EVALUATION OF THE REGIONAL MULTIPURPOSE BENEFITS THAT RESULT FROM A WATER AND RELATED LAND RESOURCE DEVELOPMENT

by

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ABSTRACT

The Mountain Home Division of the Southwestern Idaho Water Development Project was chosen as a model to study methodology for evaluating regional multipurpose benefits resulting from water and related land development. It is hoped that the methodology will be applicable in other areas.

Minimum flows in the river, municipal and industrial uses of water, and recreational side effects were evaluated to determine the impact of a large irrigation project on a region such as Southwest Idaho. The effects on power generation at Anderson Ranch Dam was also considered as a secondary effect to revised dam operation.

A discussion of irrigation efficiencies was included to point out the benefits that could be derived from using less water per unit of land.

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INTRODUCTION

The determination of regional benefits that accrue from the development of water and land related resources has received increasing attention from researchers, policy makers, and the general public. In calculating regional benefits due to water allocation, there are often more areas of concern that require study than have been recognized in the past. Water resources in a region have many uses. Some uses are not always considered in project planning and development which then gives a poor estimate of regional benefits. It may also lead to a misallocation of the water resource. For example, minimum flows may have some value, other than just an increase in the number of fishermen days. Likewise, there are other uses for water that could be conceived as costs to the specific project but beneficial to the region.

The need for analyses of projects on a regional basis has only been recently acknowledged. Previous feasibility studies were based on national efficiency criteria. Little thought was given to the needs, desires, and benefits of the people that lived within the immediate project area. Many projects were built to accommodate special interest groups. As local groups became more vocal, the need to study the effects of a proposed development on the local area became evident.

Therefore, in 1971, the Water Resources Council published the "Proposed Principles and Standards for Planning Water and Related Land Resources" in the Federal Register. These Standards included the option of regional analysis but only with prior approval. Subsequent studies which attempted to develop procedures have all included the regional option. These studies have generally demonstrated a wide disparity between the national efficiency accounts and the regional development accounts. This was especially true in areas that were experiencing a rather high unemployment or underemployment situation. Adding to this large difference was the inclusion of indirect benefits in the total. Project size as well as the number of alternatives available were also significantly different.

These studies have increased the capability of planners in doing regional analysis, but have also caused problems which must be answered. Among these is the need for methodology to determine the merits of national efficiency in contrast to regional development. Decisions must be made that will attempt to determine when national considerations override regional desires. The political process is the most likely method, but the need to educate the participants is evident.

REGIONAL DELINEATION

Constructing a region which best fits the needs of the specific research study is quite beneficial, both in terms of geography and economic analysis.

Various types of regional designations were examined, such as hydrologic basins, economic regions, and different alignments of political boundaries. The final product is a combination of all three.

One possibility for this study was the use of the Office of Business Economics (OBE) regional definitions. These regions generally encompass a major trading center which ties the rest of the area together. State boundaries are often crossed as is the case of Malheur and Harney counties in Oregon which are more closely tied to the Boise Valley area, and Boise city in particular, than to any region in Oregon. For this reason, they were included in OBE Region 159, which otherwise consists of ten south-western Idaho counties.

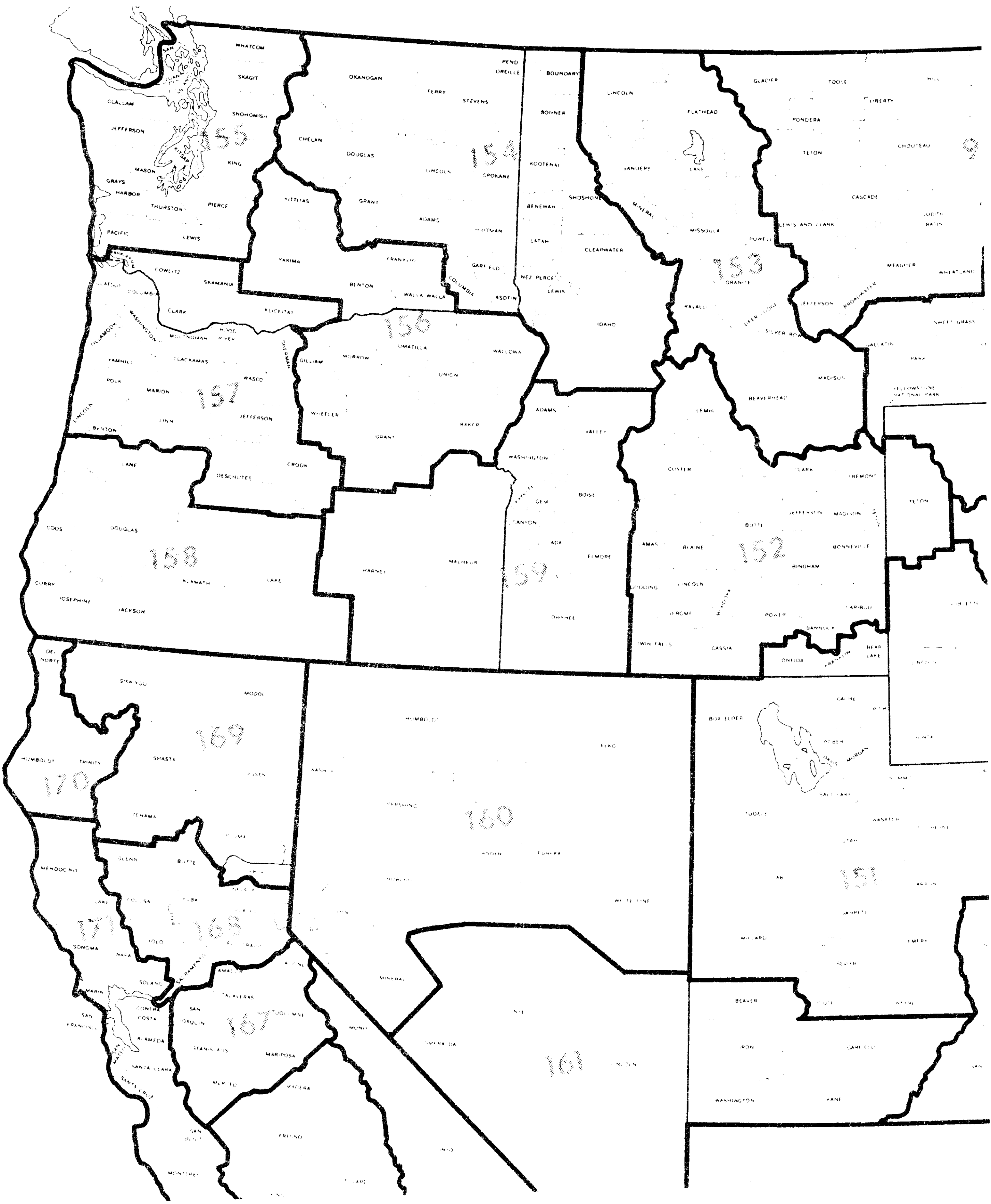
Three additional OBE regions include parts of Idaho. Region 154 which consists of northern Idaho down to and including Idaho County, has Spokane, Washington, as its economic center and is grouped with a large number of the eastern Washington counties. Region 151 has within its boundaries the northern two-thirds of Utah, the southwestern portion of Wyoming and three southeastern counties in Idaho (the Bear River Area). This section of Idaho has always had much more significant economic and cultural ties with Salt Lake City, Utah, than with any part of Idaho.

In the above cases, it is fairly easy to identify the major trading center that ties surrounding areas together. OBE Region 152, however, is not as easily described. Within this area are three major trading centers none of which equal the importance of such centers in the other areas. The northeastern corner of this region is closely tied to Idaho Falls, the central portion to Pocatello, and the western portion is tied more closely to Twin Falls, Idaho. In other words, the designation for OBE Region 152 does not appear to be entirely economic, but may also be related to the hydrologic aspect of the Upper Snake River Basin (see Figure 1).

This situation illustrates the problems encountered by planners in rationally defining regions. In fact, this aspect of a regional study can be the most difficult to solve. Conceptually, regions that are formed for reasons other than administrative facility should be done so as to best identify various economic, geographic, and cultural similarities. An overly ambitious regional designation may tend to dissipate regional benefits to the point of non-recognition. Likewise, a classification that is overly restrictive will tend to distort values and give an unrealistic picture in some instances. Current examples of this problem are readily available in measuring the environmental impact upon a region. If the region being considered is extremely small, it may appear that the environmental impact is overwhelming, whereas a larger regional designation may produce a balance of factors. When the data for any region is gathered and tabulated on a county basis, it is then easily manipulated to fit different types of regional classifications that may exist for other studies. However,

FIGURE 1

ECONOMIC REGIONS FOR OFFICE OF BUSINESS ECONOMICS



this does not allow immediate assimilation and comparison of regional data that is highly valued by some, but it is believed that having logical regional boundaries for any particular study is a basic consideration.

The Region

The region chosen for this study is located in southwestern Idaho (Figure 2) and consists of Ada, Canyon, Elmore, Gem, Owyhee, Payette, and Washington counties. Included in or adjacent to the region are major tributaries of the Snake River; the Bruneau, the Boise, the Payette, and the Weiser Rivers as well as the Snake River itself. The eastern border of the region is located approximately at King Hill, Idaho. From there it stretches along the Snake River Valley in a northwesterly direction to Oxbow Dam which is located on the Snake River above Hells Canyon.

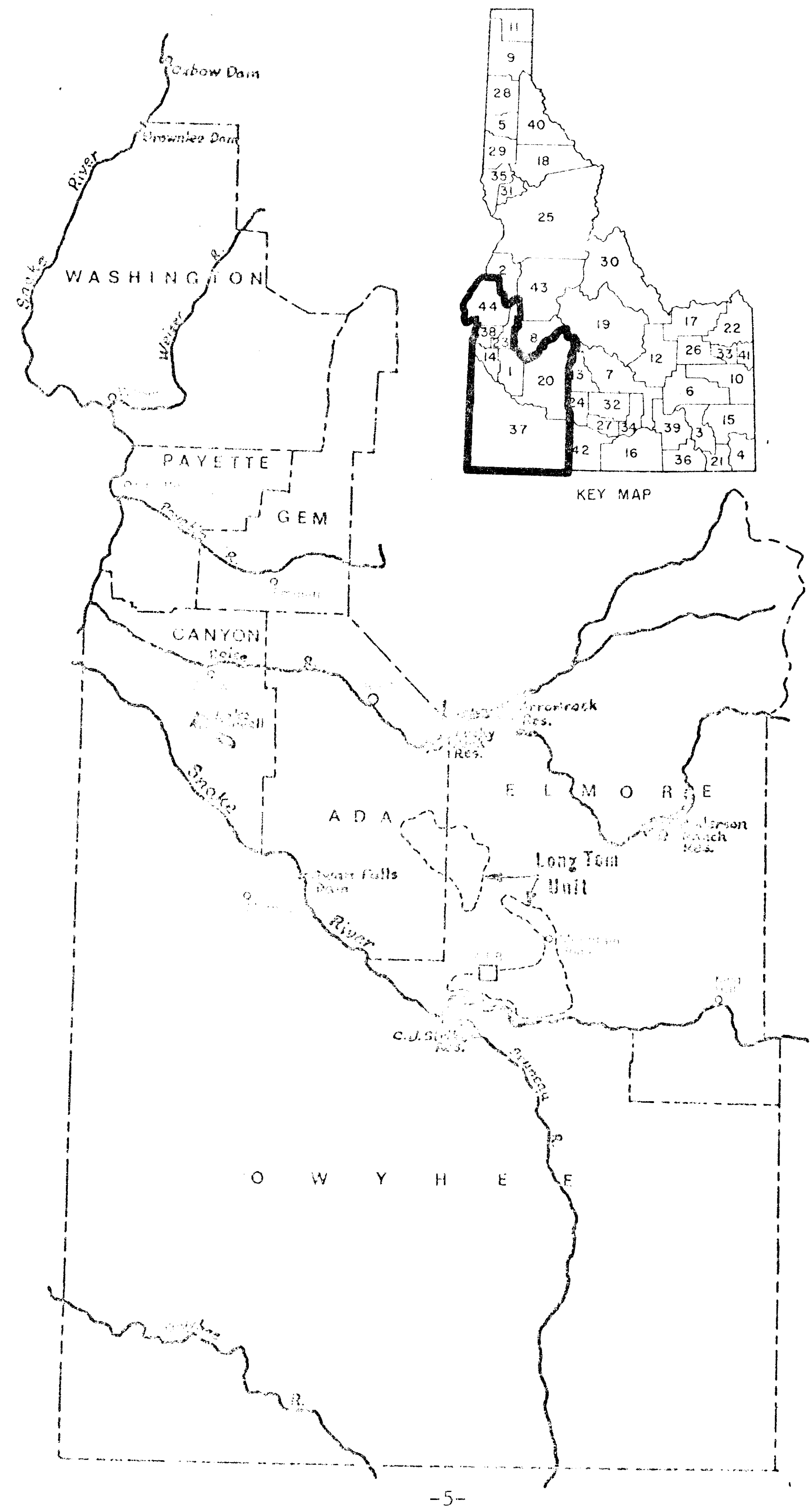
The region as defined has many diverse characteristics. Two of the counties, Owyhee and Washington, have only a small portion of their total land area under cultivation but both are tied closely to the adjacent counties which are intensively farmed. These counties could be prime suppliers of labor to the new development, especially Washington County, which has had a high unemployment rate for some time. The remaining five counties have substantial amounts of irrigated agriculture which ranges from intensive fruit orchard cultivation in Gem County to the concentrated production of seed crops such as corn and alfalfa in Ada and Canyon counties.

Historically, the economy of the region is tied to the use of natural resources. Beginning with the early fur traders, the region was subject to boom and bust cycles. This was most prevalent during the mining period when there was frenzied activity for a period of time followed by an economic slump as various mining areas declined in importance. Toward the end of the nineteenth century, ranching operations developed and the economy became more stable. This was followed by the emergence of irrigation systems which provided a stable population and an economic base that could sustain growth and provide for future development.

The irrigation projects were accelerated by passage of the Carey Act (1894) and the Federal Reclamation Act (1902). They provided for vast changes in community and commercial activities. Prior to these legislative measures, irrigation comprised about 39,000 acres operated by 550 farmers. Since then irrigation has expanded to 370,000 acres in the Boise Valley alone. Presently, Idaho is second only to California among the 11 western states in irrigated acreage. The Boise Valley has been developed for many years with several small irrigation ventures going in at the turn of the century. The Boise Project, the major reclamation development in the valley, was almost totally completed and in operation by 1920, however, full irrigation water supplies were not available until 1950. Boise City, capital of Idaho and home of many major industries, sits

FIGURE 2

SOUTHWESTERN IDAHO STUDY REGION



at the head of the irrigation development in this valley which stretches to the west about 30 miles to the confluence of the Boise River with the Snake River.

The Snake River has witnessed continuous change since early settlers began using the water for farming by diverting gravity fed canals and establishment of pumping stations. From the turn of the century to the present time, development has continued. The Dry Lake area, located south and west of Boise was developed in 1961-62 and has become a rich agricultural region. Comprising about 60,000 acres, this privately developed project secured most of its water by pumping from the Snake River. Many of the lifts are over 400 feet.

The Payette River Valley, also a part of the region, lies largely in Gem and Payette counties and grows the usual complement of feed and cash crops. Also a substantial number of fruit orchards are major contributors to the economy of the area. This valley is irrigated with water from the Payette River. In addition, there is a transfer of water from this drainage to the Boise Valley via the Black Canyon system of canals. These canals take water from the Payette River at Black Canyon Dam and provide irrigation for a sizeable acreage on the north side of the lower Boise Valley.

The Weiser River enters the Snake River at Weiser, Idaho, and is the last major tributary of the Snake River before it flows out of the region. There are some small offstream developments on this system and diversions for irrigation are made at numerous locations throughout the system.

The Bruneau River System has not been developed for irrigation like the other rivers in the area. The lower end of the river runs through a deep gorge which provides a spectacular view. The federal government has proposed to include the Bruneau River in the National Wild and Scenic Rivers system.

Population Patterns

The 1970 Census listed 221,139 persons as living in the region. This represents an increase of 22,756 over 1960. When viewed on an individual county basis, a more interesting picture comes to light. Table 1 lists the changes in rural and urban population for the counties in the region.

TABLE 1.

POPULATION IN SEVEN SOUTHWESTERN COUNTIES FOR 1960 AND 1970

	1960			1970		
COUNTY	URBAN*	RURAL	TOTAL	URBAN	RURAL	TOTAL
Ada	65,640	27,820	93,460	87,803	24,427	112,230
Canyon	30,243	27,419	56,662	34,987	26,301	61,288
Elmore	5,984	10,735	16,719	12,489	4,990	17,479
Gem	3,769	5,358	9,127	3,945	5,442	9,387
Owyhee	--	6,375	6,375	--	6,422	6,422
Payette	4,451	7,912	12,363	4,521	7,880	12,401
Washington	4,208	4,170	8,378	4,108	3,525	7,633
County Total	114,295	89,789	204,084	147,853	78,987	226,840
State Total	317,097	350,094	667,191	385,183	327,825	713,008
County Total as a % of State Total	36%	26%	31%	38%	24%	32%

* Any settlement of more than 2,500 people.

SOURCE: Number of Inhabitants, Idaho. Bureau of Census, 1970 Census of Population.

Like the rest of the nation, the rural population decreased and urban population increased. However, there are exceptions for individual counties. Washington County lost population from both sectors while Gem and Owyhee counties show an increase in the rural areas.

As indicated in Table 1, Elmore County experienced a turbulent population growth pattern during the sixties. This is not demonstrated in the total population column, which increased by 760 people, but in the urban and rural sectors which have reversed in importance. This change was due largely to Mountain Home Air Force Base situated a few miles to the south of the city of Mountain Home. At the time of the 1960 census, there was substantial construction activity at the air base and surrounding missile sites which utilized a large labor force. Since the base is not considered to be an incorporated town, this population was put in the rural sector. From 1960 to 1970, the city grew rapidly with help from service industries used by the air base and the established farming enterprises in the area. The base presently has no major construction programs underway which has lessened the demand for construction industries.

Elmore County would receive the greatest direct impact from the development of the Mountain Home project since it is still sparsely settled and depends heavily on the military complex. If a radical decline occurred in personnel stationed at this installation, the city of Mountain Home as well as the county would face a severe economic setback because there is not sufficient economic diversity in the area. The development of a large farming community would focus the local economy on agriculture, thus broadening the economic base of the county.

The largest increase to regional population occurred in Ada County, the political center of the state. The increase of almost 19,000 persons accounted for over 80% of the total change in the region. The urban area expanded substantially with the construction of many new subdivisions on former agricultural lands. There has also been a large expansion in the construction and service industries. This has increased the population density of Ada County to over 100 persons per square mile.

TABLE 2. Population Density (Persons Per Square Mile) For Seven Southwestern Idaho Counties.

County	Land Area Sq. Miles	Population Density 1960	1970
Ada	1,043	89.6	107.6
Canyon	578	99.8	106.0
Elmore	3,048	5.5	5.7
Gem	555	16.5	16.9
Owyhee	7,641	0.8	0.8
Payette	402	30.8	30.8
Washington	1,462	5.7	5.2
7 Counties	14,729	13.9	15.4
STATE TOTALS	82,677	8.1	8.6
REGIONAL TOTALS AS A % OF STATE TOTALS	18%	172%	179%

SOURCE: Number of Inhabitants, Idaho. Bureau of Census, 1970 Census of Population.

Table 2 lists the land area of the seven counties in the region and indicates their population densities for 1960 and 1970. There are wide variations in the density of the various counties. The three counties with the lowest population densities, Elmore, Owyhee, and Washington, are still largely range land and cattle ranches. Irrigation development is rather isolated, making up a small fraction of the total land area of the county. These values emphasize the beneficial impact from a large irrigation project, especially on an area such as Elmore County where there is large room for population and economic expansion. It is also worthy to note that Elmore County is still owned largely by the federal government, which does not lend itself to a broad tax base. In 1967 there was about 1.4 million acres of government land, or about 72% of the total area of Elmore County. Only Owyhee County, which makes up more than half of the total area of the region, has more federally owned land. The remaining five counties have about 32 percent of their land under federal ownership. (Idaho Statistical Reporting Service, 1972.)

Table 3 lists migration trends for the region and explains in greater detail the change in population. Ada was the only county that experienced in-migration while the remainder of the counties saw people migrating to other parts of the state or nation. This migration is often the county's youth whose loss greatly affects an area's chances of sustained economic growth. The region overall experienced a net out-migration of 1781 persons between 1960 and 1970.

Table 3. Population Shifts in Seven Southwestern Counties

County	Change from 1960 to 1970	Natural Change (Births - Deaths)	Net Migration
Ada	18,770	11,563	7,207
Canyon	3,626	5,825	-2,199
Elmore	760	4,425	-3,665
Gem	260	801	-541
Owyhee	47	655	-608
Payette	38	789	-751
Washington	-745	479	-1,224
TOTAL (REGION)	22,756	24,537	-1,781

SOURCE: "Idaho Population Changes, Density and Migration," Joel R. Hamilton, College of Agriculture, University of Idaho, August, 1971.

Another benefit to the county and to the region would be the new employment opportunities created. The large number of people used on construction projects by Mountain Home Air Force Base has declined greatly. In 1962 an average of 2,748 persons were employed in the construction trade in the county. By 1969 this had dwindled to 144 people. At the same time other employment opportunities also decreased. In fact, the only two areas that have shown any gain during the 1962-69 period were government and agriculture. The latter category increased from 456 laborers in 1962 to 871 workers in 1969. (Idaho Department of Employment 1962, 1969.)

Present Regional Irrigation Development

To better understand the farming patterns of the region, it is helpful to study the changes that have taken place during the period from 1964 to 1969. The general trend in this region has been the same as the rest of the nation during the past five years.

Table 4 points out the rapid increase in farm size in many of the counties. Only Gem County has shown a decline. Elmore County, the location of the proposed project, has had a significant increase in farm size while at the same time showing a growth in the number of farms in the county. This is due to the large number of desert entries and sales of state land for agricultural purposes. It is estimated that the amount of land irrigated in 1972 was approximately 60,000 acres or about a 15 percent increase over 1969 census figures. Many of these newer farming units are quite large, but because of the small farms that were developed as a result of the Mountain Home Irrigation District and the King Hill Irrigation District, the average farm size is not indicative of the newer agricultural units.

Table 4. Size and Number of Irrigated Commercial Farms*
1964 & 1969

County	1964 No.	1964 Acres	Average Size (Acres)	1969 No.	1969 Acres	Average Size (Acres)
Ada	987	87,106	88.2	825	77,450	93.8
Canyon	1,903	220,686	116.0	1,594	208,820	131.0
Elmore	150	35,815	238.8	159	51,127	321.5
Gem	431	45,250	105.0	356	36,614	102.8
Owyhee	462	85,261	184.6	437	98,541	225.4
Payette	530	49,679	93.7	443	42,777	96.5
Washington	334	30,861	92.4	276	30,799	111.5
REGION	4,797	554,658	115.6	4,090	546,128	133.5

*Farms with Sales of $2,500 and over.
SOURCE: U.S. Bureau of Census, Census of Agriculture, Volume I, Idaho, 1964, 1969.

For example, these two districts together have 13,400 acres under irrigation in Elmore County. This land is divided among 241 farms of five acres or larger, which produces an average acreage of 55.6 acres per farm. (King Hill Irrigation District and Mountain Home Irrigation District, 1972.)

Both Ada and Canyon counties show substantial increases in farm sizes with a resultant decline in the number of farms. A portion of this decline in farm numbers can be attributed to urbanization near the cities of Boise and Nampa-Caldwell. In 1971, 2,430 acres had been zoned for subdivision and through October of 1972 another 4,220 acres had been filed. (Ada Council of Governments and Canyon County Planning and Zoning Commission, 1972.) A major portion of the decline is due to consolidation or acquisition of farm units. This, of course, is the farming revolution that has been taking place in U.S. agriculture for many years and explains much of the change in many of the other counties of the region.

As previously noted, a large number of the new farms in Elmore County have developed through desert entry acquisition. The irrigation water for these projects and the state land that has been developed came from wells pumping from the Snake River.

Federal land developments of this nature fall under the Desert Land Act. This statute and its subsequent amendments is designed to "encourage and promote the reclamation, by irrigation, of the arid and semiarid public lands of the Western States through individual effort and private capital, it being assumed that settlement and occupation will naturally follow where the lands have thus been rendered more productive and habitable." (Department of the Interior, 1970.) An entryman may claim up to 320 acres of desert land for the above stated purposes, with a man and wife operation being allowed 640 acres. Four years are allowed for development and within this time the land must be cleared and the ability to irrigate must be demonstrated. The latter requirement has been satisfied almost exclusively through use of sprinkler systems which virtually eliminate the need for land leveling. This in turn significantly increases the efficiency of water use and requires less water to be delivered to each farm.

METHODS OF WATER APPLICATION AND ALLOCATION

Sprinkler vs. Gravity Irrigation

The agricultural area included in the region have long been irrigated primarily by gravity methods. Continued modernization and new land development, however, has led to much greater emphasis on sprinkler irrigation farms.

Sprinkler systems have certain disadvantages, some of which may be overcome by switching to different types. The hand move systems, which are quite prevalent in the region, were the only type available for several years. They demand a high labor input which in recent years has become an increasingly difficult problem. Migrant and local workers tend to shun this type of employment due to the long hours and unpleasant working conditions. Use of automated systems greatly relieved the difficulties encountered in finding a large supply of summer labor. However, this also increases the initial capital investment required to install the system.

A sprinkler system that is mounted on wheels, commonly known as a side roll unit, is a common installation and is moved manually. One man can move a large amount of sprinkler pipe thus reducing the labor requirement, but there are greater restrictions placed as to types of terrain that can be covered with this type of sprinkler unit as compared to a hand move.

A third system and one that has been receiving more attention the last few years is the circular or pivot unit. One end of the line is attached to the water source while the rest of the system rotates around this fixed point. The speed can be regulated to allow precise application of water and is totally automated requiring only periodic maintenance. Obviously, this system is very capital intensive, thereby requiring a large initial investment. Each unit is designed to irrigate a quarter section (160 acres); but due to the circular configuration approximately 16 acres out of each 160 acres cannot be farmed unless an alternative water supply is used.

An additional restriction that should be mentioned are the limitations as to the variety of crops that can be grown under sprinkler irrigation. For example, in Idaho at the present time, no field bean crop can be certified that has been grown under sprinklers. Most other types of horticultural seed crop production has been limited under this type of irrigation. Increased disease problems are cited as the primary reason for the restrictions.

In this study, the wide use of sprinklers substantially enlarged the size of the project area over original estimates. By assuming that 90 percent of the land would be watered in this manner, the project size increased to almost 140,000 acres from the original estimate of 92,000 acres - not counting 4,400 acres that would receive supplemental water. This assumes a water application efficiency rate of 70 percent.

<u>The Concept of Beneficial Use</u>

The allocation of water to various uses has long been advocated, but seldom practiced. In fact, state law governing the use of water specifies a list of priorities for those activities that are considered beneficial. The Constitution of the State of Idaho, Article 15, Section 3 states:

" . . . when the waters of any natural stream are not sufficient for the service of all those desiring the use of the same, those using the water for domestic purposes shall . . . have the preference over those claiming for any other purpose; and those using the water for agricultural purposes shall have preference over those using the same for manufacturing purposes. And in any organized mining district those using the water for mining purposes or milling purposes connected with mining, shall have preference over those using the same for manufacturing or agricultural purposes."

The Constitution does not list any other beneficial uses for water in Idaho. Minimum stream flows for water quality, fish and wildlife needs, or recreation uses are not mentioned. The need for inclusion of these areas is becoming more widely recognized, but as yet no legislation is forthcoming. Interests opposing official action believe that allowing the water to remain in the stream, for example, allows it to leave the area without being used for purposes they consider to be beneficial, such as irrigation or manufacturing.

In many respects, the need to evaluate the benefits of a regional water and related land project presents the greatest challenge of all. Many of the same difficulties encountered with conventional water uses are magnified relative to multiple purpose needs.

Water is necessary to wide variety of recreational, fish and wildlife, hydropower and water quality uses. In each of these cases, water is only one of many integral inputs that contribute to the production of benefits, and it is difficult to identify the contribution of each input.

Historically, the above uses of water have been viewed as non-consumptive. However, the increase in disposable income, available leisure time, and environmental awareness, have had a major impact on resource management. The questions associated with consumptive use versus non-consumptive use are complex, centering upon river, reservoir, and lake operations to maintain water levels. This certainly introduces new issues into any intensive analytical effort.

Among the important considerations is to determine the existing opportunities for water savings through redefining fish and wildlife, recreation, water quality, etc., as a quasi-consumptive use. The future calls for increases in the minimum pools of reservoirs for fish protection, minimum flows in rivers and higher water levels for recreation. Admittedly, though, the resource is not lost or used in the physical since the mobility and transferability to other alternative uses is blocked. Water thus "saved" can be equated with an increment in supply. It is conceivable for example that if water is an important social cost item, users may be willing to invest considerable amounts of capital into water storage, quality maintenance and environmental programs. Rates of return on these investments can then be determined for comparison with other classes of use. This, may in turn, increase the total productivity of the water by transferring some of the resource from uses of low marginal productivity to those of higher marginal productivity. Reasoning of this nature would apply to all water uses where water is the constraining resource on production and would indicate important water allocation benefits of efficient use and improved social welfare.

Many of the benefits from such a water use are normally allocated outside the conventional market framework. This is so particularly in the case of outdoor recreation. There are few or no market prices on the services, to say nothing of the resources producing the services. Two critical valuation problems grow out of these difficulties: One involves finding a way to quantify the economic value of the services and the demand for the producing resources. The second is the problem of finding ways to compare information thus developed with information about other water uses which are routinely market oriented. Such a comparison is essential to any effective regional analysis.

This study attempts to recognize the "beneficial use" of water placed in the alternative functions of recreation and hydropower. Each of these areas will be analyzed independently to determine the effects of the proposed project. However, estimating the value of contributing resources from values of goods and services produced is never easy. As a matter of fact, water resources are often combined with other classes of resources in almost fixed proportions. When this occurs, there is no readily identifiable marginal product. Given this problem, study will be given to one general application of a proposed methodology for each function, which procedure would be most satisfactory to other applications.

Water Allocation

In studying the original Bureau of Reclamation Report, it became apparent that only limited information could be taken from the report and adapted to the study. (Bureau of Reclamation, U.S. Department of Interior, 1966.) It was based on a gravity irrigation system with small farm units and a water delivery system that was very conservative in its estimates of efficiency rates. These restrictions made it necessary for budgets to be constructed using predominately sprinkler irrigation and higher water use efficiencies as well as more economically viable farming units.

The amount of water determined by the Bureau of Reclamation to be available for diversion through Long Tom Tunnel was used as given, and it was further assumed that no more Snake River water could be used to supplement Deer Flat Reservoir than had already been allotted. Minimum flows, municipal and industrial uses, and fish and wildlife needs are studied and possible pricing methods are suggested.

In the Southwest Idaho Water Development Project Study of 1966, it was estimated that an annual average diversion through Long Tom Tunnel of 486,000 acre-feet would be possible.1/

The Mountain Home Irrigation District, which consists of 4,400 acres in the immediate vicinity of the city of Mountain Home, would receive an estimated 8,000 acre-feet annually of supplemental irrigation from the proposed project. Also, the city of Mountain Home has expressed a willingness to contract for 5,000 acre-feet annually to be used as municipal and industrial water.

There are other uses of the water, however, that could enter into the allocation process. For instance, the city of Boise which is bisected by the Boise River has experienced a declining quality of groundwater during the past few years. They have expressed interest in the possible use of surface water for municipal and industrial uses. Because of this situation, it appears Boise may attempt to file on river water in the future. This would further deplete the available supply of irrigation water. In this report, it is assumed that there will be M & I water use in Boise, and the amount is estimated to be about 20,000 acre-feet annually.

Minimum flow augmentation in the Boise River itself is another possible competing use. If a certain minimum flow becomes mandatory due to the issuing of guidelines by state regulations or the Environmental Protection Agency, water must be allocated for that use. Presently there is an allocation of 50,000 acre-feet set aside in Lucky Peak for enhancement of the downstream fishery. This allotment, however, is tied to the amount of carry over storage that is available and there are numerous times when this water is not available or is simply not released. (Corps of Engineers, 1968.) Therefore, this study does not take into account this water allotment.

To determine the amount of water to be left in the river for minimum flow augmentation through the Boise City reach, the flows for the past 52 years (the average monthly flows for the five winter months) were studied. It was decided that the construction and operation of Lucky Peak Reservoir had sufficient effect on the Boise River system to limit useful data to the period from 1956 to the present. This leaves only 15 years, but in that period, there have been both lean and plentiful water years. However, even with the additional 278,500 acre-feet of storage, the situation in the Boise River deteriorated since 1956. (U.S. Geological Survey, 1970.)

Studies done by the Idaho Fish & Game Department (Idaho Fish and Game Department, 1969) and the Pacific Northwest River Basins (PNWRBC) Commission (Pacific Northwest River Basins Commission, 1971) have indicated that 120 cubic feet per second (cfs) was the desired minimum flow through Boise during the winter. For the year 1980, PNWRBC estimated that 160 cfs

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1/ Recent study by Robert J. Sutter of the Idaho Water Resource Board staff indicates this may not be true (see Appendix C).

would be the minimum amount needed to achieve adequate water quality. Comparing this projected limit with the recorded average monthly flows, there has been a substantial increase in the number of months indicating deficits since the construction of Lucky Peak.

The average historical flows during the winter months were compared with the suggested minimum flows. November through March was determined to be the critical period for flows in the Boise River at Boise. During this time period the river is often tightly regulated to allow storage of water for irrigation the next season. Because of diversion requirements downstream, there are adequate flows in the river during the summer. This was done with full realization that a change in reservoir operations could make a significant difference in the situation as it now exists.

The calculations indicated that on the average, approximately 19,000 acre-feet would be needed during the five month period to increase the flows through Boise to 160 cubic feet per second. For this purpose, water was allocated from the original estimates of water available for diversion to the Mountain Home desert.

Summary of Water Uses

Table 5 attempts to summarize the water quantities allocated to the various non-agricultural uses. The residual is assigned to irrigation on the Long Tom Unit of the Mountain Home Project and is the determining factor on the number of farms and the impact the project will have on the region.

Table No. 6. Identification of Water Uses for the Boise River

Water Allocation		Amount (Acre Feet)
TOTAL WATER SUPPLY		486,000
Supplemental Water	8,000	
Mountain Home City	5,000	
Boise City	20,000	
Minimum Flow Augmentation	19,000	
Wildlife Uses	4,000	
Total		56,000
Water Available for Irrigation		430,000

DEVELOPMENT OF PROJECT SIZE

In order to make some determination as to the number of farms that could be developed in the area, it was necessary to establish various farm sizes. Farms of 160, 320, 480, and 640 acres were used to calculate the number of new farms that would make up the Long Tom Unit of the Mountain Home Division. It was readily apparent that the 160-acre units were not economical sized units, therefore, this size was dropped from further consideration in determining the number of families that would settle in the area. It was decided to use 320-acre farms as the basic unit, which is in conformance with the amount of land presently allowed on desert land in the area.

Basic farm budgets were constructed and used to estimate the production of four specific crops, alfalfa, barley, potatoes, and sugar beets. Yields and inputs, such as fertilizers, herbicides, and water were the same for all four farm sizes. Greater labor and machinery efficiencies were used as the farming units increased in size. For the machinery, this involved a decrease in the time spent per acre plus an increase in the total number of hours any particular piece of equipment would work in a year. Joint ownership of some of the harvesting equipment with a neighbor was assumed for all of the farms.

It is apparent that a project of such magnitude has a great deal to gain by increasing irrigation efficiencies. If one assumes that water is a fixed resource (430,000 acre-feet) and the land base can be expanded or contracted to fit the available water, significant regional benefits can be derived by irrigating more land with the same amount of water, or to put it another way, applying less water per acre of ground. Table 6 illustrates the acres gained by increasing the efficiency of water application as well as the added acres available for farming by increasing the farm size. The top row indicates different irrigation efficiencies. In other words, these columns indicate the amount of water required above the consumptive requirements of the plants. If the consumptive use is two acre-feet and the efficiency factor is 70 percent, the farmer would need to apply 2.86 acre-feet of water per acre to fill the plants' needs.

Table No. 6. Comparison of Farm Sizes and Irrigation Efficiency[a]

Farm Size	Irrigation Efficiency 65%	70%	75%	80%
320[b] (304)	131,324[c]	141,329	151,386	161,680
480 (456)	132,630	142,832	152,996	163,400
640 (614)	134,026	144,336	154,607	165,120

a. Assume 430,000 acre-feet of water and 100% sprinklers.

b. Numbers in parens are the actual acres farmed. 320-acre farms have six percent waste; 480-acre farms have five percent waste; 640 farms have four percent waste.

c. Acres of irrigated farmland.

As noted in Table 6, approximately 3,000 acres of additional land could be irrigated in the project simply by doubling the farm size from 320-acres to 640-acres per farm unit and decreasing the amount of waste land by two percent. This is only a modest increase when compared to the possibilities of increasing the amount of land that could be irrigated by increasing the efficiency with which water is applied. A shift from 65 percent to 80 percent, the two extremes, would enable overall project expansion of about 30,000 acres. Even a small change from 70 percent to 75 percent efficiency would free sufficient water for an added 10,000 acres. This additional land would not only mean an increase in the production of various crops, but it would also denote an increase in farms and subsequently, farm families, hired labor, and all of the secondary effects attributed to the project.

Table 6 assumed that the project would be irrigated totally by sprinkler systems. This may not be completely realistic due to restraints placed on the types of crops that could be grown. Therefore, in determining the number of farms to be developed on the project, it was assumed that ten percent of the land would be irrigated by gravity. Table 7 demonstrates the breakdown between irrigation systems and shows the number of farms that could be developed given this specific set of assumptions. This figure was calculated by division of the total acreage allocated water by 320-acres. It should also be noted that waste was assumed to be ten percent for areas irrigated by gravity.

Table No. 7. Effects of Varying Irrigation Efficiencies

Item	70%	75%
Consumptive Use	2.0 a.f.	2.0 a.f.
Farm Diversion	2.86	2.67
Total Water Available	430,000	430,000
Acres Irrigated by Gravity (10%)[a]	14,792	15,716
Acres to be Sprinkled (90%)	133,127	141,448
Total Acres Allocated Water	147,919	157,164
Actual acres farmed[b]	138,304	146,948
No. of farms[c]	462	491

[a]60 percent efficiency in all cases.
[b]Waste: Sprinkler, 6%, Gravity, 10%.
[c]320 acres is farm size used to determine farm numbers.

Two levels in water application efficiency were included in this table for comparison. As indicated, an irrigation efficiency of five percent would allow development of approximately 30 more farms. In addition to the benefits of having more farms, farm family and labor as previously discussed, all farms in the project would be in a better position. The primary delivery system would essentially remain the same size, therefore, many of the construction costs would not change.

This would lower the repayment charges for the farmers and give them a higher net income within the project area and, consequently, greater purchasing power within the region.

REGIONAL ECONOMIC BENEFITS

Agriculture

Table 8 summarizes the budget developed for a farm of 320 acres (see Appendix A). Using these figures, it is possible to estimate the direct impact on the region.

Table 8. Summary of Farm Budget For 320-Acre Unit

TOTAL REVENUES			$89,360
FIXED COSTS:			
Interest	$ 5,610		
Depreciation	13,790		
Taxes & Insurance	3,360		
Subtotal		$22,760	
VARIABLE COSTS:			
Repairs	$ 6,000		
Hired Labor	5,270		
Custom	4,300		
Inputs (Seed, Spray, Fertilizer)	11,930		
Utilities (Farm Share)	450		
Potato Tax	630		
Operating Costs (Gas, Oil, etc.)	5,490		
Interest on Operating Capital	2,160		
Miscellaneous	1,180		
Subtotal		$37,410	
TOTAL FARM EXPENSES			$60,170
NET FARM INCOME			$29,190
Return on investment	$ 8,420		
Family Living Allowance & Return for Management	10,000[a]		
Subtotal			$18,420
RESIDUAL AVAILABLE FOR WATER			$10,770

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[a] Estimated.

As indicated in Table 7, there would be 462 farms of 320 acres each organized in the area. Combining this information with the total revenue of Table 8, produces a total farm revenue of approximately $41,284,000 for the project. This reflects a very healthy contribution to the economy of the region and the nation.

An important consideration when looking at the income and expenditures of the farmer in the region is a breakdown of the machinery. These, including trucks and tractors, would generate approximately 3 to 4 million dollars of business yearly for equipment dealers. These were also estimated by the farm budgets. Direct inputs such as fuel, insecticides, seed, and fertilizer would generate about 8 million dollars a year in benefits to the agribusiness industry. In the budget for 320 acres, it was estimated that 2775 man hours of hired labor would be needed for the farming operation. At an hourly wage of $1.90, this is $5,272.50 per farm, or about $2,425,000 for the entire project.

A more detailed breakdown of the various inputs could be made, but this would be of little value. It is, however, worthwhile to discuss these categories in more depth. The machinery and equipment used by the agriculturalists comes largely from outside the region. There are a few small equipment manufacturers who specialize in such things as potato harvesters, beet harvesters, and vine beaters, but the larger percentage of these durable items are manufactured outside of the region, and in fact, outside of the state. Therefore, the direct benefits to the region would basically be the markup applied by the dealer, and the income derived from servicing the machinery. From this differential, the dealer must pay salaries and wages, capital outlay, and operating expenses as well as show a profit.

Other inputs such as fertilizer, seed, and fuel, are in the same category as machinery. Most of these inputs are imported into the region from other areas within the state or from outside the state. Given this leakage it is easy to understand the low multiplier for farm production for both the state and the region. This concept will be discussed later.

Expansion of agribusiness endeavors would certainly be an immediate result of the development of the Long Tom Unit as just discussed. The handlers of farm produce would also find an opportunity to start new businesses or expand existing facilities.

The 462 farms in the Mountain Home Project are estimated to produce approximately 20,000 acres of sugar beets. If the average yield is 25 tons per acre, the total annual production would be about 5,000,000 tons. The present capacity of the two regional processing plants that would handle these sugar beets is estimated to average 15,000 tons per day. It is assumed that the company would extend the processing period to handle the new production rather than making any significant changes in capacity.

It is a simple arithmetic exercise to see that an extra 33 days would be needed to process the estimated increase in production from the Mountain Home Division. There are presently 550 people employed in the two factories, therefore, there would be 18,150 more days of labor attributable to the increased sugar production. Calculated in full-time job equivalents, it would represent 58 jobs using a 48 hour work week for estimating purposes. This would add approximately $350,000 to the payroll of these two factories. The additional sales of molasses and beet pulp alone would be in excess of $2.5 million.

The benefits of increased sugar beet production would carry much farther than the factory itself. New sugar beet dumps would be required and these would provide additional employment opportunities. There would also be a major contribution to the income of the railroads as a large percentage of the sugar beets from outlying areas reaches the factories by rail.

Potato production on the Long Tom Unit would only add to an already rapidly expanding industry. There are presently 22 plants in Idaho owned by 18 different companies. These businesses have over $80 million in capital investments compared to only about $5 million twenty years ago. Because of the excellent processing qualities of the Idaho Russet, the percentage of the potato crop that is handled in this manner has also increased dramatically. Over 62 percent of the crop is now used to make products such as french fries and hash browns (Sherlock, 1973).

The livestock industry would also receive a significant boost from the Mountain Home development. There would be about 894,000 hundredweight of barley which could support 20-25 thousand head of cattle on feed. If present sprinkler projects are any indication, there will also be adequate quantities of hay produced for any projected growth in the livestock industry. In fact, it is possible that there would be more hay produced than the estimated cattle numbers shown above would require. This could encourage added growth in the livestock industry in the region, or it could be exported to areas that are hay deficient.2/

Assuming that there would be another 20-25 thousand head of cattle fed each year in the region, a sizeable contribution to the economy. 1100 pound animals selling at $35.00 per hundred would return $7,000,000 to $7,700,000 to the feedlot operators. This then filters through the system multiplying the benefits of the increased activity in the livestock industry. Meat processing facilities, transportation, and suppliers of the inputs needed for this type of operation would all feel the positive effects.

2/ Beef cattle were used in the example rather than Dairy because barley becomes a limiting factor much sooner.

Minimum Flows

Throughout this study, mention has been made of project benefits. In reality what is being discussed are regional benefits that are directly or indirectly attributed to the development of the Mountain Home Division. That is, many of the benefits may be recognized in the region but have nothing to do with the project. Minimum flows in the river and municipal and industrial water are examples. These needs could be furnished without the project. Indeed, they could be met more easily without the project because of the greater amount of water available. However, if the development was to take place, the other activities requiring water would need to be included as an integral part of the planning process.

Previously the beneficial uses of water as defined under the Idaho Code were delineated (see page 13). Minimum flows in a river or stream for the purposes of water quality or fish and wildlife have not been recognized as beneficial uses. In this study, however, it is assumed that minimum flows will be provided and that these flows in the Boise River will tend to limit the development of land in the Mountain Home area. If this is the case, the water left in the river rather than being used for agriculture has a minimum value equal to its alternative use.

For this study, it was estimated that 19,000 acre-feet was needed to augment the flows of the Boise River during the winter months (see Table 5). This quantity of water would provide a minimum flow of 160 cubic feet per second through Boise City from November through March. It is not intended that this flow be considered optimum. It simply represents sufficient water to provide adequate quality and habitat conditions for aquatic life.

Table 8 estimates the residual available for water payments at $10,770 per farm, or about $12.00 per acre foot assuming 70 percent irrigation efficiency. This does not mean the farmer would have to pay this much for water, but it is an indication of the maximum amount available. Using the ability to pay concept and assuming the farmer would pay $12.00 per acre foot if there was no alternative, it is then possible to establish a surrogate price for the water left in the river. The 19,000 acre-feet used to augment flows would have a minimum value of $228,000 per year.[3]

Who pays the cost of leaving the water in the river? There is obviously no direct payment to anyone. Rather, the dollar amount represents the value of a public good that has been allocated to a public use. It is not possible to say that the decision to have a minimum flow of 160 cubic feet per second through Boise is based solely on economic rationale. The decision is made with factors such as health, recreation and aesthetics in mind. This estimated value allows all the above factors to be considered and is more than likely under stated. However, this value should serve as a minimum or base line figure. Attempt at taking creel counts or other estimates of

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3/ If M&I need could be established, the value of water in the river would be $75.00 per acre foot minus treatment costs.

use under different flow conditions and then calculating incremental values for additional water has been a rather haphazard method of determining values for certain water quantities. This type of quantification has not been able to value aesthetics such as a pleasant view or the lack of displeasing odor.

Municipal and Industrial Water

Estimates made earlier concerning the various uses of water on the Boise River allocated 20,000 acre feet to Boise City and 5,000 acre feet to Mountain Home (see Table 5). Under Idaho Code domestic water uses have priority over any other activity that has a water requirement. Presently this appears to also be based on sound economic principles. If water was limited in the quantities available, domestic water users would almost certainly outbid other users.

At this point, however, the delineation of water priorities in the Idaho Constitution does not appear to be based on any economic criteria. The industrial users of water are generally able to pay significantly higher rates for water than the agricultural interests. The present rate structure for the Boise Water Corporation indicates the present domestic and commercial rate is approximately $75.00 per acre foot. While this is not the cost of providing water, but rather the retail price, it is a valid estimate of the value of water taken from the Boise River for municipal and industrial purposes. It could in fact, be conservative because only minimum treatment is required on the groundwater presently being used.

By using the $75.00 per acre foot figure just discussed, it is possible to estimate the value of the 25,000 acre feet that has been allocated to municipal and industrial use at $1,875,000 annually.

When one compares the value for this water use with that estimated for minimum flows, it becomes evident that criteria other than economics is often necessary to achieve the goals of a society.

There would be some time periods where the minimum flow requirement could be provided by excess water above the capacity of the storage system. In these instances, the benefit accruing to the region would be zero. This is not part of the calculation of averages, because a change in the current method of operating the reservoirs would be necessary. It may well be that the flows in the river are well below the minimum during the late fall and winter, but at much higher levels in the spring when there is dumping to allow for storage space of spring runoff.

THE MULTIPLIER ASPECTS OF A REGIONAL PROJECT

Without detailed study and development of an input-output model for the region, it is impossible to have regional multipliers which represent exactly the seven county area included in this report. It is possible, however, to develop multipliers that will estimate the internal and external movement of goods within a region.

Due to significant leakage that occurs constantly, it is only natural that any regional multiplier would be somewhat low. In the section discussing the benefits derived from agriculture, it was noted that most of the sugar would be processed within the stipulated regional boundaries. The percentage of potatoes would be processed internally would not be as great but would be substantial. The final products of these crops, however, are largely exported from the region for consumption in other parts of the nation.

The livestock industry falls into the same category as the crops just discussed. Some grain and hay would be exported. The more this tends to happen, the lower the multiplier will be. Because of the expanding beef and dairy industries, the demand for feed grains and hay within the region is increasing. This allows a dollar turn over and yet keeps the product in the area for additional activities. The final outcome in this case is the same. The meat may be processed in the area, but in the end most of it is shipped to markets outside of the region.

These examples are only a few that could be cited to demonstrate the importance of export markets to the economy. However, the magnitude of the exports is the basic reason for a low multiplier.

A situation similar to that discussed above exists on the other end of the production line. Many of the inputs farmers purchase each year come from outside the region with a resultant downward effect on multipliers.

An input-output study (Rafsnider, 1971) done recently for Idaho State Planning and Community Affairs Agency in cooperation with the Idaho Department of Public Lands and the U.S. Forest Service gives an indication of what the multiplier could be for the agricultural economy of Idaho at the farm level. The multiplier used was calculated by dividing the Leontief Inverse final multiplier with the diagonal element of each relevant sector and then taking a weighted average of these sectors (based on gross revenues) (Hamilton, 1972). It should be stressed that this is a state multiplier and the numbers as given represent the estimated effects the proposed project would have on the state. Therefore the times that the farm dollar revolves is somewhat overstated. For instance, significant amounts of fertilizer are produced in eastern Idaho. The movement of this product into the region and the subsequent purchase of it by farmers would theoretically be included in the state multiplier whereas the total transaction should not show up in a regional multiplier.

Included in the grouping of agricultural sectors used to determine the multiplier were: (1) Dairy Farm Products; (2) Poultry and Eggs; (3) Meat, Animals, and Livestock Products; (4) Food, Feed Grains and Grass Seed; (5) Vegetables, Sugar, and miscellaneous crops.

The resulting multiplier for farm level revenues was approximately 1.44. This includes primary and secondary benefits at the farm level, but excludes tertiary effects. Multiplying this number by the gross revenues from agriculture calculated earlier, benefits from the agricultural production are estimated at $59,450,000. Multipliers that would include the third round effects of the farmers dollar would certainly be higher. However, in calculations of this nature, the direct contribution to the economy is obscured. For example, the wife of a farmer may have her hair done using dollars earned on the new project. This transaction is a benefit to the beauty salon operator and her suppliers. However, had the family lived in the region prior to the project development, she possibly would have had her hair done anyway, thus creating the same regional benefit.

It should be mentioned that the sector relationships in the State Input-Output Model are based on national coefficients. In other words, it is assumed a high degree of similarity exists between any particular sector at the regional level and the nation as a whole. For a state that has very little heavy manufacturing and is oriented towards industries that use basic natural resources, there may be some question as to the legitimacy of the above stated assumption. It is, however, a method that allows a product to be produced in a much shorter time frame without attempting the tremendous regional primary data collection process.

THE EFFECTS OF RESOURCE DEVELOPMENT ON LABOR AND POPULATION

Labor

The supply of available labor within a region can have a significant effect on economic growth. It can exert pressure in determining how growth takes place as well as the changes caused in the population by specified development plans. If this labor is employed within the region before the project, but then simply shifts jobs with no corresponding change in wages, there is no benefit to the region if the laborer's old job is not taken by someone else. Generally, however, there would be someone to take the old job and this person could be from outside the region or previously unemployed. However, regardless of how many steps there are in the chain reaction, there will generally be an influx into an area approximately equal to the new employment opportunities created, less the decrease in persons previously unemployed. The demand situation for the new employees could be temporary and quickly revert back to previous levels of unemployment if there is a sufficient influx from other areas.

Emphasis on socio-economic goals such as a higher standard of living and full employment, has placed increased emphasis on studying the effects of under-employment. Agriculture, with its seasonal demands on the labor force, has been considered as a major contributor to the under-utilization of human resources. Neither the labor input nor the monetary return are spread evenly throughout the year. Disguised under-employment can also be noted in the agricultural industry. Depending upon the mobility of the labor in question, there are many people who are employed full-time but whose jobs often do not permit full use of their capacities or skills. Both permanent and temporary residents of the region may fall into either of the above categories.

There are changes taking place in agriculture that over time will tend to decrease the conditions of under-employment. Increasing mechanization, diminishing seasonal labor requirements, and better training for employable directly and indirectly involved in agriculture will insure a more total utilization of the human resource in rural areas.

One can assume that in both relative and absolute terms the number of under-employed in the southwestern Idaho region has been decreasing. With the development of 138,000 acres at Mountain Home, the total number of under-utilized employees would surely increase and this should be considered a cost to the region. This could be demonstrated by an increase in those applying for public assistance during the winter, or by large amounts of vacant housing in the project area.

What effect would the Mountain Home Project have on other regions or the nation as a whole? A labor shift does not necessarily bode ill for the supplying region. It may decrease the number of unemployed or under-employed, and in turn decrease the dollar allocation to assistance programs. Also, the shift of farmers would not necessarily be a cost to the donating region. It may be that there would be increased efficiency and higher yields on the farms in that region because of consolidation of agricultural units into larger and more profitable farms. This would certainly have to be balanced against the loss of purchasing power for family consumption items that would take place when the farmer or laborer departed.

Once again, the question of regional delineation enters the picture. As previously indicated, a decrease in assistance payments could be considered a benefit. If the region that had been selected did not include a significant part of the governing body responsible for these payments, the loss of this influx of money, albeit its welfare aspects, could be considered a regional cost or at least would need to be deducted from the earnings of the former welfare recipients to arrive at a net figure.

Population

Major changes in population would occur in the project area as well as in the entire region. These changes represent increased employment in the agricultural sector and agriculturally related industries. The Idaho Department of Employment estimates that there are about 75 full-time equivalent jobs in service, support, and trade industries for every additional 100 full-time equivalent jobs in agriculture (Garrett, 1972). With this in mind, an attempt was made to estimate future employment and population changes due to project development.

Census data for rural areas in the proximity of the proposed development reveal an average of 3.37 persons per household in 1970. This is a decrease from the average 3.5 persons per household in 1960. If the rate of decline remains fairly steady during the next ten to fifteen years, the average household size could be approximately 3.25 persons. This estimate was used in the study to determine population growth in the project area.

As calculated earlier, 462 new farms would be created in the proposed project development. Assuming that one owner-operator, manager, or renter will live on each 320 acre unit, there is an initial increase of 462 workers. At the inception of the project, this assumption is realistic but may vary over time. This possibility, due to some consolidation of farm units by rental agreements, is not considered in the study. Also, it was assumed that one man year equivalent of full time hired labor would be needed for the size of farm unit planned. This man would be housed on the farm as would his family. Therefore, an additional 462 workers would be employed on the project. By multiplying these employment figures with the average household size (3.25 persons), estimates of permanent population living on the project can be made. These estimates are listed in Table 9.

Identification of employment and population changes in the Seasonal and Non-Agricultural categories was somewhat more difficult. This was due to the demographic nature of seasonal workers which required assumptions that may be somewhat heroic. In the past, it has been necessary to employ 6 seasonal (three man year equivalents) workers per farm to thin and hoe beets, move sprinkler pipe and perform other non-permanent jobs. With the rapid increase in agricultural technology and automation (more effective herbicides, electronic beet thinning, etc.), the past trend has been downward. The production of sugar beets provides an excellent example. In 1960, .54 manweeks per acre were required to grow sugar beets. This had decreased to .23 manweeks per acre by 1971, which is less than half the previous figure. This trend will continue into the foreseeable future as electronic thinners become more widely used. This new labor saving device will cut deeply into the only major manual labor requirement required in sugar beet production.

Potato labor requirements have decreased even more drastically. In 1961, this crop required .225 manweeks per acre, while in 1971, only .079 manweeks per acre were required (Department of Employment, 1971). This represents a decline of almost two-thirds just during the past 10 years. It was assumed that the need for this form of labor would decline as in the past, therefore, 4 seasonal (2 man year equivalents) workers would be needed. These workers and their families are broken down into summer and winter population groups. It was assumed that 80 percent of the migrant workers would remain in the area to provide short-term labor to other industries and processing plants.

Given these conditions, 924 man year equivalents of seasonal labor would be employed directly on the project with 739 man year equivalents remaining in the area on a permanent basis. This gives an estimated population of 3,003 people with 2,402 remaining permanently.

Using the data described earlier for non-agricultural employment (.75 man year equivalents per man year equivalent in agriculture) estimates of non-agricultural employment can be made. As indicated in Table 9, an increase of 1,848 man year equivalents of labor with its accompanying population of 4,504 people would be measured in the project area. This gives a total increase of 10,509 people during the summer months and 9,908 people during the winter.

It should be noted that these figures are at best fragile projections and may be understated. The tertiary effects of employment have not been considered. Also if sufficient industry evolved within Elmore County, more seasonal labor would become permanent. More stability will be introduced into the labor force which in turn will create higher employment.

Table No. 9. Population Growth Directly Related to Mountain Home Division

Item-Includes Familities	Population* Summer	Winter
Owners, Operators & Managers	1,501	1,501
Full-time Labor	1,501	1,501
Seasonal Labor		
Permanent	2,402	2,402
Migrant	601	
Non-agricultural Labor	4,504	4,504
Total	10,509	9,908

* These estimates are based on man year equivalents in employment. This removes much of the cyclical activity often found in such highly mobil labor forces.

Regional Effects of Population Changes

The 1970 census reported 17,479 people living in Elmore County. An increase of 10,509 people would raise the county to 27,988 and change the density from 5.7 to 10.0 persons per square mile. Compared to the 107.6 persons per square mile now in Ada County, Elmore would still be relatively uncrowded.

Many of the new jobs will be filled by people who already live in Elmore County. However, if the hypothesis advanced earlier regarding the continued mobility of labor and the eventual influx to fill jobs is considered, the net inflow into the county should be a high percentage of the total labor needs. On a regional scale, this hypothesis is still valid, but the breakdown would change substantially due to the larger population base. There would be a larger number of people unemployed or not listed as unemployed but available for work on a regional basis as compared to Elmore County singularly.

In the study, it was estimated that 90 percent of the new employment opportunities would be filled by persons outside the county with 70 percent of the residence jobs being filled by labor from outside the region. Using these rather crude estimates, the breakdown of employees by original location would be as follows: Elmore County = 323; Region = 873; Rest of Nation = 2038. The real benefit to the region, therefore, can be attributed to the 2038 immigrants to the area in addition to the benefits from having jobs for unemployed people within the region.

In calculating the regional effects of such a project, it is generally considered necessary to assume decreased assistance payments as a cost. However, if the project area is not in a depressed region with high unemployment, the savings to the state government should apply equally to that particular area. This money will probably then be spent on other governmental functions, thereby maintaining the same level of governmental spending. In this particular case, the state capitol is located within the region which guarantees large governmental expenditure in the area.

REGIONAL POWER ALLOCATION

Hydro-power generation presents a vast number of problems to resource development, the choice of alternative resource uses, and the resolution of conflicts among potential users. In recent years, principles and procedures related to solving these problems have been progressively improved and substantially broadened. However, the difficult job of establishing priorities of use and assuring the wisest overall efficiencies in multiple use objectives remain.

Basic to this problem is the nature of the industry itself. With a rate structure conceived by various regulating agencies, limits are established on the rate of return to capital. This serves to lower the actual rate to a level lower than could be charged by the utilities. On the other hand, the fact that each power company enjoys a natural and legal monopoly in its own market area enables it to develop a discriminatory rate structure which would be impossible under conditions of competition. This discriminatory pricing applies to types of users within the system as well as to the relative quantity of demand and is the most troublesome problem in estimating the benefits and cost of certain types of useages. This is especially true in cases involving irrigation development.

Within the region, several alternative uses exist for hydro-power generation. Idaho Power Company (IPC), the prime supplier of electrical energy can easily meet the existing needs. The region as a whole has a marketable surplus of 1.8 million MWh, constituting a major production area for energy. This is the opposite of general state conditions.[4/]

Benefits to power production from irrigation development are diverse and extremely difficult to define. As originally proposed, the Mountain Home project would use public power, thus further compounding the problem. This is due to the inherent differences in federal power purchases relative to those from private sources. Lower rates are the most notable along with the absence of federal taxes. Together they represent a subsidy

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4/ According to Edison Electric Institute, Statistical Yearbook - 1971, October, 1972, Idaho produced 7,470,000,000 KWH and consumed 10,263,000,000 KWH. This is a net deficit of 2,793,000,000 KWH. This deficit is met by interstate transfers and pooling by other utility companies.

to the consumers of the public energy and a redistribution of income. While this may be good in terms of regional development, it may represent a cost in terms of national efficiency.

On the other hand, private power sources would impose even higher cost to the region but may be somewhat better in terms of national efficiency. This is recognized through a rating structure more in line with what people would be willing to pay plus the added benefit of federal taxes which can be redistributed at a later date. However, the nature of large private utilities and their needs for large stocks of capital are indicative of vast regional problems. The large influx of foreign capital with its subsequent interest and dividend charges promotes intensive leakage to areas outside the region and the state. This slows regional development and constricts the redistribution of income as indicated by a low multiplier of 1.632. (Rafsnider, 1971.)

It appears that projected urban manufacturing and other non-farm uses of electrical energy will require larger amounts of energy both within the region, the state, and the nation. It does not appear that local regional scarcities will prevail. If the project were developed and it would utilize the surplus energy, benefits would occur through growth in population and economic activity within the region as well as areas surrounding it. However, development could cause significant changes in pricing and levels of use to surrounding regions. This would come through higher levels of investment into lines and delivery equipment and resultant rate increases.

The increase in electrical energy prices in those locations of agriculture irrigation where public investment in water supplies and installations are already an accomplished fact would pose complex problems to the distribution of income and capital values among farmers. Those farmers operating in already developed pump irrigation projects would experience a decline in income. Similarly, the price of their land would decline as would a portion of their capital values. Farmers operating with non-power irrigation systems would gain both in income and capital values. Hence, a redistribution of income and capital assets would occur within the region and among the different regions. This redistribution would also extend to the non-farm sector especially in small rural communities. In communities of reduced pump irrigation, the business and service sectors would experience reduced handling of inputs and outputs. Employment in the areas surrounding the project would be reduced. Likewise, areas not experiencing these problems would realize a fuller employment of resources.

The foregoing discussion has pertained to benefits and cost to the region should price of energy increase due to higher capital cost of delivery systems. The magnitude of the cost would depend upon the size of rate increases. Certainly, if the price of electricity were raised to levels equal for all users in the system, the redistribution would be large.

The legal, historic, and institutional constraints to electrical energy pricing among uses and locations, especially within agriculture, bears little resemblance to a pattern conforming to either the physical or net marginal value productivity of electrical energy in its many competing spatial, regional, or commodity alternatives. All this is indicative of the subsidy paid to irrigation through lower rates. It is readily observable that energy used for irrigation pumping returns less than the energy used in other alternatives. This violation of the equi-marginal returns principle indicates the need for compensation to the region for the loss in productivity. Also lower load factors and summer peaking conditions impose pecuniary externalities on the already imperfect market. These may be internalized but may risk pricing changes again.

In addition to these "public welfare" questions, other more conventional changes in hydro-power generation would occur in the region. A hydrologic simulation study of the Boise system was used to determine some of the effects of the Mountain Home Project on hydro-power generation (Appendix C).

Data were gathered from the 1928-1968 water years and used to estimate the river flow, reservoir contents and diversion magnitudes which would have occurred given specific assumed conditions. These conditions were consistent with the development plan as outlined earlier. The results were compared with a base condition which reflects the present level of development and management criteria. Minimum flow constraints were also added to reflect recommendations of an Aquatic Life Needs study for the South Fork of the Boise River and the main Boise River at Boise. (Idaho Department of Fish and Game, 1969.) These flows were reduced by 25 percent during periods of extreme shortage.

The hydrologic model indicated that the major effects of the proposed project would occur at Anderson Ranch Reservoir and on the South Fork of the Boise River below the dam. The remainder of the system would be relatively unchanged. However, since Anderson Ranch Dam is also a power producing facility, there are effects other than just a variation of water levels in the reservoir.

Significant cost would occur to the region due to the loss of hydro-power generation. Table 10 lists the power output for the Base condition and the changes caused by project construction. As indicated, a loss in power generation would occur during the fall, winter, and early spring months (September, November - April) but would be somewhat offset by greater generation during the irrigation season. Nevertheless, the loss in generation would equal 13,125,600 kwh or approximately $312,389. Based on the state's per capita consumption of electrical energy, this loss would be sufficient to furnish supplies to 1407 individuals.

In addition to direct loss of generation at Anderson Ranch Reservoir, cost would accrue to the region through the energy requirements of sprinkler irrigation and pumping Boise River Replacement water from the Snake River. Again these costs would be in the nature of the welfare goals mentioned earlier.

Table 10. Comparison of Hydro-Power Generation at Anderson Ranch Reservoir Before and After Project Development

	Base Condition (kw)	After Project (kw)	Net Change (kw)	Net Change* (kwh)	Net Change** (dollars)
OCT.	5150	5220	70	50400	$ 1,200.00
NOV.	8020	4180	-3840	-2764800	-65,802.00
DEC.	9910	4200	-5710	-4111200	-97,847.00
JAN.	9130	4230	-4900	-3528000	-83,966.00
FEB.	10510	4770	-5740	-4132800	-98,361.00
MARCH	10900	5790	-5110	-3679200	-87,565.00
APRIL	21030	18290	-2740	-1972800	-46,953.00
MAY	23770	25850	2080	1497600	35,643.00
JUNE	29800	31170	1370	914400	21,763.00
JULY	27570	29400	1830	1317600	31,359.00
AUGUST	19750	28500	8750	6300000	149,940.00
SEPT.	16100	11910	-4190	-3016800	-71,800.00
Total	191640	173510	-18130	-13125600	$-312,389.00

* 1KW of constant generation for one month = 720 kwh.

** Due to the industrial constraints placed upon marketing of power produced at Bureau of Reclamation Installations, the average wholesale price as established by the Bonneville Power Administration was used. The price is designed to cover the cost of the energy produced. This rate is .0238 mills.

ESTIMATION OF OUTDOOR RECREATION BENEFITS

Outdoor recreation is one of the major uses of Idaho's natural resources. All available evidence indicates that the demand for this form of recreation will continue to increase over the next 30 to 40 years. Conservative estimates show an expected doubling of demand by the year 2000 even if individual participation does not increase above present levels. (Clawson, 1959.)

Because of these levels of projected growth in recreation, it was deemed necessary to devote considerable research time to the subject in this report. Idaho has experienced a significant increase in all forms of recreational activity, but water related sports have been among the fastest growing. With this increase in demand for outdoor recreation, public policy governing resource use has been subject to reconsideration and change. The challenge to the disciplines of economics, wildlife management, and other types of resource managers is to provide quantitative measures of private and social costs and benefits that could be expected to result from alternative systems of resource development and management. A problem of special concern is that of estimating probable levels of activity and resource values for those uses which are not exchanged in a conventional price oriented market. Within the limits of this study, a theoretical model and an empirical procedure is developed for treating this problem. It provides for the estimation of activity levels and distribution as well as the quantification of value differences among recreation sites. Although the procedure can be applied to the analysis of most forms of area-specific public outdoor recreation, the empirical investigation is limited to pheasant hunting in the southwestern Idaho region.5/

Since market prices for outdoor recreation services do not usually exist, attempts at resource evaluation have relied upon price-quantity surrogates. Beginning in the late 1950's and early 1960's, increased attention has been given to this problem. The work initiated during these years spanned the range from a gross expenditure approach to the several versions of willingness to pay and consumer surplus. Notable contributions were made by Hotelling and Clawson (Hotelling, 1949, and Clawson, Report 10, 1959.)

5/ There were many types of recreation included in development of the Mountain Home irrigation project. In the original analysis, these aspects were included with benefits calculated. For example, fishing and waterfowl hunting in the diversion reservoirs and refuge lakes was added to the plan by merely estimating the user days and calculating a cost factor for days spent in pursuit of the specific activity. It was not the purpose of this study to include analysis of all aspects of recreational activity but rather to advance methodology with diverse application possibilities that would be more theoretically and empirically correct than the gross expenditure type generally in use. Although statistically limited, the values and relationships presented in the remainder of this section are consistent with theory and the present state of the arts.

The initial efforts that deal with empirical and methodological problems in the recreation use of resources have found some areas of agreement. First, is the recognition that recreational activity is an economic good and can be subjected to the rigors of economic analysis. Second, and perhaps most important, is the recognition of the need for a surrogate pricing mechanism and the use of variable costs as a consumptive regulator in the traditional manner usually given to market prices. These variable costs necessarily include provision for opportunity and time costs as well as costs associated with distance which would vary among sites.

Much has been added to the knowledge of recreational problem analysis, but the results are somewhat limited by the procedural techniques. Most noticeable of the limitations is the static nature of demand estimates which consequently yield ex-post statements of demand and value. While such statements are useful to decision makers, they do not facilitate incorporation of the potential resource use into the analysis. Also the techniques do not provide estimates of potential demand for resources or sites that are to be developed, or undergo capacity changes. Resource planning agencies need estimates of this potential prior to the commitment of scarce public funds so that the resource can be developed most efficiently, both form an economic and an aesthetic viewpoint.

Results

This study attempts to formulate new methodology for projection and valuation of recreational facility use in a specific region. It should be realized at the onset that the empirical data for the southwestern Idaho regions were not in a form that would allow reliable estimates for all cities and towns within the region. Use data were available only on a county basis, therefore, population was used to proportion these data among the many towns. For small communities, the results were not sufficiently area-specific to give reliable estimates.

The basic data necessary for calculating the expected values of the probability model for cities in Southwestern Idaho are shown in Tables 10, 11, and 12. These values, together with the distance data fulfill the requirements of equation 2 (Appendix B), and are kept in terms of the sample size to minimize rounding error.

Application of the Model

Probability estimates and predicted trip numbers were made for each of 31 origins. The probability calculations were based on the 7 alternative sites designated as constituting the study region.

Results of the iterative approximation of the exponential parameters for the 31 cities of origin are shown in Table 13. The exponents for irrigated cropland (quality), distance and the maximum R^2 are indicated. Exponential values for the quality variable ranged from .25 to 4.0. Distance parameters ranged from .25 to 3.0. The latter parameters were consistently around 1.0.

The expected number of trips determined by the model using the listed exponents correspond as closely as possible to the actual observed number of trips. Therefore, no other combination of exponential values would yield a greater R^2.

In six of the 31 origins, the model explained greater than 99 percent of the variability in trip numbers. An additional six origins indicated an accuracy exceeding 80 percent. The remaining 19 origins had a predictability too low to be significant.

The reasons for this insignificance is clear considering the source and type of data used in the calculations. Being that refined data representing observed recreator origins and respective trip numbers is nonexistant, considerable liberty was taken in data preparation. As discussed earlier, the city-origin data was assumed to be some function of county trip numbers and population. That is, the city (origin) received an "observed" number of trips directly proportional to its importance in the county population. However, this assumption proved to be erroneous in counties and cities of small population. This method of data manipulation gave origins an observed level of activity greater or less than the true distribution. In fact, certain origin may not have had an activity at all or may have been severely limited as to alternative sites.

Nevertheless, the analysis is origin specific, thus allowing the complete methodology to be demonstrated for 13 origins (all cities within Ada and Canyon counties). All other origins were assumed away for the remainder of the study; therefore, the absolute figures and values are non-representative and are not to be construed as accurate. They are used only for demonstration purposes.

The probabilities and expected trip numbers for the 13 cities were determined and the reliability was indicated by the coefficient of determination (R^2). Following the derivation of the estimated number of trips per origin site, valuation procedures consistant with the methodology were applied.[6/]

6/ The specific information is available on request from Idaho Water Resource Board. It was not published here because of its voluminous nature.

Table 11. Estimated Pheasants Per Hunter Trip for 1971 Based on the Years 1965-1970

(β = .9)

Year	Ada Canyon	Canyon County	Elmore County	Gem County	Owyhee County	Payette County	Washington County
1965	.98	1.25	.96	.94	1.62	1.47	1.49
1966	.83	1.43	.71	1.11	1.84	1.28	1.04
1967	.86	1.41	.92	1.01	1.47	1.28	1.20
1968	1.05	1.56	.96	1.11	1.47	1.65	1.09
1969	.88	1.27	1.32	.71	2.14	1.36	1.40
1970	1.17	1.75	1.22	1.79	1.64	1.78	1.87
Average	.96	1.45	1.02	1.11	1.70	1.47	1.35
Estimated	.965	1.268	.937	.956	1.638	1.451	1.447

R^2 = .961

Table 12. Ratio of Lands Used in Irrigation to the Total Land Area in the Respective Counties.

County	Total Land in County (1969)	Total Irrigated Cropland	Irrigated per total (before)	Irrigated per total (after)*	I/T I/T (before)	I/T I/T (after)
Ada	667,712	109,500	.1640	.1640	1.9204	1.6532
Canyon	370,112	315,800	.8533	.8533	9.9918	8.6018
Elmore	1,950,720	57,400	.0294	.0961	.3443	.9688
Gem	355,392	45,700	.1286	.1286	1.5059	1.2964
Owyhee	4,889,920	178,200	.0364	.0364	.4262	.3669
Payette	257,216	58,100	.2259	.2259	2.6452	2.2772
Washington	935,936	40,600	.0434	.0434	.5082	.4375
	9,427,008	805,300**				

* Project adds 130,000 acres of irrigated cropland to Elmore County (total irrigated cropland = 57,400 + 130,000 = 187,400 acres).

** Total after Project = 935,300 acres.

Table 13. Estimated exponents and coefficients of determination for 31 origins in Southwest Idaho Before the Project

Origin	Quality	Distance	R^2
1	2.50	1.00	.887
2	2.00	1.00	.912
3	2.50	1.00	.903
4	1.50	.50	.915
5	1.00	1.00	.913
6	2.00	1.00	.922
7	4.00	1.00	.992
8	2.50	1.00	.994
9	3.00	1.00	.993
10	3.00	1.00	.993
11	.25	1.00	.308
12	2.00	1.00	.993
13	3.00	1.00	.991
14	.25	1.00	.110
15	4.00	1.00	.001
16	.25	1.00	.080
17	.25	1.00	.112
18	.25	1.00	.146
19	.25	1.00	.123
20	.25	1.00	.290
21	.25	1.00	.363
22	3.50	1.00	.008
23	.25	1.00	.308
24	.25	1.00	.128
25	1.50	.25	.166
26	.25	1.00	.345
27	.75	1.00	.226
28	.50	1.00	.235
29	.25	1.00	.384
30	.25	1.00	.077
31	.25	1.00	.367

As indicated in Table 14, Canyon County had the highest total value with \$112,745. Payette County ranked second (\$11,138) followed by Gem, Ada, Owyhee, Washington, and Elmore. Once again, it should be emphasized that these values are not representative of actual conditions but are merely examples of what the described model can accomplish.

The probability and valuation procedures were applied a second time to analyze the effect of a 130,000 acre addition of irrigated cropland into Elmore County. The exponents remained the same as did the sustained yield values. The quality variable (irrigated cropland) was the same for all sites with the exception being Elmore County which reflected the increase in acres of irrigated cropland. The total number of trips generated by the origins in the region was held constant.

As expected, the increase in irrigated cropland greatly changed the distribution of hunter activity. Elmore County had the greatest increase (450 percent) followed by Ada (10 percent) and Canyon County (5 percent). Owyhee County had the greatest decrease (-35 percent) followed by Payette (-34 percent), Gem (-21 percent) and Washington County (-9 percent).

With the new distribution of hunter activity among the various sites, changes were noted in the resource values. Elmore County indicated an increase of 1,538 percent compared with smaller increases in Ada (18 percent) and Canyon counties (8 percent). Owyhee County had the greatest decrease in value (-92 percent) followed by Payette (-47 percent), Gem (-22 percent), and Washington County (-13 percent). As summarized in Table 14, the region, overall, showed a gain in value of 3 percent increasing from \$126,210 to \$130,247.

As is often the case in modern irrigation development, technology removes many of the inefficiencies of land use. Sprinkling and other water saving methods of irrigation eliminate many ditchs, drains, wasteways, and fence rows, thus altering the supply of suitable habitat. This, together with clean farming practices, combine to change the sustained yield (expected hunter success over time) of the site. Due to this possibility, provisions were made in the project to artificially develop and promote habitat.

To test the effect of a possible increase in sustained yield (relative to the constant level that was used in the first part of the study), the model was applied a third time to reflect this increase. It was assumed that sustained yield would increase to 2.0 birds per hunter trip from .937. This level is consistent with levels obtained at high quality sites such as Minidoka and Cassia Counties.

Ada County's value remained unchanged whereas Canyon County measured a decline of -2 percent. Additional decreases were noted in Gem (-2 percent), Payette (-3 percent) and Washington (-61 percent). A small increase was observed in Owyhee County (4 percent) but Elmore County increased at the rate of 4,198 percent. Overall the value for the region remained unchanged.

Table 14. Comparison of Expected Hunter Activity and Values at 7

Alternative Pheasant Hunting Sites in Southwestern Idaho

	Before Elmore County Development		After Development of 130,000 acres in Elmore County		After Development of 130,000 acres in Elmore County and a 115% increase in sustained yield		After Development of 130,000 acres in Elmore County and a 20,000 acre reduction in Ada & Canyon counties		After Development of 130,000 acres in Elmore County and a 40,000 acre reduction in Ada and Canyon counties with sustained yield increasing to 20(+115%)	
Site	Expected Trips	Value	Expected Trips	Value	Expected Trips	Value	Expected Trips	Value	Expected Trips	Value
ADA	104	$ 441	114	$ 519	101	$ 440	153	$ 935	121	$ 758
CANYON	17,210	112,745	18,134	121,773	16,985	111,010	11,404	73,516	10,306	66,378
ELMORE	26	52	117	800	386	2,183	920	5,949	2,772	15,587
GEM	256	1,343	201	1,054	244	1,315	1,182	6,504	1,117	6,107
OWYHEE	96	292	62	24	91	303	747	2,631	704	1,713
PAYETTE	1,647	11,138	1,079	5,904	1,601	10,823	4,610	29,536	4,184	26,666
WASHINGTON	80	199	73	173	77	77	863	7,050	823	6,811
TOTAL	19,419	$ 126,210	19,780	$ 130,247	19,485	$ 126,151	19,879	$ 126,121	20,027	$ 124,020
Projected to State Totals P.F. = 17.034	330,783	$2,149,861	336,933	$2,218,627	331,907	$2,148,856	338,619	$2,148,345	341,140	$2,112,557

One hunter day = 1 hunter trip assume 2 hunters per trip.

In explanation, it would seem that the quality component of the total value increased giving a somewhat lower location value. This increased quality (as measured by irrigated cropland and hunter success) resulted in different distribution of activity for the sites with each having its own pricing factor. Theoretically people would be willing to pay a higher price for increased quality factors. This is consistent with the conceptual model and theoretical argument advanced by Ricardo and its latter application to recreation. (Richardo, 1911, and Wennergren, Journal of Leisure Research, 1972.)

With the trend toward urbanization of Agricultural lands, the analysis was repeated to reflect a loss of 1,000 acres of irrigated cropland per year for 10 years in each of Ada and Canyon counties. This 20,000 acre loss within the region greatly reduced the volume of activity and value for Canyon County (-35 percent). All other counties increased with Elmore rising the most (+11,440 percent). The total value for the region remained the same.

A final analysis was made assuming a loss of 2,000 acres of irrigated cropland per year for ten years from each of Ada and Canyon counties (40,000 acres). The 115% increase in Hunter Success was included and gave results consistent with the previous analysis. Canyon County experienced a decline in value relative to increases at other sites. The region as a whole declined in value by 2 percent.

It should be noted that the analysis does not incorporate projections of potential use, only the present hunter population is used giving a predicted redistribution level which is used to establish trends. The trends in the study indicate that development of the Mountain Home project with its various wildlife provisions will act as a tradeoff for available recreation lost at alternative hunting sites. Large benefits would accrue to Elmore County users in terms of lower transportation costs and higher site values, but the region would experience only the "social benefits" recognized in various parameters such as opportunity, availability and accessibility. The amount of these values will vary greatly among individuals and among types and stages of developments.

In addition to the changes noted in pheasant hunting, changes would occur in other forms of recreation. As indicated earlier, data limitations denied a thorough analysis of all recreation alternatives. Nevertheless, an attempt was made to qualify those changes which at first glance appears to be significant. This is done with the suggestion that they be subjected to further research. While such additional study would be very productive, the limited results of this primary overview provide a number of important pieces of evidence for supporting a questioning of certain merits upon which project development decisions are currently based.

Few would argue with the proposition that recreation alters the well-being and social behavior of a community. With few exceptions, the "availability" of recreation facilities to the community is a general characteristic in this stability.

As presently outlined, the project would have major effects on the quantity and quality of water-based recreation in Elmore County. The region as a whole would not measure such dramatic changes.

To determine the ecological changes caused by the project, a small inventory and search of available literature was conducted on Anderson Ranch Reservoir, the area of major irrigation drawdown. (Appendix D) Primary indications are of a drastically reduced kokanee fishery and its subsequent recreational usage. Given the usage of 1972, (70 percent of all use came from Mountain Home and the Air Base) recreation would be redistributed to areas more distant, thus involving higher costs. Also the opportunity for year around fishing below the reservoir would be removed.

The inventory indicated that the type of fishery would be changed from a kokanee majority to one composed of warm water fish. This would significantly alter the recreation demand for Anderson Ranch with the region and would cause effects throughout the state. This is due to the loss of 3.2 million eggs normally supplied to state and federal hatcheries.

Studies also indicate that losses would occur in the upland game and big game population. This is due to the loss of winter habitat through inundation of river bottom lands.

All this implies that there are internal and external changes in recreation use given the project development. In the past, the guiding economic principle as to whether society should carry out a project is if the resources it utilizes will offer a greater return to society than they would should the resources remain in its original use. Hence, it is vital that society institute standards to avoid irreversibilities.

Conclusion

Many facets of economic analysis have direct application to management and development decisions concerned with extra-market resources. Economics in its theory and analysis seeks to ascertain the important relationships which are inherent to a wide range of phenomena - the economics of leisure as well as the economics of employment, the economics of conservation as well as the economics of depletion. This prior theoretical knowledge cautions that what is needed is a true definition of the concept of Demand and Supply and their price-quantity relationship. It is this relationship that serves as a principle of orientation for public policy, both conceptually and empirically.

Attention must be drawn to the important policy implications accruing from the analysis of recreation advanced in this study. Of primary concern is the maintenance of pheasant recreation within the region. Containing the majority of the states urban population, the region is more prone to further sub-division and urban encroachment into habitat lands. This removal of habitat lands greatly affects the number of consumers drawn to an area and directly relates to the supply of game. However, mere recognition of the problem is not sufficient as the analysis of demand for recreation whether it be for site, region, or the nation has to account for the supply situation. It has to be ascertained in a meaningful context, otherwise estimates of demand will be seriously misleading as to the true demand with consequent misallocation of resources.

As used in the model, irrigated cropland was the proxy for supply, but in the real world this may need a more refined set of data. Differentiation in types of water delivery systems and amounts of cropping diversifications would greatly increase the reliability of the model. Additional data is needed that would include all origins and sites within the state. This would enable a proper measurement of inter-regional transfers.

It should be emphasized that analysis of all phases of water-based recreation can be handled with the model as described. This would certainly be necessary before a comprehensive recreational plan could be developed for the region.

For example, data is needed to quantify the irrigation drawdown of Anderson Ranch reservoir and the possible negative effects to recreation. The economics of uncertainty associated with the loss of a valuable kokanee fishery or big game winter range should be noted.

There is validity in the argument that destruction of irreplaceable or difficultly replaced resources does indeed impose heavy costs upon the future. All kinds of investment may effect the welfare of future generations as it involves some redistribution of income and wealth toward the future. This redistribution occurs through changes in numerous physical characteristics unique to the resource based facility. The predictive model presented is a simple one and may be able to quantify this redistribution. It is based on three utility producing variables: (1) travel distance, (2) irrigated cropland, and (3) hunter success. Obviously, other more sophisticated and elaborate models could be developed which encompass greater numbers of variables and statements of relationships. Such models would provide refinement and greater detail, but the basic conceptualization reflected by this simplified model would be unaltered. Only an expanded model specification would be realized.

SUMMARY

There are many interacting forces that tend to separate regions or tie them together. Many of the forces separating different regions are geographic or cultural, while the strongest force pulling areas together is economic. This latter consideration crosses political boundaries as well as cultural and physical considerations. All of these problems point to the need for the researcher to design the region to satisfactorily suit the proposed study.

When a study of regional economic benefits is attempted, it should be noted that the region is not a closed system. Actions taken by one region usually affect other regions, the state, or the nation. These effects can be either beneficial or detrimental. The new emphasis on studying regional effects as stipulated in the "Proposed Principles and Standards for Planning Water and Related Land Resources," will help demonstrate the magnitude of the costs or benefits on a region. The inclusion of secondary benefits will allow planners to estimate the regional impact of a project rather than relying strictly on national efficiency criteria. It may be that a development that appears quite feasible from a national viewpoint has few economic benefits for the region. For example, a large recreation complex is planned in one county and the population center of the area is in another county an hour's drive away. Few benefits may go to the county where the development is located. A study done recently in the state of Oregon indicates that recreational developments, particularly those that involve private cabins on small lots often do not contribute as much to the county tax coffers as it costs to provide them the necessary services. (Youmans, 1972.)

Recent years have seen an increase in various forms of outdoor recreation with most of these being oriented towards water. These increases have drawn attention to the need for improved methods of demand projection and value estimation, especially within a specified region. Given the importance of recreation to regional development, extensive attention was given this area in the study.

A predictive model was developed which postulates that the probability of a given recreationist visiting a particular recreation site is proportional to the utility derived from that site relative to that derived from other alternative sites. Pheasant hunting is the recreational activity used in the analysis but the model has broad application to other forms of recreation use. Irrigated cropland, sustained yield, and travel distance were the variables used in the analysis. The economic rent method of valuation was used to estimate resource values. Other methods could have been applied giving similar results.

This value of recreational usage of natural resources are important policy makers as they are measures for allocating limited resources to alternative uses. Their importance is accentuated as actual and projected usage increases. The estimates of recreational user demand and resource

values were being made using ex-post data which was made more dynamic by employment of probability functions. When used for planning, these estimates of projections of potential use contain meaningful interpretations.

This analysis is an attempt to derive a simplified predictive model of recreational site usage and the effects of a redistribution of activity caused by changes in certain specific site parameters. While data limitations changed the scope of the analysis, the model presented is of sound theoretical construct.

The analysis of benefits occurring from regional irrigation use of electricity was limited to a discussion of income distribution effects and rate change possibility. Mention was made of private versus public sources for electric energy and its possible ramifications.

Due to proposed new standards of analysis for federal projects, the cost and time needed to complete such studies are greatly increased. The prime question remaining to be answered concerns the tradeoffs between the alternatives. What method will be used to determine the point where national considerations override any regional objections? It does not appear that this question will be answered by economic or engineering analysis, but more likely through the existing political processes. Hopefully, comprehensive studies will allow decision makers to take a position based on all aspects of a project. Economic efficiency will continue to be a major guideline, but other considerations will play a substantial role in the selection of a plan.

A P P E N D I X   A

FARM BUDGET

BUDGET NO 3 LAND CLASS 1,2 FARM TYPE CASH CROP

PROJECT MIN. HOME NO. IRRIGABLE ACRES 300 WATER REQUIRED 2.86 FT

SUMMARY FARM EXPENSES		RECEIPTS	
ITEM	AMOUNT	ITEM	AMOUNT
INTEREST ON INDEBTEDNESS	5610.50	CROPS	88862.94
REPAIRS,BUILDING AND IMPRVMTS	1666.00	LIVESTOCK AND PRODUCTS	0.0
REPAIRS,MACHINERY AND EQUID	4330.90	VALUE FARM PERQUISITS	500.00
DEPRECIATION,BUILDINGS	4217.33		
DEPRECIATION,MACHINERY	9576.43	GROSS FARM INCOME	89362.94
HIRED LABOR(DAY)	5272.40		
CUSTOM WORK	4295.00	CURRENT FARM EXPENSE	60156.73
TAXES,LAND AND IMPROVEMENTS	2267.77		
TAXES LIVESTOCK	0.0	NET FARM INCOME	29206.21
PURCHASED LIVESTOCK	0.0		
INSURANCE	589.50	LESS 0.600_ EQUITY ALLOW.	6415.74
MARKETING COSTS	0.0		
MISC LIVESOCK COSTS	0.0	LESS RETURN TO MGT	2920.62
SPRAY MATERIAL	1416.76		
GRAZING FEES	0.0	LESS FAMILY LIVING ALLOW.	5404.93
BALING TWINE	627.20		
SEED COSTS	4317.13	PAYMENT CAPACITY	12464.91
FEED PURCHASED	0.0		
FERTILIZER	5564.15	LESS 15- CONT.	10595.18
ELECTRICITY (FARM SHARE)	300.00		
TELEPHONE	150.00		
PICKUP,TRUCK LICENSES INSUR.	500.00		
PRIVATE TAX	629.00		
OPERATING COSTS			
TRACTOR	2735.00		
PICKUP	640.00		
TRUCK	1200.00		
SWATHER	380.80		
POTATO HAR.	432.30		
MISC TRACTOR	100.80		
INTEREST ON BORROWED CAP	2158.50		
SUBTOTAL	58977.13		
MISCELLANEOUS 2	1179.54		
CURRENT FARM EXPENSE	60156.73		

PAYMENT CAPACITY	
PER ACRE	PER ACRE-FT
' 35.32	' 12.35
' 41.55	' 14.53

WATER REQUIRED PER ACRE= 2.860 FT

IHC212I IBCOM - FORMATTED I/O, END OF RECORD ON UNIT 2

TRACEBACK ROUTINE CALLED FROM ISN	REG. 14	REG. 15	REG. 0	REG. 1
IBCOM	0001B8DC	0001E580	00000006	C001B8C0
MACHEO	6201867C	0001AE08	00000006	000163D0

FARM BUDGET

BUDGET NO - 3   LAND CLASS 1,2   FARM TYPE CASH CROP

PROJECT MTN. HOME   NO.IRRIGABLE ACRES 300   WATER REQUIRED 2.86 FT

EXPENSES

TAXES

ITEM	VALUE FOR TAXATION	ADJUST FACTOR	TOTAL VALUE FOR TAXATION	MILL LEVY	TOTALS
LAND	10600.00	1.000	10600.00	0.0800	848.00
IMPROVEMENTS	87100.00	0.200	17420.00	0.0800	1393.60
EQUIPMENT	117870.94	0.200	23574.18	0.0800	1865.93
					4127.53

INTEREST ON INVESTMENTS

INVESTMENT VALUE	INTEREST RATE	INTEREST ON INVESTMENT
28800.00	0.0600	1728.00
87100.00	0.0600	5226.00
117870.94	0.0600	7072.25
233770.94		14026.25

POWER AND EQUIPMENT OPERATING COSTS

ITEM	HOURS OR MILES	COST PER UNIT	TOTAL
TRACTOR	2103.8	0.400	841.54
PICKUP	8000.0	0.080	640.00
TRUCK	10000.0	0.120	1200.00
SWATHER	170.0	2.240	380.80
POTATO HAR.	150.0	2.880	432.00
MISC TRACTOR	72.0	1.400	100.80
			3595.14

FEED PURCHASED

ITEM	UNIT AMOUNT	PRICE	TOTAL
			0.0

FARM BUDGET

BUDGET NO 3 LAND CLASS 1,2 FARM TYPE CASH CROP

PROJECT MIN. HOME NO.IRRIGABLE ACRES 300 WATER REQUIRED 2.86 FT

LABOR SUMMARY

	TOTAL WORK UNITS MAN	TOTAL WORK UNITS TRACT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
			SEASONAL DISTRIBUTION OF MAN WORK UNITS											
TOTAL WORK ON CROPS	4886.65	2103.85	0.0	9.9	108.1	574.6	432.3	746.2	716.8	691.6	1089.1	341.1	147.7	29.4
TOTAL WORK ON MISC.	733.00	0.0	146.6	146.6	36.6	36.6	29.3	29.3	29.3	29.3	29.3	36.6	36.6	146.6
TOTAL FARM WORK	5619.65	2103.85	146.6	156.5	144.7	611.2	461.6	775.6	746.1	720.9	1118.4	377.7	184.4	176.0
WORK BY OPERATOR	2194.70		50.0	50.0	144.7	300.0	200.0	300.0	300.0	200.0	200.0	300.0	100.0	50.0
WORK BY FAMILY	650.00		0.0	0.0	0.0	50.0	50.0	100.0	150.0	150.0	50.0	50.0	50.0	0.0
TOTAL HIRED LABOR	2774.95		96.6	106.5	0.0	261.2	211.6	375.6	296.1	370.9	868.4	27.7	34.4	126.0

FARM BUDGET

BUDGET NO. 3   LAND CLASS 1,2   FARM TYPE CASH CROP

PROJECT MIN. HOME   NO. IRRIGABLE ACRES 300   WATER REQUIRED 2.86 FT

CROP LABOR REQUIREMENTS

ITEM OR OPERATION	ACRES OR HEAD	WORK UNITS ACRE OR HEAD MAN	WORK UNITS ACRE OR HEAD TRACT	TOTAL WORK UNIT MAN	TOTAL WORK UNIT TRACT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ALFALFA	128.	11.47	7.45	1468.16	953.60	0.0	0.0	29.4	73.4	117.5	352.4	352.4	264.3	220.2	0.0	29.4	29.4
BARLEY	43.	5.75	2.95	247.25	126.85	0.0	9.9	47.0	39.6	24.7	49.5	24.7	19.8	0.0	32.1	0.0	0.0
CORN SILAGE	0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STRAW	0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUGAR BEETS	43.	21.17	9.00	910.31	387.00	0.0	0.0	9.1	54.6	109.2	118.3	91.0	91.0	100.1	218.5	118.3	0.0
POTATOES	86.	26.29	7.40	2260.94	636.40	0.0	0.0	22.6	407.0	180.9	226.1	248.7	316.5	768.7	90.4	0.0	0.0
WASTE	20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				4886.65	2103.85	0.0	9.9	108.1	574.6	432.3	746.2	716.8	691.6	1089.1	341.1	147.7	29.4

FARM BUDGET

BUDGET NO 3 LAND CLASS 1,2 FARM TYPE CASH CROP

PROJECT MTN. HOME NO. IRRIGABLE ACRES 300 WATER REQUIRED 2.86 FT

CROP EXPENSES (LABOR EXCLUDED)

CROP	ACRES	SEED UNIT COST	SEED TOTAL	FERTILIZER UNIT COST	FERTILIZER TOTAL	SPRAY UNIT COST	SPRAY TOTAL	TRACTOR FUEL UNIT COST	TRACTOR FUEL TOTAL	CUSTOM HIRE UNIT COST	CUSTOM HIRE TOTAL	BALE TWINE UNIT COST	BALE TWINE TOTAL	ASSESSMENTS UNIT COST	ASSESSMENTS TOTAL	LAND INV. UNIT COST	LAND INV. TOTAL
ALFALFA	128.	3.03	387.84	10.80	1382.40	2.67	341.76	0.90	858.24	5.00	640.00	0.70	627.20	35.	4480.	90.	11520.
BARLEY	43.	6.38	274.34	8.00	344.00	0.75	32.25	0.90	114.16	11.00	473.00	0.0	0.0	35.	1505.	90.	3870.
CORN SILAGE	0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.
STRAW	0.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.
SUGAR BEETS	43.	4.00	172.00	29.75	1279.25	4.25	182.75	0.90	348.30	32.00	1376.00	0.0	0.0	35.	1505.	90.	3870.
POTATOES	86.	40.50	3483.00	29.75	2558.50	10.00	860.00	0.90	572.76	21.00	1806.00	0.0	0.0	35.	3010.	90.	7740.
WASTE	20.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.	100.	90.	1800.
TOTAL			4317.18		5564.15		1416.76		1893.46		4295.00		627.20		10600.		28800.

FARM BUDGET

BUDGET NO 3 LAND CLASS 1,2 FARM TYPE CASH CROP

PROJECT MTN. HOME NO. IRRIGABLE ACRES 300 WATER REQUIRED 2.86 FT

CROP PRODUCTION AND DISPOSALS

CROP	ACRES	UNIT OF YIELD	YIELD PER ACRE	TOTAL PRO-DUCTION	DISPOSAL OF PRODUCT: FARM USE	AMOUNT	SALES PRICE	VALUE	AVERAGE INVENTORY: AMOUNT	VALUE
ALFALFA	128.	TON	7.0	896.	0.0	896.00	21.00	18816.00	0.0	0.0
BARLEY	43.	BU.	90.0	3870.	0.0	3870.00	1.10	4257.00	0.0	0.0
CORN SILAGE	0.		0.0	0.	0.0	0.0	0.0	0.0	0.0	0.0
STRAW	0.		0.0	0.	0.0	0.0	0.0	0.0	0.0	0.0
SUGAR BEETS	43.	TON	25.0	1075.	0.0	1075.00	17.00	18275.00	0.0	0.0
POTATOES	86.	CWT.	325.0	27950.	0.0	*******	1.70	47515.00	0.0	0.0
WASTE	20.		0.0	0.	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	300.							88862.94		0.0

FARM BUDGET

BUDGET NO 3 LAND CLASS 1,2 FARM TYPE CASH CROP

PROJECT MIN. HOME NO. IRRIGABLE ACRES 300 WATER REQUIRED 2.86 FT

FEED REQUIREMENTS

****

		ROUGHAGE ALFALFA TON EQUIV.		STRAW BU. PER HEAD		BARLEY CWT PER HEAD		RATION CWT PER HEAD		MILK REPLACERS	
LIVESTOCK	NUMBER	FEED RATE	TOTAL REQUIRED	FEED RATE	TOTAL REQUIRED	FEED RATE	TOTAL REQUIRED	FEED RATE	TOTAL REQUIRED	FEED RATE	TOTAL REQUIRED
			0.0		0.0		0.0		0.0		0.0
SUPPLIED		ALFALFA	896.00	STRAW	0.0	BARLEY	3870.00				
		PUB.RANGE	0.0								
PURCHASED			0.0		0.0		0.0		0.0		0.0
SOLD			896.00		0.0		3870.00				

FARM BUDGET

BUDGET NO 3 LAND CLASS 1,2 FARM TYPE CASH CROP

PROJECT MTN. HOME NO. IRRIGABLE ACRES 300 WATER REQUIRED 2.86 FT

BUILDINGS AND IMPROVEMENTS

ITEM	CAPACITY	ORIGINAL COST	INVENTORY VALUE	REPAIRS RATE	REPAIRS AMOUNT	ANNUAL DEPRECIATION YEARS LIFE	ANNUAL DEPRECIATION AMOUNT	INSURANCE FACTOR	INSURANCE AMOUNT
DWELLING (OWNER)		20000.	10000.00	0.02	400.00	50.	400.00	0.004	80.00
DWELLING (LABOR)		10000.	5000.00	0.02	200.00	30.	333.33	0.004	40.00
SHOP		2000.	1000.00	0.02	40.00	25.	80.00	0.004	8.00
IMPLEMENT SHED		2500.	1250.00	0.02	50.00	25.	100.00	0.004	10.00
GRANARIES		2500.	1250.00	0.01	25.00	25.	100.00	0.004	10.00
IRRIGATION STRUCTURES		45000.	22500.00	0.02	900.00	15.	3000.00	0.0	0.0
DOMESTIC WATER		3100.	1550.00	0.01	31.00	25.	124.00	0.0	0.0
FENCES		2000.	1000.00	0.01	20.00	25.	80.00	0.0	0.0
TOTAL		87100.	43550.00		1666.00		4217.33		148.00

FARM BUDGET

BUDGET NO 3 LAND CLASS 1,2 FARM TYPE CASH CROP

PROJECT MIN. HOME NO. IRRIGABLE ACRES 300 WATER REQUIRED 2.86 FT

MACHINERY AND EQUIPMENT

ITEM	CAPACITY	ORIGINAL COST	INVENTORY VALUE	REPAIRS RATE	REPAIRS AMOUNT	ANNUAL DEPRECIATION YEARS LIFE	ANNUAL DEPRECIATION AMOUNT	INSURANCE FACTOR	INSURANCE AMOUNT
PLOW	3 BOTTOM	1700.	850.00	0.02	34.00	15.	113.33	0.0	0.0
DISC	12 FEET	1500.	750.00	0.02	30.00	20.	75.00	0.0	0.0
HARROW		400.	200.00	0.01	4.00	20.	20.00	0.0	0.0
DRILL	12 FEET	1860.	930.00	0.02	37.20	20.	93.00	0.0	0.0
SWATHER	12 FEET	8200.	4100.00	0.02	164.00	12.	683.33	0.0	0.0
BALER		3900.	1950.00	0.02	78.00	12.	325.00	0.0	0.0
STACK WAGON		6000.	3000.00	0.04	240.00	12.	500.00	0.0	0.0
LAND LEVELER		2000.	1000.00	0.01	20.00	20.	100.00	0.0	0.0
POTATO PLANTER	4 ROW	4500.	2250.00	0.02	90.00	12.	375.00	0.0	0.0
BEET PLANTER	6 ROW	2500.	1250.00	0.02	50.00	10.	250.00	0.0	0.0
POTATO HARVESTER (HALF)		7000.	3500.00	0.05	350.00	12.	583.33	0.0	0.0
BEET HARVESTER (HALF)		4100.	2050.00	0.05	205.00	12.	341.67	0.0	0.0
CULTIVATOR (2)		2500.	1250.00	0.01	25.00	15.	166.67	0.0	0.0
BEATER		3760.	1680.00	0.02	75.20	12.	313.33	0.0	0.0
SIDE DRESSER		700.	350.00	0.02	14.00	15.	46.67	0.0	0.0
SPRAYER		1200.	600.00	0.02	24.00	12.	100.00	0.0	0.0
MULCHER		3000.	1500.00	0.02	60.00	12.	250.00	0.0	0.0
SPRING TOOTH		900.	450.00	0.01	9.00	20.	45.00	0.0	0.0
AUGER		500.	250.00	0.02	10.00	15.	33.33	0.0	0.0
TRUCK BEDS (3)		3300.	1650.00	0.02	66.00	15.	220.00	0.0	0.0
ROTARY BEATER		1000.	500.00	0.02	20.00	12.	83.33	0.0	0.0
FERTILIZER SPREADER	12 FOOT	500.	250.00	0.01	5.00	10.	50.00	0.0	0.0
SMALL TOOLS		3051.	1525.50	0.01	30.51	10.	305.10	0.0	
SUBTOTAL		64071.							
TRACTORS (4)		26300.	13150.00	0.05	1315.00	15.	1753.33	0.005	131.50
TRUCKS (3)		24000.	12000.00	0.05	1200.00	10.	2400.00	0.010	240.00
PICKUP		3500.	1750.00	0.05	175.00	10.	350.00	0.020	70.00
TOTAL		117871.	58935.50		4330.90		9576.43		441.50

APPENDIX B

The Conceptual Model.

Previous analytical efforts directed toward the economic aspects of recreation have been preoccupied with apparent differences between recreation activity and other economic activities. This has resulted in negligence in application of analyses that have been tested in other areas of economic endeavor.

In contrast, this study proceeded on the premise that useful models have been developed for predicting marketing areas to be developed, (i.e. shopping centers). Application of these models for predicting recreation use is based on the a priori judgment that the relevant factors influencing choices between different alternative sites are similar to those factors found in market price activities. Namely, these are the opportunities available at the site being examined (capacity), competing opportunities (some factor-weighing successful opportunities available at a site relative to opportunities at alternative sites), and the impact of price (consumptive regulator).

Modification of two concepts which have been used for prediction and valuation purposes were combined to produce a model for recreation use. These being the gravity model--an obvious resemblance to the Newtonian gravity model of physics--and an economic rent model, used for estimation of resource values.

Gravity models, so-named because they relate the movement of people toward centers of economic activity, have been reviewed extensively in the literature. Reilly, one of the first to use this methodology, tried to determine the pulling power of two competing cities on a third intervening area (Reilly, 1929). He assumed that the cities attract trade from adjoining areas approximately in direct proportion to their population and in inverse proportion to the square of the distance from the intermediate area.

Huff advanced a more current variation of the gravity model by measuring the probable share of the market which would be attracted to a certain shopping area (Huff, 1963). He claimed that empirical evidence indicated that two variables exert such an influence on the consumer choice of a shopping center that for all practical purposes, they may be all that is needed to make an acceptable prediction of its use. As stated, these two variables include:

(1) The number of items of the kind a consumer desires that are carried by the various competing shopping centers.

(2) The travel time that is involved in getting from a consumer's travel base to alternative shopping centers.

Implicitly included in the gravity model is the concept of intervening opportunities as described by Stouffer (Stouffer, 1940). In other words, the number of persons going a given distance is directly proportional to the number of opportunities at that distance and inversely proportional to the number of opportunities encountered between home and the final destination. Involved in this concept are two major factors which would affect the choice of selecting an alternative site: (1) the distance involved and (2) the competition from alternative site possibilities. Empirical evidence supporting this was advanced in separate studies by Clawson and Wennergren (Report No. 10, Clawson 1959 and Wennergren, 1964). In separate studies, they found significant relationships between cost and per capita use of the recreation complex. These efforts substantiated evidence of the importance of variable travel cost.

The model presented in this study was developed to predict the selection of alternative recreation sites available to recreationists. The following elements are fundamental to the conceptual presentation of the model and follow closely those arguments advanced by Wennergren. As a general proposition, assume that $X_1 \ldots X_n$ represent individual alternatives within a set of alternatives (S). The consumer can make his choice within the range of alternatives dictated by his individual demand determinants, i.e., income, occupation, etc. It is assumed that each alternative has a positive value or utility function (UX). Value and utility are used synonymously in the sense that each alternative has value to the consumer due to the utility generated by its use.

Given these assumptions, the probability of any given alternative being selected is proportional to the utility (UXi) associated with the individual alternative relative to the utility of all alternatives ($UX_1 \ldots UX_n$) within the set (S). Mathematically the probability of any single alternative (Xi) being selected is:

$$PXi = \frac{UXi}{\sum_{i=1}^{n} UXi} \qquad \text{Equation 1}$$

where:

PXi = Probability of selecting alternative Xi.
UXi = Value or utility associated with alternative Xi.

$\sum_{i=1}^{n}$ UXi = Total value or utility associated with all alternatives ($X_1 \ldots X_n$) where the condition that

$$\sum_{1=1}^{n} PXi = 1 \text{ and } 0 < PXi < 1.0 \text{ is met.}$$

The general probability conditions for alternative selection can be restated for a recreationist. To facilitate the explanation of the model, the discussion is directed toward the selection of alternative sites for pheasant hunting, since the empirical analysis presented deals with this type of activity.

The utility producing factors related to site usage and visitation rate are consistent with those developed in Utah and Wisconsin by Wrigley, et. al. and Wagner, respectively (Wrigley, 1972 and Wagner 1965). These are: (1) the ratio of irrigated cropland to total land in the site, (2) hunter success over time expressed as the expected bird kill per hunter trip, and (3) travel distance from the consumer's point of origin (Residence) to the alternative hunting sites being considered. Substituting these variables into equation

1, the probability of a hunter at a given origin (i) selecting an alternative hunting site (j) is:

Equation 2

$$P_{ij} = \frac{\dfrac{X_j S_j^{a}}{D_{ij}^{b}}}{\displaystyle\sum_{j=1}^{n} \frac{X_j^{a} S_j}{D_{ij}^{b}}}$$

where:

X_j = The ratio of irrigated cropland to total land in the jth site.
S_j = Hunter success expressed as bird kill per hunter trip at the jth site.
D_{ij} = Distance from the ith origin to the jth hunting sites (i goes from 1 to m and j goes from 1 to n).

a = a parameter which reflects the effect of irrigated cropland on the number of trips to the site.

b = a parameter which reflects the effect of distance on the number of trips to the site, and subject to the condition that

$$\sum_{j=1}^{n} P_{ij} = 1$$

The estimated probability is proportional to the utility derived from the individual sites and that of all alternative sites. The probabilities for all sites sum to 1.0. The estimate of utility related to each site is quantatively expressed by those factors which give rise to the utilities, i.e., the quality, as expressed by irrigated cropland, hunter success (sustained yield), and travel distance. The probability of site selection is, therefore, proportional to the relative site quality and price as reflected by the travel distance from the origin to the alternative hunting site.

The expected number of trips per season from a given origin (i) to a site (j) is a function of the total trips taken by hunters from origin i and the probability of their selecting site j. This relationship can be expressed as:

Equation 3

$$\hat{T}_{ij} = \frac{\dfrac{X_j^{a} \quad S_j}{D_{ij}^{b}}}{\displaystyle\sum_{j=1}^{n} \frac{X_j^{a} S_j}{D_{ij}^{b}}} \cdot T_i$$

or

$$\hat{T}_{ij} = P_{ij} \cdot T_i$$

Where:

$\hat{T}_{ij}$ = Expected number of trips per season from the ith origin to the jth site.

T_i = Total number of hunter trips per season taken by hunters from the ith origin.

The total number of trips taken per season by recreators from a given origin (Ti) has to be known prior to using this model so that the number of trips to a new or improved site can be estimated. The expected total trips to a given site ($\hat{T}_{ij}$) is calculated by the simple summation of expected trips numbers from all origins visiting the site.

The use of the mentioned site characteristics to represent the hunter's utility for a given site is undoubtedly a simplified abstraction. However, previous empirical research supports the relevance of these variables in the recreationists decision-making process (Wrigley, Agr. Exp. Station, 1972). This analysis relies heavily on this earlier work.

The existence of site quality is obvious as recreationists are continually choosing among various alternative sites. The fact that they often choose and visit sites more distance from their place of residence relative to sites of less distance indicates their knowledge of a difference in site quality. Variations in quality could be due to a host of physical factors or site characteristics. Such site characteristics influence the alternative preference of recreationists and vary in importance among individuals and may be natural endowments and/or man-made facilities. Included might be such socio-economic factors as site congestion, expendable leisure time available to the consumer relative to his length of stay at the site, and the desire for additional opportunities which can be had through visitation to additional sites.

Specification of site quality as represented by irrigated cropland, and hunter success is based upon earlier studies which determined the effect of these site characteristics as expressed by the coefficient of determination (R^2). The coefficients desired have ranged as high as .98 for given types of recreation use with the results being consistent with habitat studies directed by biologists. Thus, site quality has a positive effect on an individual's utility for hunting, i.e., the larger the amount of irrigated cropland or higher the hunter success, the greater the hunter preference or use generated. On the other hand, travel distance involves a cost in money and time and exerts a negative effect on the utility of the hunter. That is to say, if two hunting sites are equal with respect to quality but one requires more in terms of travel or time, it would have less utility to the hunter. Inversely, if two hunting sites had identical travel cost, but were different in terms of quality, the site of higher quality (more irrigated cropland) would have greater amounts of utility.

Estimation of Resource Value.

The methodology used to estimate the value of a recreation site utilizes a cost minimizing spatial equilibrium model and the concept of economic rent. Obviously, neither of these are unique tools in economic analysis. However, their synthesis, as set out by Wennergren and Fullerton (Wennergren, Journal of Leisure Research, 1972) and others (Rodriquez, 1970 and Wrigley, Thesis, 1972) provides an interesting possibility for extending quantitative methodology into a consideration of quality problems in outdoor recreation. A theoretical basis for this methodology is provided by the fact that rent values related to the total observed site activity include both quality and location values and are similar to those rents derived from other uses for land resources.

Given a spatial separation between recreation sites and recreationists identified by origin within a geographic area, observations can be made of the total level of activity from each origin to each site. The nature of the data distribution can be best viewed in terms of a matrix (Figure 3). Such a matrix depicts the distribution of total observed activity from all origins to all sites where:

O_i = the origins from which recreationists come to use each site (i = 1 ... n)

S_j = the recreation sites used by the distribution of origins.

X_{ij} = the volume of observed activity between origin (i) and site (j).

B_i = the total number of trips from an origin (i)

T_j = the total number of trips to a site (j)

Given such a distribution of recreation activity, a total rent value can be calculated for an individual site based on the most distant user origin. The total rent is estimated as follows:

Equation 4

$$
\begin{array}{ll}
W_n - W_1 = R_1 & R_1 \cdot A_1 = N_1 \\
W_n - W_2 = R_2 & R_2 \cdot A_2 = N_2 \\
\cdot & \cdot \\
\cdot & \cdot \\
\cdot & \cdot \\
W_n - W_n = R_n & R_n \cdot A_n = N_n \\
\hline
 & \sum_{i=1}^{n} N_i
\end{array}
$$

where:

W_n = the variable cost per unit of activity from the most distant origin.
$W_1 \ldots W_n$ = the variable-use cost per unit of each origin using the site.
$R_1 \ldots R_n$ = total economic rent per unit of activity for each origin.
$A_1 \ldots A_n$ = level of recreation activity.
$N_1 \ldots N_n$ = total economic rent for each origin using the site.
$\sum_{i=1}^{n} N_i$ = total annual economic rent for the site.

The implications of economic rent and the factors which give rise to it are applicable to the problems of recreation resource valuation. Recreation

ORIGINS	SITES							TOTAL
	S_1	S_2	S_3	.	..	.	S_m	
O_1	X_{11}	X_{12}	X_{13}	.	.	.	X_{1m}	B_1
O_2	X_{21}	X_{22}	X_{23}	.	.	.	X_{2m}	B_2
O_3	X_{31}	X_{32}	X_{33}	.	.	.	X_{3m}	B_3
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
O_n	X_{n1}	X_{n2}	X_{n3}				X_{nm}	B_n
TOTAL	T_1	T_3	T_3	.	.	.	T_m	

Figure 3. Matrix of Conceptual Distribution of Observed Recreationist's Activity

sites possess both quality and location characteristics, similar to those assigned to the agricultural land and produce a commodity of value which is scarce in supply. In the same sense that highly productive agricultural lands earn more rent than do less productive lands, higher quality recreation sites earn greater rent than do lower quality sites. Furthermore, recreation sites located more advantageously to user origins earn economic rents relative to those located less advantageously or more distant.

As in the case of other applications of rent models such as wheat production in agriculture, the total rent value for a given production site is a product of the sum of the rent per unit and the total units associated with each location. For wheat land, it is the sum for all locations of rent per bushel times the number of bushels produced at each location. In the recreation case, it is the sum of rent per unit of activity multiplied by the total units of activity for all origins. Measures of recreation activity are often expressed in units such as number of trips, recreationist days, and activity days.

The activity levels estimated in the gravity model become highly important in the decision-making process. The difference between these values and others generated by demand estimation is that they result from data depicting a probable relationship, and not from simple ex-post data reflecting known but past recreation usage. Consequently, the statements of resource value reflect probable values based on probabilities and relationship inherent to the consumer and the site. Generation of expected activity levels and consequent values from these subjective probabilities remove the restriction of static existing data and allows the analysis to become more dynamic over time.

Method of Analysis and Data Collection.

Estimates of site visitation rates and values were made for the 7 counties in southwestern Idaho. These sites are consistent with those defined earlier in the study. The calculation procedures were consistent with the methodology previously presented.

The data were collected by the Idaho Department of Fish and Game from a mail questionnaire. Information was obtained relative to the hunter's county of origin, the various counties (sites) hunted during the season, and the number of hunter trips taken to the site from the origin county. Additional information pertaining to origin population were obtained from the 1970 census. In the absence of more refined data, it was assumed that hunter trips would be apportioned to the individual city origins within the origin counties relative to the population of the city. That is, the city having the largest population would have the highest number of hunter trips. It was then assumed that this distribution constituted the "observed" distribution of hunter trips by origins.

Standardized distances from origins (cities) to sites (counties) were calculated by the use of a hand-operated odometer utilizing the most direct routes as measured on a published Idaho road map. A centrally located point within each hunter's unit was used as a common measuring point in calculating the mileage to the unit. In site travel mileage was represented by the average distance from all origins within the site to the common measuring point and was added to the round trip totals. It was assumed that each trip involved two recreationists.

The quality variables (irrigated cropland and hunter success) were quantified from data provided by the IWRB and Idaho Department of Fish and Game, respectively.

An expectation model that has received wide use in recent years was utilized to reflect hunter success over time. This model assumes that the expected value of any series is the weighted average of past observed values of that series with the most recent observation being given the highest weights. The particular function used is as follows (Gardner, 1961).

Equation 5

$$S_j^* = \beta S_T + (1 - \beta)\, \beta S_{T-1} + (1 - \beta)^2\, \beta S_{T-2} + \ldots + (1-\beta)^{n-1} \beta S_{T-(n-1)}$$

where:

S_j^* = expected value of S_j (Hunter Success).

$S_T \ldots S_{T-(n-1)}$ = the observed values of S_j for n time periods beginning with T - (n-1) and extending forward to the current period t.

β, $(1-\beta)$, $(1-\beta)^2$, ... $(1-\beta)^{n-1}$ = the weights given the S_j's in periods T back to T - (n-1), respectively.

The sum of the weights approaches unity when:

$0 < B < 1.$

It was assumed that $\beta = .9$. A coefficient of this size weighs the most recently observed hunter success just equal to the proportion of the total weights assigned to all other observations. Under this assumption, 99.9 percent of the total weight attached to the expected hunter success is accounted for in the last 10 years.

An Example

To illustrate the computations, assume a situation with three hunting sites (j = 1 to 3) and three origins or residences (i = 1 to 3). The bird kill per hunter trip is assumed to be:

Site (j)	Bird Kill Per Hunter Trip									
	1970	1969	1968	1967	1966	1965	1964	1963	1962	1961
1	1.0	1.2	1.5	.8	2.0	.6	1.0	1.1	1.5	.6
2	1.1	1.5	2.0	.6	1.0	1.1	1.5	.6	.8	1.5
3	.5	.4	.1	.2	.6	.5	.4	.3	.1	.2

Substituting the appropriate values into equation (5) and assuming $\beta = .8$, the expected sustained yield (S_j^*) are as follows:

$$S_1^* = .8(1.0) + (1-.8).8(1.2) + (1-.8)^2.8(1.5) + (1-.8)^3\ .8(.8) + (1-.8)^4$$
$$.8(2.0) + (1-.8)^5.8(.6) + (1-.8)^6\ .8(1.0) + (1-.8)^7\ .8(1.1) + (1-.8)^8$$
$$.8(1.5) + (1-.8)^9.8(.6) = 1.0$$

$$S_2^* = .8(1.2) + (1-.8).8(1.5) + (1-.8)^2.8(2.0) + (1-.8)^3.8(.6) + (1-.8)^4$$
$$.8(1.0) + (1-.8)^5\ .8(1.1) + (1-.8)^6.8(1.5) + (1-.8)^7.8(.6) + (1-.8)^8$$
$$.8(.8) + (1-.8)^9\ .8(1.5) = 1.3$$

$$S_3^* = .8(.5) + (1-.8).8(.4) + (1-.8)^2-.8(.1) + (1-.8)^3.8(.2) + (1-.8)^4$$
$$.8(.6) + (1-.8)^5.8(.5) + (1-.8)^6.8(.4) + (1-.8)^7.8(.3) + (1-.8)^8$$
$$.8(.1) + (1-.8)^9.8(.2) = .5$$

Expected hunter success figures were deemed more appropriate then observed figures in a given season because the hunter makes his decision as to activity levels on the basis of what he expects his success to be. What the hunter-consumer expects in the future is some function of what he has experienced in the past. Under these circumstances, it seems reasonable to assume that future success expectations will be a considerable number of past observations of the same variable. Where there are trends or cycles over time, the expectation model removes the fluctuation.

The expected bird kill per hunter trip for the seven sites used in the study are found in Table 1. A simple correlation coefficient indicated that these estimates were accurate to the 96.1 percentile.

The exponential parameters were estimated independently and are subject to the following constraint:

(1) Let (a) and (b) represent the exports desired for equation (2).

(2) Find the values for (a) and (b) such that the coefficient of determination (R^2) for the actual and expected number of trips to a given hunting season site is maximized.

The statistical formulation needed for determination of the coefficient of determination is:

Equation 6

$$R^2 = 1 - \sum \frac{(Tij - \hat{T}ij)^2}{(Tij - \bar{T}ij)^2}$$

where:

R^2 = coefficient of determination.

T_{ij} = actual number of trips made to the jth site from the ith origin.

$\hat{T}_{ij}$ = predicted number of trips to the jth site from the ith origin.

$\bar{T}_{ij}$ = average number of trips to the jth site from the ith origin.

Equation 6 also provides methodology for measuring the accuracy of the model expressed by equation (3). That is, as the predicted and actual number of trips taken from a respective origin draw closer, the deviation becomes smaller and the R^2 value approaches 1.0. Where $T_{ij} = \hat{T}_{ij}$ the R^2 equals 1.0.

APPENDIX C

OWRR ECONOMIC IMPACT STUDY

Boise River Hydrology

An operation study of the Snake and Boise rivers was made to determine the hydrologic effect of the assumed project. Hydrologic data from the 1928 through 1968 water years were used to approximate the flows, reservoir contents, and diversion magnitudes that would have occurred under assumed conditions. The results were compared with a base condition operation study of the Snake and Boise rivers which reflects the present operating criteria and level of development for the 41 year hydrologic period. This section compares the base condition study, with the results of the assumed project, and describes the major effects to the Snake and Boise river systems caused by the assumed project.

Base Condition Operation.

The base condition operation provides an estimate of the 1928-68 monthly flows, reservoir contents and diversions of the Snake River from King Hill to Weiser. Also included is the Boise River. The base condition describes the operation of the present river systems through a period of history, and provides a control for evaluation of alternate plans of operation. In the base study it was assumed that all presently operated reservoirs existed throughout the historical period and that all releases, diversions, and return flows were of similar magnitude to those which currently exist (1970). Criteria for operation were chosen to meet these objectives.

Assumed Project Conditions.

The principal feature of the project is the irrigation of 138,000 acres of land near Mountain Home with waters diverted from the South Fork of the Boise River below Anderson Ranch Dam. Annual diversions would be approximately 430,000 acre-feet. Additional diversions for supplemental irrigation (8,000 acre-feet) and domestic and flow maintenance (9,000 acre-feet) would occur annually. The source for the total diversion, 447,000 acre-feet, would be the natural flow and reservoir storage of the South Fork of the Boise River at a point 5-1/2 miles below Anderson Ranch Dam.

Diversions to lands in the Boise Valley were maintained at the present level of magnitude. To accomplish this, water was pumped from the Snake River to the Boise Project, thus replacing the amount diverted from the South Fork. Water was pumped to both the Mora-Waldvogel canals and to Lake Lowell. Other Boise Valley canals which divert from the Main Canal and from the Boise River retained current service methods.

As proposed by the Bureau of Reclamation, the amount pumped from the Snake River would vary with water supply conditions on the Boise River. During years of high runoff, Boise River could supply the diversion to Mountain Home and also meet most of the requirements of the Boise Project. In years of low runoff, pumping from Snake River would begin early in the year with minimal use of Boise River water on the Boise Project.

Specific criteria were developed to control the amount of water pumped from Snake River. Assuming a 10 percent loss, the maximum amount available to the Boise Project was 67,500 acre-feet per month. No water would be pumped from November through January and the amount pumped from February through May would depend on the magnitude of the runoff forecast of Boise River near Boise and Lake Lowell reservoir contents.

Table 1 summarizes the February through May target content-forecast relationships used to determine the amount pumped to Lake Lowell.

Table 1. Lake Lowell Target Content-Forecast Relationship.
(All units in 1000 ac-ft)

April-July Forecast	Target Contents			May-July Forecast	Target Contents May
	Feb.	Mar.	April		
1000	145	155	160	800	165
1000	97	100	130	800	130

The forecast determined the target content to which Lake Lowell was filled by pumping. The amount pumped was limited by the maximum pumping rate, and reduced by flood control releases or spills which were diverted to the Lake from the Boise River.

The maximum allowable pumping rate is given in Table 2. These amounts were chosen to provide an even distribution throughout the year for the total pumping requirement (see below).

Table 2. Maximum Diversion from Snake River to Lake Lowell (1000 ac-ft)

Month	Oct.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
Diversion	55	25	25	45	45	25	10	5	15

June through October pumped diversions to Lake Lowell were at the maximum rates shown in Table 2 except when limited by the target contents listed in Table 3.

Table 3. Lake Lowell June - October Target Contents
(1000 ac-ft)

Month	June	July	Aug.	Sept.	Oct.
Contents	120	105	90	110	100

Table 4 lists the maximum monthly acre-feet of water pumped from Snake River to the Mora-Waldvogel canals. Only during years of low water supply

Table 4. Maximum Diversion from Snake River to Mora-Waldvogel Canals (1000 ac-ft)

Month	Apr.	May	June	July	Aug.	Sept.
Diversion	30	30	50	60	60	40

(April-July forecast 900,000 acre-feet) was water diverted in April. Flood control releases or spills from the Boise system were used to reduce the May through July Mora-Waldvogel pumping requirement whenever possible. When the values in Table 4 are added to the maximum Lake Lowell pumping requirements, the total maximum possible pumping requirement from Snake River becomes 520,000 acre-feet per year.

Minimum Flows and Municipal & Industrial Use

A minimum flow constraint was placed on the South Fork of the Boise River below the Long Tom tunnel diversion. This flow was not less than 250 cubic feet per second (cfs) unless an extreme shortage existed. In that case the flow was reduced 25 percent.

Another feature of the operation study was to provide a minimum flow in the Boise River at Boise. The Idaho Water Resource Board Planning Report #3 lists a minimum aquatic life flow of 160 cfs at Boise River at Barber Dam. This flow was provided at Boise but could be reduced 25 percent, during periods of extreme shortage.

Also provided for in the operation study was a diversion from the Boise River above Boise for municipal and industrial purposes. This diversion of 20,000 acre-feet per year was distributed equally throughout the year.

The final item considered was a change in the flood control operation of Boise River. To maintain the present level of flood operation, it was necessary to reduce the flood space requirements in the three Boise River reservoirs. Long Tom diversion would provide the additional outlet for flood flows if needed.

Study Results.

The major water supply effects of the proposed project would occur on the Boise Project at Anderson Ranch Reservoir and on the South Fork of the Boise below the Long Tom diversion. With the exception of slightly greater flows at Boise during the winter months, the Boise River below Boise would not be affected. Operation of Lucky Peak Reservoir and Arrowrock Reservoir would be similar to the present pattern.

Table 5 lists the operation study results for Anderson Ranch Reservoir. The values are end of month contents that would have occurred during the 1928-1968 historical period given the assumed project conditions. Table 6 lists similar data from the base condition study. It is obvious the assumed project would have a marked effect on the reservoir. With the project, the reservoir

Table 5

CENTRAL SNAKE STUDY   4. CONTENT ANDERSON RANCH RESERVOIR (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
28	346.5	371.3	386.4	399.8	385.3	390.0	360.0	460.0	459.3	354.4	257.1	226.8
29	223.2	223.8	222.3	220.8	221.1	235.6	243.2	288.0	281.2	170.0	68.8	37.0
30	31.3	30.0	36.0	33.3	37.6	52.2	98.2	135.9	138.8	108.4	43.4	9.4
31	12.0	12.9	11.5	11.4	12.5	21.3	48.8	108.4	132.6	72.0	8.8	0.0
32	0.0	0.0	0.0	0.0	0.0	14.7	65.7	209.0	288.0	204.5	108.6	79.3
33	76.4	79.9	78.5	79.4	79.8	84.3	112.8	170.6	255.4	151.6	55.0	26.1
34	23.4	26.1	28.3	33.1	43.1	77.4	110.9	108.4	124.4	108.4	8.8	0.0
35	0.4	1.0	1.7	2.3	5.4	14.2	62.1	153.9	189.9	108.4	43.4	23.8
36	17.0	15.9	13.3	12.3	12.1	24.3	171.0	345.4	350.7	239.3	140.6	110.4
37	104.7	104.1	104.4	102.9	103.0	113.6	131.6	193.2	150.0	108.4	43.4	23.8
38	17.1	18.4	41.2	47.3	52.6	80.0	224.3	455.9	464.2	397.2	305.9	278.7
39	281.9	290.2	297.0	301.8	305.1	338.3	380.3	427.7	366.3	245.7	142.2	74.2
40	68.6	67.5	67.7	68.3	71.4	106.3	179.5	268.3	239.4	120.0	43.4	23.8
41	22.1	26.6	29.7	31.9	36.0	57.5	76.4	151.8	149.0	108.4	43.4	9.4
42	10.7	15.7	28.9	33.5	37.8	48.7	129.8	176.8	200.5	109.8	43.4	23.8
43	19.4	24.8	32.2	50.5	62.0	99.4	360.0	439.0	464.2	450.9	368.8	342.1
44	343.5	352.8	357.0	362.6	366.1	373.8	360.7	402.1	389.9	286.5	183.3	157.4
45	152.5	156.3	156.3	158.2	162.7	173.6	189.2	262.1	287.8	195.7	98.8	69.2
46	65.6	68.6	62.5	50.1	53.8	84.8	244.7	418.4	452.4	355.2	260.6	234.1
47	237.4	244.4	255.0	259.6	268.9	304.1	357.9	464.2	459.4	357.1	255.7	225.3
48	224.9	228.1	230.8	234.2	237.2	241.0	266.2	366.4	423.7	324.5	226.4	195.1
49	192.1	196.0	197.9	199.2	204.6	213.5	300.7	442.6	444.9	337.0	236.4	205.5
50	203.0	208.1	209.7	214.0	218.6	232.1	310.8	460.0	464.2	417.9	326.4	306.1
51	307.1	322.1	334.1	341.6	357.0	335.3	360.0	464.2	464.2	396.8	311.7	288.7
52	293.7	300.2	309.6	319.0	300.0	217.8	332.8	460.0	464.2	390.7	303.9	280.8
53	277.2	281.1	285.0	296.3	302.4	322.5	360.9	429.7	464.2	415.2	330.4	305.0
54	300.3	306.7	310.8	314.5	322.3	344.2	420.0	464.2	464.2	384.5	294.2	266.7
55	260.2	263.1	263.4	264.2	265.4	267.5	253.2	310.8	356.3	262.1	165.4	132.3
56	127.3	133.9	169.1	190.2	202.4	237.6	345.4	460.0	464.2	389.1	302.7	274.5
57	276.5	285.5	295.0	301.8	310.5	334.8	383.6	461.3	464.2	380.7	268.1	257.8
58	258.4	261.4	269.0	273.7	285.3	296.2	337.7	460.0	464.2	377.5	290.9	265.5
59	261.4	268.3	279.1	286.4	291.2	303.6	349.8	389.3	412.9	308.9	210.8	168.7
60	195.0	201.0	201.3	203.8	207.5	229.0	298.9	361.4	373.2	264.1	166.3	137.3
61	131.4	134.0	133.8	135.0	140.1	150.7	157.5	181.1	149.5	108.4	43.4	23.8
62	21.8	23.9	23.6	26.4	33.0	40.4	139.0	226.3	298.1	216.5	126.3	98.2
63	96.5	100.2	102.1	100.9	130.1	142.9	145.9	245.0	298.6	210.3	116.5	89.2
64	85.1	91.7	94.4	98.2	100.9	106.7	138.8	228.7	273.3	183.7	87.8	58.6
65	53.4	56.4	105.3	122.3	134.8	158.2	317.7	460.0	464.2	462.8	395.9	386.2
66	390.0	398.9	403.0	408.0	386.7	386.3	404.5	460.0	416.6	298.8	199.0	158.6
67	151.2	151.3	152.9	159.8	164.6	178.7	180.4	310.6	435.6	362.2	268.8	240.1
68	238.4	242.9	246.6	248.6	260.6	284.1	286.1	304.3	301.6	190.8	103.5	76.3
AVG	156.1	160.6	166.5	170.7	174.9	188.3	243.8	331.3	346.5	266.7	178.6	151.5

Table 6

CENTRAL SNAKE STUDY   2. CONTENT ANDERSON RANCH RESERVOIR (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
28	350.0	365.8	365.6	363.6	319.6	342.6	300.0	420.0	438.2	392.8	313.8	299.7
29	309.6	301.2	284.3	273.6	279.5	297.0	300.0	392.7	404.3	301.4	269.3	235.1
30	239.2	229.0	219.7	207.7	195.3	213.0	268.3	360.0	347.5	232.2	195.9	114.8
31	127.8	119.8	103.0	100.0	100.0	123.6	177.7	233.7	170.0	50.0	22.0	0.9
32	5.9	0.0	0.0	1.3	7.9	37.3	139.2	360.0	457.2	402.9	334.5	320.8
33	331.0	325.6	308.9	300.0	287.5	295.2	300.0	405.2	464.2	418.9	345.2	330.1
34	338.4	332.2	319.0	308.5	300.0	300.0	311.4	360.0	298.8	215.0	169.0	95.0
35	101.3	92.9	78.3	82.0	93.4	116.9	215.5	360.0	414.0	305.1	272.9	229.7
36	225.6	215.6	197.7	187.4	169.0	184.3	322.2	464.2	464.2	411.7	381.1	350.0
37	350.0	340.5	325.4	308.5	300.0	300.0	300.0	408.9	376.8	300.0	238.5	206.3
38	212.8	205.2	212.6	209.4	220.3	250.8	300.0	420.0	464.2	456.6	402.5	369.1
39	361.0	360.4	351.8	341.2	330.7	342.4	440.0	445.6	402.9	341.5	290.0	260.3
40	267.9	257.9	242.8	234.1	226.8	264.8	309.9	420.0	409.4	347.9	290.0	275.0
41	286.4	282.0	269.7	262.6	272.3	297.0	300.0	420.0	431.3	334.7	290.0	261.4
42	272.0	268.0	265.9	261.3	271.1	285.1	324.5	419.0	451.3	400.0	314.0	298.9
43	307.6	304.1	296.1	300.0	257.8	190.9	349.3	420.0	464.2	464.2	451.8	420.0
44	410.1	410.5	399.4	389.6	378.7	362.7	388.6	420.0	426.5	382.4	319.5	304.6
45	313.0	307.8	292.5	285.2	295.3	300.0	300.0	420.0	464.0	430.5	390.0	350.0
46	350.0	344.1	322.6	300.0	300.0	300.0	373.2	420.0	464.2	426.4	390.0	350.0
47	350.0	348.1	343.4	332.6	327.9	341.6	426.2	464.2	464.2	421.3	389.3	350.0
48	350.0	344.3	331.6	319.6	306.8	300.0	330.4	420.0	464.2	424.3	388.8	350.0
49	350.0	345.0	331.5	317.4	302.5	300.0	300.0	428.5	449.5	401.1	354.2	339.3
50	350.0	346.2	332.5	321.3	300.0	300.0	300.0	420.0	464.2	464.2	442.2	398.5
51	388.2	394.3	391.0	383.1	384.7	310.3	345.2	420.0	464.2	456.2	408.6	368.5
52	362.2	359.8	353.9	347.8	300.0	186.8	273.0	412.2	464.2	450.1	390.0	350.0
53	350.0	344.9	333.5	329.4	321.6	320.1	409.2	420.0	464.2	464.2	448.9	403.7
54	387.8	385.3	374.0	362.4	356.3	356.6	376.0	434.8	464.2	443.9	395.8	361.5
55	350.0	344.0	328.9	314.3	301.6	300.0	300.0	405.5	464.2	428.9	390.0	350.0
56	350.0	347.7	367.5	373.2	300.0	300.0	300.0	420.0	464.2	448.5	402.5	364.0
57	354.7	354.8	349.0	340.4	335.2	338.0	338.6	420.0	464.2	440.1	390.0	350.0
58	350.0	344.1	336.4	325.7	323.3	314.7	300.0	420.0	464.2	436.9	390.0	350.0
59	350.0	343.0	343.5	335.4	326.2	314.9	391.9	420.0	462.3	417.5	388.6	350.0
60	350.0	347.1	332.1	319.1	307.0	307.1	407.5	456.3	464.2	414.1	385.4	350.0
61	350.0	343.7	328.2	313.9	300.0	300.0	300.0	371.2	354.1	289.0	255.1	226.6
62	237.7	230.9	215.3	208.8	220.9	231.4	300.0	420.0	464.2	441.3	390.0	350.0
63	350.0	344.7	331.3	314.7	330.0	321.2	354.7	439.7	464.2	434.6	390.0	350.0
64	350.0	347.7	335.1	323.4	311.7	300.0	362.4	438.2	464.2	433.2	390.0	350.0
65	350.0	344.0	377.6	379.2	300.0	247.2	291.6	375.0	464.2	464.2	460.0	420.0
66	412.6	412.6	401.3	390.9	378.7	371.9	435.5	431.2	406.6	348.3	290.0	272.4
67	278.2	269.4	255.7	253.4	263.7	280.9	296.4	420.0	464.2	450.1	390.0	350.0
68	350.0	345.5	333.9	320.5	318.1	317.9	309.0	375.3	391.1	335.7	299.1	287.6
AVG	313.0	308.7	299.5	291.3	281.0	279.6	321.2	409.8	433.1	388.3	344.1	310.1

exceeded 450,000 acre-feet in 14 of 41 years; without the project it would have done so 26 times. Average contents would range from 80,000 to 160,000 acre-feet less throughout the year if the proposed project were built. End of year contents fell below 100,000 acre-feet once in the base study; this occurred 18 times in the project study.

Tables 7 and 8 show with and without project conditions for the discharge in the South Fork of the Boise below the assumed diversion. In 22 years in the project study, the flow was completely regulated at 250 cfs or less the entire year. During 8 years the flow was reduced to 188 cfs (11,600 acre-feet) for extended periods. In the base condition study, flows approached zero for two months or more in 3 of the years and fell below 250 cfs in 21 of the years. Base condition July through August flows range from 800 to 2,000 cfs.

With the assumed project the diversion to the Boise Project area would remain the same, but the operation of the Main Canal and Lake Lowell would be changed. Because of the pumped diversion from Snake River to the project, the Main Canal diversion would average 300,000 acre-feet per year less than under present operation. Table 9 lists the total pumped diversion from Snake River. Values in Table 9 are the result of the forecast and target content criteria described in the previous section. Annual pumping varied from 129,000 to 518,000 acre-feet and averaged 334,000 acre-feet. Of this average, 116,000 acre-feet was pumped directly to Lake Lowell and 218,000 was pumped to the Mora-Waldvogel canals. The greatest effect on Lake Lowell under project conditions was that the late summer (August - September) contents would be reduced from an average of 100,000 acre-feet to an average of 55,000 acre-feet.

Flows in the Snake River below Murphy would be reduced by about 1200 cfs during the summer months of most years. In the most critical year of the operation study the present condition flow at Weiser was 7200 cfs in the month of July. With the project, this flow was reduced to 6,000 cfs.

Tables 10 and 11 show project and base condition discharges of Boise River at Boise. July through October flows are similar in both studies. November through March minimum of 160 cfs (9,800 acre-feet) were provided in the project study. Many of the high flows March through June were reduced significantly in the project study.

The monthly distribution of the diversion required for irrigating the 138,000 acres near Mountain Home is given in Table 12. The water supply at the point of diversion on the South Fork of the Boise was insufficient to meet the total diversion requirements in 9 of the 41 years.

Table 12. Diversion Requirements to Mountain Home Full Service Lands (138,000 acres)

	Oct.	Apr.	May	June	Jul.	Aug.	Sept.	Total
Diversion (1000 ac-ft)	4.3	34.4	60.2	90.3	120.4	94.6	25.8	430.0
Ac-Ft/Acre	0.03	0.25	0.44	0.65	0.87	0.68	0.19	3.11

Table 13 lists the shortages that would occur on the project and the percent shortage. These shortages are greater than normally used in irrigation project planning. More realistic scoping of the project would result in modifications

Table 7

CENTRAL SNAKE STUDY 4. DISCHARGE SF BOISE BELOW LONG TOM DIVERSION (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
28	15.4	14.9	15.4	15.4	36.5	55.1	89.3	141.3	14.9	15.4	15.4	14.9	443.7
29	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
30	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	11.2	11.6	11.6	25.6	180.4
31	12.5	14.9	15.4	15.4	13.9	15.4	11.2	11.6	11.2	48.0	46.2	15.1	230.7
32	11.1	11.4	12.2	13.6	12.3	15.4	14.9	15.4	14.9	15.4	15.4	14.9	166.7
33	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	12.8	11.2	174.7
34	15.4	14.9	15.4	15.4	13.9	15.4	14.9	11.6	11.2	11.6	46.2	15.1	200.8
35	11.6	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	11.6	11.6	11.2	165.9
36	15.4	14.9	15.4	15.4	14.4	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.5
37	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	13.8	11.6	11.6	11.2	168.6
38	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	125.7	15.4	15.4	14.9	291.8
39	15.4	14.9	15.4	15.4	13.9	15.4	45.0	15.4	14.9	15.4	15.4	49.9	246.2
40	15.4	14.9	15.4	15.4	14.4	15.4	14.9	15.4	14.9	14.7	11.6	11.2	173.3
41	11.6	14.9	15.4	15.4	13.9	15.4	14.9	15.4	11.2	11.6	11.6	25.6	180.4
42	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	11.6	11.6	11.2	165.9
43	15.4	14.9	15.4	15.4	13.9	15.4	65.6	152.4	121.1	15.4	15.4	14.9	475.0
44	15.4	14.9	15.4	15.4	14.4	15.4	35.0	15.4	14.9	15.4	15.4	14.9	201.6
45	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
46	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
47	15.4	14.9	15.4	15.4	13.9	15.4	14.9	34.6	14.9	15.4	15.4	14.9	200.2
48	15.4	14.9	15.4	15.4	14.4	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.5
49	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
50	15.4	14.9	15.4	15.4	13.9	15.4	14.9	23.5	122.4	15.4	15.4	14.9	296.6
51	15.4	14.9	15.4	15.4	13.9	53.2	154.4	124.2	82.3	15.4	15.4	14.9	534.6
52	15.4	14.9	15.4	15.4	39.4	106.2	55.7	211.9	110.1	15.4	15.4	14.9	629.8
53	15.4	14.9	15.4	15.4	13.9	15.4	46.1	15.4	82.0	15.4	15.4	14.9	279.4
54	15.4	14.9	15.4	15.4	13.9	15.4	14.9	127.1	31.8	15.4	15.4	14.9	309.6
55	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
56	15.4	14.9	15.4	15.4	14.4	15.4	86.3	170.9	129.1	15.4	15.4	14.9	522.7
57	15.4	14.9	15.4	15.4	13.9	15.4	14.9	132.4	108.0	15.4	15.4	14.9	391.2
58	15.4	14.9	15.4	15.4	13.9	15.4	14.9	206.1	95.9	15.4	15.4	14.9	452.7
59	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
60	15.4	14.9	15.4	15.4	14.4	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.5
61	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	11.2	11.6	11.6	11.2	166.0
62	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
63	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
64	15.4	14.9	15.4	15.4	14.4	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.5
65	15.4	14.9	15.4	15.4	13.9	15.4	14.9	128.8	243.2	15.4	15.4	14.9	522.7
66	15.4	14.9	15.4	15.4	36.9	30.3	38.0	21.6	14.9	15.4	15.4	21.5	254.9
67	15.4	14.9	15.4	15.4	13.9	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.0
68	15.4	14.9	15.4	15.4	14.4	15.4	14.9	15.4	14.9	15.4	15.4	14.9	181.5
AVG	15.0	14.8	15.3	15.3	15.7	19.8	26.5	46.7	40.9	15.5	16.2	15.9	257.6

Table 8

CENTRAL SNAKE STUDY 2. DISCHARGE SF BOISE R AT ANDERSON RANCH DAM (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
28	16.1	23.8	30.7	30.7	66.0	36.9	138.6	184.9	89.3	79.9	94.2	26.8	817.9
29	6.1	23.8	30.7	24.6	8.3	12.3	56.1	30.7	89.3	130.5	43.0	44.8	500.5
30	9.4	23.8	30.7	24.6	30.6	12.3	41.9	24.2	113.5	142.4	51.5	93.6	598.4
31	6.1	23.8	30.7	18.3	15.0	0.6	0.6	34.0	100.0	130.8	35.6	28.9	424.4
32	6.1	17.3	12.2	12.3	5.8	0.6	0.6	1.1	89.3	109.4	84.5	26.8	365.9
33	6.1	23.8	30.7	25.1	26.3	12.3	74.8	30.7	133.0	79.9	86.0	26.8	556.1
34	6.1	23.8	30.7	30.7	32.3	49.7	73.2	21.5	98.9	84.3	51.5	81.2	583.9
35	6.1	23.8	30.7	12.3	5.6	0.6	0.6	25.5	89.3	142.4	43.0	52.4	432.4
36	16.5	23.8	30.7	24.6	32.6	12.3	59.9	110.8	112.9	79.9	43.9	43.4	591.4
37	13.6	23.8	30.7	30.7	22.5	26.0	69.3	30.7	95.1	95.8	68.9	39.9	547.2
38	6.1	23.8	30.7	24.6	8.3	12.3	146.3	190.2	183.0	79.9	75.3	49.2	829.9
39	30.7	23.8	30.7	30.7	27.8	36.9	26.0	120.5	89.3	79.9	60.4	39.4	595.1
40	6.1	23.8	30.7	24.6	24.8	12.3	79.3	57.2	89.3	79.9	66.2	27.5	521.7
41	6.1	23.8	30.7	24.6	8.3	12.3	66.8	33.5	89.3	126.0	63.6	43.1	528.1
42	6.1	23.8	30.7	24.6	8.3	12.3	92.6	30.7	98.5	95.0	100.3	26.8	549.9
43	6.1	23.8	30.7	29.7	67.6	119.7	204.3	224.3	195.2	126.0	43.0	48.0	1118.6
44	30.7	23.8	30.7	30.7	28.8	39.1	32.6	88.8	89.3	79.9	76.9	26.8	578.2
45	6.1	23.8	30.7	24.6	8.3	21.5	66.9	31.4	89.3	79.9	55.4	52.7	490.6
46	15.6	23.8	30.7	25.6	17.6	46.4	137.7	205.4	97.8	79.9	54.4	56.1	791.1
47	22.7	23.8	30.7	30.7	27.8	36.9	20.8	166.1	103.2	79.9	43.0	51.7	637.5
48	19.1	23.8	30.7	30.7	30.2	26.0	46.2	89.2	120.9	79.9	49.7	50.2	596.8
49	16.4	23.8	30.7	30.7	34.2	26.8	138.6	92.2	89.3	79.9	58.7	26.8	648.3
50	6.3	23.8	30.7	30.7	39.8	28.9	130.1	116.2	175.6	93.0	43.0	66.2	784.5
51	30.7	23.8	30.7	30.7	27.8	105.9	180.9	217.1	131.3	79.9	74.9	60.1	994.0
52	30.7	23.8	30.7	30.7	68.2	137.2	121.2	263.5	155.6	79.9	85.8	59.8	1087.3
53	16.0	23.8	30.7	30.7	27.8	36.9	32.2	136.6	165.5	90.3	43.0	62.6	696.3
54	30.7	23.8	30.7	30.7	27.8	36.9	108.0	176.0	95.6	79.9	70.4	49.6	760.2
55	24.5	23.8	30.7	30.7	27.3	19.1	37.2	30.7	94.5	79.9	54.2	49.5	502.8
56	14.3	23.8	30.7	30.7	99.8	50.6	230.6	229.1	182.3	79.9	72.2	53.1	1097.3
57	30.7	23.8	30.7	30.7	27.3	36.9	99.9	192.2	159.9	79.9	73.1	52.6	835.3
58	20.0	23.8	30.7	30.7	27.8	36.9	105.8	271.9	149.1	79.9	72.8	57.5	907.0
59	15.4	23.8	30.7	30.7	27.8	39.1	20.8	90.1	89.3	79.9	43.0	59.2	549.9
60	25.7	23.8	30.7	30.7	30.2	36.9	20.8	92.2	111.6	79.9	43.0	48.9	574.6
61	13.4	23.8	30.7	30.7	32.9	26.0	58.0	30.7	89.3	79.9	43.0	39.9	498.5
62	6.1	23.8	30.7	24.6	8.3	12.3	81.1	45.7	134.9	79.9	72.8	54.3	574.7
63	17.6	23.8	30.7	30.7	27.8	36.9	20.8	92.2	136.5	79.9	62.6	55.1	614.7
64	15.1	23.8	30.7	30.7	28.8	32.9	20.8	92.2	125.9	79.9	58.9	53.1	593.0
65	14.0	23.8	30.7	30.7	105.6	91.5	166.5	251.2	251.6	137.9	50.0	73.3	1227.0
66	30.7	23.8	30.7	30.7	27.8	36.9	29.2	144.8	89.3	79.9	71.0	26.8	621.7
67	6.1	23.8	30.7	24.6	8.3	12.3	37.5	85.1	188.4	79.9	79.1	54.1	630.1
68	17.8	23.8	30.7	30.7	28.8	39.1	62.4	30.7	89.3	83.6	61.4	26.8	525.2
AVG	15.4	23.6	30.3	27.8	30.2	34.6	76.5	107.6	121.0	91.4	61.5	47.9	667.8

Table 9

TABLE * TOTAL PUMPED DIVERSION FROM SNAKE RIVER TO BOISE PROJECT (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
28	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	60.0	65.0	55.0	233.3
29	34.2	0.0	0.0	0.0	0.0	25.0	65.0	75.0	74.6	70.0	65.0	55.0	463.8
30	55.0	0.0	0.0	0.0	25.0	25.0	65.0	75.0	71.6	70.0	65.0	55.0	506.6
31	55.0	0.0	0.0	0.0	25.0	25.0	75.0	75.0	73.3	70.0	65.0	55.0	518.3
32	55.0	0.0	0.0	0.0	0.0	7.0	45.0	30.0	50.0	70.0	65.0	55.0	377.0
33	40.1	0.0	0.0	0.0	0.0	0.0	45.0	74.9	50.0	70.0	65.0	55.0	400.0
34	55.0	0.0	0.0	0.0	0.0	25.0	75.0	75.0	56.3	70.0	65.0	55.0	476.3
35	55.0	0.0	0.0	0.0	0.0	7.0	41.1	49.2	50.0	70.0	65.0	55.0	392.3
36	55.0	0.0	0.0	0.0	0.8	7.6	17.4	30.0	50.0	70.0	65.0	55.0	350.8
37	40.9	0.0	0.0	0.0	25.0	25.0	70.0	75.0	56.3	70.0	65.0	55.0	482.2
38	55.0	0.0	0.0	0.0	0.0	7.0	2.7	0.0	0.0	70.0	65.0	55.0	254.7
39	22.2	0.0	0.0	0.0	0.0	25.0	0.0	30.0	50.0	70.0	65.0	55.0	317.2
40	55.0	0.0	0.0	0.0	25.0	0.0	38.1	30.0	68.6	70.0	65.0	55.0	406.7
41	55.0	0.0	0.0	0.0	12.2	7.6	65.0	75.0	71.2	70.0	65.0	55.0	476.0
42	55.0	0.0	0.0	0.0	12.2	7.6	45.0	75.0	62.3	70.0	65.0	55.0	447.1
43	55.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.0	55.0	175.0
44	15.7	0.0	0.0	0.0	25.0	25.0	40.4	50.8	50.0	70.0	65.0	55.0	396.9
45	55.0	0.0	0.0	0.0	25.0	0.0	29.9	30.0	50.0	70.0	65.0	55.0	379.9
46	40.1	0.0	0.0	0.0	0.0	0.0	0.0	30.0	50.0	60.0	65.0	55.0	300.1
47	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	60.0	65.0	55.0	261.4
48	34.2	0.0	0.0	0.0	0.0	0.0	45.0	30.0	50.0	60.0	65.0	55.0	339.2
49	32.2	0.0	0.0	0.0	0.0	0.0	0.4	8.7	50.0	70.0	65.0	55.0	281.3
50	55.0	0.0	0.0	0.0	0.0	0.0	0.4	45.0	0.0	70.0	65.0	55.0	290.4
51	42.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	65.0	55.0	222.0
52	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	65.0	55.0	193.2
53	26.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	65.0	55.0	206.1
54	17.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	65.0	55.0	197.3
55	14.6	0.0	0.0	0.0	25.0	25.0	19.7	30.0	50.0	64.2	65.0	55.0	348.5
56	39.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	65.0	55.0	219.6
57	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	65.0	55.0	191.1
58	24.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	65.0	55.0	204.0
59	23.0	0.0	0.0	0.0	0.0	0.0	0.0	45.6	50.0	70.0	65.0	55.0	308.6
60	55.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	50.0	60.0	65.0	55.0	315.0
61	31.4	0.0	0.0	0.0	0.0	0.0	45.0	75.0	75.0	70.0	65.0	55.0	416.4
62	55.0	0.0	0.0	0.0	0.0	0.0	45.0	30.0	50.0	60.0	65.0	55.0	360.0
63	32.6	0.0	0.0	0.0	0.0	25.0	28.5	30.0	50.0	60.0	65.0	55.0	346.1
64	8.0	0.0	0.0	0.0	0.0	0.3	33.3	30.0	50.0	60.0	65.0	55.0	301.6
65	8.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.0	55.0	128.8
66	0.7	0.0	0.0	0.0	0.0	25.0	23.8	31.8	50.0	70.0	65.0	55.0	321.3
67	55.0	0.0	0.0	0.0	0.0	1.7	45.0	75.0	54.9	70.0	65.0	55.0	421.6
68	55.0	0.0	0.0	0.0	25.0	25.0	60.1	68.6	50.0	70.0	65.0	55.0	473.7
AVG	37.1	0.0	0.0	0.0	5.5	7.8	26.0	34.4	40.6	62.8	65.0	55.0	334.2

Table 10

CENTRAL SNAKE STUDY 4. DISCHARGE BOISE RIVER AT BOISE (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
28	15.4	9.5	9.8	9.8	9.2	87.7	375.5	286.2	71.4	73.7	49.1	41.7	1039.0
29	15.3	9.5	9.8	9.8	8.9	9.8	29.8	73.8	71.3	73.8	49.2	41.6	402.5
30	9.8	9.5	9.8	9.8	8.9	9.8	29.8	73.8	71.4	73.8	43.0	23.8	373.0
31	9.8	9.5	9.8	9.8	8.8	7.4	29.8	73.8	59.5	65.2	43.0	23.8	350.0
32	9.8	7.1	8.3	7.7	8.4	7.4	29.8	73.8	89.5	79.9	67.6	41.6	430.9
33	30.7	9.5	9.8	9.8	8.9	9.8	29.8	73.8	71.4	79.9	65.9	41.7	441.1
34	15.3	9.5	9.8	9.8	8.9	9.8	59.5	73.8	59.5	65.2	43.0	23.8	387.9
35	9.8	9.5	9.8	9.8	8.8	7.4	29.8	73.8	71.4	73.8	49.2	41.6	394.5
36	9.8	9.5	9.6	9.8	9.2	7.4	59.5	93.0	71.4	76.7	49.1	41.7	446.8
37	15.3	9.5	9.8	9.8	8.9	9.8	29.8	73.8	71.4	73.8	47.6	23.8	383.3
38	9.8	9.5	9.8	9.8	8.9	9.8	240.9	91.8	166.7	79.9	67.6	41.7	746.1
39	30.7	9.5	9.8	9.8	8.9	9.8	59.5	73.8	71.4	73.8	43.0	32.7	432.8
40	9.8	9.5	9.8	9.8	9.2	9.8	59.5	73.8	71.4	73.8	49.2	41.4	426.9
41	9.8	9.5	9.8	9.8	8.9	9.8	29.8	73.8	71.4	73.8	49.2	23.8	379.2
42	9.8	9.5	9.8	9.8	8.9	7.4	29.8	73.8	71.4	73.6	49.2	41.7	394.6
43	9.8	9.5	9.8	9.8	8.9	323.5	403.0	319.6	109.1	79.9	67.6	41.7	1392.2
44	30.7	9.5	9.8	9.8	9.2	9.8	59.5	73.8	71.3	73.8	49.2	41.6	448.2
45	9.8	9.5	9.8	9.8	8.9	9.8	29.8	73.8	71.4	79.9	67.6	41.7	421.7
46	15.3	9.5	9.6	9.8	8.9	9.8	393.7	73.8	71.4	79.9	67.6	41.7	791.3
47	20.9	9.5	9.8	9.8	8.9	9.8	59.5	128.7	71.4	79.9	62.6	41.7	512.6
48	15.3	9.5	9.8	9.8	9.2	9.8	59.5	73.8	71.4	79.9	67.6	41.7	457.4
49	22.1	9.5	9.8	9.8	8.9	9.8	77.6	81.0	71.4	73.7	49.2	41.7	464.5
50	15.3	9.5	9.8	9.8	8.9	9.6	270.9	73.8	72.8	79.9	67.6	41.6	669.7
51	30.7	9.5	9.8	9.8	8.9	132.9	405.2	150.8	109.1	79.9	67.6	41.6	1056.0
52	30.7	9.5	9.8	9.8	113.9	317.5	328.5	276.7	71.4	79.9	67.6	41.7	1357.1
53	30.7	9.5	9.8	9.8	8.9	9.8	59.5	73.8	160.1	79.9	67.6	41.6	561.2
54	30.7	9.5	9.8	9.8	8.9	9.8	187.9	153.9	71.4	79.9	67.6	41.6	681.0
55	30.7	9.5	9.8	9.8	8.9	9.8	29.8	73.8	71.4	73.8	49.2	41.7	418.2
56	15.3	9.5	9.8	9.8	9.2	380.6	393.7	250.3	117.9	79.9	67.6	41.6	1385.4
57	30.7	9.5	9.8	9.8	8.9	9.8	234.6	284.0	184.2	79.9	67.6	41.6	970.6
58	30.7	9.5	9.8	9.8	8.9	9.8	200.2	423.9	89.0	79.9	67.6	41.7	980.9
59	30.7	9.5	9.8	9.8	8.9	9.8	59.5	73.8	71.4	73.8	49.2	41.7	447.9
60	30.7	9.5	9.8	9.8	9.2	9.8	70.2	73.8	71.4	79.9	58.9	41.7	474.8
61	15.4	9.5	9.8	9.8	8.9	9.8	29.8	73.8	71.4	73.8	49.2	41.6	402.7
62	12.7	9.5	9.8	9.8	8.9	9.8	59.5	73.8	71.4	79.9	53.2	41.7	439.9
63	16.8	9.5	9.8	9.8	8.9	9.8	59.5	73.8	82.7	79.9	67.6	41.6	469.8
64	30.7	9.5	9.8	9.8	9.2	9.8	59.5	73.8	86.5	79.9	67.6	41.6	487.9
65	30.7	9.5	55.0	37.0	249.1	300.9	278.0	260.9	272.7	79.9	67.6	41.6	1682.8
66	30.7	9.5	9.8	9.8	8.9	9.8	59.5	73.8	71.4	73.8	48.3	32.6	438.0
67	9.8	9.5	9.8	9.8	8.9	7.4	29.8	73.8	71.4	75.2	49.1	41.7	396.0
68	15.3	9.5	9.8	9.8	9.2	9.8	29.8	73.8	71.4	73.8	49.2	41.7	403.0
AVG	19.6	9.4	10.9	10.4	17.4	45.7	123.2	118.7	87.5	76.6	57.2	39.0	615.6

Table 11

CENTRAL SNAKE STUDY   2. DISCHARGE BOISE RIVER AT BOISE (1000 AC-FT)

W-YR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	TOTAL
28	15.3	7.5	5.2	9.7	8.0	150.2	400.1	402.2	71.4	73.7	49.2	41.6	1234.0
29	4.3	2.8	0.4	0.4	2.8	4.9	33.2	73.8	71.4	73.8	49.2	32.7	349.5
30	4.3	1.1	0.4	0.4	2.8	3.1	29.8	73.8	71.4	65.2	43.0	32.7	327.9
31	4.3	1.1	0.4	0.4	2.8	3.1	29.7	73.8	59.5	65.2	30.7	17.8	288.7
32	4.3	1.1	0.4	0.4	0.3	3.1	29.8	73.8	71.4	79.9	49.2	41.6	355.3
33	4.3	2.8	0.4	0.4	7.7	4.9	40.2	73.8	71.4	79.9	49.1	41.7	376.5
34	4.3	2.8	0.4	0.4	7.7	4.9	59.5	73.8	59.5	65.2	43.0	32.7	354.2
35	4.3	1.1	0.4	0.4	2.8	3.1	29.8	73.8	71.4	73.8	49.2	32.7	342.6
36	4.3	1.1	0.4	0.4	2.9	3.1	105.5	148.8	86.7	79.9	49.2	41.6	523.9
37	4.3	2.2	0.4	0.4	7.7	4.9	56.6	73.8	71.4	73.8	43.0	32.7	371.2
38	4.3	1.1	0.4	0.4	2.8	4.9	395.1	252.1	178.4	79.9	67.6	41.7	1028.7
39	30.7	7.5	5.2	2.9	7.3	4.9	124.1	79.9	71.4	73.7	49.2	32.7	435.7
40	4.3	1.1	0.4	0.4	2.8	4.9	59.5	76.7	71.4	73.8	49.2	41.6	385.0
41	4.3	2.8	0.4	0.4	2.8	4.9	29.8	73.8	71.4	73.8	49.2	32.7	346.1
42	4.3	1.1	0.4	0.4	2.8	3.7	59.5	73.8	71.4	79.9	49.2	41.7	388.1
43	4.3	2.8	0.4	2.9	234.4	368.1	405.7	418.0	223.0	148.7	67.6	41.7	1917.4
44	30.7	7.5	5.2	7.5	8.0	4.9	59.5	73.8	71.4	75.5	49.2	41.6	434.8
45	4.3	2.8	0.4	0.4	3.4	4.9	59.5	73.8	71.6	79.9	67.6	41.7	410.1
46	15.3	7.5	5.2	2.9	7.8	166.3	407.3	257.2	103.5	79.9	67.6	41.7	1162.1
47	15.3	7.5	5.2	2.9	7.3	47.8	142.5	222.5	78.0	79.9	67.6	41.7	718.5
48	15.3	2.8	0.4	0.4	8.0	4.9	59.5	153.5	175.6	79.9	67.6	41.7	609.6
49	13.2	2.8	0.4	0.4	7.7	4.9	279.8	94.4	71.4	79.9	49.2	41.7	645.9
50	10.1	2.8	0.4	0.4	7.8	4.9	398.2	129.9	143.7	79.9	67.6	41.6	887.2
51	30.7	7.5	7.5	10.3	68.9	189.2	405.4	295.6	116.2	79.9	67.5	41.7	1320.4
52	30.7	7.5	5.8	10.3	206.7	347.8	391.2	370.1	71.4	79.9	67.6	41.7	1630.6
53	30.7	7.5	5.2	2.9	7.8	35.5	191.4	73.8	279.2	79.9	67.6	41.7	823.0
54	30.7	7.5	5.2	2.9	15.4	109.0	271.0	186.3	126.9	79.9	67.6	41.7	544.0
55	30.7	7.5	5.2	2.9	7.7	4.9	59.5	73.8	71.4	79.9	51.0	41.7	436.1
56	15.4	2.8	5.2	50.6	163.8	375.8	395.1	415.4	142.2	79.9	67.6	41.7	1755.3
57	30.7	7.5	5.2	2.9	7.8	110.4	333.7	368.5	138.3	79.9	67.6	41.7	1244.2
58	15.4	7.5	5.2	2.9	7.8	64.3	351.4	423.9	177.3	79.9	67.6	41.7	1244.7
59	20.2	7.5	5.2	2.9	7.8	4.9	64.3	81.5	105.3	79.9	67.6	41.7	488.7
60	30.7	7.5	5.2	2.9	8.0	59.4	161.8	100.1	112.6	79.9	56.7	41.7	666.4
61	15.4	2.8	3.1	0.4	7.7	4.9	59.5	73.8	71.3	73.7	43.0	32.7	398.3
62	4.3	1.1	0.4	0.4	2.8	3.1	115.0	73.8	71.4	79.9	67.6	41.7	461.4
63	25.9	7.5	5.2	2.9	7.8	23.8	59.5	150.6	236.4	79.9	67.6	41.7	708.7
64	30.7	7.5	5.2	2.9	8.0	4.9	59.4	133.8	198.9	79.9	67.6	41.7	640.5
65	30.7	7.5	33.9	143.3	328.7	368.1	391.2	369.7	272.8	136.5	67.6	53.4	2203.3
66	30.7	7.5	31.6	10.3	7.8	57.9	59.5	79.9	71.4	73.7	49.2	41.6	521.1
67	4.3	1.1	0.4	0.4	2.8	3.1	29.8	73.8	112.0	79.9	67.6	41.7	416.8
68	30.7	7.5	5.2	0.4	8.0	4.9	59.5	73.8	71.4	73.8	49.2	41.7	425.9
AVG	15.8	4.5	4.2	7.0	29.9	63.1	164.7	159.5	112.3	80.3	57.3	39.6	738.2

TABLE 13. Mountain Home Project Shortage Summary
(each row represents 1 year of 41 years operation)

Shortage (1000 ac-ft)	%
356	81
266	61
121	28
120	27
117	27
93	21
65	15
33	8
30	7

of the results presented in this section.

Shortages in the Boise Project area and other Boise Valley lands would have only minor shortages similar to base conditions. However, the areas served by the Mora-Waldvogel canals and the lands below Lake Lowell would have no shortages because of the pumping capability from Snake River.

APPENDIX D

FISHERY INVENTORY

Anderson Ranch Reservoir

Inventory studies made by Idaho Department of Fish and Game personnel indicate the following fish species present in Anderson Ranch Reservoir:

Game Fish Species

Kokanee, Oncorhynchus nerka
Rainbow Trout, Salmo gairdneri
Dolly Varden Trout, Salvelinus malma
Mountain Whitefish, Prosopium williamsoni
Yellow Perch, Perca flavescens
Smallmouth Bass, Micropterus dolomieui
Coho Salmon, Oncorhynchus kisutch

Non-game Fish Species

Squawfish, Ptychocheilus oregonesis
Largescale Sucker, Catostomus macrocheilus
Bridgelip Sucker, Catostomus columbianus
Redside Shiner, Richardsonius balteatus
Chiselmoutn, Acrocheilus alutaceus

The predominant species in the reservoir are Kokanee and squawfish followed by Rainbow Trout and Yellow Perch. Smallmouth Bass, which have recently been planted, are expected to become a major species in the future.

Kokanee, which were initially planted in 1964, make up the major portion of the game fish population in the reservoir. The first spawning run of Kokanee, which have a 3 year life cycle, occurred in 1967 when an estimated 6,000 fish migrated up the tributaries. The steady increase in Kokanee population is indicated by an estimated 50,000 spawning fish in 1971 and possibly more in 1972. There are actually two spawning runs from Anderson Ranch; early spawners migrate in August and September; late spawners make their run in October and November.

This reservoir provides a major source of early spawning Kokanee. Trapping of spawners from Trinity Creek in 1971 provided 1.5 million eggs for Idaho Department of Fish and Game hatcheries and 1.7 million eggs for federal hatcheries.

For food, Kokanee rely almost entirely on zoo plankton which appear to be abundant enough to support the large population. As yet no stunting effects from lack of food have appeared.

Anderson Ranch does not support a natural Rainbow Trout population. Maintenance of this trout fishery is solely due to releases (twice a year) of catchable size trout that have been reared in hatcheries.

Smallmouth Bass have recently been introduced into Anderson Ranch Reservoir. The habitat and spawning requirements for Smallmouth are essentially the same as for Squawfish and it is hoped that competition for food and space and the highly predacious feeding habits of the Smallmouth will provide a natural control of Squawfish populations.

There has been a rather intensive program of squawfish population control carried on during the past 5 years. Shoreline spawning areas have been treated with rotenone during and after spawning in an effort to eliminate emergent fry and fingerlings. Squawfish spawn during the latter part of June and first part of July in shoreline waters less than 3 feet deep.

Squawfish have had the reputation of being serious predators and competitors with Kokanee; however, studies now indicate that the two species have different habitat preferences. Squawfish primarily occupy shoreline and warmer surface waters while Kokanee are generally found in deep, cold offshore water. Generally speaking, squawfish are found in waters with temperatures in excess of 55°F with a majority in waters with a temperature over 60° F. In Anderson Ranch most of the squawfish have been found in water less than 40 feet deep.

In 1968 a rapid drawdown (3 to 5 feet per week during June and July) caused a drastic reduction in Squawfish population by dewatering the eggs.

South Fork, Boise River

The fish population in the South Fork below the dam is essentially all salmonid. It consists of Rainbow Trout, Whitefish, and in the past, an occasional Coho Salmon. A number of Kokanee are now making spawning runs up this river from Arrowrock Reservoir. These Kokanee have evidently been carried over from Anderson Ranch sometime in the past and have established themselves in Arrowrock. Last year an estimated 1,000 fish spawned directly below Anderson Ranch Dam.

ANGLING USAGE

Anderson Ranch Reservoir

The following table indicates fishing trends in Anderson Ranch reservoir from 1968 through 1971:

Table 1. Estimates of Total Effort and Percent Composition of Catch at Anderson Ranch Reservoir, 1968-1971[1/]

Year	Total Hours	Total Catch	Boat Anglers				
			RBT	KOK	COHO	SQ	Others
1968	21,115	29,255	13.5	8.3	9.0	69.0	0.2
1969	18,940	23,111	14.7	3.4	3.3	71.9	1.7
1970	24,479	27,955	6.9	25.9	0.1	64.0	2.4
1971	37,933	27,679	5.2	58.6	0.0	35.6	0.6
1972	64,500						

Year	Total Hours	Total Catch	Bank Anglers				
			RBT	KOK	COHO	SQ	Others
1968	8,523	10,418	20.4	0.9	9.8	67.1	1.8
1969	8,106	9,186	27.0	0.1	0.9	55.9	16.4
1970	5,134	4,707	27.2	8.2	0.1	47.5	17.0
1971	3,250	3,281	14.9	0.0	0.0	52.0	33.5
1972	12,000						

Sources:

1/ From Idaho Department of Fish and Game creek census report.
2/ At this time the only data available for 1972 are total catch (combined boat and bank anglers); Rainbow Trout, 7,500; Kokanee, 36,000; Squawfish 12,000.

The results of these surveys indicate that boat angling has increased by nearly 60 percent per year in 1971 and 1972. During this period there was a 70 percent increase in total Kokanee harvested.

Bank fishing has decreased through 1971, probably because of the low catches of fish other than squawfish. In 1972, however the increase in bank fishing could reflect an increased catch of Yellow Perch in 1971. The increased Perch fishery may be a compensatory response to a decrease in the population of mature Squawfish as a result of rapid reservoir drawdown during June and July of 1968.

The current program for developing a Smallmouth Bass fishery should produce an increase in bank fishing efforts.

Origin of Anglers

Surveys indicated that in 1969 the majority of anglers were from Boise and Mountain Home (36 and 31 percent respectively). Fishermen from the Nampa-Caldwell and Jerome-Twin Falls area made up most of the remaining usage

In 1972, however, indications are that nearly 30 percent of the anglers came from the Mountain Home Air Base and about 40 percent from Mountain Home. Fishermen from the Boise and Twin Falls-Jerome area composed most of the remaining usage.

SOUTH FORK BOISE RIVER

The South Fork between Anderson Ranch Dam and Arrowrock pool is about 20 miles long; however, readily accessible fishing area is limited to about 12 miles immediately below the dam.

Cold water released from the dam provides an excellent summer trout fishery. Creel census surveys indicate that about half of the Rainbow Trout caught are naturally spawned fish. The rest are hatchery fish which migrate upstream from Arrowrock pool. This stretch of river is considered as the best fly fishing stream in Southern Idaho.

During the winter the river remains free of ice through this section. As a result, a prime winter fishery for White fish has developed.

Although the river is heavily used there are no figures available at this time as to the actual number of fishermen.

RESERVOIR WATER QUALITY DYNAMICS

General

The physical, chemical and biological aspects of a reservoir with deep water withdrawal are considerably different from natural lakes.

In natural lakes large amounts of organic material, which has been synthesised from incoming nutrients, sinks to the bottom and is decomposed. This bacterial decomposition tends to deplete the hypolimnion (bottom layer) of available oxygen. Formation of a thermacline prevents the return of regenerated nutrients to the epilimnion (upper layer) and also the exchange of oxygen to the hypolimnion. Thus, in natural lakes nutrients are accumulated and oxygen depleted in the deeper water during summer stagnation. In this manner natural lakes act as nutrient traps and tend to progress toward eutrophication more rapidly with age than do reservoirs with deep water withdrawals.

In contrast, reservoirs with deep water withdrawals tend to deplete the lake of nutrients, which accumulate in deep water during stagnation, by releasing rich water through the outlet. This method of releasing water tends to increase productivity in streams below these dams.

The temperature regime in natural lakes is somewhat modified by the release of warm surface water. As a result outflowing streams could have a higher temperature than incoming water. The effect of deep water withdrawal is the reverse. Heat energy is stored within the reservoir while the cold deep water is being released. Thus, streams below this type of dam are generally colder than incoming water during the summer. In winter the opposite is generally true and streams below are warmer than inflowing water.

Anderson Ranch Reservoir.

Anderson Ranch Reservoir appears to follow the classic pattern of dams with deep water withdrawals. The impoundment is over 12 miles long and 300 feet deep. The outlet is located at the 200 foot level leaving a dead pool a little more than 100 feet deep.

Although there is no water quality data available visual examination indicates that the water quality dynamics does follow the classic example just discussed. Algal growth, although present, does not appear excessive at this time. Dissolved oxygen concentration remains satisfactory, at least through the 200 withdrawal foot level. Primary productivity, in terms of algae growth immediately below the dam indicates that a considerable amount of accumulated nutrients are being released from the reservoir.

Stratification of the lake begins toward the end of May and is well established by the middle of June. The thermocline begins to disappear toward the end of October and temperatures remain fairly constant at all depths throughout the winter. During the summer months the top 12 to 15 feet of water has an average temperature of about 70°F. Below depths of 35 to 40 feet the temperature remains about 45°F. throughout the year. Surface water temperature changes, although somewhat higher, parallels changes in inflowing water during the summer. Water released through the penstock maintains a constant 42 to 45°F. in the river below the dam.

Historically, the reservoir has maintained a relatively full pool. Maximum drawdown during dry years has been about 70 feet.

PROPOSED LONG TOM PROJECT

Effects of Proposed Reservoir Operational Requirements

General

Development of the Mountain Home segment of the Southwest Idaho Water Development Project would result in much greater water level fluctuations in Anderson Ranch Reservoir than have occurred in the past. Of major concern is the magnitude and timing of expected level changes.

Hydrologic projections (Appendix C) based on assumed project conditions, indicate that if the project had been in operation during the 40 year period from 1928 to 1968 the reservoir would have filled only 12 of those years (11 years in the month of June and 3 years in May). Under the assumed conditions the average maximum levels would have been 45 feet from the top. The average minimum pool level, occurring during September and October was minus 114 feet. During 14 of the 40 years the drawdown would have exceeded 150 feet. Under these conditions the reservoir generally began filling in October and November.

Fish

Under the project operational conditions maximum pool levels would occur in June. Between June and July projected withdrawal requirements indicate an average rate of decrease in water levels of nearly 1 foot per day. Such a drawdown at this time of year would have a serious effect on natural populations of warm water fish species. Squawfish, yellow perch, and smallmouth bass all spawn in shallow shoreline water at about that time of year. Deposited eggs would seldom have time to develop before being dewatered. As a result, a very few years of operation would virtually eliminate the warm water fishery from Anderson Ranch.

Kokanee, being a cold water fish and not using the reservoir pool for spawning would probably survive in the lake. Continuous and extended reduction in the size of the pool could, however, result in either a limited population or stunted growth. The major effect of the operation on Kokanee would be through some spawning losses. Minimum levels, which would occur during September and October while spawning runs are taking place, would result in extending inflowing streams some 5 or 6 miles into the pool area. Kokanee redds in this area would be covered by the pool which begins filling in October and November. Since salmonid egg development requires flowing water these potential fish would be lost.

With continued and extended low water levels, serious oxygen depletion in the hypolimnion may occur.

The effect of operation procedures on the Rainbow Trout fisheries in the reservoir would be negligible since this population is maintained almost completely from hatchery stock.

Angling Usage

The effects of increased drawdown and water level fluctuations in fishery usage should parallel the fish population.

Bank fishing, which showed a considerable increase in 1972, would be virtually eliminated by a combination of decreased accessability and decreased warm water game fish populations.

Boat angling for Kokanee has become the major usage on Anderson Ranch reservoir. Kokanee will probably survive in the reservoir under low water operation; however, the much reduced size of the pool would act as a limiting factors in regulating the size of the population. Projections indicate that natural populations would stabilize at a much lower level over an extended period of time. As a result of reduced pool size, therefore, fishing use could be expected to increase during the first few years after initiation of the project and then fall off to a constant carrying capacity based on fish harvest.

Water Quality

The effects of the proposed operation procedures on water quality within the reservoir pool is difficult to project. Theoretically, as long as the withdrawal is from deep water the major part of the nutrients would not accumulate and dissolved oxygen would remain adequate throughout the depth of water. With operations requiring extensive drawdown, however, the outlet becomes progressively shallower and the relative volume of the dead pool becomes greater.

Using conditions of the past 40 years as a projection of the next 40 years it can be estimated that 30 to 35 percent of the years the drawdown will exceed 150 feet. Under these conditions the reservoir could assume the characteristics of a natural lake with nutrients and organic detritus accumulating much more rapidly in the dead pool than under normal circumstances.

If these low water levels occurred during a number of sequential years, the total nutrient increase could result in extensive algal blooms. Bacterial decomposition of the increased mass of organic detritus could result in oxygen depletion in the hypolimnion. In extreme cases, fish kills could result.

EFFECTS ON SOUTH FORK, BOISE RIVER

Long Tom Diversion Dam

The Long Tom Project calls for construction of a diversion dam about five miles below Anderson Ranch Dam. From this low dam (65 feet high) water is to be diverted via a 7 mile tunnel through the mountains to the Mountain Home irrigation project. The diversion dam is expected to produce a pool 2-1/2 to 3 miles long. During the irrigation period (June through September) the volume of diversion water required would produce high flows on the remaining section of river between the two dams.

Fish

The combination of the Long Tom diversion pool and high water flows would drastically reduce natural reproduction of the current salmonid population in this section of river. Therefore, a fishery in this area would be almost totally dependent upon releases of hatchery fish. There is also the possibility that large numbers of fish would leave the area through the tunnel.

Assuming a minimum flow in the remaining section of the South Fork, the effects of the Long Tom project on fish populations in that reach would probably be due to changes in water quality and reduced early spring flushing. Kokanee runs from Arrowrock would be seriously hampered by temperature increases in water released from Long Tom.

Angling Usage

Construction of the Long Tom Diversion would reduce the free flowing fishing areas, which is now accessible to fishermen, by nearly half.

A trout fishery could be developed in the Long Tom impoundment and through "put and take" management methods and angling usage would undoubtedly be increased by establishment of improved picnicking and camping sites.

Summary

Development of the Mountain Home segment of the proposed Southwest Idaho Water Development project would result in considerable change in the operational regime of Anderson Ranch Reservoir and on the South Fork of the Boise River immediately below.

The following paper is an attempt to assess the probable and possible effects of the proposed operation upon the fish and wildlife of the Anderson Ranch area. No attempt was made to quantify these effects.

Included is an inventory of present fish and wildlife resources, fishing usage, and indicated trends.

Since no water quality data is available a number of assumptions, based on biological responses and reservoir dynamics are made. Consideration is limited to two parameters which have readily observable effect on aquatic biota (nutrients and dissolved oxygen) and to temperature which is of major importance to species habitat.

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