.06\ (1.06)^{10}}{1.06^{10} - 1}$$

$$= 3,061\ (0.1359)$$

$$= \$416$$

The AAEV and the AAW are identical for any single year and will remain constant when the AAW, including commercial values, is projected as a straight (horizontal) line for the life of the project. The AAW may be substituted for AAEV in a HUEE evaluation when the straight (horizontal) line projection exists. Values for the construction and operation phases of a project are summed when the PW or AAEV are used to evaluate monetary impacts for both time periods.

4.3 Commercial, scientific, or educational uses. The method for evaluating commercial uses presented in this section applies where significant commercial or similar uses of wildlife occur or are expected to occur as a result of project implementation.

This method may be used to determine the dollar value of all commercial uses of wildlife, including consumptive uses such as fishing and trapping and non-consumptive uses such as photography or wildlife tours. Scientific or educational uses of wildlife also can be evaluated based on the net "profit", which is the difference between the amount that the users are willing to spend and the amount actually spent to use the wildlife.

The net value of the output (or harvest) to the user (that is, returns less associated costs of production or harvesting) for each alternative and for without-plan conditions is estimated in evaluating commercial uses. Costs considered in the analysis include both variable expenditures per unit of product (e.g., fuel costs) and fixed costs (e.g., equipment depreciation).

The present commercial use of wildlife should be based on actual use data or information on historical trends. This information can be used to project use throughout the life of the project, unless changes in patterns of use are expected. Commercial use data, including annual harvest rates, use-days, license sales, harvest and production costs, ex-vessel or other prices for goods, and resource productivity, may be available from appropriate Federal, State, and local agencies, universities, and private research organizations.

Adjustments may have to be made in commercial evaluations when trapping animals for pelts is involved. Fur trapping often is pursued both for recreation and profit (the net return from the sale of pelts). Data on the recreational values associated with trapping may be found in study reports pertinent to the area, determined by a survey of area trappers, estimated using the UDV (Appendix B), or determined with the CVM. The recreational values of trapping are added to the net pelt values to obtain the total commercial value of trapping. The total trapping value is added to the total recreational value to provide the total dollar value of all uses of the species.

The economic value of using wildlife as environmental "indicators" (Wildlife Management Institute undated) may be estimated as the difference between the costs of using a species for this purpose and the cost of purchasing, installing, and operating machines to measure the changes in environmental conditions (e.g., fish used instead of machines to measure aquatic contaminants).

There may be harvestable populations of wildlife in a project area that are not currently being utilized. Project-related changes in this resource surplus may not have a measurable impact on commercial activities in the project area. When this occurs, there will be no net economic gain or loss associated with the project.

4.4 Externalities. Secondary effects of the human use of wildlife resources may occur due to project implementation. When applicable, these externalities should be added to recreational and commercial values. Externalities can occur as either technological or monetary effects and can accrue to individuals, groups, or industries.

Technological externalities may arise when a new or improved technology is developed or employed as a direct result of the project. Increased profits to an industry or individuals producing an animal by-product (e.g., hide, oil, or scent), by means of a process not possible without the project, is one example of a technological externality. Benefits of this kind can be expressed as a reduced average production cost per unit of output or as increased gross output multiplied by a profit ratio for the industry. Technological externalities are rare when wildlife resources are involved and benefits, if present, are likely to be relatively small.

Monetary externalities are project-induced price or cost changes. These changes generally reflect distributional shifts rather than increased use efficiency or output and are not included in the evaluation.

Specialized assistance may be needed to estimate the value of externalities, if significant.

4.5 Impact analysis. Changes in human recreational, commercial, scientific, and educational use of wildlife resources, and the associated dollar values, can be measured with a variety of methods. Data from these various methods are converted into common terms that can be used to predict and compare impacts that result from project implementation.

The AAU in use-days, AAW in nondiscounted dollars, and PW and AAEV in discounted dollars can be displayed for each alternative project plan. The monetary impacts of any alternative can be obtained by comparing future conditions with and without the proposed action. This comparison reflects the relative monetary impact of a particular proposed action on the human use of wildlife resources.

The AAU data provide the basis for comparing project impacts on recreational uses of species or species groups. The AAW, PW, and AAEV reflect the effects of proposed actions on the dollar values of recreational and other uses of a species.

5. References

Jenkins, R. M. 1976. Prediction of fish production in Oklahoma reservoirs on the basis of environmental variables. Ann. Okla. Acad. Sci. 5:11-20.

Water Resources Council. 1983. Economic and environmental principles and guidelines for water and related land resources implementation studies. March 10, 1983.

Wildlife Management Institute undated. Wildlife: The environmental barometer. Wildlife Management Institute, Washington, D.C. Unpaged brochure.

Appendix A. Bio-Economic Analysis of Wildlife

This appendix provides additional information on bio-economic analysis of wildlife. It is included to provide the reader with an opportunity to better understand the concepts, methods, and data used in bio-economic evaluations involving wildlife.

This information was prepared by Dr. John B Loomis, Economist, Western Energy and Land Use Team, during an Intergovernmental Personnel Act assignment, under contract to the US Bureau of Land Management The objective of this Appendix is to expose the reader to the variety of bio-economic procedures used by various Federal agencies. An additional objective is to elaborate on the concepts discussed in HUEE and provide additional references for those desiring a detailed discussion of a particular issue. This Appendix is neither a cookbook nor an exhaustive treatment of all of the issues.

FEDERAL REQUIREMENTS FOR WILDLIFE ECONOMICS

Most Federal agencies are required by one or more Instruction Memoranda, Planning Regulations, or Benefit-Cost Guidelines to translate the biological effects of some action into economic values. The Bureau of Land Management's "Final Rangeland Improvement Policy" (Bureau of Land Management, 1982) indicates that "willingness to pay" values for wildlife need to be developed so they can be utilized with livestock values in the SAGERAM Program (a program for ranking of alternative rangeland investments). The U.S. Forest Service's "National Forest System Land and Resource Management Planning" (U.S. Forest Service, 1982) procedures require forest plans to estimate the "Present Net Value" of all resources having an established market value or an assigned value Wildlife recreation has a dollar value set by the Chief of the Forest Service. This value is initially developed from existing research on the economic value of wildlife recreation. The Present Net Value (in dollar terms) has become one of the U.S. Forest Service's key criteria in comparing planning alternatives and in determing what represents "maximum net public benefits" (Peterson, 1983).

The need for economic valuation of wildlife recreation has recently become even more imperative for Federal agencies involved in water resource development projects. On March 10 1983, the "Environmental Quality" objective was eliminated from the U.S. Water Resources Council's Principles and Standards. The new benefit-cost procedures, called the "Principles and Guidelines" require agencies to select the alternative plan with the greatest net economic benefit, ie, maximum Present Net Value (U.S. Water Resources Council, 1983). The Federal agencies under the purview of these new "Principles and Guidelines" (U.S. Army Corps of Engineers (Corps), Bureau of Reclamation (BR), Soil Conservation Service (SCS), and Tennessee Valley Authority) are required to present only the economic effects of alternative plans Inclusion of the environmental effects in the Environmental Quality account is only necessary when required by laws and regulations other than the Principles and Guidelines. Thus, if the effects on wildlife habitat and populations are to be fully reflected in the benefit-cost aspect of water development project studies, biological effects must be translated into economic effects

The bio-economic evaluation concepts and methods discussed in the appendix are applicable to any study. However, the actual procedures and critical assumptions that must be followed by Corps, BR, and SCS planners in conducting benefit-cost analyses are detailed in their internal guidance documents. Before examining the benefit-cost aspects of any project, the investigator should discuss the project with the agency's planners and obtain copies of the current economic procedures they are required to follow.

MEANING AND MEASUREMENT OF ECONOMIC VALUE OF WILDLIFE LIFE

Much unnecessary confusion exists among wildlife managers, conservationists, and even some misinformed economists over what constitutes an economic value. Much of this confusion stems from failure to identify what questions the economic analysis will be answering. The financial value to the State Game Department is different than the local economic impact from hunter expenditures, and both are quite distinct from the values to the recreationist or the nation. This appendix provides a field guide allowing the biologist to match questions to be answered by the analysis with the dollar values that can be used to answer the questions.

FINANCIAL VERSUS ECONOMIC VALUE

Many public and private decisionmakers confuse financial values with economic values. Financial values reflect only revenue or sales received by firms or public agencies (ie, cash changing hands) Economic values are much more general, financial values are a subset of economic values. For any good or service to have an economic value, it must have two properties. It must provide at least some consumers (but not necessarily all) satisfaction or enjoyment. Second, the good or service must be scarce in the sense that at a zero price (free) recreationists want more than is available. Wildlife certainly meets both of these properties. Some wildlife recreation opportunities are so scarce they can occur only once in a lifetime, as in the example of bighorn sheep and mountain goat hunting permits.

Figure 1 illustrates what Randall and Stoll (1983) call a "Total Value Framework." The financial value of wildlife reflects a portion of the

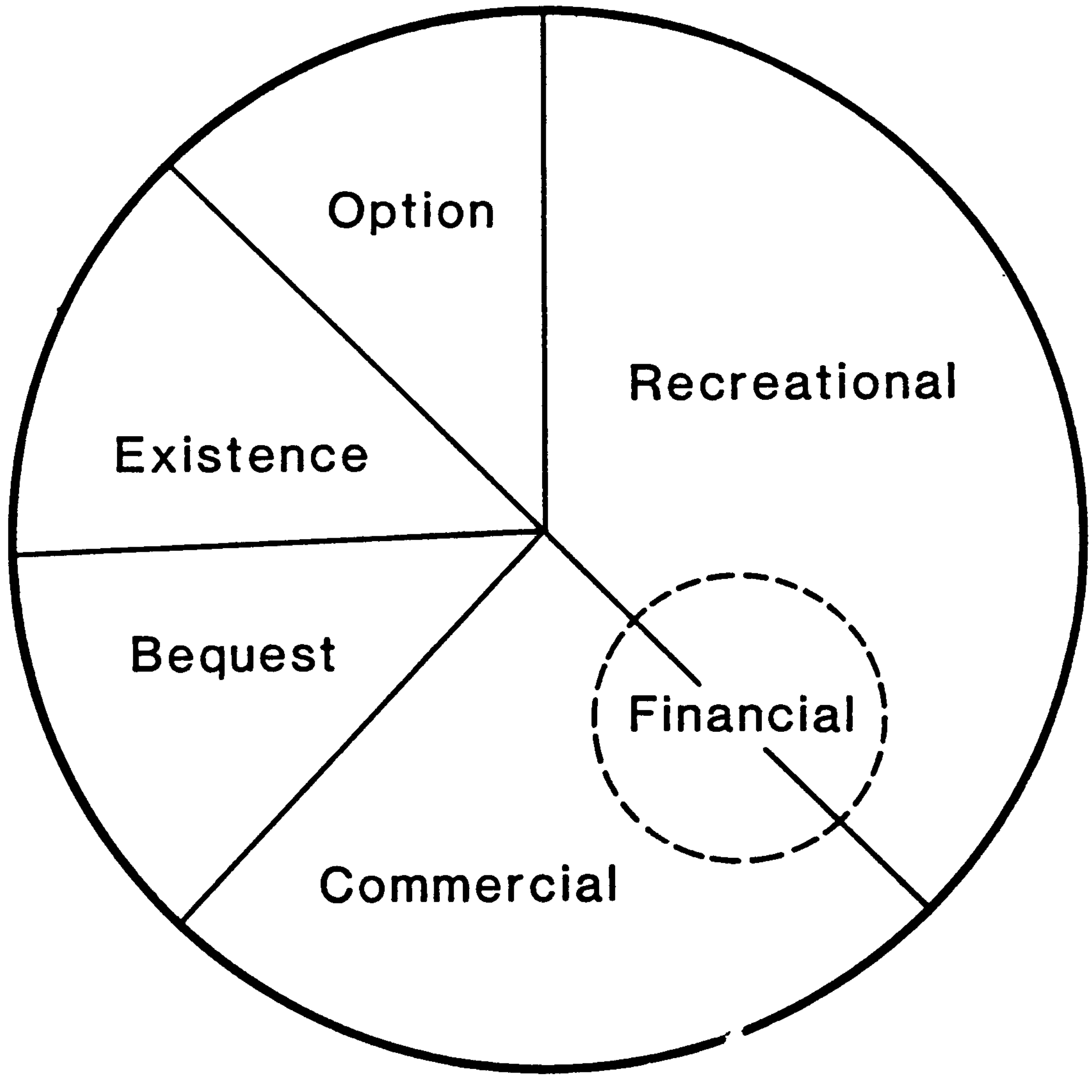


Figure A-1. Total value framework.

social benefits, (defined in terms of willingness to pay) of recreational and commercial uses of wildlife. Even in the cases of commercial fisheries or commercial recreation, the economic benefits received by the consumer exceed the revenue or income (ie, financial values) to the firm. This "consumer surplus" must be taken into account in benefit-cost analysis to provide accurate recommendations about the change in social well-being associated with a management action (Sassone and Schaffer, 1978). In addition to the citizens' economic values of recreation and commercial uses of wildlife, there are many off-site user values. These include option, existence, and bequest value. Option value refers to an individual's willingness to pay to maintain the current wildlife recreation opportunities in the face of possible irreversible losses of such opportunities. Option value can be thought of as an insurance premium people would pay to insure that wildlife recreation opportunities are available in the future, if in the future they decide to engage in wildlife recreation. Existence Value is the economic benefits received from simply knowing what wildlife exist. Bequest value is the willingness to pay or economic benefits of providing wildlife resources to future generations.

These off-site user values were originally presented in the economics literature by Weisbrod (1964) and Krutilla (1967). The values have been measured using the Bidding Method for bighorn sheep and grizzly bears by Brookshire, Eubanks and Randall (1984). They have also been measured for water quality, air quality, and wilderness by Walsh et al. 1980, Brookshire et al., 1982, and Walsh et al. 1984. While option and existence values may be present for manufactured consumer goods, Randall and Stoll (1983) claim those values are likely to be, at the margin, empirically insignificant in size compared with scarce wildlife species.

This relationship of economic and financial values for wildlife is confusing to managers used to dealing only with marketed resources such as coal or timber. For these marketed resources, the economic and financial values are almost synonymous. They differ only in the extent to which the timber harvesting is subsidized or that coal mining results in loss of environmental quality not fully mitigated by reclamation.

What is relevant for public decisionmakers at the Federal, State, and county level are economic values not financial values. One justification for State ownership of wildlife and Federal ownership of land is that managing wildlife resources using only the financial values generated in the private sector would result in a misallocation of resources making everyone, on average, worse off. The conditions under which reliance solely on market prices flowing from financial transactions makes society worse off were formalized by Francis Baton in his article entitled "The Anatomy of Market Failure" published in

1958. Financial values (sales revenue, profit) are only useful in this context for answering questions about profitability of guide services or retail outlets dependent on Federal land resources. More will be presented on economic valuation later in this appendix.

BIOLOGICAL-RECREATIONAL-ECONOMIC RELATIONSHIPS: OVERVIEW

As discussed in the introduction, there is a recognized need to translate biological effects of habitat and range management practices into economic values. In response to this need, several governmental units have developed bio-economic procedures to translate impacts on habitat or wildlife populations to change in wildlife recreation use days. Five sets of procedures known to the author that can be implemented by field biologists include: (1) U.S. Fish and Wildlife Service's "Human Use and Economic Evaluation (HUEE) system (U.S. Fish and Wildlife, 1980); (2) the State of Washington Game Department's "Short Form for Bio-economic Evaluations of Wildlife in Washington State" (Oliver, Young and Eldred, 1975); (3) the Bureau of Land Management's Biological Response Approach developed by the Oregon State Office (4) Suislaw National Forest's Salmonid Fisheries Model (Kunkel and Janik, 1976); and (5) the Moab District Hunter Bay Short Form developed by Robert Milton, Moab District, Bureau of Land Management (BLM) (1983). This form has been developed for big game hunting only.

This discussion will provide an overview of the inventory data needed for translation of biological effects into economic values and highlight the similarities of the five approaches listed above. The details of data collection and manipulation will be covered in Section III. Figure 2 provides a schematic representation of the critical linkages. These five approaches all have in common the requirement that harvest (or population) figures be known or estimatable. In the State of Washington's "Bio-Economic Short Form" and Suislaw National Forests U.S. Fish and Wildlife Service anadromous fish models biological effects must be estimated in terms of effects on populations. If population simulation models are available, the linkage of resource decisions to populations may be possible. While the U.S. Fish and Wildlife Service's HUEE analysis and the Oregon approach can model the biological impacts in terms of population or harvest, both have the capability to convert changes in habitat variables (e.g., food, cover, reproduction) into changes in carrying capacity. This is done in such a way, using habitat models that changes in carrying capacity can often be converted to a change in population or harvest. Because changes in habitat variables due to management actions are often easier to predict, this habitat based evaluation capability may be quite useful in evaluating resource management plans.

The next step required in all five approaches is the estimation of wildlife recreation use levels associated with a given number of animals (or fish) available for harvest. Typically, what is done is the hunter-days or angler days per animal harvested is multiplied by the management action induced change in animals available for harvest. It can also be done for non-consumptive use days per animal or other units observed or otherwise utilized multiplied by the induced change in animals or other units available.

Once the change in days of wildlife recreation is known, these days are multiplied by a dollar value per day. This only yields the economic effects of the change in wildlife recreation associated with some biological change not the total economic effects to society as a whole. Option values and existence values can also be quantified as described above but at cost that makes it impractical for routine analyses of Management plan.

There is also considerable confusion among wildlife biologists recreation planners, and a few economists about the precise meaning and measurement of dollar values of wildlife. The dollar values appropriate, e.g. for benefit-cost analysis or SAGERAM or U.S. Forest Service Resource Planning Act, are quite different than for local-regional income analysis using multipliers from input-output models. Given the large degree of confusion and the importance of this distinction, the fourth section will provide what should be a reasonably clear and concise explanation of what types of dollar values of wildlife are appropriate for the two types of analyses discussed above. Figure 2 provides an overview of four of the five methods for linking wildlife biology and economics, and also allows for representation of the continuum of available methods. That is, the five methods provide a range of analysis techniques varying from quite simple to more complex. Thus it cannot be said that one approach is better than the other, only that one approach may be more cost-effective for screening possible management plans while another may be better suited for in-depth analysis of the remaining (after screening) candidate management plans. For example, the BLM Moab District's Short Form requires one to prorate the hunting days associated with the amount of time the animals are present on the allotment or area under study. If the animals spend three months on the allotment in the spring then 25 percent of the hunter days are attributed to this area. This, of course, assumes equal

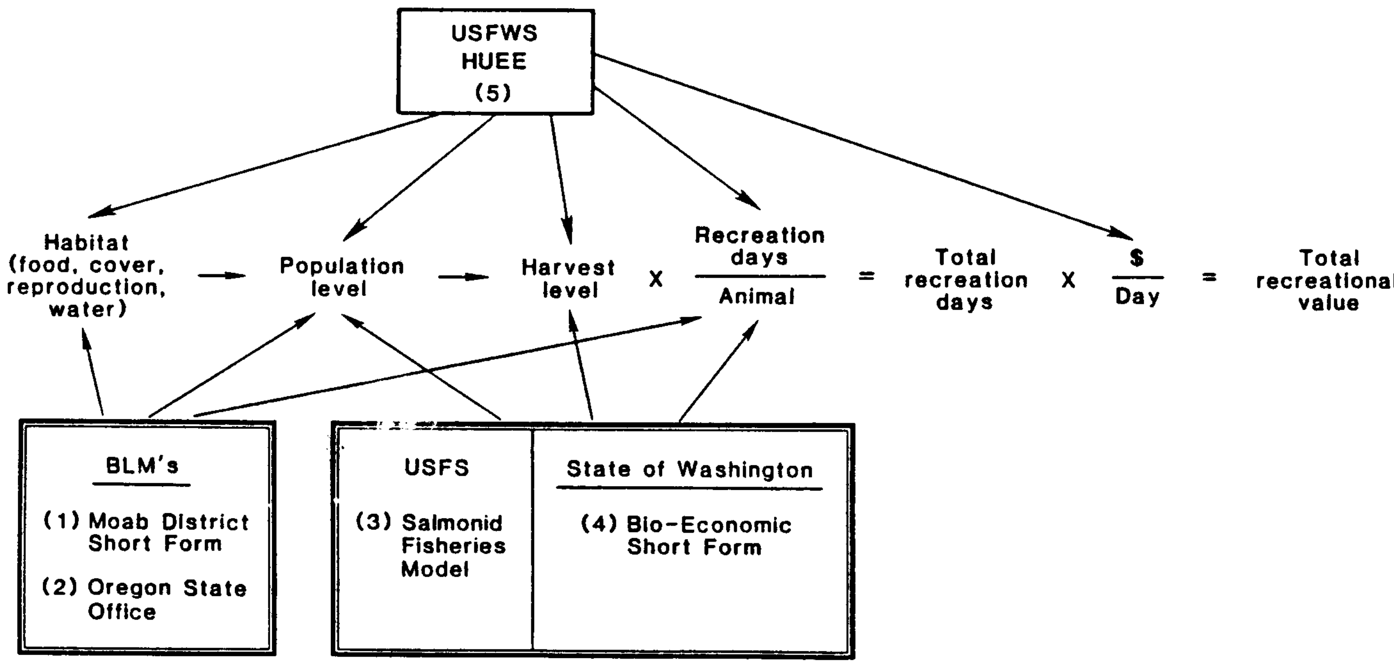


Figure A-2. Overview of bio-economic approaches.

importance of each habitat type. Habitat models developed by the USFWS's Habitat Evaluation Procedures (HEP) Group build in the importance of each habitat component and, therefore, recognize critical seasons of use much like livestock-economic models. Using the more detailed habitat models with HUEE may allow one to avoid the assumption of a constant proration of times to hunter days. But this added realism is not without its cost in terms of added inventory data to be collected. For the purpose of making an initial ranking between dozens of areas for big game habitat improvements it is more cost effective to use the Moab District Short Form. Once the two or three candidate areas have been identified for in-depth analysis, then the more realistic HEP models combined with the HUEE procedures would be warranted. The general rule is to judge the various approaches by the importance of having precise answers against the study constraints of time, budget, and personnel.

Before discussing each approach, it is worthwhile to look at one bit of inventory data common to all of these basic approaches for determining the wildlife recreationists' days dependent on or produced from the wildlife unit under study. The reason this concern is important is that very few animals may actually be harvested on the area under study. For migratory animals, big game animals, and fish species, each piece of habitat contributes something to "producing" a harvestable animal.

The first step is to determine how many of a particular species are harvested in the study area. This can often be determined by looking at the State Game and Fish Department's Harvest Books. It may be necessary to prorate the population or harvest over the wildlife management unit to the allotment. While an acre per acre proration is the simplest information on population distribution within the unit will allow a more accurate proration. Once the number of animals harvested (or population) in the study area is estimated, the next step is to determine whether the animals harvested are year-round residents in the study area or migrants from another area. If they are residents, the total harvest (or population) will be used as one component. If they are part-time residents, then one can prorate harvest (or population) based on time spent on the allotment or the importance of that habitat in supporting that animal. The key in this latter approach is to ask the following question "If I took away half of the available area of this habitat component, would the population fall by one half?" If much of this allotment's habitat is redundant due to some other habitat type (in some other season) being the limiting factor, then preparation of harvest (or population or hunter days) based on time spent on the allotment may be misleading. Habitat Suitability Index (HSI) models often can provide this type of information.

Having estimated the harvest of a given species from the area the second step is to determine the number of animals harvested elsewhere that depend on the study area for part of its habitat requirements. For this step, one basically follows the prorating techniques regarding part-time residents. Knowledge of the seasonal migration pattern is necessary to identify likely harvest locations of the animals that winter, mate or calve on the study area that are likely to be harvested. Once again, either a simple proration based on time in the study area or based on the importance of the study areas habitat to life requirements of the species is required.

Table 1 provides a procedure one might follow to do this. A less detailed approach can be found in the Oregon State Office's Biological Response Approach.

Next, we will turn to a discussion of three approaches to modeling biological-economic relationships. We will start with the simplest approach and progress to the more complex HUEE procedures.

MOAB DISTRICT HUNTER DAY SHORT FORM

BLM's Moab District Short Form was developed by Robert Milton to allow for a systematic but rapid evaluation of the change in big game hunter days associated with changes in livestock use levels. Table 2 shows one of these forms. The first page provides a simple "word model" of the changes in life requisites or habitat components in relation to habitat suitability for a particular big game species. The word model keys in on the critical factors likely to be affected by changes in livestock uses.

The current model structure does provide some information on limiting habitat factors such as water, but the importance of that limiting factor is not explicitly recognized. The model structure assumes that lack of water can be offset by greater cover, space, or forage. This assumption may be tenuous. At times information on the specific limiting factor(s) can be helpful as an aid to biologists in designing habitat improvements. In the case where water is the limiting factor, guzzlers would provide the biggest habitat benefits, for example, not more cover. The model is somewhat deficient in this regard, but could easily be modified to make the limiting factor concept explicit by taking the smallest score from each category and dividing it by three. This would yield a zero to one index but take into account the most limiting factor. This modification represents an extreme application of

Table A-1. Procedure for harvest proration.

Section I. Animals Harvested in the Study Area		
Enter animals harvested in study area	______	Line 1
Multiply Line 1 by the percent that are year round residents	______	Line 2
	______	Line 3 (answer)
Number of animals harvested on site that are migrants Subtract Line 3 from Line 1	______	Line 4
Multiply Line 4 by the dependency of these migrant animals on the study area	______	Line 5
	______	Line 6 (answer)
Subtotal of animals harvested on study area Add Lines 3 and 6	______	Line 7
Section II. Animals harvested outside the study area but dependent on the study area.		
Enter animals harvested in state wildlife management area or herd unit adjacent to or surrounding study area	______	Line 1
Enter percentage of these animals that spend time on the study area but are harvested elsewhere	______	Line 2
Multiply the percentage in Line 2 by Line 1 and enter on Line 3	______	Line 3
Multiply Line 3 by the importance of the study areas habitat to the species (can use time in study area)	______	Line 4
	______	Line 5 (answer)
Section III. The total equivalent number of animals harvested that are dependent on the study area is found by adding Line 5 from Section II and Line 7 from Section I.	______	Total

Table A-2. Rangeland investment analysis - based on population.

_____ Hunter Day Estimates without investment package
__X__ Hunter Day Estimates with investment package
_____ of _____ Habitat changes through time

Allotment #1
Wildlife Species Deer

Alternative 1
Wildlife Biologist Jim Smith

Category	Rank	Criteria	Points Change 1	Points Change 2
Forage Competition	3	Forage consumption conflicts totally or nearly eliminated.		
	1,2	Forage consumption conflicts reduced.	2	
	0	No change.		
	-1,-2	Forage consumption conflicts increased.		
	-3	Forage consumption conflicts become a major problem.		
Forage	3	Key browse, forb, and grass species increase in vigor and trend by more than 30 percent.	3	
	1,2	Either/or browse, forbs, and grass increase in vigor and trend by less than 30 percent.		
	0	No change.		
	-1,-2	Either/or browse, forbs, and grass decrease in vigor and trend by less than 30 percent.		
	-3	Key browse, forb, and grass species decrease in vigor and trend by more than 30 percent.		
Cover	1,2,3	Cover availability increases.	1	
	0	No change.		
	-1,-2,-3	Cover availability decreases.		
Water	1,2,3	Water availability increases.	2	
	0	No change.		
	-1,-2,-3	Water availability decreases.		
Space	1,2,3	Spatial conflicts decreases.	2	
	0	No Change.		
	-1,-2,-3	Spatial conflicts increases.		
		Total Points	10	

Total Points / (number of categories considered x 3) = Adjustment Factor

10 / (5 x 3) = | .67 | Adjustment Factor Change 1

_____ / (_____ x 3) = | _____ | Adjustment Factor Change 2

Table A-2. Continued.

Hunter Day / population (HD/pop) estimates	
Deer	2.0 HD/pop
Elk	4.0 HD/pop
Antelope	0.2 HD/pop
Desert Bighorn Sheep	0.2 HD/pop

Base Year:

	100	Existing Population
	x 2.0	HD/pop
	200	HD
3 months on allotment ÷ 12 =	x .25	Length of stay adjustment
	[50]	Base year HD input

Habitat Worsening

Change 1	Change 2	
		Base Year HD
x ____	x ____	Adjustment factor
		HD Loss
+ ____	+ ____	Base Year HD
[ ]	[ ]	HD Input
[ ]	[ ]	Years to Change

Habitat Improvement

200 Prior Stable for General Area

	Change 1	Change 2	
- 100 Existing Pop =	100		Potential Change
	x .67	x ____	Adjustment Factor
	67		Population Change
	x 2	x ____	HD / pop
	134HD		HD
3 Months on Allotment ÷ 12 =	x .25	x ____	Time Adjustment
	33HD		HD Change
	+ 50HD	+ ____	Base Year HD
	[88]	[ ]	HD Input
	[20]	[ ]	Years to Change

the limiting factor concept. More moderate use of the limiting factor concept would involve taking each category's score, dividing by each score three and then multiplying all the resulting index scores together and taking the fifth root. This calculation penalizes the index score if one factor is very low. Note that if one factor is negative or zero, this approach will not work.

The basic advantage of BLM's Moab District Hunter Day Short Form is its minimal data requirements and rapid analysis. It is a very useful approach when dozens of areas must be evaluated in such a short time and additional inventory data collection is impossible.

The second page of the Moab District Short Form involves calculation of hunter days from species population figures and application of the index factor. Table 2 shows an example of using the index and other data to calculate change in hunter days associated with a habitat improvement.

The hunter day/population estimates provided at the top of the table are for southeastern Utah. These numbers may seem counter-intuitive inasmuch they combine percentage of population that is harvestable and days it takes to harvest one animal. A detailed explanation of the Moab District Hunter Day Short Form can be found in Moab District Bulletin Number UT-060-83-B6.

The second page of the Moab District Short Form requires the analyst to provide an estimate of the existing population. In addition, for Habitat Improvement the prior stable or potential population must be entered. If such population estimates are available, this approach is probably preferable because population is more likely related to habitat than is harvest. For some species in some areas, existing population data and potential population estimates (prior stable) may not be available, but State Game and Fish Departments generally have existing harvest data. It is no more difficult to estimate potential harvest with optimum habitat conditions than potential population. In addition, using harvest instead of population allows use of hunter days per animal harvested, a number which is also more readily available. Table 3 presents a modified Hunter Day Short Form for use with harvest data.

In summary, the Hunter Day Short Form provides, for big game animals, a very easy-to-use and yet systematic approach for evaluating biological-economic effects. By using some of the modifications suggested in this paper, the Short Form analysis can be upgraded when sufficient data exists on the importance of one habitat type as a limiting factor. The form can be modified to use harvest data when population data is unavailable.

Table A-3. Rangeland investment analysis - based on harvest.

____ Hunter Day Estimates without investment package
__X__ Hunter Day Estimates with investment package
____ of ____ Habitat changes through time

Allotment #1 Alternative 1
Wildlife Species Deer Wildlife Biologist ____

Category	Rank	Criteria	Points Change 1	Points Change 2
Forage Competition	3	Forage consumption conflicts totally or nearly eliminated.		
	1,2	Forage consumption conflicts reduced.	2	
	0	No change.		
	-1,-2	Forage consumption conflicts increased.		
	-3	Forage consumption conflicts become a major problem.		
Forage	3	Key browse, forb, and grass species increase in vigor and trend by more than 30 percent.	3	
	1,2	Either/or browse, forbs, and grass increase in vigor and trend by less than 30 percent.		
	0	No change.		
	-1,-2	Either/or browse, forbs, and grass decrease in vigor and trend by less than 30 percent.		
	-3	Key browse, forb, and grass species decrease in vigor and trend by more than 30 percent.		
Cover	1,2,3	Cover availability increases.	1	
	0	No change.		
	-1,-2,-3	Cover availability decreases.		
Water	1,2,3	Water availability increases.	2	
	0	No change.		
	-1,-2,-3	Water availability decreases.		
Space	1,2,3	Spatial conflicts decreases.	2	
	0	No Change.		
	-1,-2,-3	Spatial conflicts increases.		
		Total Points	10	

Total Points / (number of categories considered x 3) = Adjustment Factor

10 / (5 x 3) = | .67 | Adjustment Factor Change 1

____ / (____ x 3) = | ____ | Adjustment Factor Change 2

Table A-3. Continued.

Hunter Days/harvest (HD/harvest) estimates for Utah

Deer	8.0 HD/harvest
Elk	11.3 HD/harvest
Antelope	3.0 HD/harvest
Desert Bighorn Sheep	13.0 HD/harvest

from Utah Big Game Harvest Book

Base Year:

	25	Existing Harvest (or avg. of 3 years)
	x 8	HD/ harvest
	200	HD
3 months on allotment ÷ 12 =	x .25	Length of stay adjustment
	50	Base year HD input

Habitat Worsening

Change 1	Change 2	
		Base Year HD
x ____	x ____	Adjustment factor
		HD Loss
+ ____	+ ____	Base Year HD
[ ]	[ ]	HD Input
[ ]	[ ]	Years to Change

Habitat Improvement

50 Prior Stable or Potential Long Run Harvest

\- 25 Existing Harvest = 25

	Change 1	Change 2	
Existing Harvest =	25		Potential Change
	x .67	x ____	Adjustment Factor
	16.75		Population Change
	x 8	x ____	HD /harvest
	134		HD
3 Months on Allotment ÷ 12 =	x .25	x ____	Time Adjustment
	33		HD Change
	+ 50	+ ____	Base Year HD
	88	[ ]	HD Input
	20	[ ]	Years to Change

BLM OREGON STATE OFFICE BIOLOGICAL RESPONSE APPROACH

This is a habitat-based approach to evaluating impacts on both terrestrial and aquatic species. An index model approach is used to quantify the effects of a management action on species habitat, and then to link changes in habitat to population. Once the population is known, the percentage of the population which can be harvested on a sustained yield basis is multiplied by the total population to determine the number of animals available for harvest. The number of animals available for harvest times the days it takes to harvest one animal yields the hunting use days the population can support. Table 4 is a copy of the Table used by the Oregon BLM office to record the habitat population, and hunter use days data.

This approach provides one general word model for terrestrial species and one for aquatic species. (See Table 5). These models do not incorporate the limiting factor concept described above, however, they could be easily modified to use the lowest score of any component as the limiting factor. Alternatively, the multiplicative approach is possible allowing limited habitat component substitutability.

As can be seen from Table 5, much more inventory data is required in the Oregon system, especially for aquatics. However, BLM's Oregon approach provides a useful bridge, particularly for the aquatic species, between BLM's Moab District Short Form and the U.S. Fish and Wildlife Service's HUEE. The terrestrial portions of the Oregon system and Moab Short Form are similar. In some cases, the Moab District Short Form is superior in terms of modeling impacts big game species habitat.

For complete details on the Oregon State Office Biological Response Approach, contact Ed Parsons, Division of Rangeland Resources, Bureau of Land Management Washington, D.C. or Stan Detering, BLB Oregon State Office, Portland, Oregon.

Table A-4. Oregon State Office table for recording habitat, population, and hunter use days data.

	Total Acreage of Suitable Habitat					Population Density of Suitable Habitat (#/ac.)					Estimated Population					Estimated Hunting Use Days				
	Base Year	Level				Base Year	Level				Base Year	Level				Base Year	Level			
		1st yr.	2nd yr.	3rd yr.	4th yr.		1st yr.	2nd yr.	3rd yr.	4th yr.		1st yr.	2nd yr.	3rd yr.	4th yr.		1st yr.	2nd yr.	3rd yr.	4th yr.
Deer																				
Antelope																				
Elk																				
Other Big Game																				
Waterfowl																				
Upland and Other Small Game																				

Table 5. Oregon State Office word models.

Terrestrial Model

		Rating range
1	Potential for vegetative improvement	(0) - (5)
2	Types of vegetation to benefit from grazing system	(-5) - (5)
3	Current livestock grazing system in relation to key forage species	(0) - (5)
4	Proposed livestock grazing system via AMP objectives	(-5) - (5)
5	Effects of AMP developments on wildlife habitat	(-5) - (5)
6	Effects of grazing system and developments on special wildlife use areas, e.g., elk calving areas, antelope kidding grounds, sage grouse strutting grounds, etc.	(-5) - (5)
7	Degree of change from past grazing practices to the future	(-5) - (5)

Aquatic Model
Stream Habitat Condition of the Allotment

Eight factors are involved in rating the current habitat condition element of the allotments:

		Rating Range
1	Stream Flow and Water Quality	1-10
2	Riffle/Pool Ratio	1-10
3	Stream Temperature	1-10
4	Channel and bank stability	1-10
5	Riparian vegetation structure	1-10
6	Spawning area quality	1-10
7	Substrate	1-10
8	Stream structure and diversity	1-10

HEP HABITAT SUITABILITY INDEX MODELS AS AN INVENTORY AID

BLM's Oregon State Office approach represents a useful approach, particularly for aquatic species, for evaluating wildlife habitat improvements or effects when the analysts can collect a small amount of data. One disadvantage, that is shared with the BLM Moab District approach, is the lack of individual species models. An improvement in peasant habitat may represent a worsening of waterfowl habitat. A rise in water temperature may reduce trout habitat suitability but increase the suitability for smallmouth bass. Perhaps more important, the word models for the terrestrial species are so general as to provide insufficient guidance in terms of critical amounts of grass or shrubs. Species models line those built by the U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) group are generally quite specific regarding critical variables. This aids in inventory design as well as keeping the time and costs of inventories at a minimum. Some species models are even being designed to use data which can be collected from aerial photographs.

As an example of a simple species model, we will use the pronghorn antelope model by Allen and Armbruster (1982). The food component is pictured in Figure 3. There is a food suitability index that includes two variables: (1) percentage of the land that is winter wheat; and (2) shrub characteristics. The shrub variable is related to shrub height and crown closure. Mathematical formulas are used to combine these factors into a single food suitability index. The values of this index and the cover suitability index are compared and the lowest one is used as the Habitat Suitability Index (HSI). This type of deterministic model is referred to as an HSI model. The HEP Group has published about numerous aquatic and terrestrial models.

The Habitat Suitability Index is multiplied by the area of available habitat for a species to yield what are called Habitat Units. This is similar to the multiplication of suitable acres times animal density in the BLM Oregon State Office approach. The Habitat Unit (HU) defines the quality-quantity dimensions of the available habitat. In a sense, a Habitat Unit can be thought of as the carrying capacity equivalent of an acre of optimum habitat for that species. For details on HSI models and Habitat Units see 102 ESM and 103 ESM (U S. Fish and Wildlife Service 1980b and 1981).

The next section discusses how Habitat Units can be used to reflect impacts to habitat suitability and area of available habitat in estimating the wildlife recreation impacts of management actions. Use of the models to estimate the purely biological effects of projects on wildlife provides a spinoff benefit to biologists and economists in performing bio-economic analyses.

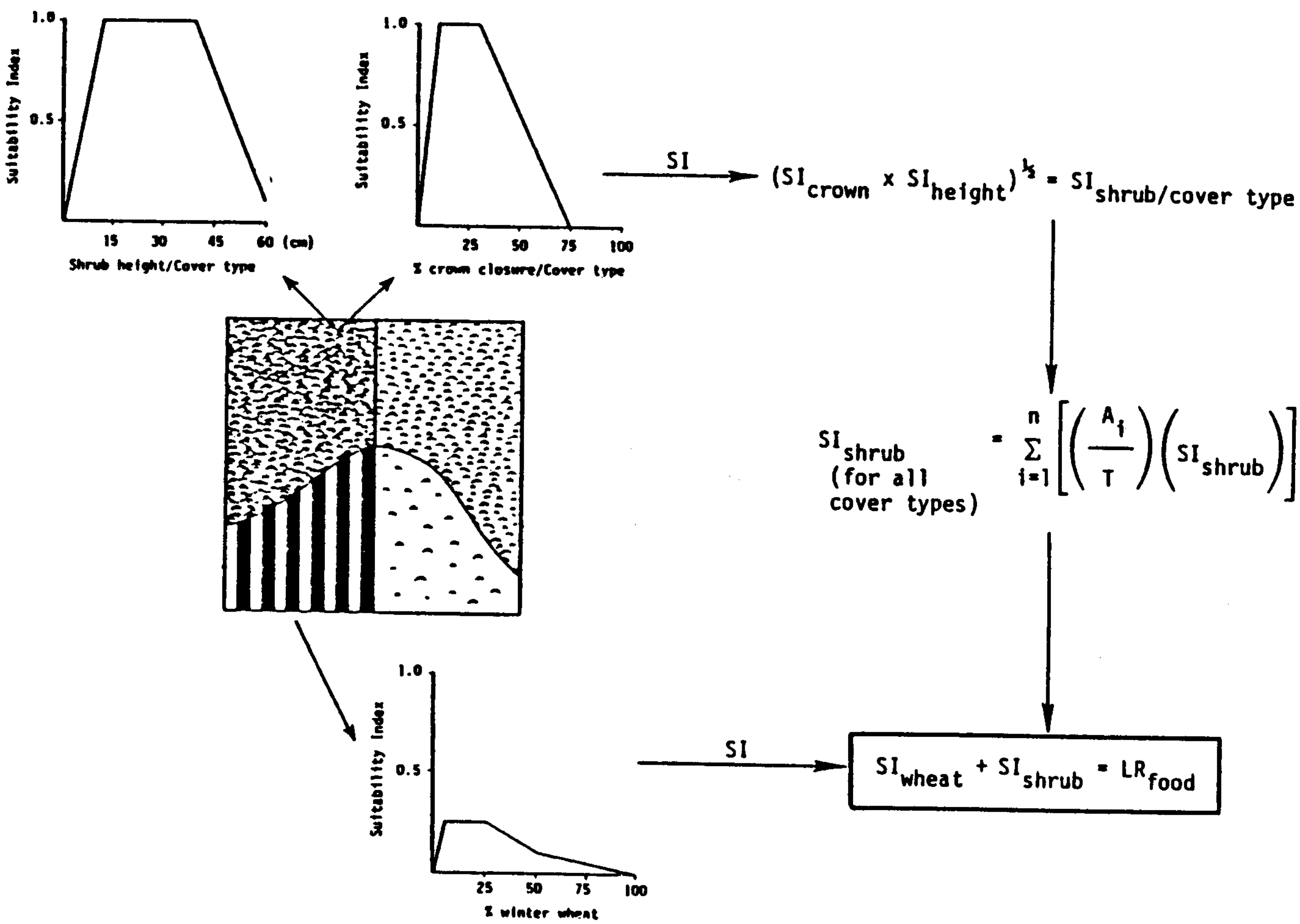


Figure A-3. Relationships of vegetative measurements to suitability indecies (SI) and food life requisite (^{LR}food). These relationships are for the pronghorn. n = number of cover types; A_1 = area of individual cover typ; T = total area of all cover types (excluding cropland).

BIO-ECONOMIC ANALYSES USING HUEE

The U.S. Fish and Wildlife Service's Human Use and Economic Evaluation (HUEE) system was developed by Rod Olson of the Western Energy and Land Use Team. The HUEE procedures can be used in conjunction with HEP Habitat Units or with population or harvest data. An overview of the procedures is provided in Figure 4. As can be seen in Figure 4, HUEE provides a way to evaluate a projects effects on supply of hunter days, and effects on the demand for hunter days. In addition, HUEE is compatible with the Travel Cost or Continent Valuation methods of valuation. The Travel Cost Method will be discussed in detail later, but briefly it is one of the best methods for empirically estimating dollar benefits of wildlife recreation and estimating recreation use. However, HUEE can utilize unit day values such as U.S. Forest Service R.P.A. values or the unit day values of the U.S. Water Resources Council.

In Figure 4, the term Potential Use refers to the amount of use people wish to make of the wildlife resource; Sustainable Use is the number of use days that can be provided by the habitat. Planned use is the lesser of the sustainable or potential use. Thus, HUEE is sufficiently general to accommodate the case when demand exceeds supply at the current price (and hence we have lotteries for permits) and the case where supply of animals exceeds the demand. Figure 5 shows how supply and demand over time are related to HUEE's concepts of sustainable use, potential use, and planned use. In this example, the middle graph shows that the factor determining hunting days to start with is human demand. By year 20, demand has risen and supply fallen such that there is equality between hunter days demanded and supplied. After year 20, demand (at current permit fees) exceeds supply so that lottery rationing or shorter seasons are needed to keep hunter pressure in line with available populations. Of course, by increasing the level of management, sustainable use can be increased, resulting in an upward shift of the sustainable use curve.

Figure 6 illustrates a negative impact to a particular wildlife population. Loss of habitat generally does not change the demand or potential use by humans but rather impacts the ecosystem's capability to support hunting or fishing. Thus, the effects are modeled as a reduction in sustainable use.

This conceptual framework is fairly complete, but for it to be useful it must be easy to translate into practice. The two factors influencing the actual amounts of hunting which can be realized are Potential Use

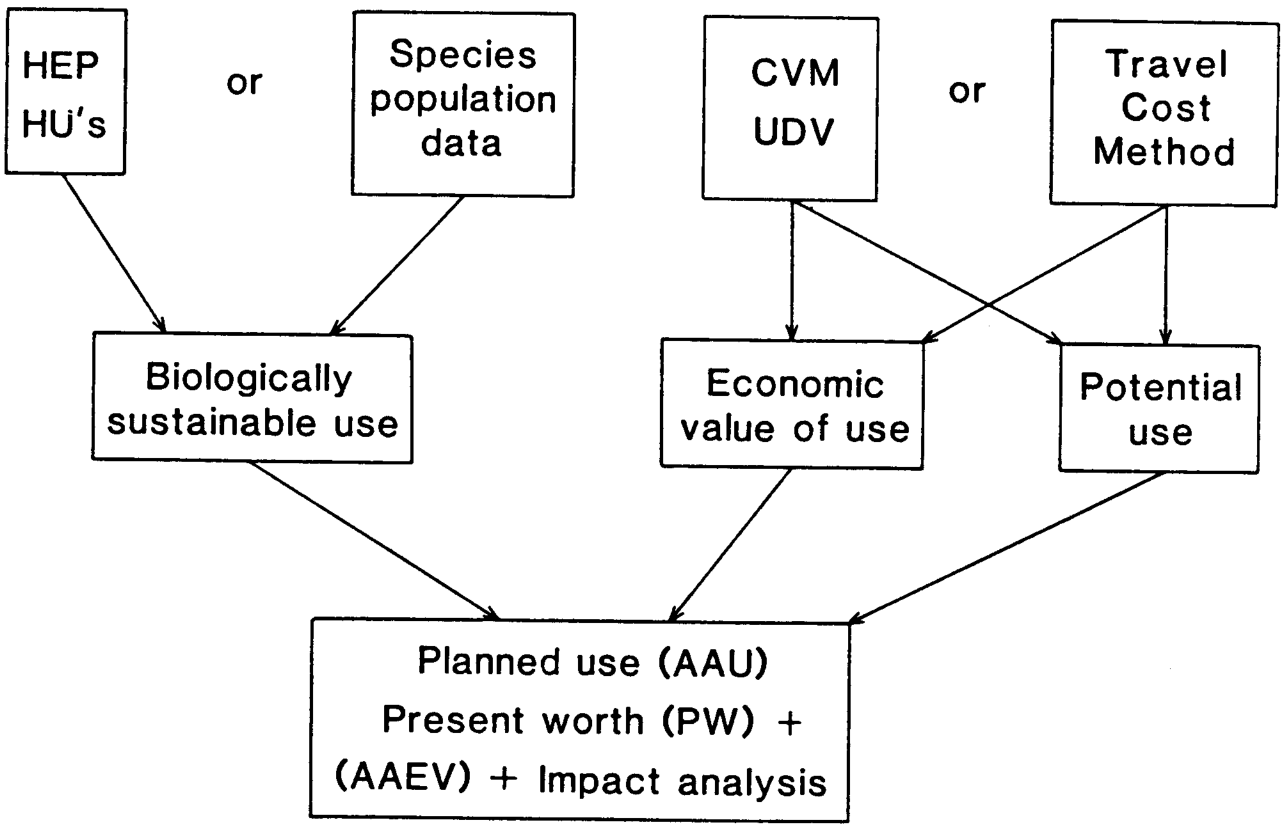


Figure A-4. Human Use and Economic Evaluation concepts.

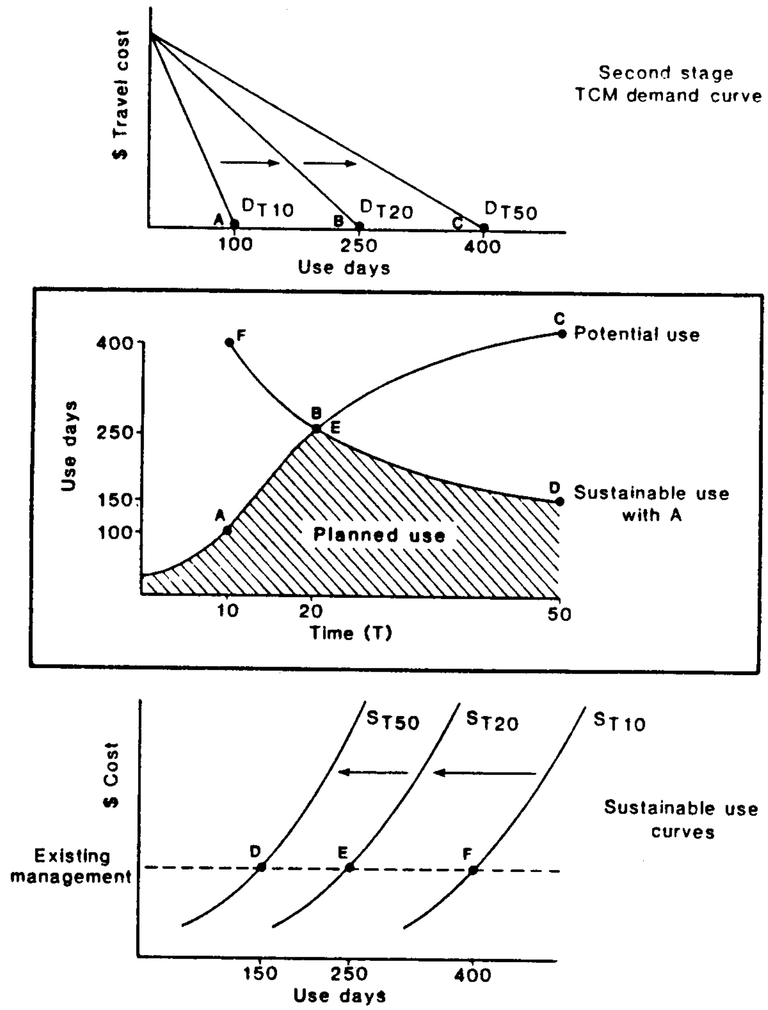


Figure A-5. Relationship of demand and supply to potential and sustainable use.

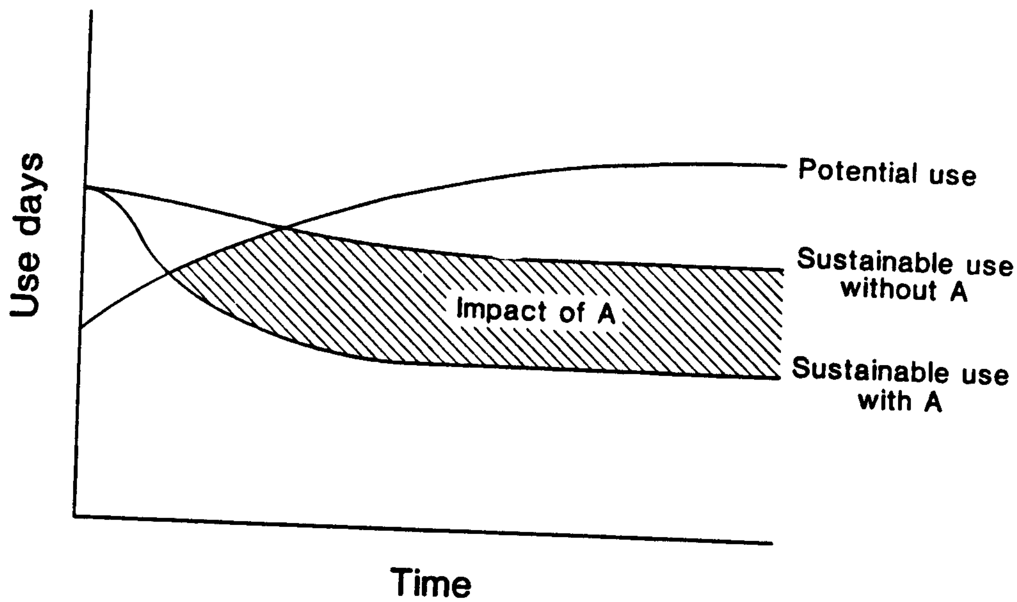


Figure A-6. Illustration of negative impacts using HUEE.

and Sustainable Use. Potential Use can be estimated in several ways. A time series regression or trend line analysis of past hunter day levels in that herd unit can be computed. This equation can then be used to forecast hunter demand if current trends continue. It is important to remember that these forecasted levels of demand will not be translated into actual use unless the wildlife habitat can support such levels of use. An alternate and better way to forecast future use is to utilize the Travel Cost Method. This technique estimates the economic benefits per day and allows for use forecasting. A general discussion of the Travel Cost Method can be found in the section on Techniques for Valuing Wildlife Use.

Once we have an estimate for the number of wildlife recreation days demanded (potential use), the amount of use the wildlife habitat can support on a sustainable basis must be computed. In HUEE this is accomplished using Form 1107, shown in Figure 7. The result of this form is shown in column 15. Column 15 shows the sustainable use days of fishing or hunting associated with that plan alternative (or future without). It is a calculation of the use days that is the end product of this form.

The analyst can begin the calculation for any particular species or group of species (i.e., waterfowl, upland game birds, etc.) in either columns 7 (Habitat Units), 9 (population), or 13 (harvest). Thus, HUEE allows use of data on Habitat Units (HU's in column 7), population (column 9), or harvest (column 13). The biologist selects the starting point. The biologist's decision is generally constrained by the availability of data on harvest, population, or habitat units. If a HEP Habitat Suitability Index (HSI) model for the species being evaluated is available along with either current population or current harvest, it is fairly easy to estimate sustainable use days.

To illustrate how the biologist uses the HSI models, inventory data and Form 1107 to estimate sustainable use days, we will go through an example for the common mallard. The mallard model is taken from Matulich, Hanson, Lines, and Farmer. The hunter day data is from application of HUEE to the Gunnison Salinity Control Project in Gunnison, Colorado (Loomis and Olson, 1981). Figure 8 presents the HSI model for breeding habitat. This model would be useful if the study area provided habitat for breeding. The model may initially appear to be somewhat complicated and to require a lot of inventory data but this is only partially true. Many of the variables to be measured are repeated several times, for example, as with units density of emergent vegetation and water depth. The first thing the model tells the biologist is which variables to inventory. For each variable there is a suitability curve to convert the measured value to an initial index score that will then be multiplied by other index scores to eventually

1. Study	Date	2. Proposed action
3. Evaluation species		

			Annual habitat capability							Utilization	
						Fish					
Activity or use	Cover type (optional)	Target year	HU's	Productivity per HU	Animal population	Percent catchable size	Catchable crop	Sustained harvest rate or use	Annual animal harvest Blocks Fish: 11 x 12 Terr: 9 x 12	Use-days per kill or catch or non-consumptive use rate	Use-days (annual)
4	5	6	7 x	8 =	9 x	10 =	11	12	13 x	14 =	15

Figure A-7. Form 3-1107. Estimate of use-day productivity by species.

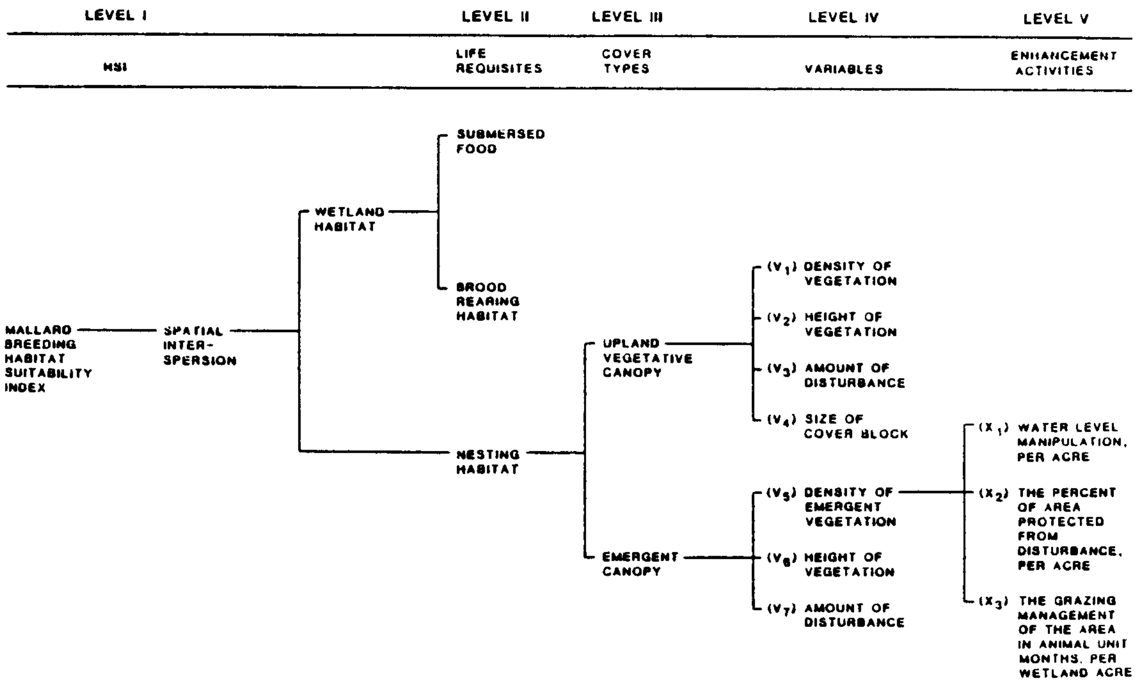


Figure A-8. Sample of simplified breeding habitat suitability index model for the common mallard (Anus platyrhynchos).

arrive at the overall Habitat Suitability Index. The other advantage of this modeling structure is that it facilitates evaluating what the proposed management action will do to duck production on this habitat. Figure 8 also shows an example of linking management actions to habitat variables. In this figure, the level of grazing (measured in AUM's), water level manipulation, and percent of habitat protected from disturbance all influence the density of emergent vegetation. The details of this interaction will not be presented here, but the linkage should be apparent to the reader. Fencing or reduction in AUM's in and around wetlands will increase the density of emergent vegetation. This increase can be seen in Figure 8 to translate into improved Nesting Habitat and possibly improvement in brood rearing habitat. Once the increase in the Habitat Suitability Index is calculated (many models have been computerized for ease of calculation), it can be multiplied by the number of acres over which the improvement occurs to yield the increase in Habitat Units. Note that if nesting or brood rearing habitats are not the limiting factors then the HSI will not rise as emergent vegetation density rises and there will be no change in Habitat Units (HU's). However, if nesting or brood habitat is limiting, then the current level of HU's in the base year (Target Year 0) and new level (base plus increase) associated with the change is entered in column number 7 of Form 1107.

Figure 9 shows the HU's for a reduction in Habitat Suitability Index and habitat area as a result of increased grazing on the study area. By a year or so, the HU's are projected to fall from the current level of 34,856 to 29,201. By using the HSI models and the effect on area of available habitat, the biologist is thus able to calculate, by species, the change in habitat carrying capacity.

If current populations are known, the animals per HU can be calculated by dividing current population (or the average population for the last three years) by HU's in target year zero. This yields animals per HU (to be entered in Column 8) which can then be multiplied by HU's in future target years to arrive at future duck populations under that alternative. In this application, we did not know current population but did know current harvest. Current harvest in the area was 4,950 ducks. Dividing this by HU's in target year zero yielded 142 ducks harvested per HU. This was recorded in column 12 and then used to predict production of harvestable ducks in future years as habitat suitability and area decreased. As is shown in column 13, available harvest decreases as HU's fall.

The next step is to estimate hunter days per harvest to calculate sustainable use days. The possible approaches here are similar to the Oregon State Office approach and the State of Washington Bio-Economic Short Form. Basically, one looks at the success rate and number of days

1. STUDY Lower Gunnison						2. ALTERNATIVE Plan A				
3. EVALUATION SPECIES Mallard Duck										
		ANNUAL HABITAT CAPABILITY						UTILIZATION		
					FISH					
ACTIVITY OR USE	TARGET YEAR	HU'S	ANIMALS PER HU	ANIMAL POPULA-	PERCENT CATCHABLE SIZE	CATCHABLE CROP	(Harvest HU's) HARVEST RATE	ANNUAL ANIMAL HARVEST	USE DAYS PER HARVEST	USE DAYS (ANNUAL)
4	6	7 x	8 =	9 x	10 =	11	12	13 x	14 =	15
Hunting	0	34,856					.142	4,950	1.0	4,950
	1	33,033					.142	4,691	1.0	4,691
	15	31,807					.142	4,516	1.0	4,516
	50	29,201					.142	4,146	1.0	4,146

Figure A-9. Example Form 3-1107. Estimate of use-day productivity by species.

the hunters spend in the field and calculates the user days per harvest. The data used in this example indicated an average of one duck per hunter per day. Thus, the available ducks for harvest converts to sustainable use days. Potential use figures are checked insure that there is sufficient demand for these use days. While the reader may recognize that if success rate fell (as the number of ducks available for harvest decreases) use days could in theory, remain unchanged. That is, the same number of hunters continue to hunt even as success falls. HUEE can easily accommodate this type of hunter behavior. This constant level of lower and lower quality hunter days will be reflected as a drop in economic benefits because as harvest per day falls, benefits per day will also generally decrease. One advantage of HUEE over other Bio-Economic systems is its ability to estimate changes in economic values even if the number of days hunted or fished remains unchanged.

The sustainable use days in column 15 of Form 1107 are entered onto column 11 of Form 1108 (shown in Figure 10). Form 1108 multiplies the sustainable recreation use days times the net willingness to pay or value per use day to arrive at the economic value of the sustainable use days. The estimation of economic value is discussed in a later section. As can be seen in Figure 10, HUEE allows for evaluation of wildlife species that have a recreational value, a commercial value or both. Form 1108 is also the point in the evaluation where one links the assumption about hunting quality over time to dollar values over time. If in Form 1107 success or bag is assumed to be dropping, then in column 12 of Form 1108, the value per day would also fall (other things affecting the value remaining equal).

The comparison of sustainable Use Days and Potential Use Days by target year and alternative is shown in Figure 11 (Form 1109). As seen in Figure 11, the effect of Plan A is to reduce the days and economic benefits below the future without. Thus the shaded areas are the loss in days and dollar benefits over the life of Plan A. These days and dollar benefits can be inputed into the HUEE software to calculate Present Net Worth (i.e., Present Net Value) of the loss in dollar benefits. Form 1109 complete the linkage from habitat to use days and dollar values. The HUEE discounting software is available in BASIC. Alternately, the data could be entered into SAGERAM software to make similar Present Net Worth or Internal Rate of Return calculation.

This mallard duck example has, so far, looked at only the change in harvest and economic benefits of year-round resident ducks. If some the ducks that breed in the study area are harvested elsewhere, an adjustment of the economic benefits is necessary. For example, maybe only half the ducks that breed in the study area are shot there, the other half are shot somewhere else. Those harvested elsewhere are partly a product of the study area's habitat, thus a loss of the study

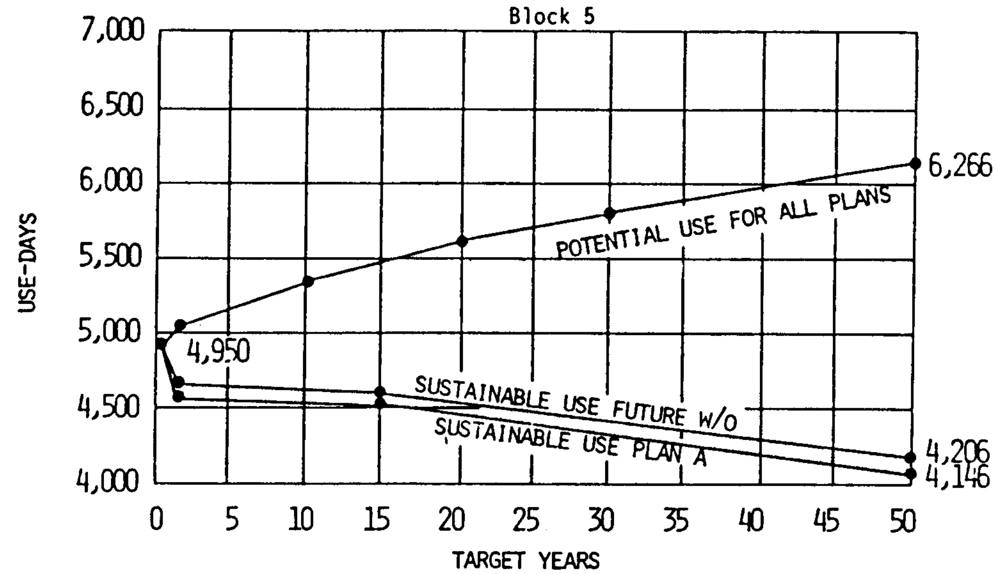
1. STUDY Lower Gunnison 2. PROPOSED ACTION Plan A

3. EVALUATION SPECIES Mallard Duck

ACTIVITY OR USE (4)	TARGET YEAR (5)	RECREATIONAL USES: TOTAL USE DAYS (11)	RECREATIONAL USES: VALUE PER USE DAY (12)	RECREATIONAL USES: TOTAL RECREATION VALUE (13)	COMMERCIAL AND OTHER USES: HARVEST (14)	COMMERCIAL AND OTHER USES: NET VALUE	COMMERCIAL AND OTHER USES: TOTAL COMMERCIAL VALUE (16)	TOTAL VALUE (13 + 16)
Hunting	0	4,950	$10.80	$53,460				$53,460
	1	4,691	$10.80	$50,663				$50,663
	15	4,516	$10.70	$48,321				$48,321
	50	4,146	$10.60	$43,947				$43,947

Figure A-10. Example Form 3-1108. Summary of potential productivity by species and other uses.

1. Study LOWER GUNNISON Date	2. Proposed Action A AND W/O
3. Evaluation Species MALLARD DUCK	4. Use HUNTING



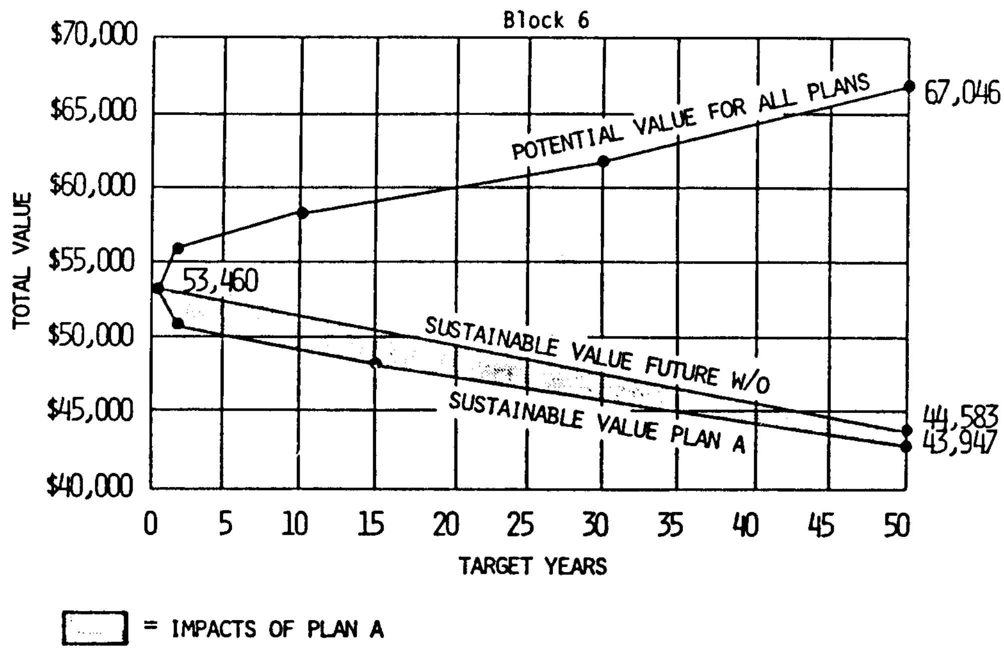


Figure A-11. Example Form 3-1109. Fish and wildlife supply and demand curves for the life of the project.

area's habitat will reduce duck hunting benefits somewhere else. This loss must be attributed to the study area in relation to how critical the study area's habitat is to the life cycle of the duck. An adjustment must also be made for any ducks that are harvested in the study area that are in migrants. The total duck hunting value occurring in the study area may be partially dependent on other habitat areas. The key is to be consistent in your assumptions so that your "rule of thumb," if applied over the entire flyway, would yield the correct total of ducks. No double counting of duck hunting benefits is allowed! The benefits of ducks passing through an area before or after duck hunting season should be valued as non-consumptive use of waterfowl (bird watching, photography, etc.).

What has been presented so far is an overview of how species specific habitat models can be used in Bio-Economic analysis. The type of inventory data to be collected and the level of detail necessary are dictated by the complexity of the habitat model chosen. The simple word models provide a useful approach for a first pass and evaluation. The more realistic models require so much extra inventorying that they should be reserved for in-depth analysis of the study areas likely to be recommended for funding. Form 1107 is adaptable to measure non-consumptive uses of wildlife as well. In this case, population and sustainable use days are directly linked. The next section of theis appendix provides an explanation of the economic value of wildlife. The techniques and data required to measure this economic value are also discussed.

ECONOMIC EFFICIENCY VALUES VERSUS EXPENDITURES

Many of the questions posed by BLM's Rangeland Investment Policy (and SAGERAM) involve determining whether the economic gain from some investment (e.g. in fencing or water development) exceeds the costs of such developments. A similar question is asked in habitat management plans, National Forest Plans and in some mitigation plans. The answer to the question "Do the benefits exceed the cost of some resource action?" requires comparison of the willingness to pay of gainers to willingness to pay of the losers (U.S. Water Resources Council 1979, 1983; Walsh, 1983; and Dwyer, Kelly and Bowers 1977). When the willingness- to-pay values of project gainers exceed willingness to pay of losers the Present Net Value is positive and the Benefit-Cost Ratio is greater than 1. This means that the efficiency of resource use has been increased by reallocating resources from lower-valued uses to higher-valued uses. Such a reallocation of resources is economically efficient because it increases the size of the economic "pie". Harberger (1971), Mishan (1976), and others (Just, Hueth and Schmitz, 1982; Sassone and Schaffer, 1978) state that the demand curve for the service under study should be used as the basis for estimating consumers' (or in this case, recreationists') willingness to pay for increases in wildlife recreation opportunities (more trips, higher harvest, increased sightings of a particular bird).

Economists' term for consumers willingness to pay is called "consumer surplus." Consumer surplus represents the consumer's additional willingness to pay for the opportunity to hunt, fish, or observe wildlife at some site. It is a net or additional willingness to pay because it is in addition to their current expenditures. Figure 12 will be used to illustrate the concept of consumer surplus. The demand curve shows the quantity of trips that a birdwatcher would like to take at alternative travel costs, where travel cost is used as the "price" of a trip. If the travel cost is only $10, he or she will take four trips. This birdwatcher's net willingness to pay to have the opportunity to go birdwatching at this site is the area under the demand curve but above the cost of $10. In Figure 12, the consumer surplus and hence, net willingness to pay associated with four trips is $105 (45 + 32.5 + 20 + 7.5). This $20.25 trip ($105 divided by 4) represents the economic efficiency benefits.

While willingness to pay is the general standard of value, there are situations where the users' "willingness to sell" or "willingness to accept" is theoretically preferred. For example, in valuing the loss of a wildlife recreational resources, if the current users have a property right to the current condition, then willingness to accept should, in theory, be used rather than willingness to pay. The difficulty with using willingness to accept in practice is that there are few estimates of these values available. Most demand estimation techniques directly provide estimates of willingness to pay. In some instances, the differences between willingness to accept and willingness to pay is expected to be rather small. Thus,it is used an approximation of willingness to accept, even when theory requires willingness to pay. It should be kept in mind that willingness to pay is a conservative estimate of willingness to sell values. Willingness to pay however, is always used for valuing improvements or enhancements to users. To answer the questions posed in Benefit Cost Analysis, SAGERAM, Resources Planning Act, and other similar evaluations, net willingness to pay (consumer surplus), not actual expenditures, is relevant. Actual expenditures provide an answer to a totally different question than the one posed above. After we show that use of actual expenditures will provide a misleading estimate of wildlife benefits we will discuss the questions relevant to the use of actual expenditure figures.

The demonstration that actual expenditures (say our $10 per trip in Figure 13) is not correct for <u>valuation</u> of wildlife recreation proceeds at two levels: First, we must remember that costs are benefits

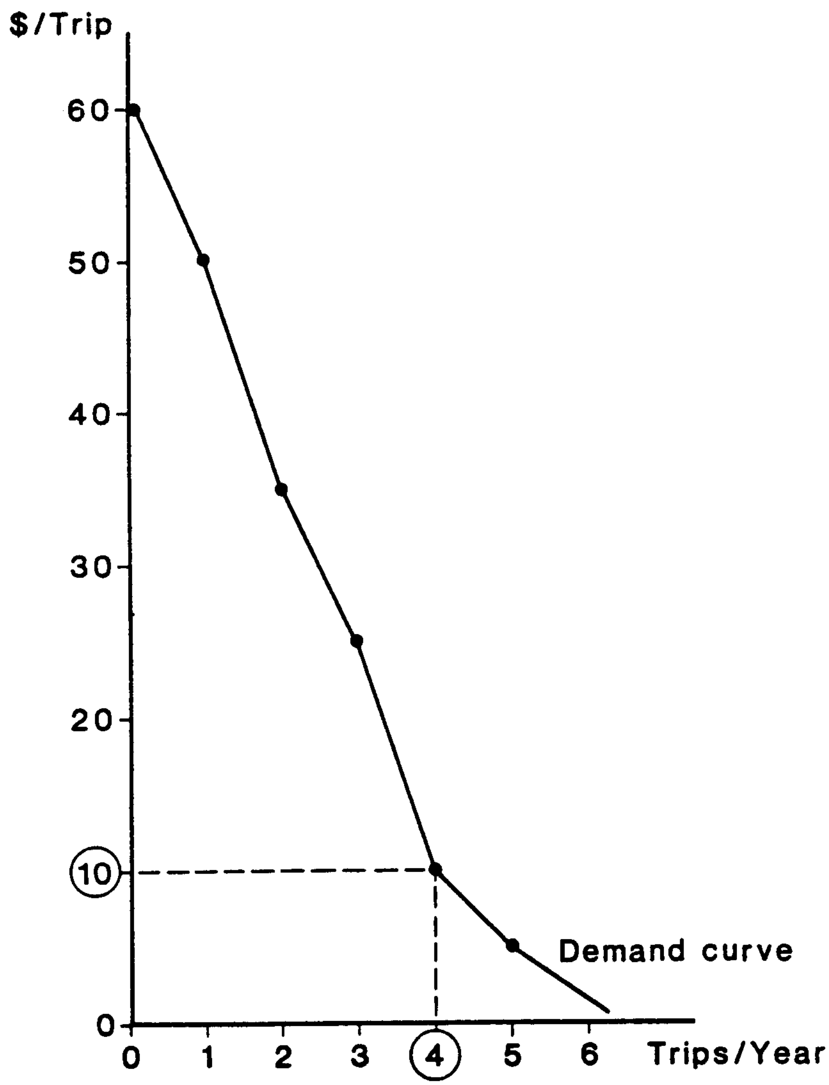


Figure A-12. Hypothetical demand curve for wildlife recreation.

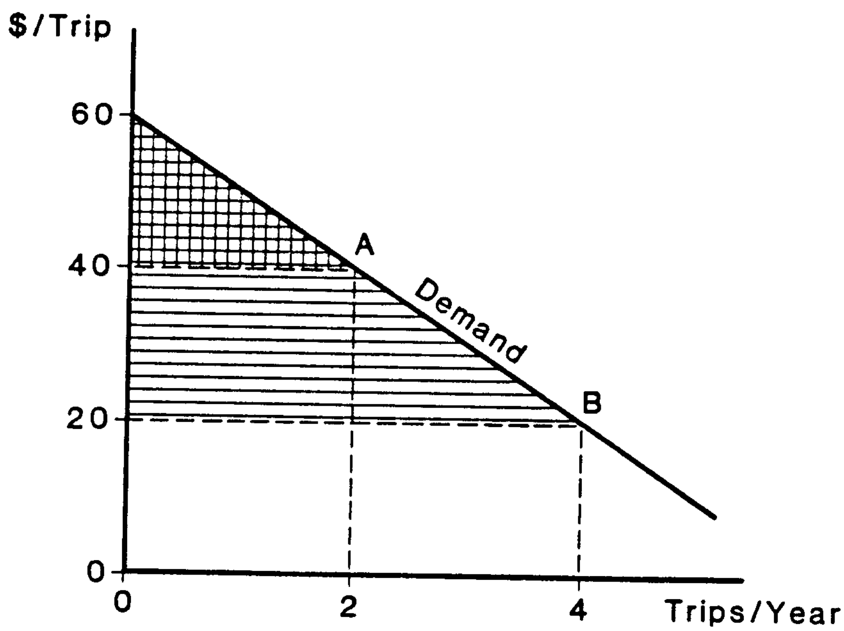


Figure A-13. Demand for two identical lakes.

foregone. The more it costs society to harvest a certain number of trees, the less the net gain to society. - That is, the more we give up to get something, the less net benefit there is to having it. In this respect, not only is it inappropriate to compare expenditures (or jobs created), it works to the detriment of wildlife anyway. A grossly inefficient deficit timber sale that requires several miles of expensive road building will result in thousands of dollars of expenditure and dozens of jobs. But if the value of the trees is lesser than all these expenditures, there has been a net loss to society. When expenditures exceed economic benefits the cost of what was given up exceeds the benefits accrued.

An example of the beneficial treatment wildlife gets when the net benefits (gross benefits minus the expenditures) of agricultural development is compared with habitat preservation can be seen in Hyde, Dickerman and Stone's (1982) paper on the Birds of Prey Conservation Area. The net benefits to agricultural development were very low due to the high costs (expenditures) necessary for farmers to cultivate this land and pump the water from the Snake River. If economic benefits are judged solely on expenditures, the inefficient agricultural development would look great. In fact, the more inefficient (the higher the expenditures) the better something looks according to the expenditure view. This is, of course, fallacious argument. Thus, there were low net agricultural benefits foregone by maintaining the prey base for the Birds of Prey Conservation area.

Figure 13 illustrated the inappropriateness of expenditures for valuing wildlife. Let's say that an agency has the choice of restoring one of two lakes for fishing. Lake A is located at a distance which requires $40 of expenditure to visit the site. At this cost per trip only two trips are taken. The total fisherman expenditure associated with Lake A is thus $80 ($40 x 2). Alternatively, Lake B could be improved and opened for fishing. Lake B is close enough so that the expenditure associated with visiting it is only $20 per trip. With our given demand curve, we can see that fishermen would cake in four visits to Lake B. At a cost of $20 per trip, this also results in an expenditure of $80.

The recreationist's expenditures will be the same whether one selects Lake B or Lake for improvement. Does the equality of recreationist's expenditure mean there is equality of economic benefits? Clearly not! If fishermen would prefer four trips to two trips (for the same total cost of $80) certainly it would be more beneficial to improve Lake B. What sort of measure or criterion would lead a decisionmaker to choose B over A. From the expenditure viewpoint, the answer is provide A or B. Not surprisingly, comparing recreationists net willingness to pay or consumer surplus will lead us to choose Lake B over A, because the consumer surplus associated with Lake B is ($80) larger than for Lake A

($20). Therefore, use of expenditures as a measure of benefits will often lead us to improve or build new recreational sites as far away from users as possible. With a higher cost, fewer trips will be taken. Maximizing expenditures leads to maximum inefficiency not efficiency.

While the loss of benefits from eliminating a fishing site because of development is measured by the loss in consumer surplus, the loss in actual on-site expenditures is not an economic cost to society. Fishermen are not simply going to take the money formerly spent on fishing at Site X and set fire the money. They (or their spouses) will spend that money visiting site Y or in buying some other good or service. Thus, the local gasoline station next to Site X may lose sales revenue when Site X is eliminated but the gasoline station at Site Y will get more revenue. There is generally no net effect on the economy of moving expenditures from one place to another. It is merely a transfer of the same level of economic activity from one place to another. Of course, BLM, the U.S. Forest Service, or Corps of Engineers is often interested in which local areas gain and which lose in this transfer of recreationist expenditure.

The question that this change in expenditures answers relates to "regional economic analysis". The specific question often is "In taking some action to improve hunting at site Y, what will the impacts be on local business and employment in the surrounding communities?" The improvement in hunting may result in more hunters and more spending in nearby Towns A and B. This gain to Town A and B will be offset by a reduction in spending somewhere else in the State or multi-State economies. But in the spirit of an agency's good neighbor policy and to fulfill the requirement of the National Environmental Policy Act of 1969, these local economic impacts need to be displayed. As we showed in Figure 13, if a manager attempted to maximize the amount being spent in Town A, this would result in an inefficient use of natural resources and lower the wildlife benefits received by the recreationist and the nation as a whole. Thus, actual expenditures are necessary data to be collected when local economic impacts are to be displayed. Often, an Input-Output model that estimates the multiplier effects, is a useful aid in measuring expenditure impact. Once again the multiplier effect of additional income to Town A is offset by a multiplier reduction in local income in Towns C through Z.

It is often alleged by managers, and a few economists, that market prices and consumer surplus estimates cannot be compared. Figure 14 will help us show that this is incorrect. We again rely on the demand curve as the general indicator of consumer's valuation (Harberger, 1971). Let us say that the current quantity of a good being provided in some market area is 100 units. The price is $10. What is the value of supplying one additional unit in this market area? For this small

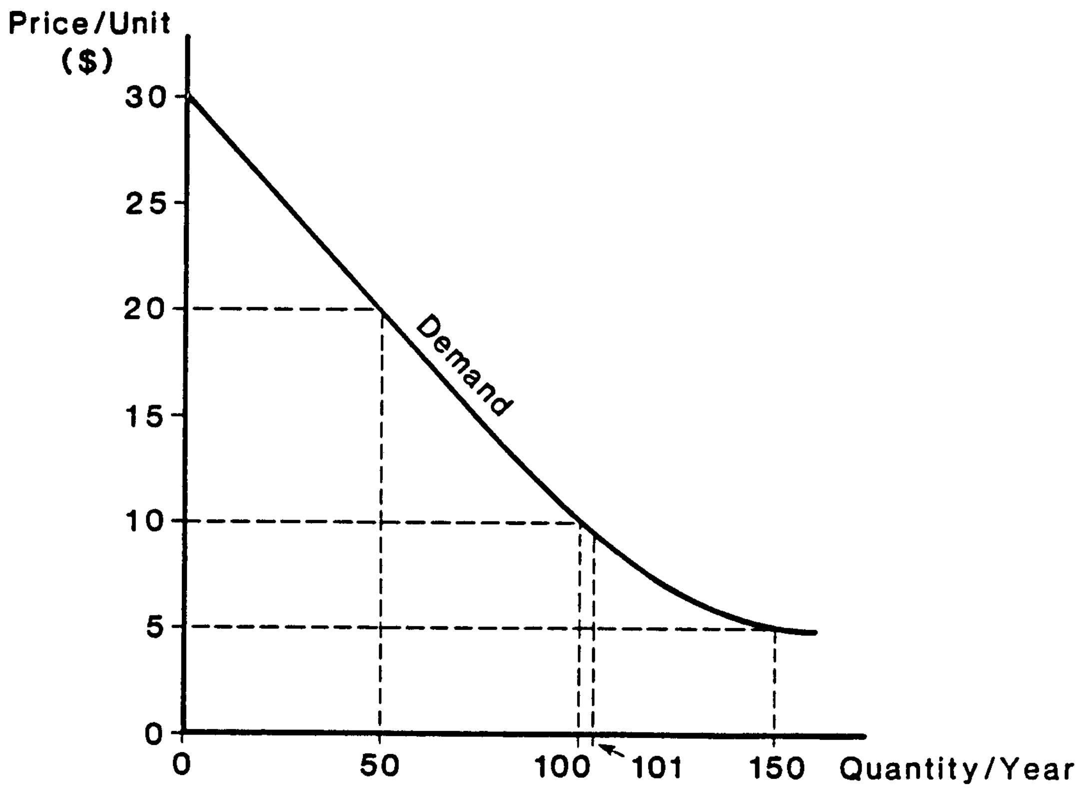


Figure A-14. Comparison of benefits using price and consumer surplus.

increase in output the price of $10 is a reasonable approximation of the consumer's gross willingness to pay. So $10 times one unit equals the $10.

Now if we substantially increase the output of this good to 150 units per year, the old price of S10 can no longer be used as a measure of consumers valuation of 50 additional units. Given that extra units are worth something less than the current quantity (because demand curves slope downward) we will estimate that the willingness to pay for the additional units is about $7.50. This figure is based on the area under the demand curve from 100 to 150 units. This is sometimes approximated by taking the price halfway between the new and the old price times the change in quantity. This same concept, i.e., that prices are not being representative of benefits to society for large increases in output, holds for large decreases in output as well. If the quantity was reduced to 50 units, the loss is not $500 but rather $750 (again the willingness to pay, as reflected by the area under the demand curve is greater than $10 for units 50 to 100). Prices represent a special or limited case of willingness to pay. Willingness to pay is the general case; prices are just a special case of measuring the willingness to pay for one additional unit.

Consumer surplus is often used for valuation of wildlife and recreation, while market prices are used for timber or beef, because of the size of the change in quantity induced by some proposed action. Timber and meat are traded in national or international markets. The change in forage available on one (or even 100) allotments in a particular state is such a small part of the total amount of forage available, it will have an almost imperceptible effect on the quantity of beef in national cattle markets. If the quantity does not perceptively change the price will not change, and thus market price remains a useful indicator of willingness to pay. However there maybe "producer surplus" or rancher income gains from additional AUM's that must be evaluated.

In the case of hunting or fishing, markets are generally very small or localized. A majority of fishermen or hunters visit areas within 200 miles of their residences. In areas like southern California, southern Utah, southern Idaho, eastern Oregon, or eastern Washington elimination of one major stream or lake will result in a substantial change in the quantity of fishing opportunities available to fishermen living in a given county. Price (travel cost) will no longer reflect willingness to pay because the increase in travel cost to visit the remaining sites would be so large; consumer surplus (the area under the demand curve between the current travel cost and new travel cost) must then be used to measure the loss in benefits to wildlife recreationists due to elimination of a major lake or stream.

Our next step is to identify which methods are available for measuring the willingness to pay for wildlife and what type of data these methods require.

METHODS FOR VALUING WILDLIFE RECREATION

Travel Cost Method:

The Travel Cost Method (TCM) relies on the variation in recreationists travel costs to trace out the demand curve for a recreation site. The strengths and weaknesses of the TCM as a tool for estimating benefits of recreation are are described in Dwyer, Kelly, and Bowes (1977). Figure 15 shows the different supply costs of making a trip from each of four origins (counties) surrounding the site. Next, we record the number of visits per capita from each county to the site, at each travel cost. These different combinations of travel cost and visits per capita represent price-quantity points that trace out a demand curve. From this demand curve we can calculate the consumer surplus or net willingness to pay for a recreation site by taking the area under the demand curve but above the travel cost for each zone of origin.

This basic demand curve should be augmented to include shifter variables reflecting the price of substitute sites and socioeconomic variables such as income. By combining origin-visitation data for several sites a quality variable can be incorporated as a demand curve shifter. The quality variable could reflect biological factors such as harvest or catch rate.

Another use of the TCM besides valuation is use estimation. A simple single site TCM demand curve can be used to estimate hunter demand (Potential Use in HUEE) over time. This is easily done by multiplying each county's current visit per capita rate times the projected future county population. Thus, if a demand estimate is needed for the year 1990, all one must do is:

1. At the current travel cost for each county, use the equation to estimate current visits per capita.

2. Multiply this result by each county's forecasted Population in 1990.

When using a Regional TCM equation that includes a quality variable such as harvest, one can even estimate a future visit per capita rate that will vary with future harvest. To get a future demand estimate, the analyst would multiply each county's future visit per capita figure by each county's future population.

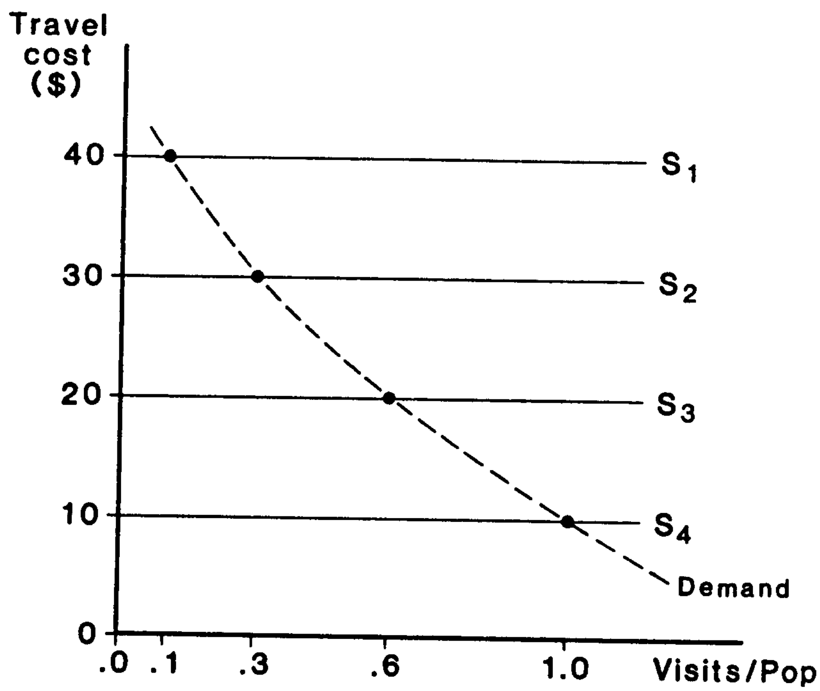


Figure A-15. Derivation of Travel Cost Method demand curve.

Inventory Data Required:

The Travel Cost Method (TCM) requires data on wildlife recreationist's travel cost or distance traveled to the site. If surveys are available providing travel cost (or distance) and city or county of residence they should be used. However, one advantage of the TCM is that existing information from hunting licenses, game tags or even license plates can be used to determine the wildlife recreationist's city or county of residence. If one knows the county or city of residence, the round-trip distance to the fishing or hunting site can be calculated from maps. The distance can be converted to a travel cost using the U.S. Department of Transportation's "Cost of Owning and Operating a Motor Vehicle".

The information on visits needs to be grouped by county so that the visits per capita can be calculated by dividing visits by county population. This variable becomes the dependent variable in the regression for statistically estimating the demand curve. Thus, it is generally important to know the county or city (or zip code) of hunter/fishermen/wildlife observers. Knowing the number of wildlife recreationists per vehicle and number of days per trip is also useful.

Data Sources: Several data sources exist for big game hunting. The State game and fish departments often record (or when asked are willing to record) the zip code or city of residence when they do their post-season harvest survey for the general big game season. The game department records the herd unit that an animal is harvested in, (and often the herd unit where hunting not leading to harvest took place,) thus, the two basic types of data for TCM have been collected: location of residence and herd unit. Connecting these enables us to calculate round trip distance and estimate round trip travel costs. Other big game data sources include applications for controlled, limited, or special hunts. The applications for a hunting permit require the herd unit to be identified, therefore, the data are present to estimate a TCM demand curve. Even if some of the applicants were unsuccessful in obtaining a permit, the demand curve can be estimated using applications, with the average value per permit applied to the number of successful applicants only. See Loomis (1982) for details.

For activities such as upland game or waterfowl hunting, the analyst must rely on the State game agency to record or at least match city or zip code of residence from the license to the hunting unit hunted in when the State performs its harvest survey. In other cases, special surveys may have been performed as "Federal Aid" reports, from which data on residence and hunting unit may be matched. In some cases the published data is highly aggregated and does not provide the necessary detail. Generally, if one can access the original surveys or postcards the required level of detail can be obtained. For example, the postmark often indicates the city from which it was mailed. Assuming it is mailed from the hunter's residence, the postmark will often provide the necessary resolution of location to perform a TCM analysis.

Data on fishermen residence and fishing sites may often be obtained from special "creel census" carried out by the state or from Masters Thesis and Ph.D. dissertations in Departments of Economics, Agricultural Economics, or Wildlife Biology. USFWS Cooperative Wildlife/ Fisheries units have often collected survey data on fishermen travel expenditures, distance travel, number in the party, days on site, etc. In many cases, the data indicates county of residence and provides sufficient detail for performing a TCM analysis.

In many States, license plate numbers are keyed to county of residence. By simply visiting the recreation site of interest and recording license plate numbers (in some States, the county name is even printed on the plate) one can get an approximate idea of the origin of wildlife recreationists. This is a useful method for collecting data on non-consumptive use of wildlife such as birdwatching or photography.

The BLM's Oregon State Office, and Washington Office have developed a "Social and Economic Survey Instrument." The Wildlife Economics sections contain answers to some questions which could provide data for performing a TCM analysis. Standardized national surveys such as the U.S. Fish and Wildlife's 1980 National Survey of Fishing, Hunting and Wildlife Associated Recreation provide some information on travel costs that would enable one to perform the "individual observation" type Travel Cost Method (see Brown. et al. 1983). The USFWS's "National Survey" includes the both the TCM and Bidding Method (to be discussed in the next section) for deer hunting, duck hunting, and trout fishing. Data to build TCM demand curves is available for elk, antelope, upland game, and warm water fishing.

<u>Contingent Value Method</u>:

The Contingent Value Method (CVM) is also known as the Direct Method or Bidding Method. With this method, wildlife recreationists are asked to hypothetically bid for the right to have access to a recreation site for fishing or hunting. The intent is to <u>directly</u> estimate the wildlife recreationist's net willingness to pay (consumer surplus).

Estimation (as distinct from application) requires the administration of a carefully constructed survey. The U.S. Water Resources Council (1979) and Dwyer, Kelly and Bowes (1977) provide a good review of the steps in survey design and implementation. Inasmuch as the wildlife biologists at the field level will rarely construct such a survey, what is relevant is information sources on <u>existing</u> CVM-derived willingness to pay estimates. The data sources and application of CVM derived estimates of net willingness to pay will be discussed in the next section. Before doing so, it is worthwhile to dispel any doubts about the validity and reliability of dollar estimates of net willingness to pay derived from application of the Contingent Value Method. Bishop and Herberlein (1979) have shown that CVM estimates of net willingness to pay are conservative estimates of value. They based this conclusion on a unique controlled experiment comparing acceptance of cash for goose hunting permits versus CVM responses to hypothetical questions of willingness to pay. Brookshire et al. (1982) have shown that the CVM yields conservative estimates of willingness to pay for air quality improvements. These researchers base their conclusion on a comparison of CVM responses to hypothetical questions of willingness to pay and actual property value differentials calculated by the Hedonic Method.

Sources of Existing CVM-Derived Values: Table 6 presents CVM values for trout fishing and deer hunting in 11 western states. These dollar values per day were the result of an iterative bidding sequence performed in an in-person survey. The values represent net willingness to pay over and above current costs. For a comparison of these dollar values to TCM-derived values for Colorado, Utah, Oregon, and Arizona, see Loomis and Sorg (1983).

Other sources of CVM-derived values include articles appearing in such journals as Land Economics, American Journal of Agricultural Economics, Western Journal of Agricultural Economics, and Journal of Leisure Research. Ph.D. dissertations and Masters Theses in the economics departments of the University of Wyoming, University of New Mexico, Utah State University, and University of Washington have empirically estimated dollar values for western States using the Contingent Value Method. The Transactions of the North American Wildlife Conference often contains economic values derived using CVM.

Table 6. 1980 national survey of fishing, hunting, and wildlife associated recreation

State	Mean	Standard Error
Trout values per day		
Arizona	19 54	± 4.195
California	20.53	± 2.083
Colorado	16.16	± 1.95
Idaho	12.93	± .93
Montana	16.47	± 1.88
Nevada	12.35	± 1.485
New Mexico	15.70	± 1.46
Oregon	13.49	± 1.82
Washington	14.03	± 2.54
Wyoming	16.87	± 1.54
Utah	12.57	± 1.17
Deer values per day		
Arizona	32.50	± 4.95
California	37.35	± 7.87
Colorado	23.49	± 4.187
Idaho	28.77	± 2.63
Montana	25.42	± 2.43
Nevada	29.02	± 3.92
New Mexico	29.11	± 2.60
Oregon	21.44	± 3.06
Washington	24.18	± 4.26
Wyoming	36.26	± 3.26
Utah	25.72	± 2.69

These net willingness- to- pay values were derived from the Contingent Value Method using iterative bidding.

In some States, the game and fish agency or universities are willing to cooperate with a Federal agency in performing a Contingent Value survey. This is often a timely and inexpensive way to develop CVM derived dollar values for both current conditions and hypothetical future conditions. The biologist should be careful to not get the Federal agency involved financially in the survey itself otherwise OMB clearance may be required. This can, in some cases, delay the survey several months.

CONCLUSION

The purpose of this appendix is to describe a continuum of bio-economic analysis techniques. All of the techniques discussed translate habitat or population into wildlife recreation days. Some of the techniques use simple word models of species-habitat relationships. These simple bioeconomic techniques are well-suited for a quick, cursory evaluation that simply ranks alternative areas or management actions. When the alternatives have been narrowed down to three or four areas or actions, species specific habitat suitability models are likely to be more accurate indicators of biological response.

Once the biological response in terms of hunter or fishermen days has been estimated for each alternative, there is a need for valuation of those hunter or fishermen days. The economic valuation must be performed in a manner that yields dollar values consistent with how marketed commodities such as beef, coal, or wheat are valued. The standard of valuation used in Benefit-Cost analysis for marketed and non-marketed outputs is net willingness to pay. It was shown that prices are a special case of net willingness to pay, i.e., price is the willingness to pay for the last, perfectly divisible, unit of a good.

Two techniques for measuring the net willingness to pay for wildlife recreation were discussed. These are the Travel Cost Method and Contingent Value Method. Each method has its strengths and weaknesses in valuing wildlife recreation. The Travel Cost Method has two advantages:

1). The capability to use existing data from hunter applications or licenses to allow statistical estimation of the demand curve for the activity at a particular site.

2). Allowing both a benefit estimate and use projection (demand projection) over time from the same model framework.

The advantage of the Contingent Value Method is its ability to look directly at the dollar value of improvements in harvest or quality of recreation. For example, the increase in value for higher success rates or for trophy animals can be estimated. Estimates of net willingness to pay derived from the Contingent Value Method for deer hunting and trout fishing were presented.

As is evident from this chapter, several bio-economic analysis systems provide the capability to translate the benefits of habitat improvements into dollar terms. Besides fulfilling legal requirements to make such conversions, the benefits can be compared to the costs of making a habitat improvement. Inasmuch, our traditional valuation techniques only value recreation, it would be inappropriate to interpret the recreation benefits as the value of the habitat. Rather, the net benefits (Present Net Worth or Internal Rate of Return) provide information on the economic efficiency of habitat improvements. If the recreation benefits alone exceed the cost, there is assurance that the project will increase national well-being. If the benefits are less than the cost, the decisionmaker must ask whether the Project substantially increases intangible economic efficiency benefits (option, existence, or bequest values for a wildlife species of high public interest) or substantially improves equity. Thus, the Internal Rate of Return or Benefit Cost Ratio does not, by itself make the decision on whether or not to implement a management action. The Internal Rate of Return or Benefit Cost Ratios inform the decisionmaker and the public taxpayer regarding the economic efficiency of such investments. There may be other legitimate social objectives that outweigh economic efficiency in determining whether the investment is to be made. These other objectives should be documented in the decision process regardless of what the economic efficiency analysis shows. In this way, bio-economic analysis and economic analysis in general can make a contribution to an improved decision rather than appearing to bind the decisionmakers hands.

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B.1 Introduction. This Appendix provides the forms and instructions for developing estimates of use-days and dollar values of recreational and other uses of wildlife. Figure B-1 provides an overview of each HUEE form in relation to all other forms. Note that Forms 1107 and 1108 are used to estimate the use sustainable by the wildlife. The potential use or demands by humans are estimated from consumptive or non-consumptive worksheets. Form 1109 is used to show use that is both sustainable by animals and demanded by humans (area under both curves) as well as the value of this use. Output data are calculated on Forms 1110 and 1111, and compared on Form 1112 to show impacts. Frequent reference to Figure B-1 can maintain perspective when using individual forms.

A list of species must be developed for the Human Use and Economic Evaluation (HUEE). This list of species is used throughout the HUEE; each species on the list must be evaluated for each proposed action, and for without project conditions, even if no change in use occurs with a given proposed action. By evaluating the identical list of species for each proposal, the levels of use projected for each proposed plan can be compared with the levels of use for the same species evaluated under without-plan conditions.

If human use of a species is significantly changed by any alternative plan, that species should be entered on the list.

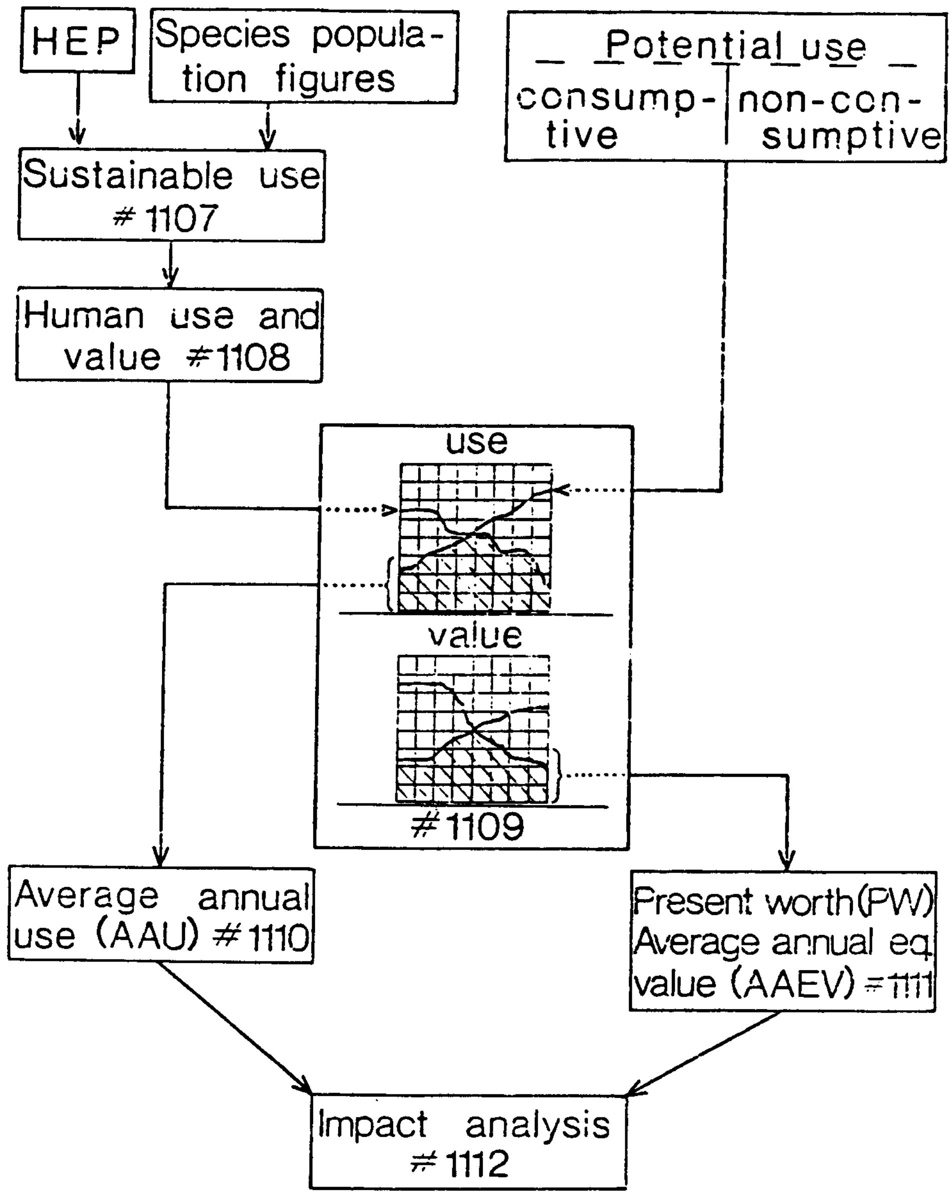


Figure B-1. Human Use and Economic Evaluation Forms.

B.2 Form 3-1107. Estimate of use-day productivity by species.

A. Purpose. This form is used to develop estimates of use-days for each terrestrial or aquatic evaluation species. Both consumptive and nonconsumptive uses are evaluated. The annual use that the species can sustain constrains or limits the demands (human needs) for the species.

B. Instructions. For each proposed action, Form 3-1107 must be completed for each evaluation species. Estimate the level of use that each terrestrial or aquatic species can sustain each year without reducing the available population in the future or reducing the quality of nonconsumptive use. This estimate is the potential use level or supply available for hunting, fishing, trapping, and nonconsumptive activities. The species and its harvestable population are dependent on habitat quantity and quality. Changes in population numbers will reflect habitat changes, including those changes induced by a project.

(1) Block 1. Enter name of study and date.

(2) Block 2. Enter name of the proposed action.

(3) Block 3. Enter name of evaluation species from common list (see Introduction).

(4) Columns 4-6. Enter uses, by cover type(s) if cover type(s) have been developed in the HEP analysis, and target years as shown in the following example for Canada geese:

Activity or Use 4	Cover Type 5	Target Year 6
Hunting	Cornfield	1
		25
		50
		100
	Riparian hardwood	1
		25
		50
		100
Bird-watching	Riparian hardwood	1
		25
		50
		100

(5) Column 7. Enter estimates of HU's for the evaluation species. These numbers are produced by the Habitat Evaluation Procedures (102 ESM) (HEP Form B, Column 7 or HEP Form A-2, Column 9). Form A-2 is optional and is used only if data are needed by cover type. If animal population data are used instead of animals per HU, enter the number of acres or other geographic unit for the evaluation species.

(6) Column 8. Enter the number of animals per HU. This estimate is based on the productivity of the habitat for the evaluation species as measured by the habitat analysis. Data for species requiring more than one unit of area are entered as fractions. A deer, for example, that requires four HU's is entered as 0.25 or ¼. For aquatic species, standing crop is used rather than animals per HU. Standing crop data may be expressed in pounds per acres, or similar units.

If animal population data are used instead of animals per HU, enter the number of animals per acre or other geographic unit.

(7) Column 9. Calculate animal population by multiplying each entry in Column 7 by the corresponding entry in Column 8. For example, the fall population of terrestrial species prior to harvest or the standing crop of fish.

(8) Column 10. Enter the percent catchable size for aquatic species. Columns 10 and 11 also may be used for terrestrial species by entering in Column 10 the percent of the population represented by a given sex and age group when, for example, only bucks of a certain size are harvested.

(9) Column 11. Calculate aquatic catchable crop (or similar data for a terrestrial species) by multiplying each entry in Column 9 by the corresponding entry in Column 10. Where a species is used for both recreational and commercial purposes, estimate the proportion harvested by each method and enter prorated figures for recreational use in Columns 11-13. Enter prorated figures for commercial use on Form 3-1108.

(10) Column 12. Enter the estimated sustained harvest rate or use. This estimate is developed by members of the evaluation team utilizing hunting, fishing, trapping, or nonconsumptive use records.

(11) Column 13. Calculate the annual harvest by multiplying each entry in Column 12 by the corresponding entry in Column 9 for terrestrial species or by the corresponding entry in Column 11 for aquatic species and those terrestrial species entered in Columns 10 and 11.

(12) Column 14. Enter use-days per kill or catch or nonconsumptive use rate estimated from hunting, fishing, trapping, or nonconsumptive use records. Data for species that require less than one day per catch or kill or other use are entered as fractions. For example, a catch of four trout per day. would be entered as 0.25 or ¼ of a day per trout caught. Nonconsumptive use rates should reflect the number of use-days the species can tolerate without significantly reducing the quality of the activity.

(13) Column 15. Enter the product obtained by multiplying the entry in Column 13 by the corresponding entry in Column 14. This provides an estimate of the annual use sustainable by the specified evaluation species.

Form 3-1107. Estimate of use-day productivity by species.

1. Study　　　Date　　　2. Proposed action

3. Evaluation species

			Annual habitat capability							Utilization	
						Fish					
Activity or use	Cover type (optional)	Target year	HU's	Productivity per HU	Animal population	Percent catchable size	Catchable crop	Sustained harvest rate or use	Annual animal harvest Blocks Fish: 11 x 12 Terr: 9 x 12	Use-days per kill or catch or non-consumptive use rate	Use-days (annual)
4	5	6	7 x	8 =	9 x	10 =	11	12	13 x	14 =	15

B.3 Form 3-1108. Summary of potential productivity by species for recreational and other uses.

A. Purpose. This form is used to develop estimates of the potential productivity, in use-days, for each recreational use. It also provides an estimate of, and the total dollar value of, these use-days, plus the dollar value of commercial or other uses. The summation must include a value for each target year for each activity so that the sum for a given target year will include values for all activities.

B. Instructions. Prepare a separate Form 3-1108 for each species under each alternative.

(1) Block 1. Enter the name of the study and date.

(2) Block 2. Enter name of the proposed action.

(3) Block 3. Enter name of the evaluation species.

(4) Column 4. Enter activity or use listed in Column 4 of the corresponding Form 3-1107 for the evaluation species.

(5) Column 5. Enter target years from Column 6 of the corresponding Form 3-1107.

(6) Columns 6-10. If HEP Form A-2 is used to enter HU's on Form 3-1107, list the cover types from Column 5 of the corresponding Form 3-1107 at the top of Columns 6-10. Enter the use-days for each target year for each cover type from the appropriate line in Column 15 of Form 3-1107. If additional columns are needed, the user must develop an expanded Form 3-1108 or use a blank Form 3-1108. If HEP Form A-2 is not used, Columns 6-10 are blank.

(7) Column 11. Enter data from Column 15, Form 3-1107, if HEP Form B is used to enter HU's on Form 3-1107. Otherwise, sum the entries in each line in Columns 6-10 and enter the total use-days in Column 11.

(8) Column 12. Enter the value per use-day for each activity listed in Column 4. These values can be developed and justified by following the Instructions for Calculating Unit Dollar Values for Recreation (Appendix C). Values also may be obtained from State files, consultants, Federal agency studies or surveys, or other sources. These values should be justified and explained when used.

(9) Column 13. Calculate total recreational value by multiplying the entry in Column 11 by the corresponding entry in Column 12.

(10) Column 14. Enter the annual commercial harvest (e.g., number of animals harvested) or scientific or educational usage (e.g., number of animals taken or number of visit-days).

(11) Column 15. Enter either the net value or profit per unit of commercial harvest (e.g., net value per pelt, lb or kg of fish, or animal) or the net scientific or educational value per use. Net scientific or education values may be estimated as the difference between the value that a user would be willing to pay to obtain an additional unit of use and the cost of obtaining that use.

Both variable costs per unit of use (e.g., fuel) and fixed costs (e.g., annual depreciation of additional equipment required to obtain increased output from a hatchery) should be deducted from gross return (income) received from the sale of commercial products.

The commercial or other use should be estimated for the geographic area pertaining to the cover type areas shown in Columns 6-10 or a more extensive area if appropriate for commercial or other uses.

(12) Column 16. Calculate total commercial harvest or other use by multiplying the entry in Column 14 by the corresponding entry in Column 15. If multiple uses occur (e.g., commercial and educational), calculate the value of each separately and enter the total of these values in Column 16.

(13) Column 17. Add each entry in Column 13 with the corresponding entry in Column 16 and enter this sum in Block 17. This sum is an estimate of the total value of recreational and commercial or other uses.

Form 3-1108. Summary of potential productivity by species for recreational and other uses.

1. Study   Date   2. Proposed action

3. Evaluation species

Activity or use	Target year	Use days by cover type[1/] if HEP Form A-2 is used (list types)					Recreational uses			Commercial / other uses			Total value (13 + 16)
							Total[1/] use-days	Value per use-day	Total value	Annual commer-cial harvest	Net value (per pelt, kg, etc.)	Total commercial or other value	
4	5	6 +	7 +	8 +	9 +	10 =	11 x	12 =	13	14 x	15 =	16	17

[1/] From Form 3-1107 (Column 15).

B.4 <u>Form 3-1109. Fish and wildlife supply and demand curves for the life of the project.</u>

A. <u>Purpose</u>. This form is used to determine the projected or planned use that is both sustainable by the species and needed (or demanded) by humans for recreational, commercial, and other uses. The projected use for each proposed action and the future-without-project conditions is constrained by the use sustainable by the species.

B. <u>Instructions</u>. Complete a separate Form 3-1109 for each species under each proposed action. Construct separate supply and demand curves covering the life of the project for each of the uses listed on Form 3-1108 so that the availability (supply) and use (demand) of these resources can be annualized. The supply curves are developed from the potential sustainable use data developed on Forms 3-1107 and 3-1108. The demand curves are developed from appropriate sources (e.g., State wildlife agencies, hunting and fishing surveys, or other similar records). Demands should reflect the total use needed by humans, whether or not the wildlife can sustain this use. Example supply and demand curves (in use-days) are shown on Form 3-1110.

(1) <u>Block 1</u>. Enter the name of the study and date.

(2) <u>Block 2</u>. Enter name of proposed action.

(3) <u>Block 3</u>. Enter name of the evaluation species.

(4) <u>Block 4</u>. Enter use. A separate Form 3-1109 is completed for each use shown on Form 3-1108, Column 4.

(5) <u>Block 5</u>. Plot the supply curve using the use-days data in Column 11, Form 3-1108, for each target year. These data reflect the species' capability to sustain human recreational uses.

Develop and plot demand data obtained from appropriate sources (e.g., State wildlife agencies, hunting and fishing surveys, studies using travel cost or other models, or similar sources or records). Demand may be estimated based on the projected rate of population growth, income and other socioeconomic variables, preferences for certain species, and other factors. A statistical projection using regression techniques is desirable but not required. Plot the use-day demand curve with points (data) developed for each of the target years for "Without Project" conditions. The same "Without Project" demand curve is used for each proposed action, unless a proposed action induces changes in demand. Such changes are unlikely because human needs or demands exist independently of the project. A proposed action may, however, stimulate previously latent demand.

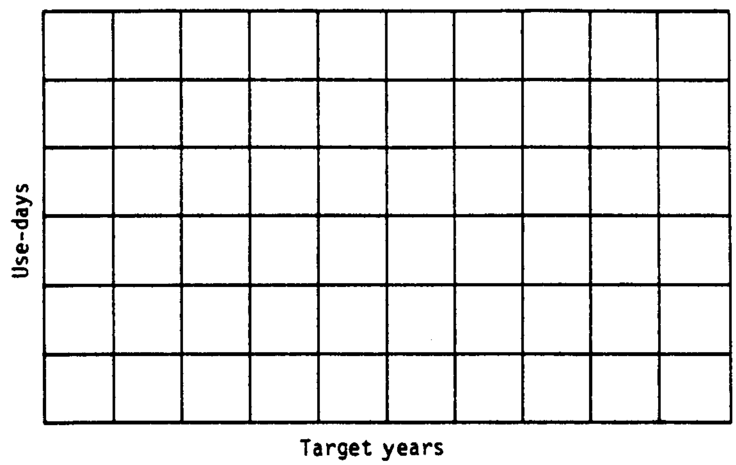
(6) Block 6. Plot the total value (Column 17, Form 3-1108) of recreational, commercial, and other uses in Block 6. These data reflect the capability, expressed in dollar values, of the species to supply harvestable populations.

Translate the demand data in Block 5 into dollar values using the values from Column 12, Form 3-1108. Combine these dollar values with estimated values of any commercial or other uses for the species and plot the totals in Block 6.

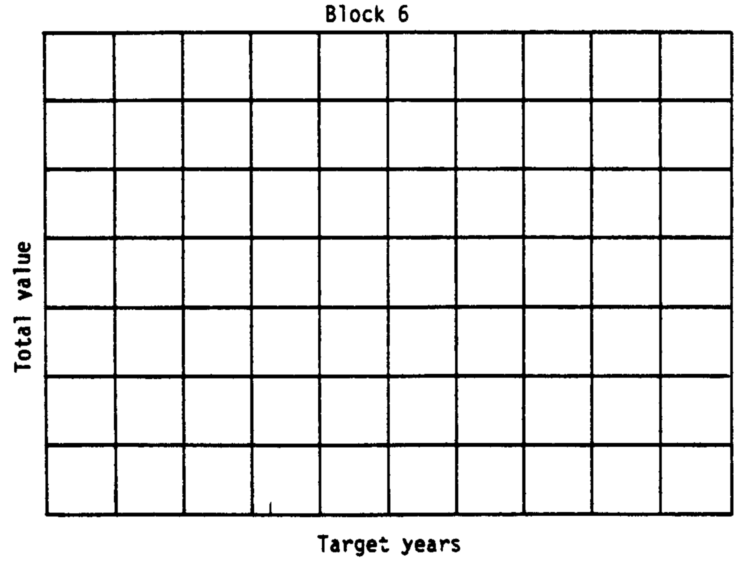
Form 3-1109. Fish and wildlife supply and demand curves for the life of the project.

1. Study Date	2. Proposed action
3. Evaluation pecies	4. Use

Block 5



Block 6



B.5 Form 3-1110. Determination of average annual use.

A. Purpose. This form is utilized to: (1) determine the use that is sustainable by the species and needed (or demanded) by humans. and (2) to calculate the AAU of the species projected for an alternative study plan.

B. Instructions. Complete a separate Form 3-1110 for each species under each proposed action. Determine the use-days for each target year for each use during the life of the project and then calculate the average annual use-days for the species. The portion of the use-days supply and demand graph to be annualized is the area that falls under both the supply and demand curves and is shaded in the graph shown on Form 3-1110.

(1) Block 1. Enter the name of the study and date.

(2) Block 2. Enter name of proposed action.

(3) Block 3. Enter name of the evaluation species.

(4) Block 4. Enter use from Block 4, Form 3-1109.

(5) Column 5. Divide the area under the supply and demand curves in Block 5 on Form 3-1109 into rectangles or triangles in order to determine the areas under the curve (see example graph on Form 3-1110). Number these areas and enter the identification numbers in Column 5 of Form 3-1110.

(6) Column 6. Determine the average use-days per year for each identified area and enter these data on the corresponding line in Column 6. The average use-days per year for an area that is a rectangle is the height of the rectangle. Divide the height of areas that are triangles by 1/2 to obtain the average use-days per year for these areas.

(7) Column 7. Enter the number of years as indicated by the length of each area on the corresponding line in Column 7. Calculate the period covered for areas beginning in the future by subtracting their beginning year from their end year. Area 5, for example, begins with year 50 and extends through year 100. The number of years covered (100 years - 50 years = 50 years) is entered in Column 7.

(8) Column 8. Multiply each entry in Column 6 by the corresponding entry in Column 7 and enter the product in Column 8.

(9) Block 9. Sum the entries in Column 8 and enter in Block 9.

(10) Block 10. Divide the number in Block 9 by the number of years in the life of the project and enter in Block 10.

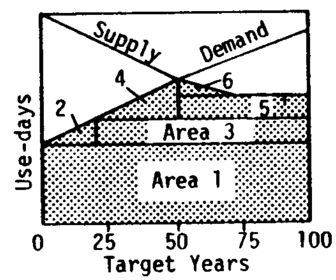
Form 3-1110. Determination of average annual use.

1. Study Date	2. Proposed action
3. Evaluation species	4. Use

Area identification number 5.	Average use-days per year for the area 6.	Number of years 7.	Use-days over period 8.

9.	Total use-days
10.	Average annual use (Block 9 ÷ life of project)

Example supply and demand graph



B.6 Form 3-1111. Determination of average annual equivalent value and present worth.

A. Purpose. This form is used to discount the dollar values of the use required to meet human needs that can be sustained by the species for each proposed action and for the future-without-project conditions. The discounting process translates future values into dollars, expressed in terms of today's values, so that values for each proposed action and without-project conditions can be directly compared. The sum of the discounted future values is termed PW.

Form 3-1111 also is used to average the discounted values (PW) over the life of the project, taking account of the interest rate for the project. This average value is referred to as the AAEV.

Form 3-1111 may be used to evaluate effects, in dollar terms, occurring before project operation begins. (See Appendix E, Prestart Analysis.)

B. Instructions. A separate Form 3-1111 is prepared for each set of supply and demand curves entered in Block 6 of Form 3-1109. The area to be analyzed is the dollar value supply curve in Block 6 of Form 31109 unless the demand curve falls below the supply curve, in which case the demand curve is followed (see example graph on Form 3-1110). Only the dollar values under both the supply and demand curves, from Block 6 of Form 3-1109, are entered on Form 3-1111.

(1) Block 1. Enter the name of the study and date.

(2) Block 2. Enter the name of the proposed action.

(3) Block 3. Enter the name of the evaluation species.

(4) Block 4. Enter use from Block 10, Form 3-1109.

(5) Block 5. Enter the interest rate authorized for the project; include the source of the authorized rate.

(6) Column 6. Divide the entire area under the supply and demand curves (Block 6 of Form 3-1109) into a series of rectangles and triangles (see example graph on Form 3-1110). Number each rectangle or triangle as in the example on Form 3-1110.

(7) Column 7. Enter the number of each rectangle or triangle in Block 6 of Form 3-1109 in the appropriate line of Column 7 of Form 3-1111. Select the appropriate line according to the type of area. For example, Type C represents a rectangle beginning in a future year. Types D and F represent triangles that begin in a future year while Types A, B, and E are areas that begin with the base year. Enough lines are provided for two or three entries for each type of rectangle or triangle.

(8) Column 8. Enter the maximum vertical height, in dollars, of each rectangle or triangle listed in Column 7. Data for Types A and C (rectangles) are entered in Column 10. The maximum vertical height is indicated by a bracket for each type of area listed in Column 6.

(9) Column 9. Enter number of years covered by each rectangle or triangle listed in Block 8 and Types A and C rectangles if data are entered in Column 10.

(10) Column 10. Divide the entry in Column 8 by the corresponding entry in Column 9 and enter the result in Column 10 for Type B, D, E, and F areas. Enter the maximum vertical height for Type A and C areas if not already entered.

(11) Columns 11-13. Obtain an Interest and Annuity Table (I and A Table) for the discount rate listed in Block 5 (see example in Appendix D). Enter discount factors from the I and A Table into the corresponding Columns 11-14 for each entry in Column 10. For example, all discount factors entered in Column 11 are taken from the "Present Worth of 1 Per Period" column of the I and A Table. Select the appropriate column and number of years covered (Column 9 above) in the I and A Table. For example, an entry of 25 in Column 9 of Form 3-1111 specifies the factor at line 25 in the respective column of the I and A Table.

(12) Column 14. Enter discount factors from the "Present Worth of 1" column of the I and A Table for each entry in Column 10 for Types C, D, and F areas. These discount factors are selected for the number of years between the beginning of the project and the period covered. For example, discount factors for a Type C area covering years 75 to 100 would come from the year 75 line of the "Present Worth of 1" column of the I and A Table.

(13) Column 15. Multiply each entry in Column 10 by the corresponding entry or entries in Column 11-14. A second multiplication is necessary for Types C, D, and F areas.

(14) Block 16. Enter the sum of the entries in Column 15. This is the Present Worth of the use specified in Block 4 for this proposed action (Block 2) and species (Block 3).

(15) Block 17. Enter the discount factor from the "Partial Payment" column of the I and A Table for the interest rate specified in Block 5. The discount factor from the Partial Payment column is selected based on the number of years in the life of the project. For example, the discount factor to be used in a project with a 100-year life would be obtained from the 100 year row in the Partial Payment column.

(16) Block 18. Multiply the entry in Block 16 by the entry in Block 17. This product is the Average Annual Equivalent Value.

Form 3-1111. Determination of average annual equivalent value and present worth.

1. Study   Date

2. Proposed action   3. Evaluation Species

3. Use   5. Interest and annuity table (%)

Type	6. Area evaluated (from supply/ demand curve)	7. Area No.	8. Maximum annual dollar value of area	9. No. of years covered	10. Calculation base	Values from Interest and Annuity Table: 11. Present worth of 1 per period	12. Pres. value of annuity decrease by 1 (1/N) per year	13. Pres. value of annuity increase by 1 per year	14. Present worth of 1	15. Present worth per area
A	Max. →		Enter in Column 10			X				=
						X				=
B	Max. →			÷	=			X		=
				÷	=			X		=
C	→		Enter in Column 10			X			X	=
						X			X	=
						X			X	=
D	→			÷	=			X	X	=
				÷	=			X	X	=
				÷	=			X	X	=
E	→			÷	=		X			=
				÷	=		X			=
F	→			÷	=		X		X	=
				÷	=		X		X	=
				÷	=		X		X	=

16. Total of Column 15 (Present Worth)	X
17. Partial payment factor from I and A Table	
18. Average Annual Equiv. Value	=

B.7 Form 3-1112. Summary of proposed actions and future without-project.

A. Purpose. This form is used to compile data on: (1) Average Annual Use (in use-days); (2) Average Annual Worth (non-discounted dollars); (3) Present Worth (discounted dollars); and (4) Average Annual Equivalent Value (discounted dollars) for the uses of all the species for each proposed action and the future without-project conditions. The difference between the without-project condition and each proposed action can then be calculated. This difference is the total impact on all evaluation species of each proposed action compared with the future without-project conditions.

The Average Annual Use and Average Annual Worth show impacts on recreational human uses (such as hunting and fishing) of the species listed, whereas the Average Annual Equivalent Value and Present Worth reflect the impacts, in discounted dollars, on direct recreational uses (hunting, fishing, and nonconsumptive uses) and the value of commercial or other uses.

B. Instructions.

(1) Block 1. Enter the name of the study and date.

(2) Blocks 2-4. Enter the names of the proposed actions. Use additional Forms 3-1112 if needed.

(3) Column 5. List the evaluation species for each proposed action and without-project conditions. List the uses for each species after the species name. For example:

Geese - Hunting
- Birdwatching

(4) Column 6. Enter Average Annual Use from Block 10 of Form 3-1110 for each use listed in Column 5.

(5) Column 7. Multiply the Average Annual Use (Column 6) by the corresponding dollar value per use-day (from Column 12 of Form 3-1108) for each use in Column 5.

(6) Column 8. Enter the Present Worth (from Column 16 of Form 3-1111) for the future without-project for each use listed in Column 5.

(7) Column 9. Enter the Average Annual Equivalent Value (from Block 18 of Form 3-1111) for the future without-project for each use listed in Column 5.

(8) Columns 10-21. Enter data for each plan listed in Blocks 2-4, following the instructions for Columns 6-9, above, and using data from the appropriate forms for each proposed action.

(9) Block 22. Sum the entries in Columns 6-21.

(10) Block 23. Subtract the totals in Block 22 for the future without-project (Columns 6-9) from the corresponding data for each proposed action. Negative results from this subtraction are entered with a minus (-) sign. The minus sign indicates a decrease attributable to the proposed action. For example, a without-project entry of 80 subtracted from a proposed action entry of 60 is -20 which reflects a reduction (impact) attributable to the proposed action.

Form 3-1112. Summary of proposed actions and future-without-project

1. Study

Date

5. Evaluation species and use(s)	Future without project				Proposed actions											
					2. Plan name				3. Plan name				4. Plan name			
	6. Avg. annual use	7. Avg. annual worth	8. Avg. annual equiv. value	9. Present worth	10. Avg. annual use	11. Avg. annual worth	12. Avg. annual equiv. value	13. Present worth	14. Avg. annual use	15. Avg. annual worth	16. Avg. annual equiv. value	17. Present worth	18. Avg. annual use	19. Avg. annual worth	20. Avg. annual equiv. value	21. Present worth
22. Totals																
23. Difference																

Appendix C. Instructions for Calculating Unit Dollar Values for Recreation

C.1 Introduction. The following instructions provide a method for determining dollar values to be entered in Column 12 of Form 3-1108. These instructions are based on guidance issued by the Water Resources Council for water resource development projects. (See 104 ESM 5 - References.) The dollar values shown in Table C-1 pertain to FY1980. Current value ranges may be obtained from the Western Energy and Land Use Team, U.S. Fish and Wildlife Service, Creekside One, 2627 Redwing Road, Fort Collins, CO 80526-2899.

C.2 Instructions. These instructions provide a point rating system that can be used to select a unit dollar value from a range of values. The choice of unit day value should consider transfers of recreation from existing projects to the proposed project to avoid double counting of recreational benefits. The point system takes such transfers into account.

The point rating system reflects quality, relative scarcity, ease of access, and aesthetic features. The criteria and weights used in the point system can be modified as appropriate for project conditions. The use of a point rating system is illustrated below:

A. Step 1. Decide whether the activity is "General" or "Specialized", according to the categories of activities shown in Table C-1.

"Specialized" activities are those for which opportunities in general are limited, intensity of use low, and users skill, knowledge, and appreciation great. "General" refers to activities primarily attractive to the majority of outdoor users and that generally require the development and maintenance of convenient access and adequate facilities.

Hunting and fishing affected by resource development projects may be considered either general or specialized recreation, depending on whether they are associated with developed areas or back country areas. As examples, most activities associated with water resource development projects including swimming, picnicing, boating, and most warm water fishing, are included in the general recreation category. Activities less often associated with water resource development projects, such as big game hunting and salmon fishing, are included in the specialized category.

The value of specialized recreation activities generally will be lowered, or even excluded, by the type of development that enhances activities in the general recreation category. Thus,

Table C-1. Conversion of points to dollar values.

Activity categories	Point values										
	0	10	20	30	40	50	60	70	80	90	100
General Recreation (Points from Table C-2)	1.07	1.25	1.44	1.68	1.93	2.30	2.48	2.67	2.85	3.04	3.22
General Fishing and Hunting (Points from Table C-2)	1.57	1.74	1.90	2.07	2.28	2.51	2.73	2.94	3.06	3.17	3.20
Specialized Fishing and Hunting (Points from Table C-3)	7.50	7.69	7.88	8.08	8.27	9.01	9.80	10.57	11.34	12.10	12.97
Specialized Recreation Other than Fishing and Hunting (Points from Table C-3)	4.29	4.65	5.00	5.36	5.72	6.44	7.15	8.58	10.01	11.44	12.87

activities involving low density use and development, such as big game hunting and wilderness pack trips, constitute the higher end of the range of values for specialized recreation. Also included in the upper end of the specialized range are relatively unique experiences, such as the following examples involving water resources: fishing for salmon and steelhead, white water boating and canoeing, long-range boat cruises, and other activities in areas of outstanding scenic value. Examples of activities to which values at the lower end of the range would be assigned include bird hunting and specialized nature photography.

B. Step 2. Determine points by judging each activity according to the judgment factors for criteria shown in Table C-2 (general recreation) or Table C-3 (specialized recreation).

When hunting or fishing is evaluated (general or specialized), the recreation experience (criterion "a" in Tables C-2 and C-3) should be assigned points according to the additional consideration of the chances of success; the midpoint of the value range is associated with the region's average catch or bag. Other criteria may be modified based on available evidence about the preferences and willingness of hunters and fishermen to pay for different recreational quality factors.

C. Step 3. Calculate total points by adding the points for each criterion listed in Table C-2 or C-3 for the respective activity.

D. Step 4. Convert the total points for each activity to dollar values by selecting a dollar value for each activity from Table C-1. Values may be interpolated, if necessary, between those provided.

E. Step 5. Enter the dollar value for each activity in Column 12 of Form 3-1108.

Table C-3. Guidelines for assigning points for specialized recreation.

Criteria	Judgment factors				
a) Recreation Experience[1/]	Heavy use or frequent crowding or other interference with use	Moderate use, other users evident and likely to interfere with use	Moderate use, some evidence of other users and occasional interference with use due to crowding	Usually little evidence of other users rarely if ever crowded	Very low evidence of other users, never crowded
Total Points: 30 Point Value:	0-4	5-10	11-16	17-23	24-30
b) Availability of Opportunity[2/]	Several within 1 hr. travel time; a few within 30 min travel time	Several within 1 hr. travel time; none within 30 min travel time	One or two within 1 hr travel time; none within 45 min travel time	None within 1 hr travel time	None within 2 hr travel time
Total Points: 18 Point Value:	0-3	4-6	7-10	11-14	15-18
c) Carrying Capacity[3/]	Minimum facility development for public health and safety	Basic facilities to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Total Points: 14 Point Value:	0-2	3-5	6-8	9-11	12-14
d) Accessibility	Limited access by any means to site or within site	Fair access poor quality roads to site; limited access within site	Fair access fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Total Points: 18 Point Value:	0-3	4-6	7-10	11-14	15-18
e) Environmental Quality	Low esthetic factors[4/] exist that significantly lower quality[5/]	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Total Points: 20 Point Value:	0-2	3-6	7-10	11-15	16-20

[1/] Intensity of use for activity.

[2/] Likelihood of success at fishing and hunting.

[3/] Value should be adjusted for overuse.

[4/] Major esthetic qualities to be considered include geology and topography, water, and vegetation.

[5/] Factors to be considered in lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.

Table C-2. Guidelines for assigning points for general recreation.

Criteria	Judgment factors				
a) Recreation Experience	Two General activities[1]	Several General activities	Several General activities; one high quality value activity[2]	Several General activities; more than one high quality high activity	Numerous high quality value activities; some general activities
Total Points: 30 Point Value:	0-4	5-10	11-16	17-23	24-30
b) Availability of Opportunity[3]	Several within 1 hr. travel time; a few within 30 min travel time	Several within 1 hr. travel time; none within 30 min travel time	One or two within 1 hr travel time; none within 45 min travel time	None within 1 hr travel time	None within 2 hr travel time
Total Points: 18 Point Value:	0-3	4-6	7-10	11-14	15-18
c) Carrying Capacity[4]	Minimum facility development for public health and safety	Basic facilities to conduct activity(ies)	Adequate facilities to conduct without deterioration of the resource or activity experience	Optimum facilities to conduct activity at site potential	Ultimate facilities to achieve intent of selected alternative
Total Points: 14 Point Value:	0-2	3-5	6-8	9-11	12-14
d) Accessibility	Limited access by any means to site or within site	Fair access poor quality roads to site; limited access within site	Fair access fair road to site; fair access, good roads within site	Good access, good roads to site; fair access, good roads within site	Good access, high standard road to site; good access within site
Total Points: 18 Point Value:	0-3	4-6	7-10	11-14	15-18
e) Environmental Quality	Low esthetic factors[5] exist that significantly lower quality[6]	Average esthetic quality; factors exist that lower quality to minor degree	Above average esthetic quality; any limiting factors can be reasonably rectified	High esthetic quality; no factors exist that lower quality	Outstanding esthetic quality; no factors exist that lower quality
Total Points: 20 Point Value:	0-2	3-6	7-10	11-15	16-20

1/ General activities include those that are common to the region and that are usually of normal quality. This includes picnicking, camping, hiking, riding, cycling, and fishing and hunting of normal quality.

2/ High quality value activities include those that are not common to the region and/or Nation and that are usually of high quality.

3/ Likelihood of success at fishing and hunting.

4/ Value should be adjusted for overuse.

5/ Major esthetic qualities to be considered include geology and topography, water, and vegetation.

6/ Factors to be considered in lowering quality include air and water pollution, pests, poor climate, and unsightly adjacent areas.

Appendix D. Example Discount Factors for a 7.125% Interest and Annuity Table

D.1 Introduction. This Appendix provides example discount factors for use on Form 3-1111. A different I and A Table is required for each discount rate. The 7.125% I and A Table shown is applicable only to projects with a 7.125% discount rate.

A printout of discount factors for a specified rate may be obtained from the Western Energy and Land Use Team, U.S. Fish and Wildlife Service, Creekside One, 2627 Redwing Road, Fort Collins, CO 80526-2899. In addition, a copy of the computer program used to calculate these factors is available. This program is written in BASIC.

Table D-1. Example discount factors for a 7.125% interest and annuity table.

	Present worth of 1 per period	Present value of annuity decr. by 1 (1/N) per year	Present value of annuity Incr. by 1 per year	Present worth of 1	Partial payment
1	0.93349	0.93349	0.93349	0.93349	1.07125
2	1.80489	2.73838	2.67629	0.87140	0.55405
3	2.61833	5.35671	5.11662	0.81344	0.38192
4	3.37767	8.73439	8.15399	0.75934	0.29606
5	4.08651	12.82090	11.69817	0.70884	0.24471
6	4.74820	17.56910	15.66331	0.66169	0.21061
7	5.36588	22.93498	19.99208	0.61768	0.18636
8	5.94248	28.87746	24.60486	0.57660	0.16828
9	6.48073	35.35819	29.44909	0.53825	0.15430
10	6.98318	42.34137	34.47358	0.50245	0.14320
11	7.45221	49.79358	39.63291	0.46903	0.13419
12	7.89004	57.68362	44.88693	0.43783	0.12674
13	8.29876	65.98238	50.20020	0.40871	0.12050
14	8.68029	74.66266	55.54162	0.38153	0.11520
15	9.03644	83.69910	60.88393	0.35615	0.11066
16	9.36890	93.06800	66.20337	0.33247	0.10674
17	9.67926	102.74726	71.47937	0.31035	0.10331
18	9.96897	112.71623	76.69417	0.28971	0.10031
19	10.23941	122.95564	81.83257	0.27044	0.09766
20	10.49187	133.44751	86.88166	0.25245	0.09531
21	10.72753	144.17504	91.83060	0.23566	0.09322
22	10.94752	155.12255	96.67036	0.21999	0.09134
23	11.15288	166.27543	101.39359	0.20536	0.08966
24	11.34457	177.62000	105.99436	0.19170	0.08815
25	11.52352	189.14353	110.46809	0.17895	0.08678
26	11.69057	200.83410	114.81131	0.16705	0.08554
27	11.84651	212.68060	119.02159	0.15594	0.08441
28	11.99207	224.67268	123.09741	0.14556	0.08339
29	12.12795	236.80063	127.03802	0.13588	0.08245
30	12.25480	249.05543	130.84338	0.12685	0.08160
31	12.37321	261.42864	134.51406	0.11841	0.08082
32	12.48374	273.91238	138.05112	0.11053	0.08010
33	12.58692	286.49931	141.45612	0.10318	0.07945
34	12.68324	299.18255	144.73096	0.09632	0.07884
35	12.77316	311.95571	147.87790	0.08991	0.07829
36	12.85709	324.81280	150.89947	0.08393	0.07778
37	12.93544	337.74823	153.79842	0.07835	0.07731
38	13.00858	350.75681	156.57770	0.07314	0.07687
39	13.07685	363.83366	159.24040	0.06827	0.07647
40	13.14058	376.97425	161.78973	0.06373	0.07610
41	13.20008	390.17433	164.22900	0.05949	0.07576
42	13.25562	403.42994	166.56157	0.05554	0.07544
43	13.30746	416.73740	168.79084	0.05184	0.07515
44	13.35586	430.09326	170.92023	0.04840	0.07487
45	13.40103	443.49429	172.95317	0.04518	0.07462
46	13.44320	456.93749	174.89307	0.04217	0.07439
47	13.48257	470.42006	176.74332	0.03937	0.07417
48	13.51932	483.93938	178.50724	0.03675	0.07397
49	13.55362	497.49301	180.18816	0.03430	0.07378
50	13.58565	511.07865	181.78929	0.03202	0.07361

Table D-1. Example discount factors for a 7.125% interest and annuity table.

	Present worth of 1 per period	Present value of annuity decr. by 1 (1/N) per year	Present value of annuity incr. by 1 per year	Present worth of 1	Partial payment
51	13.61554	524.69419	183.31383	0.02989	0.07345
52	13.64344	538.33764	184.76487	0.02790	0.07330
53	13.66949	552.00713	186.14545	0.02605	0.07316
54	13.69381	565.70094	187.45852	0.02432	0.07303
55	13.71651	579.41744	188.70696	0.02270	0.07290
56	13.73770	593.15514	189.89355	0.02119	0.07279
57	13.75748	606.91262	191.02100	0.01978	0.07269
58	13.77594	620.68856	192.09193	0.01846	0.07259
59	13.79318	634.48173	193.10886	0.01724	0.07250
60	13.80927	648.29100	194.07425	0.01609	0.07242
61	13.82429	662.11528	194.99045	0.01502	0.07234
62	13.83831	675.95359	195.85973	0.01402	0.07226
63	13.85139	689.80499	196.68428	0.01309	0.07219
64	13.86361	703.66860	197.46621	0.01222	0.07213
65	13.87502	717.54362	198.20753	0.01141	0.07207
66	13.88566	731.42928	198.91020	0.01065	0.07202
67	13.89560	745.32488	199.57607	0.00994	0.07197
68	13.90488	759.22976	200.20693	0.00929	0.07192
69	13.91354	773.14330	200.80449	0.00866	0.07187
70	13.92162	787.06493	201.37039	0.00808	0.07183
71	13.92917	800.99410	201.90619	0.00755	0.07179
72	13.93622	814.93031	202.41341	0.00704	0.07176
73	13.94279	828.87310	202.89346	0.00658	0.07172
74	13.94893	842.82203	203.34773	0.00614	0.07169
75	13.95466	856.77669	203.77751	0.00573	0.07166
76	13.96001	870.73670	204.18406	0.00535	0.07163
77	13.96500	884.70171	204.56856	0.00499	0.07161
78	13.96966	898.67137	204.93215	0.00466	0.07158
79	13.97402	912.64539	205.27590	0.00435	0.07156
80	13.97808	926.62347	205.60086	0.00406	0.07154
81	13.98187	940.60534	205.90799	0.00379	0.07152
82	13.98541	954.59074	206.19824	0.00354	0.07150
83	13.98871	968.57946	206.47248	0.00330	0.07149
84	13.99180	982.57126	206.73157	0.00308	0.07147
85	13.99468	996.56593	206.97631	0.00288	0.07146
86	13.99736	1010.56330	207.20745	0.00269	0.07144
87	13.99987	1024.56317	207.42574	0.00251	0.07143
88	14.00222	1038.56539	207.63184	0.00234	0.07142
89	14.00440	1052.56979	207.82642	0.00219	0.07141
90	14.00644	1066.57623	208.01011	0.00204	0.07140
91	14.00835	1080.58458	208.18348	0.00191	0.07139
92	14.01013	1094.59471	208.34709	0.00178	0.07138
93	14.01179	1108.60650	208.50149	0.00166	0.07137
94	14.01334	1122.61983	208.64717	0.00155	0.07136
95	14.01478	1136.63462	208.78460	0.00145	0.07135
96	14.01613	1150.65075	208.91424	0.00135	0.07135
97	14.01739	1164.66815	209.03653	0.00126	0.07134
98	14.01857	1178.68672	209.15185	0.00118	0.07133
99	14.01967	1192.70639	209.26060	0.00110	0.07133
100	14.02070	1206.72708	209.36315	0.00103	0.07132

Appendix E. Prestart Analysis

E.1 Purpose. Significant modifications in wildlife use, that are attributable to project development but occur before project operation, should be evaluated. Examples are wildlife uses affected by land clearing by private landowners in anticipation of a water resource development project or an extremely long construction period which significantly affects hunting or fishing. The effects of impacts that occur before the beginning of project operation should be evaluated in a separate analysis and combined with those that occur during the project life.

E.2 Instructions. Forms 3-1107 through 3-1111 are used for evaluating prestart effects with the following change: Instead of discounting future values and reducing them to present worth, the values estimated for the proposed action (Column 10, Form 3-1111) are increased to reflect the accrual of interest before Year 1. The accrual of interest before Year 1 is comparable in concept to the discounting of future values for the period after Year 1. Thus, dollar value in the future is worth less in the present, whereas value obtained in the past will increase as interest accrues.

The only change required in the HUEE forms and procedures, to account for prestart effects, is the use of a different set of factors in Form 3-1111. Instead of using discount factors, use Prestart Factors (Example Factors provided in Table E-1). Thus, for Prestart Analysis, enter factors for the appropriate years from a Prestart Factor Table for the appropriate interest rate in the respective Columns 11 through 14 of Form 3-1111. The following columns show the difference in column headings for Prestart and Discount Factors to be entered in the Columns 11 through 14 of Form 3-1111:

Form 3-1111 Column	Prestart Factors (before Year 1)	Discount Factors (following Year 1)
11	Amount of 1 Per Period	Present Worth of 1 Per Period
12	Amount of 1 Decreasing by 1 (1/N) Per Year	Present Value of Annuity Decreasing by 1 (1/N) Per Year
13	Amount of 1 Increasing by 1 Per Year	Present Value of Annuity Increasing by 1 Per Year
14	Amount of 1	Present Worth of 1

Table E-1. Example factors used in prestart analysis (7.125%).

	Amount of 1 per period	Amount of 1 decreasing by 1 (1/N) per yr	Amount of 1 increasing by 1 per year	Amount of 1
51	455.47801	17552.49419	6132.36237	33.45281
52	488.93082	19292.04022	6621.29319	35.83632
53	524.76714	21191.36522	7146.06033	38.38966
54	563.15680	23264.40680	7709.21712	41.12492
55	604.28172	25526.27750	8313.49835	44.05507
56	648.33679	27993.36156	8961.83564	47.19400
57	695.53079	30683.41937	9657.36643	50.55657
58	746.08736	33615.70035	10403.45379	54.15872
59	800.24608	36811.06509	11203.69968	58.01753
60	858.26362	40292.11709	12061.96349	62.15128
61	920.41490	44083.34533	12982.37339	66.57956
62	986.99446	48211.27815	13969.37285	71.32336
63	1058.31782	52704.64953	15027.69067	76.40514
64	1134.72296	57594.57877	16162.41363	81.84901
65	1216.57197	62914.76448	17378.98560	87.68075
66	1304.25272	68701.69417	18683.23832	93.92801
67	1398.18073	74994.87061	20081.41905	100.62038
68	1498.80111	81837.05625	21580.22016	107.78958
69	1606.59069	89274.53719	23186.81084	115.46959
70	1722.06027	97357.40824	24908.87112	123.69679
71	1845.75707	106139.88064	26754.62813	132.51019
72	1978.26726	115680.61440	28732.89544	141.95154
73	2120.21880	126043.07697	30853.11424	152.06559
74	2272.28439	137295.93060	33125.39863	162.90026
75	2435.18465	149513.45030	35560.58328	174.50691
76	2609.69156	162775.97519	38170.27484	186.94052
77	2796.63208	177170.39551	40966.90693	200.26004
78	2996.89212	192790.67831	43963.79904	214.52856
79	3211.42068	209738.43482	47175.21973	229.81372
80	3441.23441	228123.53270	50616.45413	246.18795
81	3687.42236	248064.75677	54303.87649	263.72884
82	3951.15120	269690.52188	58255.02769	282.51952
83	4233.67072	293139.64229	62488.69841	302.64904
84	4536.31976	318562.16156	67025.01817	324.21278
85	4860.53254	346120.24812	71885.55072	347.31294
86	5207.84549	375989.16128	77093.39620	372.05899
87	5579.90448	408358.29350	82673.30068	398.56819
88	5978.47267	443432.29459	88651.77336	426.96618
89	6405.43885	481432.28443	95057.21221	457.38752
90	6862.82637	522597.16106	101920.03858	489.97633
91	7352.80275	567185.01153	109272.34133	524.88720
92	7877.68994	615474.63354	117150.53127	562.28541
93	8439.97535	667767.17654	125590.50662	602.34824
94	9042.32360	724387.91146	134632.83022	645.26556
95	9687.58915	785688.13930	144320.41937	691.24073
96	10378.82988	852047.24911	154699.24925	740.49163
97	11119.32151	923874.93712	165818.57076	793.25166
98	11912.57317	1001613.59956	177731.14393	849.77084
99	12762.34400	1085740.91252	190493.48793	910.31701
100	13672.66101	1176772.61354	204166.14895	975.17710

Table E-1. Example factors used in prestart analysis (7.125%).

	Amount of 1 per period	Amount of 1 decreasing by 1 (1/N) per yr	Amount of 1 increasing by 1 per year	Amount of 1
1	1.00000	1.00000	1.00000	1.07125
2	2.07125	3.14250	3.07125	1.14758
3	3.21883	6.58523	6.29008	1.22934
4	4.44817	11.50260	10.73824	1.31693
5	5.76510	18.08726	16.50334	1.41076
6	7.17586	26.55184	23.67921	1.51128
7	8.68714	37.13080	32.36635	1.61896
8	10.30610	50.08247	42.67245	1.73431
9	12.04041	65.69126	54.71287	1.85788
10	13.89829	84.27005	68.61116	1.99025
11	15.88854	106.16294	84.49970	2.13206
12	18.02060	131.74754	102.52031	2.28397
13	20.30457	161.43913	122.82488	2.44670
14	22.75127	195.69294	145.57615	2.62103
15	25.37230	235.00836	170.94845	2.80778
16	28.18008	279.93278	199.12853	3.00783
17	31.18791	331.06590	230.31644	3.22214
18	34.41005	389.06439	264.72648	3.45172
19	37.86176	454.64699	302.58824	3.69765
20	41.55941	528.60000	344.14766	3.96111
21	45.52052	611.78327	389.66818	4.24334
22	49.76386	705.13669	439.43204	4.54567
23	54.30953	809.68721	493.74157	4.86955
24	59.17909	926.55651	552.92065	5.21651
25	64.39560	1056.96926	617.31625	5.58819
26	69.98378	1202.26210	687.30003	5.98634
27	75.97013	1363.89341	763.27016	6.41287
28	82.38300	1543.45381	845.65316	6.86979
29	89.25279	1742.67768	934.90595	7.35925
30	96.61205	1963.45552	1031.51800	7.88361
31	104.49566	2207.84738	1136.01365	8.44532
32	112.94097	2478.09748	1248.95463	9.04704
33	121.98802	2776.64994	1370.94264	9.69165
34	131.67966	3106.16591	1502.62231	10.38218
35	142.06184	3469.54207	1644.68415	11.12191
36	153.18375	3869.93069	1797.86739	11.91434
37	165.09809	4310.76134	1962.96598	12.76324
38	177.86133	4795.76441	2140.82731	13.67262
39	191.53395	5328.99657	2332.36125	14.64679
40	206.18074	5914.86832	2538.54199	15.69038
41	221.87112	6558.17380	2760.41311	16.80832
42	238.67943	7264.12312	2999.09254	18.00591
43	256.68534	8038.37723	3255.77739	19.28883
44	275.97417	8887.08579	3531.75206	20.66315
45	296.63733	9816.92798	3828.38939	22.13541
46	318.77274	10835.15685	4147.16214	23.71256
47	342.48530	11949.64707	4489.64744	25.40208
48	367.88738	13168.94681	4857.53482	27.21198
49	395.09936	14502.33362	5252.63418	29.15083
50	424.25819	15959.87508	5676.88436	31.22783

Following entry of these different factors from the appropriate Prestart Factor Table in Columns 11 through 14 on Form 3-1111, Present Worth and Average Annual Equivalent Values are calculated following the instructions provided for completing each column on Form 3-1111. The Present Worth and Average Annual Equivalent Value of the prestart period are added to the Present Worth and Average Annual Equivalent Values, respectively, calculated for the period of proJect operations (following Year 1). The sum of Present Worth and Average Annual Equivalent Values is posted in the appropriate columns of Form 3-1112 for each alternative plan.

The table of factors used in the Prestart Analysis is selected for the same rate specified for discounting. Table E-1 shows an example set of prestart factors reflecting a 7.125 percent rate.

Appendix F. Glossary

Amount - The sum that a payment or series of payment will be worth at some future time.

Annual Value - The monetary value of an activity, such as hunting, taking place during a year. For monetary valuations, values generally are assumed to occur at the end of the year. This assumption is consistent with agency practice and the assumptions underlying the Interest and Annuity Tables. During the prestart period, however, values are assumed to occur at the beginning of the year.

Annuity - A series of fixed periodical payments, such as payment of $10.00 per year for 100 years.

Average Annual Equivalent Value - The amortized value of the cumulative present worth values of the undiscounted benefits or losses. The benefits (or losses) due to the project are brought to present worth effective in the base year and then amortized over the entire project life.

Average Annual Use - The use-days of humans participating in recreational activities, such as hunting or fishing, associated with a particular project alternative plan, averaged over the life of the project. The difference between the "without project" or "no project" activities and the levels of activity projected for a plan constitutes the loss or gain from the plan.

Base Year - The first year in which the recommended plan is expected to be operational. The base year will usually be designated by the construction agency. The base year encompasses 12 calendar months.

Consumptive Uses - The use of fish and wildlife where species are taken or harvested for sport or commercial purposes (see Nonconsumptive Uses).

Contingent Valuation Method (CVM) - A method for evaluating recreational uses based on the willingness of users to pay for changes in quality and quantity of recreational opportunities at a proposed site as determined by a detailed survey of potential users.

Discount Factor - The factor for any specific discount rate which translates the expected benefit (or loss) in any specific future year into its present value. The discount factor is equal to $1/(1 + r)$ where r is the discount rate and t is the number of years since the date of initiation of the project.

Discount Rate - The interest rate used in calculating the present value of the expected yearly benefits (which may be negative if losses are projected) attributed to the project.

Discounting - The mathematical procedure used to determine the present value or worth of amounts that will occur at some future time.

Economic Efficiency Analyses - Techniques and decision rules that will indicate which project or alternative generates the largest difference between the benefits of what is produced and the cost of unputs used. Economic efficiency analysis attempts to discover the alternative which allocates resources to their highest valued use, where values are determined by consumers.

Externality - Synonymous with external effect. An effect on parties other than users of the outputs of a plan.

Harvest - for consumptive uses, the number or pounds of an animal population killed or harvested per year for sport or commercial purposes. For nonconsumptive uses, the harvest may be evaluated in terms of "sightseeing days", "encounters", or other appropriate units.

Net Value - Maximum additional willingness to pay over and above current costs. Also known as consumer surplus for consumer goods and producer surplus for firms.

Nonconsumptive Uses - The use of fish and wildlife for activities, such as sightseeing or photography, where species are not taken or harvested (see Consumptive Uses).

Period of Analysis - For evaluation purposes, time period (or specified portion thereof) during which benefits or losses of a proposed plan accrue, generally 50 or 100 years.

Potential Use - The maximum number of use-days a particular habitat or segment can sustain without having an adverse effect on the brood stock of the animal species being evaluated. This is the concept of "supply" as used in the Human Use and Economic Evaluation.

Present Worth - Present Worth (PW) is the value of the annual series of hunting, fishing, or other recreational activity summed at Year 1 (the beginning of the project) (see Prestart Period).

Appendix G. Abbreviations and Symbols

Abbreviations

AAEV	Average Annual Equivalent Value
AAU	Average Annual Use
AAW	Average Annual Worth
CVM	Contingent Valuation Method
ESM	Ecological Services Manual
HEP	Habitat Evaluation Procedures
HSI	Habitat Suitability Index
HU	Habitat Units
HUEE	Habitat Use and Economic Evaluation
PW	Present Worth
TCM	Travel Cost Method
UDV	Unit Day Value Method
WRC	Water Resources Council

Symbols

Σ	Summation (sum of a series)

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Appendix F. Glossary

Prestart Period - The number of years prior to Year 1 during which project impacts occur.

Travel Cost Method - A technique that uses observations of travel cost and visitation at a specific recreation site to statistically estimate a demand curve. From the demand curve the net willingness to pay for recreation at the site can be calculated.

Unit Day Value Method (UDV) - A method for evaluating recreational uses based on expert or informed opinion or judgment to estimate the average willingness of recreation users to pay for the activity.

Use-Day - The presence of one person on an area of land or water for the purpose of engaging in one or more recreation activities during all or part of a calendar day, synonymous with recreation day.

Value - The value of human use of fish and wildlife expressed in monetary units (dollars).