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Abstract

Comprehensive planning is an elusive ideal. The practical planner must sort the relevant information from the vast amounts of data that modern technology can collect. The objective of this study was to use the Upper Blackfoot watershed in the mountains of Southeastern Idaho as an arena for developing methods for construction, refinement, and application of indices needed to design land and water management schemes, compare alternatives, and influence the public in their uses of the area. A total of 21 uses were examined on 343 land units of a 160 square-mile area ranging in elevation from 6300 to 9000 feet and where the principal activities of grazing, lumbering, mining, and recreation can only be undertaken in the summer after the snow has melted. The indices considered were a reasonability index for screening out unreasonable uses at the start of the planning process, an index of use intensity for estimating an amount for reasonable uses, and an index for estimating the utility of the amount of use made from the public viewpoint. Data were collected on 43 attributes for the 343 land units and used in a linear programming model to maximize 1) economic benefits from use of the area and 2) minimize environmental disturbance. The resolution in the available use data limited the model solution to allocating uses among 18 larger land units. The primary factor limiting the modeling, however, was the lack of information for defining the interactions among the uses. The analysis provides a framework for classifying and identifying interactions beginning with the simplest case of simultaneous use by two uses in near proximity. The contribution of the study was a framework for analysis and the identification of the needs for research on the physical interactions among simultaneous uses, the perceived interactions of simultaneous users, and characterization of attributes for defining the quality of an area for a use.

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CHAPTER 1

INDEXING AS A PLANNING TOOL

Water resources development supplies water for municipal and irrigation uses, generates hydroelectric power, controls floods, and provides facilities for outdoor recreation. Land resources development provides sites for cities and farms, minerals, and recreation open space. Often these and other land and water uses conflict with one another and management is required to integrate multiple uses in the public interest. The task of management has been made increasingly complicated as more people employing higher levels of technology use more of nature's fixed resource base. Further development for still greater use requires larger projects with greater energy consumption. The resulting fuller resource utilization reduces the management flexibility previously associated with under-used resources and simultaneously increases the number and the complexity of the interactions among physical, economic, ecologic and social factors in natural and human environments.

For example, as larger demands exhaust local water sources, new water supply facilities must be more massive. The needed projects have greater direct impacts and, in a more interactive world, more numerous and lingering indirect impacts. Interactive effects alter vegetation, change flow regimes, spread pollution, and reshape aquatic environments.

Planning is the art of anticipating impacts and adjusting development plans and management policy accordingly. Planners strive to achieve ever expanding human goals for a better life within ever tighter constraints. Their ideal is to be comprehensive, to estimate every impact, to evaluate every interactive relationship, and to use the information in the objective maximization of social goals.

For years comprehensive planning has been the accepted rhetoric. Ideally, its pursuit should begin with research defining the effects of natural resource uses (individually and interactively) on the total environment and proceed with applications, monitoring and refinement through experience. For the most part, comprehensive planning has not worked this way. One sees instead data collection ad infinitum, with minimal quality control on the measurements, no consistency on measured items from one project to the next, and little depth of interpretation.

Comprehensive planning remains elusive. Instead of eliminating surprises in the objective maximization of human welfare, the multiplication of data has made planning more costly and more time consuming. Presentations have grown more difficult to understand, partly because of their bulk, but also as the coverage of additional interactions adds new concepts and new technical terms to the planning vocabulary.

As fuller natural resource use causes more interactions, as new instrumentation increases the capacity to collect data, and as faster computer systems can massage more numbers into more forms, the mass of data available for planning grows geometrically. However, the process cannot just continue to add inputs to decision making without causing overload and breakdown. Well intentioned planners take great time and cost checking out inconsequential details. Masses of unconnected data are misapplied by people of diverse viewpoints and sometimes ulterior motives. Issue resolution is delayed as bad cases are made stronger by proponents with more facts. Planning productivity plunges. Information overload is counterproductive to objectivity.

In conclusion, the need for comprehensiveness has led to form without substance. As one example, the legal requirements for environmental impact statements are satisfied if information is made available; integration into decision making need not be demonstrated. The planning process needs a way back to anticipating important impacts and delivering information that promotes the good and hinders the harmful.

It is just not practical to approach comprehensive planning by presenting all the data that modern technology can collect. The trend toward information overload must be counteracted by 1) collapsing data (reducing their bulk for a given content) and 2) displaying differences among alternatives quickly and efficiently in understandable form. Collapsing data reduces redundancy, and efficient display facilitates thoughtful comparison of alternatives. Improved data management is essential to improved planning productivity. Indexing can provide the needed framework.

Index construction (expressing extensive information into a few indicators of processes or states) needs to begin from sound scientific principles. Principles from the physical sciences can be applied in engineering design to assure functional performance. Principles of economic efficiency can be applied to maximize net benefit. Principles of environmental protection and social well-being can be used to protect these vital systems. For example, environmental health is found in the stability of a mature ecosystem, and social health is found in human satisfaction and fulfillment (James et al. 1978a).

Scientific principles are important in organizing information for objective choice, but planning is not rote implementation of measures selected through a model of scientific rationality. It is not ethically acceptable to let scientific optimization dominate the fundamental precepts of free choice. People are not inert objects to be manipulated by modelers. What is best for a person depends not only on objective observations of how he or she is affected, but also (probably more so) on how he or she feels about it. The planning process should, according to the democratic ideal, culminate not in implementation but in display that conveys understanding.

While resource management decisions are ultimately political, scientific relationships constrain the choices. Counterproductive political controversy and political selections of choices impossible (or impractical) to implement can be reduced by better understanding, more careful application, and clearer exposition of scientific principles.

In order to search out how people feel, planning has married the ideal of scientific understanding to the ideal of public participation, broadening the base of decision makers to all who care. People are asked what they want; often through leading questions on how they feel about what planners propose. In soliciting responses, planners face the practical problems of presenting scientific information so that a nontechnical public can make rational decisions and can negotiate compromises when groups have differences in preferences.

After a choice is made, one step remains; implementation. Most land and water uses are not made directly by governmental planners. The decisions are implemented by influencing people toward uses deemed in the public interest (James 1975). Decision making requires passive consensus; implementation requires active concensus or going out to do something in the spirit of the decision. There is a big difference. As an example, Clark et al. (1971) found distinct differences between campers and campground managers over the types of activities best meeting common goals. The implementation process will probably always disclose sources of disagreement unanticipated during the plan's development. But without systematic information collection, these disagreements may go unnoticed or misdiagnosed, and resources managers may design implementation programs that are undermined by public opposition.

All three planning processes (scientific evaluation, public participation, and plan implementation) are facilitated by objective information. The quality of the planning product is determined by how well and how widely relevant information is identified, collected, collapsed into succinct form (indexed), presented (displayed), and understood.

Scientific facts are needed by designers for performance evaluation. Facts on both sides of tradeoffs must be presented in good faith as planners interact with the public in policy formulation. Motivating facts must be convincingly presented to get potentially nonbelieving land and water users to follow public policy.

For developing indices that efficiently display the important factors from a mass of complex information for these three applications, the questions of interest are: What do people (designers, deciders, users) want to know? What forms (varying both among and within the three groups) communicate that information best? What appeals do best in encouraging individual users to conform to collective decisions on public interest? What index and display systems promote decisions that give those making them long run satisfaction? People want assurance that an alternative will perform. In making up their minds, they want to know how alternatives differ in effects on the things they value. They want technical detail collapsed into the essence of worthwhileness or objectionability.

Collapsing data into fewer indices, however, results in information loss, and attention must be given to preserving the information content most meaningful to users. Information content can be technically defined and provides a statistical criterion for evaluating how much additional information a new index adds. Other criteria must be applied in determining how useful the information is. These criteria grow out of the needs of the three planning processes: importance in the technical interactions governing design, relativity to values governing group consensus, and contribution to getting user groups to conform to collective choices. In order to avoid information overload, interactions of secondary concern or influencing the decisions of few users may have to be omitted when making tradeoffs in index development.

The system designer, policy decider, and water user can all work more efficiently with a few indices relating to basic values. Designers seek performance; policy deciders seek economic efficiency and a few other social objectives; water and land users are concerned with personal economic, environmental, and social goals. Because different groups want different indices, more indices must be developed than are of interest for any one purpose.

The objective of this study was to use a high mountain watershed in southeastern Idaho as an arena for gathering facts and developing methods for the construction, refinement, and use of indices which capture the economic, social, and ecological impacts needed to guide land and water management schemes, compare alternatives, and influence uses. A high mountain watershed was selected as a site where land and water management presents issues on which many people feel keenly in a setting where most uses are light and the interactions (at least the social ones) are relatively less complex than those that occur with the greater number of actors in more densely populated areas.

The indexing was to 1) employ known physical, biological, and perceptual relationships in hypothesizing the determinants of land and water use, evaluating uses according to the public interest, and estimating competing or complementary interactions among uses, 2) use historical data to assess the reasonableness of these relationships, and 3) construct a model permitting planners and the public to see the implications of alternative choices. A capability to forecast the implications of alternatives and express the important implications in indices representing priority concerns is an invaluable deterrent to regretted choices; it is the hope for comprehensiveness in planning; it is the foundation for monitoring to be sure that all remains well.

CHAPTER 2

PRINCIPLES OF INDEXING

Introduction

Indices capture the important information content for three major applications; to 1) define relationships among variables for development or management design, 2) forecast development or management results for evaluating alternatives, and 3) motivate cooperation among diverse interests in implementation. The first role is primarily scientific or predictive. The second and third roles are both evaluative with the second addressing evaluation from the overall public interest and the third contributing to evaluations from the viewpoints of the particular interests of specific groups or individuals.

Economists have used indices for years in watching changes in prices or economic productivity. In the last 25 years, both the predictive and evaluative roles of indices have been expanded conceptually.

Tinbergen (1952) introduced and Land (1974, 1975) refined the combined use of policy instrument (manipulable) indicators, initial state (nonmanipulable) indicators, and output indicators depicting direct results and side effects (Figure 1) for examining economic policy alternatives. Their configuration uses indices to compare the utilities of outcomes, but it also draws attention to the applicability of indices in defining causal relationships for use in predicting outputs from input factors. Such defined causal relationships can be used to forecast the influences of both exogenous and controllable variables on the output variables. Conversely, they can also be used to identify the values of the controllable variables necessary for the planner to achieve a "desired" outcome. Fox et al. (1966) define the two-way use of these constructs as "consistency modeling."

For both predictive and evaluative applications, index construction begins by applying statistical techniques to reduce redundancy. For predictive applications, selection of the relevant information content requires identification of the applicable laws in the physical, economic, biological and social sciences. For evaluative applications, selection requires information on how people feel about the futures predicted for them.

The Data Base

Index development starts with a system to be examined and a purpose for that examination. For planning purposes, one needs to know the

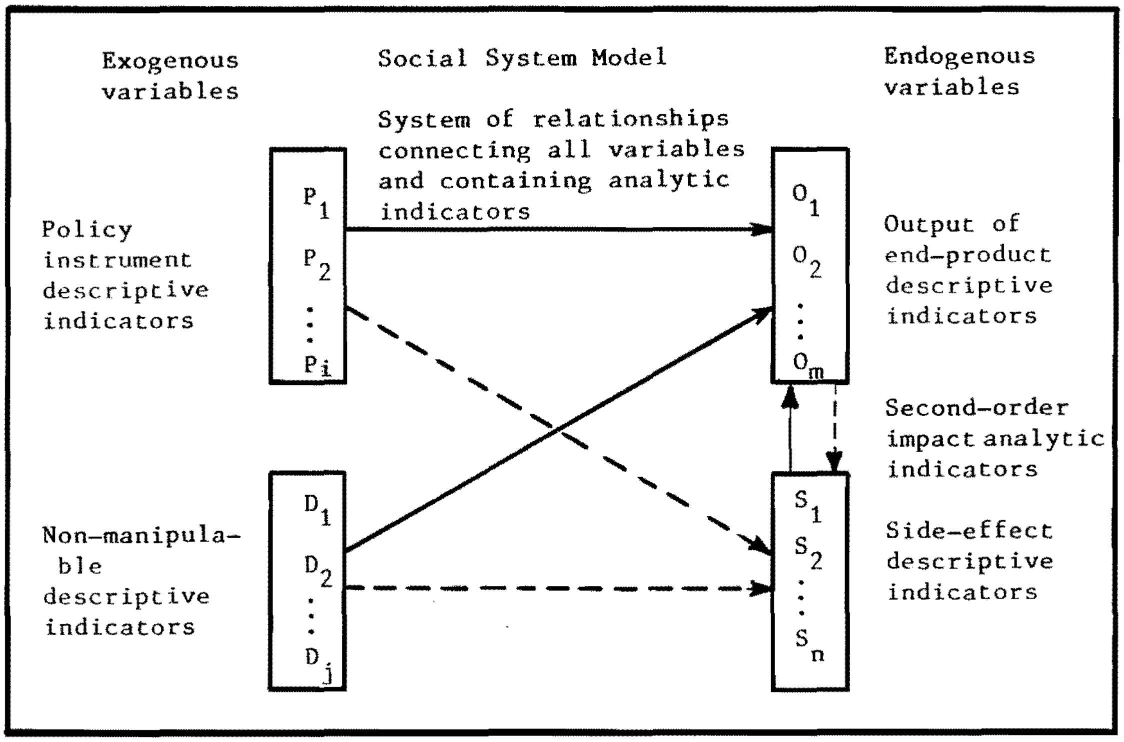


Figure 1. Kinds of indicators and their relationships (from Land 1975).

state of the systems and how the factors describing that state interact with one another. Descriptive information must be collected to begin the study.

Limitless indicators can be used to describe the states of the physical, economic, ecologic, and social systems existing at a given time on a given area of land. Some are very simple; others can only be measured with sophisticated instruments by people with special interpretive training. Relevant measurements must be selected and made, and the mass of data then has to be reduced so that the information obtained can be applied.

Statistical Analysis

The collected data need to be examined for redundancy; correlations need to be identified so that total information can be expressed with fewer numbers. Each number needs to be scaled so that changes in its magnitude can be properly interpreted.

A variety of statistical methods has been proposed for these purposes (Gum 1973, 1974, 1976; Arthur et al. 1976). Mahmood and Messer (1982) outlined the combination of factor and principal components analyses used in formulating water quality indices for this study. Stevens (1946) identified four empirical operations in constructing scales as the determination of a) equality, b) greater or less, c) equality of intervals, and d) equality of ratios. A nominal scale is based only on the first; an ordinal scale is based on the first and second; an interval scale on the first three; and a ratio scale on all four (Metfessel 1947). Ranking provides only an ordering of items with respect to preferences. Rating also provides the distance between points on a preference scale. Comparative techniques add a zero point and thus allow such ratio comparisons as A being preferred twice as much as B.

Construction of rankings, ratings, and comparison ratios requires different information processing algorithms. Possibilities include but are not limited to:

1. Ranking - average rank of each item over the sample

2. Rating

   a) average rating for each item over the sample

   b) ratings calculated from Theory of Signal detection methods (Swetts et al. 1961; Daniel et al. 1971)

3. Comparative judgment

   a) general allocation of points among all categories (Metfessel 1947; Gum 1973)

b) ratio scale calculated by rational origin method based on paired comparison (Thurstone and Jones 1959)

c) ratio scale based on paired allocation of points (Comrey 1950)

For mathematical manipulations, such as combining indicators into indices, the value weightings must have ratio scale properties. The tests used in the social sciences for these properties are the Comrey Paired Allocation Test and the Gum General Allocation Test.

Indicators that pass the test can be combined into indices through a function of the form

$$P = x^b y^c z^d \qquad (1)$$

where, for example,

P might be an index of recreation

x might be an indicator of fishing

y might be an indicator of camping

z might be an indicator of hunting

The exponents b, c, and d define the relation of the indicators to the perceived overall recreation value. Gum (1973) explains the theoretical basis for converting the preference measures obtained from the Comrey or Gum tests to the exponents in Equation 1. Other methods for incorporating preference information into indices have been proposed by Brown et al. (1970, 1971), Crawford et al. (1973). The selection of appropriate means depends on the theory used in specification of the indicator (Biderman 1966), on the information needs of the potential users (De Neufville 1975; Garn et al. 1976), and on the mathematical properties of the indicators to be combined (Kruskal 1968; Osborne 1976; Ott 1978).

Predictive Effectiveness

The best predictive indices are obviously those that are key variables in a causative relationship. Where a causative relationship is known, indexing becomes a task of finding the best way to measure a needed variable in the given field situation. Where the causative relationship is not known, indexing becomes a task of identifying plausible factors and then testing them by statistical or other means. In either case, the effectiveness of an index as a predictor is evaluated scientifically.

Evaluative Effectiveness

For evaluative applications, indices must also be concensus acceptable to those using them. De Neufville (1975, Ch. 10) describes how a social indicator must be institutionalized to affect decision making. Institutionalization legitimizes concepts and ensures continuing measurement of the indicator. The elements of institutionalization are:

1. The concept of the indicator meshes with user perception of relevance.

2. The agencies that collect and massage the data are respected, and their measurements are free from political control.

3. Long term financing for regular measurement is dependable.

4. The data are presented in a nonpolitical context.

5. Informed, active interest groups use and support continuance of the data series.

6. The media and the public are conscious of the indicator's existence and its role.

7. Processes are established and followed for orderly refinements in concepts and methods to update the indicator.

8. The indicator is tied into particular programs as a criterion for funding or a trigger for operation.

9. The indicator is tied into the conduct of policy to which government is committed.

10. Governmental or quasi-public groups use the indicator in formulating policies.

Items 1, 2, 6 and 10 in De Neufville's list vary among different index user groups according to both their desired application and level of analysis (Larson et al. 1979). Much of the work to define social indicators has been done from a national perspective. Little attention has been given to indexing to serve the policy needs of state and local jurisdictions or to support appeals to resource users to follow the public interest in choosing among available alternatives. The focus of this study on small mountain watersheds and on information needs at local and individual levels is breaking new ground in index application to the local arena where land use planning occurs in the United States.

Considerations in Defining Evaluative Indicators

Analytic Approach

Evaluative indicators, those for comparing the utilities of alternatives, have received the most attention; and, of these, economic value (benefits net of or divided by costs) has often had the bottom line in decision making. However, environmental movement now has planners looking more broadly and uncovering areas where individual viewpoints vary and consensus is more difficult to reach.

Two principal approaches have been used in the search. One popular approach ("Toward a Social Report," U. S. Department of Health, Education and Welfare 1969; Techcom (the Technical Committee) 1971, 1974) has been to identify reasonable goals for society and then reason increasingly detailed objectives until reaching a set of measurable indicators. The "Principles and Standards" (U.S. Water Resources Council 1973) were built by this intellectual exercise.

Synthetic Approach

In contrast to the above analytic approach, the synthetic approach (Andrews and Withey 1976) identifies popular concerns by public survey techniques. General concerns are translated into specific criteria, and indicators are constructed to represent these criteria. Of the two methods, the synthetic approach seems far more useful for establishing indices that explain the tradeoffs made among diverse groups in reaching a consensus or that can be used to encourage implementation. Different viewpoints can be ascertained by surveying various groups much easier than they can be determined analytically. Further illustrations and applications are provided in Finsterbusch and Wolf (1977).

Hierarchy of Indices

When selecting indices of value, one should cover the important values; but there is no need to add indices that restate values already contained in accepted indices. Human values can be broadly classified as economic, ecologic, and social. The logical approach to minimizing duplication was to begin with the economic index, try to capture as much residual information as possible in the second index, and continue in this manner to cover the important effects. The specific strategy was:

1. Forecast economic consequences and express them in estimates of net benefits.

2. Assuming the second ranking value in mountain areas to be preservation of the natural environment, identify environmental values not covered by the economic analysis and convert them into an index measuring net environmental impacts.

3. Identify social values not covered by the economic and environmental indices. For example, human well-being may suffer when opportunities for mountain experiences are reduced.

4. Assess a) whether the indices agree with index user perceptions of importance and b) whether measured values of these indices satisfy user information needs.

Economic Aspects

Economic activity in a high mountain watershed is largely driven by forces operating within a larger economy. Schumpeter (1961) attributes development in the economy at large to one or more of new combinations of productive resources. These are: introduction of a new good, introduction of a new production method, opening of a new market, development of a "new" raw materials supply, and modification of the way industry is organized. Mountain areas primarily supply raw materials, including both commercial products and natural environments for recreation experiences.

Maki (1968), MacMillan (1968), and MacMillan et al. (1968) describe economic development as encompassing greater resource productivity, a wider range of real choice for consumers and producers, and broader clientele participation in policy formulation. All three apply to mountain areas.

Economic development in high mountain areas thus implies greater rates of extraction of both renewable and nonrenewable resources, and more recreation facilities. Decisions to make greater use are made by individual users (recreationists, cattlemen, lumber company managers, etc.) interacting with resource managers (U.S. Forest Service officials, water quality control officials, etc). The users are motivated more by profits and personal satisfaction, and the managers are motivated more by overall net benefits to whomsoever they may accrue.

Both sets of decision makers need reliable information on the costs and benefits associated with particular actions at particular locations. Site development costs vary greatly over small distances, but benefits are much the same wherever a use occurs. Consequently, the economic indices emphasize 1) the benefits of resource development (use) from the national viewpoint and 2) the costs of development (use) at the specific site from the viewpoint of the private sector. Local (traditionally called secondary) benefits and national costs are recognized to exist but assumed to be much smaller in magnitude.

Environmental Aspects

The environmental values of a high mountain area that does not contain unique wilderness features are largely associated with aesthetics and runoff. The quality of the aesthetics and the amount and quality of runoff are in part determined by biological activity that may of itself have additional long term environmental values.

Preservation of these environmental values thus requires that settings of high aesthetic character or that generate high quality runoff be protected. Special attention needs to be given to protecting runoff when managing mountain area land use because of the importance of mountain areas as a water source, the dependence of runoff quantity and quality on catchment characteristics, and the potential alteration of those characteristics by commercial or recreational use. Meaningful evaluation and land use changes require quantitative relationships for estimating land use impacts. However, derivation of adequate relationships is complicated by the fact that neither quantity nor quality are simply conveyed in a single measurement. Quantity is a total volume, but water users also need information on how runoff is distributed within the year and varies from year to year. Quality is a collective concept combining innumerable parameters to define water pollutants and their effects. However, the number of indices that are needed to establish reliable predictive relationships are fewer than one might expect. The basic uses of mountain lands are few, mountain areas classify into relatively few ecosystem types, and downstream users are concerned with relatively few quantity and quality parameters.

In selecting runoff indices, one needs to cover runoff quantity and quality characteristics that affect either instream or diversion uses. For example, the use of water for drinking is limited by viruses, bacterial pathogens, toxic heavy metals, and many organic compounds. Activities that increase concentrations of these variables shift water to less productive uses. Where the original uses are still permissible, reductions in the value of water should be estimated (Helweg and Alvarez 1980).

Instream values depend on the health of the aquatic ecosystem. Aquatic ecosystems possess two complements, the abiotic environment and the natural community. Assuming that the geologic and climatic features are relatively constant, within the annual cycle of seasons, a steady state develops within which solar energy flows into the natural community, is processed by various life forms, and is released as heat or productivity. A steady state of annual cycles is maintained as long as the pattern of energy and material inputs continues. Ecosystem stress occurs with the expenditure of energy in disrupting the system. Ecosystem stability (resistance to stress) is a function of diversity (Margalef 1968) or the number of ecological niches or functional roles that exist within the community.

A climax community generally has maximum diversity and is reached at the end of successional steps that result from competitive changes within the ecosystem and occur in a systematic and definable manner. The climax reached at a given location depends on environmental variables (hydrologic, soil, physiographic, climatic, and other factors). Carrying capacity can be defined only under steady state conditions for a climax community.

One can logically hypothesize ecological maturity as the ideal state for the environment at a given location. However, it is one that conflicts with use of the same area by the human economy. Some natural environments have to be sacrificed. In deciding which ones, the planner must recognize that some mature ecosystems are more productive, aesthetic, or unusual than others. One general index to the value of a mature ecosystem is the time nature required to achieve it (James et al. 1978b). The time depends on the life-spans of the predominant species in the various stages of the succession toward maturity; for example, a mature forest environment takes much longer to achieve than does a mature grassland environment.

For quantifying the quality of a specific ecosystem, a watershed can be divided into i ecologically homogeneous areas, A_i as illustrated in Figure 2. The j possible uses for the areas can then be listed as U_j. For ecologically homogeneous area A_1, one can visualize environmental factors E_1 and E_2 as controlling the carrying capacity for (ability of the environment to support) use U_1 (Table 1). Some other indicator, E_3, may be more reasonable for estimating the carrying capacity of A_1 for use U_2. A still different combination of indicators, E_2 and E_3, may represent the carrying capacity for use U_1 of area A_2. Other areas and uses could have still different combinations.

Human energy expenditure on a land area may increase populations of some species to more than their carrying capacity (agriculture, tree farming, range seeding, etc.), decrease populations until a climax species can no longer sustain itself (clearcutting, burning, etc.) and faster-growing species take over, or change the carrying capacity by altering populations of supporting or competing species. Specific changes depend on the amount and form of energy expenditure.

Social Aspects

The social values of a high mountain area are largely found in their satisfaction of the human need for wilderness experiences. Social-psychologists and mental health researchers have long recognized that people are affected by their environment. Social-psychological literature suggests that physical and mental health are fostered by self-actualization. Specifically, a person profits by encountering, coping, and surmounting a variety of obstacles that are challenging, but not so hostile that life or the will-to-live is destroyed.

For the purpose of this research, social indices may be considered in analogy to the relationship of environmental indices to ecological maturity. The effect of a uniform environment (whether natural or social) is to diminish the quality of life. People are made happier by environmental diversity. A succession exists in that a person is attracted to a new environment; but as his needs for the experiences that it provides are met, he shifts to other environments for still new experiences. Eventually a person reaches a state ("maturity") that balances the environmental experiences in a manner best meeting his or her needs (maximizing his or her health).

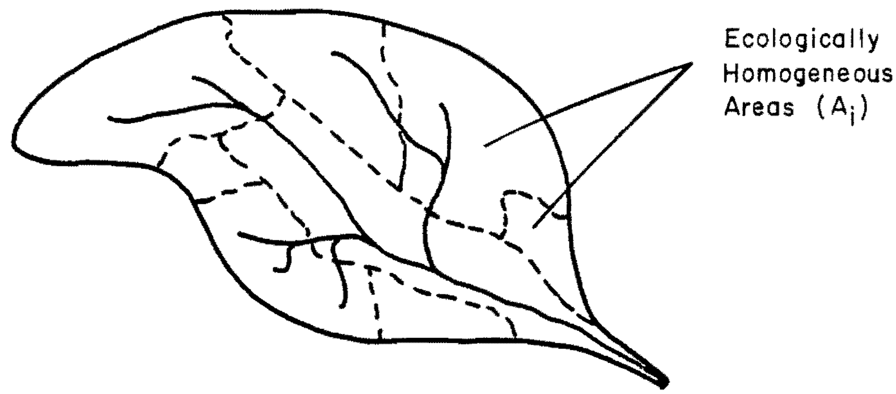


Figure 2. Illustration of watershed subdivision for ecological analysis.

Table 1. Index combinations used to evaluate the environmental quality of a specific ecosystem.

Uses	Homogeneous Areas			
	A_1	A_2	. . .	A_i
U_1	$E_1, E_2,$	E_2, E_3		
U_2	E_3			

Note: The Es are hypothetical environmental indices of the carrying capacity of a specific ecosystem subarea.

The combination of environmental experiences best for an individual varies with culture, social background, age, physical condition, and other personal characteristics. Strictly speaking, each individual has his own ideal environmental experience. The practical problem is to index health and environmental factors so that indices can be derived and the concept can be made operational (Brogan and James 1980). One advantage of selecting a high mountain watershed to consider indicators of social value is that the number of likely causative linkages between environment and health are fewer than they are in environments where people live and work.

Five major conceptual linkages have been proposed for explaining how the physical environment affects human well-being: physiological change (MetroStudy Corporation 1972), territoriality (Lyman and Scott 1967), personal security (Glass and Singer 1972), environmental control (Hill and Meek 1971; Perlmuter and Monty (1977), and social communion (Hirschi 1969; Cassel 1971). James et al. (1974) found the last of these to be the most significant in the relationship between people and their residential environment in Atlanta, Georgia.

In mountain watersheds, one might expect the following relationships:

1. Physiological change: The fresh air and exercise of wilderness experiences benefit physical health. On the negative side, one can visualize wilderness accidents or disease brought on by exposure to the elements (for example, being drenched by a summer thundershower).

2. Territoriality: Visitors to wilderness areas are not willing to accept the same frequency of intrusions by outsiders as people are in other environments. Some intrusions do not even require the personal presence of the intruder but only refuse, crushed plants, trail erosion, or other evidence of his having been there.

3. Personal security: Visitors to wilderness areas can be frightened or harmed by wildlife or by other visitors, by becoming lost, or by perceptions of hazardous conditions.

4. Environmental control: Visitors to wilderness areas come with preconceptions of the environment that they would like to see and are disturbed by encountered degradation. Even people who do not visit may feel offended at hearing of such changes.

5. Social communion: Visitors to wilderness areas can draw closer to accompanying family or friends or become better adjusted through escape from people or cares left behind.

Implementation Applications

Planning decisions on land and water uses are implemented through indirect means such as regulation, charging, and information dissemination. All too often, the regulatory process is assumed to achieve total compliance at zero cost. In actuality, regulation involves cost, and some activities are much more costly to regulate than are others. Information dissemination can facilitate compliance and reduce regulatory costs. Charging schemes provide incentives, help defray management costs by raising revenue, and ration use according to need.

Watershed planning needs to optimize in terms of maximizing the benefits from land use and from use of the runoff net of the costs of implementing the plan. Indices are useful in optimizing the implementation scheme, determining when plans should be adjusted to avoid costly implementation problems that encourages public compliance, and improving the efficiency of individuals charged with executing the implementation plan.

Forest Service Planning

Since the U.S. Forest Service is the major land owner in the study area, this study was coordinated with their planning so as to be able to use their data and to produce results they can apply. Forest Service planning divides the total land area into recreation units and subdivides these into ski areas, recreation highway corridors, developed hiking areas, pristine hiking areas, areas for dispersed recreation, and areas of restricted use. Areas are also classified according to whether they are open, restricted, or prohibited to mineral development, grazing, or lumbering. The classifications follow stated management objectives for an area.

Forest Service activities are structured to achieve these objectives. They define permissible uses of water, air, recreation lands, visuals, wildlife, range forage, timber, and historical and archeological sites and attempt to prevent other uses from occurring. The Forest Service also has programs for fire control, insect and disease control, and mineral development.

Management objectives in allocating land uses are:

1. Meet basic requirements of law, regulation, and policy.

2. Resolve conflicts in land use.

3. Establish an optimal mix of uses.

4. Meet public health requirements.

5. Meet economic and social needs of individuals in a manner acceptable to the general public.

6. Provide a basis for land ownership adjustments.

Gomm (1979) outlines Forest Service study plan formulation as encompassing 1) involvement of the public and all levels of government in defining management schemes and criteria for deciding among them,

2) systematic evaluation of the schemes according to the criteria chosen, and 3) implementation so as to be responsive to new issues and concerns through what is called dynamic land management planning. The process identifies tradeoffs in consequences (between big game and livestock, for example), gathers data for weighing the tradeoffs at particular locations, involves the public in their resolution, announces the management decision, and monitors response.

Suhr and Carder (1979) compare three indexing techniques for Forest Service use. The "alternative action evaluation technique" uses preassigned weights to combine factors into a composite preference index. The "pairwise comparison approach" uses pairs to rank evaluation criteria in importance, normalizes performance toward each criterion on a 0 to 1 scale, and sums the products to establish the preference index. The "trade off evaluation procedure" (McKee and Simmons 1978) ranks alternatives by developing a factor profile for each for comparing scores, criterion by criterion, and then using indifference scaling to rank the profiles. All three indices are oriented toward application by a single decision maker charged with optimization of overall forest management.

Basic Relationships

For this study, the indices were formulated from indicators that represent attributes that affect use decisions, use impacts, or use interactions. According to the adopted terminology, attributes are conceptual causal factors, indicators are numerical measurements used to quantify those attributes, and indices are used to express the combined effect of two or more indicators. Rather than using the shotgun approach of measuring many indicators and using statistical methods to search for significant associations with use, this study began by hypothesizing what a person would logically want to know when considering a given use decision, what characteristics of an area affect use impacts, and what characteristics affect use interactions. The hypothesized attributes were used to suggest indicators that could be measured. Information hypothesized as relevant could then be confirmed or refuted from correlations between the measurements and use data.

Uses result from decisions made by individuals (for themselves or as part of a management group) from information available at various levels of aggregation and interpreted from various viewpoints. For example, decisions to cut firewood are made by people combining recreation with their need for fuel and guided by land manager decisions formulating policy regulating cutting. The decisions are also influenced by opportunities for other uses perceived to be complementary (a trout stream adding to the recreation experience) or competitive (a herd of cattle interfering with the work). The prospective firewood cutter also considers factors that influence demand for firewood (alternative fuel cost), the general destination (travel distance), and the specific location at that destination for cutting (availability of suitable trees). Management decisions try to influence users to act in compliance with such broader concerns as aesthetics, fire hazard, and national energy policy.

Information useful to each decision can be expressed by indices. To reduce the cost of planning, the decision making can be facilitated by screening out land areas in which the use is not even reasonable (firewood cutting on riparian grasslands, for example). Accordingly, the evaluation of the suitability of a given land area for a given use began by establishing a reasonability index of the form:

$$IR_{ui} = f_u\ (A_{1i},\ A_{2i}\ .....\ A_{ni}) \qquad (2)$$

where IR_{ui} is a binary variable of value 1 if use u deserves further consideration in land unit i and 0 if it does not, and f_u is some rule which can be applied for determining the reasonability of use u from data on A_n easily measured indicators. Specifically, f_u converts indicators into an index. For the example application described in the next chapter, ownership, vegetation type, and locations with beetle infestation were known. The IR_{2i} (firewood cutting was use 2) were assigned a value of 1 for land units containing dead conifers on public land and 0 for other land units. Obviously, another reasonability rule would be applied in areas where a beetle infestation has not led to a policy promoting removal of dead trees.

For units whereon a use was indexed as reasonable, a use intensity index was sought with the form

$$IP_{ui} = g_u\ (B_{1i}\ .....\ B_{oi},\ C_1\ .....\ C_p) \qquad (3)$$

where IP_{ui} is an ordinal scale becoming increasingly larger with greater amounts of the use, and g_u is some rule which can be applied for use u with data on B_{oi} indicators (combining selected A_{ni} indicators with other information whose measurement is more difficult but justified where the use will probably occur) representing attributes of the immediate land unit and C_p indicators representing attributes of a larger area round about. For this study, the C indicators are assumed to have the same value for all land units.

Since the desirability of a use depends on both user and public viewpoints, Equation 3 can be expanded to estimate the utility rather than the amount of the use giving

$$IU_{ui} = M_{ui}\ V_{ui}\ IP_{ui} \qquad (4)$$

where IU_{ui} is an index of the overall utility of the use, V_{ui} represents the unit value of use to the user, and M_{ui} is a multiplier to adjust user value to desirability from the public viewpoint.

M_{ui} is greater than 1 when it is in the public interest to promote a use and less than 1 when it is in the public interest to restrict the use. It was assumed for this study that V_{ui} is a scalar value with economic units and constant for all land units (i). The M_{ui} are potentially functions (h_u) of subsets of the B and C variables in Equation 3.

The B and C variables represent attributes expected to influence 1) people deciding whether and where to engage in a particular use or 2) the public attitude toward those uses. The analysis seeks to identify attributes current users consider important, measure indicators of those attributes, and combine them into indices. Measurement selection requires evaluation of how much information on an attribute is improved by greater measurement effort.

For the firewood cutting example, factors hypothesized as influencing the amount of firewood cutting within the total watershed (the C variables) were 1) a gravity model estimate of the demand of the population in the general area for firewood, 2) the profitability of firewood cutting as estimated by the price, 3) the relative advantage of using firewood as estimated by the price of alternative fuels, and 4) the competitive location of the watershed in comparison to other firewood areas with respect to population centers. The factors hypothesized as influencing where a person cuts firewood within the watershed were 1) the amount of dead wood, 2) the quality of road leading to the site, 3) access as indexed by elevation because higher lands are generally steeper and farther from good roads, 4) land ownership, and 5) owner restrictions on cutting.

Two sorts of data are required for establishing g_u (estimating IP_{ui}). One is actual use data, U_{ui}, defined as the amount of use u occurring annually in unit i normalized to a unit area basis. The other is measurements of the B and C indicators.

Derivation of g_u thus requires data on U_{ui}, B_{ki} (k from 1 to o), and C_ℓ (ℓ from 1 to p). Since only one watershed was examined in this study, no variation was available in the C indicators. All that could be defined was a relationship

$$IP_{ui} = g2_u \; (B_{1i} \; \ldots\ldots \; B_{oi}) \qquad \ldots\ldots\ldots\ldots \qquad (5)$$

given the one setting defined by C_1 ..... C_p. Regression provides one tool for defining $g2_u$. Approximations can be used when the amount and quality of the data do not support regression methods. Some of the preselected B_o variables may not be significant and should be dropped. If the predictive power of the best formula is low, some definitions or measurement methods may need to be revised, or other variables may need to be added. On the other hand, a poor correlation may be simply caused by approximate use data or its inaccurate disaggregation into the i units.

The C variables could not be brought into a quantitative relationship in this study because data were only available for this one watershed, a situation making it impossible to quantify variability among watersheds. With a multiple watershed data base, one could regress watershed values of use per unit area on the C variables. Whatever form they may eventually take, quantitative relationships move water and land use planning from subjective judgments to an analysis which permits simultaneous tracking of many factors from many viewpoints.

Estimation of the desirability of a use also requires consideration of the public viewpoint. Information useful in estimating M_{ui} (Equation 4) includes descriptions of current governmental efforts to promote or restrict use, attributes of a unit which influence public opinion on the desirability of that use at that location, and impacts of a use that make people feel it to be desirable or undesirable. For the example use of firewood cutting, the unit or B variables hypothesized as potentially important to the public were 1) exposure of the unit to easy view from the surrounding area and 2) the amount of dead wood as it influences both sightliness and fire hazard.

The relationship (again using h_2 as an approximation of h for the given setting)

$$M_{ui} = h_{2u} (B_{1i} \; ..... \; B_{oi}) \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad (6)$$

given C_1 ..... C_p has both scientific and public opinion inputs. For firewood cutting, the reduction in forest fire hazard would be scientifically determined while the improvement to sightliness would be evaluated from public opinion to the gains from removing dead trees killed by bark beetles.

CHAPTER 3

DESCRIPTION AND USES OF THE UPPER BLACKFOOT WATERSHED

General Information

The Upper Blackfoot watershed selected for study lies some 60 miles east of Pocatello and 25 miles northeast of Soda Springs in Caribou County, Idaho (Figure 3). Defined as the catchment tributary to the Blackfoot River at the point where it leaves the Caribou National Forest, just below where the river flows out of a canyon called the Narrows, the study area covers 160 square miles (sq. mi.), 109 of which are within the National Forest. Ownership of the remaining area is divided among private parties (43 sq. mi.), the State of Idaho (5.5 sq. mi.), and the Bureau of Land Management (2.7 sq. mi.). Established in 1907, the Caribou National Forest covers, in several separated units, a total of 1,250 square miles.

The study area centers in Upper Valley located between two north- to northwest-trending mountain ranges. The grassed valley plains range up to several miles wide, are about 11 miles long, and geologically resulted from folding and subsequent block faulting. The Webster Range of the Rocky Mountains forms the eastern boundary, and from south to north, Dry Ridge, Wooley Range, and Grays Range border the catchment to the west. A gentle rise in the valley floor forms the northern boundary.

Catchment elevations range from almost 9,000 feet above mean sea level at several points along the ridge line of its southeastern border down to about 6,300 feet at the point where the Blackfoot River leaves the study area. Mean annual precipitation varies from about 35 inches (primarily snowfall) at the higher elevations to less than 20 inches (still largely snow) on the valley floor (U.S. Forest Service 1978).

Upper Valley is drained by two perennial streams, Lanes Creek in the northern half and Diamond Creek in the southern half. The two join to form the Blackfoot River which flows eastward through the Narrows separating Dry Ridge from the Wooley Range. The 160-square mile drainage area contains 97 miles of stream of third order or higher. Downstream from the study area, the Blackfoot River flows into the Blackfoot Reservoir (storage capacity of 237,000 acre feet) built about 1920 by the U.S. Bureau of Indian Affairs for irrigating Indian lands on the Fort Hall Reservation. Although the study area constitutes less than 28 percent of the reservoir's drainage area, it contributes most of the runoff.

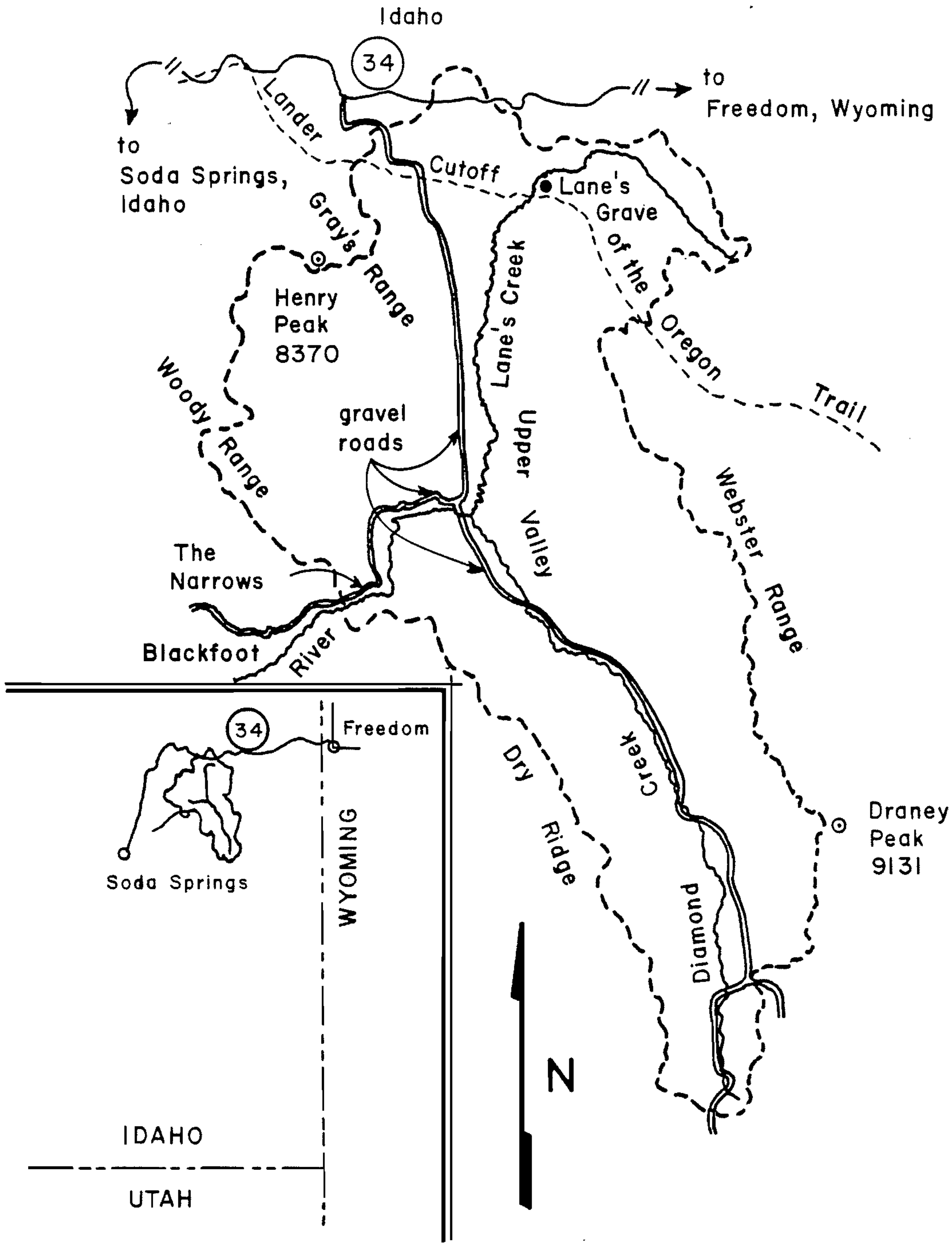


Figure 3. Location map for Upper Blackfoot River watershed.

The geologic feature of principal interest is the scattered outcrops of the Meade Peak Phosphatic Shale Member of the Phosphoria Formation, particularly on Dry Ridge where several active phosphate mines are located. The study area also lies in the western Overthrust Belt, making it the object of active oil and gas exploration. No producing wells have been drilled so far.

The Forest Service maintains gages on a number of smaller streams near the phosphate mining areas. Flow rates and several quality parameters are measured. Four U.S. Geological Survey gages are maintained on the Blackfoot River along its 80 mile course to the Snake River. Stream gage locations, tributary drainage areas, and average annual runoff amounts are listed in Table 2.

According to the Forest Service's classification based on morphology and soils, 40 land types in 10 major groupings are found in the study area (Table 3). Each land type was rated by the Forest Service according to its susceptibilities to erosion and mass failure (landslides) and productivities for range and timber.

The vegetation varies with elevation, moisture, aspect, and soil. The six principal types of cover are conifer (primarily Douglas Fir and Lodgepole Pine), aspen, mountain brush, sagebrush and grass, riparian grass, and riparian willows. The forests are located primarily at higher elevations on north and east facing slopes. The dry, cold climate is less than ideal for commercial timber regeneration but sufficient to support a moderate harvest program. Recently, a bark beetle infestation has damaged mature stands, and the dead trees are being harvested for firewood.

A 1977 environmental impact statement (U.S. Department of the Interior 1977) identified 75 species of mammals, 272 species of birds, 13 species of reptiles, 6 species of amphibians, and 9 species of fish in the Caribou National Forest. Since the Upper Blackfoot drainage contains only about 8 percent of the forest area, fewer species would be expected in the study area. Game species include deer, elk, partridge, grouse, ducks, rabbits, and cutthroat trout. No endangered species are known to reside in the area.

The nearest population center is Soda Springs, Idaho, established in the 1860s to secure a popular Oregon Trail rest stop from Indians (Bureau of Land Management 1978). Agriculture and phosphate ore processing now provide the major commercial support for its 4,500 residents.

Idaho Highway 34 from Soda Springs to Afton, Wyoming, passes through the northern tip of the unit and is the only paved road in the area. Because it is a more direct route from the Idaho population centers, however, the primary access to Upper Valley is by a gravel road entering through the Narrows from the west, following the Blackfoot River, and branching north and south in Upper Valley with the forks following Lanes and Diamond Creeks, respectively. Numerous dirt roads connect to this gravel road and provide access to mountain

Table 2. Stream gage stations--Blackfoot River.

Location/Name	Drainage Area (mi2)	Average Annual Discharge (ac. ft.)	Yield (in.)
USGS Gages			
Blackfoot River near Blackfoot, Id.	1,295	139,100	2.0
Blackfoot River near Shelley, Id.	909	255,700	5.3
Blackfoot Reservior near Henry, Id.	581	*	-
Blackfoot River above reservoir	350	121,700	6.5
Blackfoot River below the narrows	161	111,523	13.0
USFS Gages			
Stewart Creek at confluence with Diamond Creek	2.70	1,148	8.0
Diamond Creek above confluence with Stewart Creek	10.69	2,876	5.0
Mill Creek near confluence with Blackfoot River	2.47	1,608	12.2
Upper Angus Creek at Wooley Valley Mine	1.42	279	3.7
Lower Angus Creek near confluence with Blackfoot River	4.19	1,232	5.5
Sheep Creek at Forest boundary	7.37	5,681	14.5

*Inflow to Blackfloot Reservoir is not gaged.

Table 3. Land types found in the Upper Blackfoot River Area.

Code	USFS Number	Description	Inherent Erosion Hazard[a]	Mass Failure Hazard[b]	Productivity Potential	
					Range[c]	Timber[d]
MOUNTAIN VALLEY BOTTOMLANDS						
01	044	Alluvial fans--timbered	L	VL	NR	H
02	061	Alluvial lands--wet and overflow	VL	VL	VH	VL
03	066	Dry alluvial land	L	VL	H	VL
04	081	Toeslopes--timbered--deep, fine loamy soils	M	VL	H	VL
05	082	Toeslopes--nontimbered	M	L	H	VL
06	084	Toeslopes--timbered--deep sandy soils	M	L	NR	L
RIDGELANDS						
07	200	Smooth ridgelands	M	VL	L	VL
08	201	Dissected ridgelands	H	VL	M	VL
09	202	Smooth ridgelands--shallow to moderately deep fine loamy soils	M	M	L	VL
STABLE MOUNTAIN UPLANDS						
10	300	Smooth mature fluvial lands	M	M	L	H
11	301	Mature fluvial lands--nontimbered	M	VL	M	VL
MOUNTAIN BASIN LANDS						
12	330	Smooth, mature basin lands--deep fine and fine-loamy soils	M	L	H	VL
13	333	Timbered upland basins--moderately deep loamy--skeletal soils				

Table 3. Continued.

Code	USFS Number	Description	Inherent Erosion Hazard[a]	Mass Failure Hazard[b]	Productivity Potential	
					Range[c]	Timber[d]
UNSTABLE SCARP AND DIP UPLANDS						
14	360	Unstable dissected scarp-dip slope land--moderately deep fine and fine-loamy soils	M	H	M	VL
15	362	Unstable steep scarp-dip slope land	M	M	M	VL
16	380	Dissected scarp and dip slope land--mixed open and timbered	M	L	M	M
17	381	Dissected broken and fluvial lands--nontimbered	M	VL	VH	M
CANYONLANDS						
18	404	Steep canyon side slopes--timbered-shallow to moderately deep loamy-skeletal soils	H	L	L	M
19	405	Steep canyon side slopes--nontimbered	H	M	M	VL
20	432	Steep unstable canyon lands--shaly-shallow to moderately deep loamy-skeletal and fine-loamy soils	H	H	L	VL
21	433	Steep unstable north-facing canyon lands--shaly-shallow loamy-skeletal soils	H	H	VL	L
FOOTHILLS						
22	454	Unstable low foothills, mixed aspen and sage, deep fine soils	M	H	H	VL
23	456	Moderately dissected unstable foothills--mixed aspen and sage--deep fine loamy to loamskeletal soils	M	M	H	L
SIDE SLOPES						
24	500	Low relief unstable side slopes--deep fine and moderately deep fine loamy soils	M	M	H	L
25	501	Weakly dissected unstable side slopes--aspen-brush-deep fine and fine-loamy soils	H	H	H	VL

Table 3. Continued.

Code	USFS Number	Description	Inherent Erosion Hazard[a]	Mass Failure Hazard[b]	Productivity Potential	
					Range[c]	Timber[d]
26	551	Weakly dissected valley side slopes--timbered	M	L	L	H
27	552	Mature low relief valley side slopes	M	VL	L	H
28	553	Weakly dissected broken scarp slopes--south-facing	H	L	M	VL
29	554	Weakly dissected broken scarp slopes--north-facing	M	L	L	M
30	602	Unstable moderately dissected side slopes--timbered-moderately deep to deep-loamy and skeletal soils	H	M	VL	M
31	651	Moderately dissected valley side slopes--nontimbered	M	VL	M	VL
32	653	Headlands--steep short slopes--sharp ridges on short drainages	H	L	L	M
33	654	Moderately dissected side slopes--timbered--moderately deep to deep sandy and loamy-skeletal soils	H	L	VL	L
34	656	Moderately dissected valley side slopes--timbered	M	L	L	M
35	703	Unstable strongly dissected side slopes--deep fine and fine-loamy soils	M	H	L	M
MOUNTAIN SLOPES						
36	755	Broken mountain slopes--steep and timbered	M	L	VL	M
37	871	Faulted mountain slopes	M	VL	M	M
ESCARPMENTS						
38	911	Smooth escarpments	M	L	L	VL
39	912	Dissected escarpments--high relief	H	M	L	VL
40	913	Dissected benchy escarpments	H	L	L	VL

[a]Erosion Hazard: VL = no appreciable hazard; L = permits exposure of bare soil with minimum precaution; M = permits limited and temporary exposure during development; H = exposure will severely damage productive capacity or yield high volume of sediment; VH = exposure will permanently damage capacity or yield excessive sediment volumes.

[b]Mass Failure Hazard frequency (actual or potential) per 1,000 feet of slope horizontally on the contour: VL = 1 or less; L = 2-3; M = 4-5; H = 6-7; VH = 8 or more.

[c]Range Productivity Potential (lbs/acre - air dry): NR = Nonrange, < 50; VL = 50-250; L = 250-500, M = 500-1,000; H = 1,000-2,000; VH > 2,000

[d]Timber Productivity Potential (cu.ft./acre/year): VL < 20; L = 20-50; M = 50-85; H = 85-120; VH = 120-160.

Source: U.S. Forest Service, Pocatello, Idaho.

areas on both sides of the valley for mining, logging, grazing, and recreation.

The first mining activity in the region was for gold, found in 1870 near Caribou Mountain, several miles north of the study unit. The Phosphoria Formation outcrops were discovered in northern Utah in 1889, but the deposits were too remote from the central states fertilizer market, and the fields were slow to develop. In 1908 and 1909, reacting to acquisition and mining for export by European interests of major Tennessee phosphate deposits, the Secretary of Interior reserved to the United States all the potentially valuable phosphate deposits on federal, state, and private lands in southeastern Idaho, northern Utah, and southwestern Wyoming (Bureau of Land Management 1978). These mineral rights were subsequently placed under a leasing program (by the Mineral Lease Act of 1920) that continues to the present (30 U.S.C. 181). Two significant mines opened prior to World War II, but virtually all current leases were issued after 1948.

Most of the oil and gas rights are also federally controlled, but both sites where exploratory drilling has occurred have been on state lands. The establishment of the Caribou National Forest similarly placed most of the area's timber resources under federal management. The main activity of the private landowners is livestock grazing, using their valley lands as summer range for cattle and sheep. Most of the public land is divided into cattle or sheep allotments, although few of the private landowners hold permits.

Hydrogeologic Data

The major geologic formations in the study area, as reported by Montgomery and Cheney (1967, p. 5), are the Monroe Canyon Limestone (Mississippian Series), Wells Formation (Pennsylvanian Series and Permian Series), Park City and Phosphoria Formations (Permian Series), Dinwoody, Woodside, and Thaynes Formations (Triassic System), and alluvial and colluvial deposits (Quarternary System). The Dinwoody and Wells Formations, along with unconsolidated deposits of colluvium and alluvium, are the most important aquifers (Cannon 1979, p. 39). The geologic and hydrogeologic characteristics of these geological units are described in Table 4 (modified from Ralston and Williams 1979, p. 243). The low permeability of the Phosphoria Formation divides the groundwater into two systems (Dinwoody Wells above and below the Phosphoria Formation). Flows may occur between the aquifers through fractures.

The lithology of these formations (primarily limestone, siltstone, and phosphatic rock) suggests that groundwater discharging from them would have high concentrations of calcium carbonate, phosphate, and a pH greater than 7.0. This is typically the case.

Table 4. Summary of the lithology and hydrogeologic characteristics of important geologic formations.

Formation/ Rock Unit	Member	Thickness (m)	Lithology	Hydrogeologic characteristics (permeability)
Triassic:				
Dinwoody	Upper	274 (900)	interbedded limestone and siltstone with discontinuous shale zones	moderate for limestone and siltstone, low for shale and silt
	Lower		calcareous shale and siltstone with few thin limestone beds	
Permian:				
Phosphoria	Rex Chert Unit	37-46 (120-150)	chert and cherty limestone, thick bedded	permeable when fractured
	Mead Peak Unit	46-61 (150-200)	phosphatic shale, mudstone and phosphatic rock; some limestone and siltstone	low to very low
Carboniferous:				
Wells	Upper	15 (50)	siliceous limestone	moderate
	Middle	457 (1,500)	sandy limestone, sandstone	high
	Lower		limestone, mostly sandy and cherty	moderate to high

Source: Ralston and Williams 1979, p. 243.

Climatological Data

Temperatures at valley floor elevations range from -40° to 90°F. Mean monthly temperature for July is 58°, and for January, 12°. The growing season varies from 105 days at 6,500 feet to 15 days at 8,500 feet. The mean elevation is about 7,250 feet, and the average growing season is 49 days. The short growing season restricts ranching to summertime grazing by cattle and sheep.

Snow begins falling at higher elevations by October. Prevailing winds from the southwest cause snow to accumulate on the north and east sides of ridges. Drifts sometimes exceed 30 feet in depth and 6 miles in length. By March, snow depth varies from a few inches on the windblown, south- and west-facing ridgetops, to 6 feet or more in some valley bottoms and northeast-facing slopes. Spring snowmelt begins at the lower elevations and proceeds more rapidly up the south and west facing slopes with their greater exposure to the sun. The peak runoff occurs from mid-April to late May.

Table 5 shows available temperature and precipitation data for recent water years for Afton, Wyoming, and Conda, Grace and Henry, Idaho. No regular measurements are made in the study area. The water year 1977 was characterized by a drought that was actually more severe than indicated by the table because much of the precipitation fell in summer storms generating little runoff.

The vegetation shows that precipitation increases with altitude but measured data are not available for higher elevations. On an average, the temperature decreases as altitude increases. The rate of decrease vertically (the lapse rate) averages about 3.8°F per 1000 feet (Linsley et al. 1975). Better information on how both precipitation and temperature change with elevation would be useful in developing models to predict runoff.

Cloudy weather prevails throughout the winter with measurable precipitation (snow) about one day out of three. Snow course data are available for four stations located near the study area. Summer precipitation is mostly in local, intense thunderstorms.

Relative humidity is lower in summer than in the winter, and in afternoon than in morning. July and August have the lowest monthly averages of 40 percent. Annual mean relative humidity is 62 percent (U.S. Department of Commerce 1976).

A four-foot stainless steel evaporation pan is located at Lifton Pumping Station, Idaho (elevation 5275 ft) south of the study area. Evaporation is measured at this station during the growing season. Data show the highest evaporation during July (Table 6 from National Oceanic and Atmospheric Administration (NOAA) 1975, 1976, 1977, 1978, 1979).

Table 5. Average annual temperature and precipitation data for recent water years.

Water Year	Temperature Average °F	Precipitation in.
	Afton (elev. 6210)	
1975	38.0	18.41
1976	38.3	19.62
1977	-	13.00
1978	-	22.17
1979	-	10.45
	Conda (elev. 6200)	
1975	38.6	16.05
1976	-	23.65
1977	-	15.64
1978	-	-
1979	-	-
	Grace (elev. 5550)	
1975	41.3	13.71
1976	-	14.02
1977	-	10.87
1978	-	15.00
1979	41.2	14.31
	Henry (elev. 6320)	
1975	-	-
1976	37.1	22.68
1977	37.9	15.42
1978	-	23.04
1979	-	14.91

Table 6. Pan evaporation at the Lifton Pumping Station.

	June	July	Aug.	Sept.
1975	7.49	9.17	7.91	5.49
1976	7.71	9.10	7.87	5.43
1977	8.71	9.85	7.61	5.53
1978	8.25	9.83	7.99	5.32[a]
1979	8.63	8.79	7.49	6.37

[a]Adjusted to compensate for some missing days.

Land and Water Uses

Selection

A use was defined as an activity utilizing a land unit or the waters of a stream reach. A use was selected for analysis if 1) significant amounts are now occurring (determined through consultation with people familiar with the area), 2) it has distinctive land or water requirements not automatically accommodated in providing for other uses in the selected set, and 3) it has sufficient interaction with other uses to require that the interaction be analyzed to determine the best overall combination of uses. By way of illustrating the second and third criteria, use of the study area by many small animals and birds was not analyzed because a) their needs are automatically met by providing timber and habitat for big game and b) they are not known to compete with other uses.

Application of these criteria assumed that major use changes will not occur in the period of analysis. Where doubts exist, the area could be monitored for major use changes that could require adding or deleting uses from the set being analyzed and repeating the study. For example, one should watch for rare species with localized habitat that might be harmed by a land use change over a small area. New commercial or recreational demands can also develop. The likelihood of use additions or deletions occurring in the Upper Blackfoot River catchment in the next few years was considered too remote to warrant further attention.

The 17 land uses and the 4 water uses selected according to the above criteria for analysis of the Blackfoot River watershed are listed in Table 7. They are classified according to 1) the locus of decision making on the amount, type, and location of the use, 2) the general goals for engaging in the use, and 3) according to whether the use is amenable to incorporation in the management model developed in this study.

As to locus of decision making, the centers were classified into three groups:

C. Centrally managed uses, generally undertaken after a somewhat objective analysis by some formal decision group such as corporate management and with which planners can interact directly in minimizing conflict between private development objectives and the public interest. These uses can be subdivided between those which occur occasionally (CO) and those which become relatively permanent on a selected land area (CP).

D. Dispersely selected uses, chosen by individuals widely scattered in place and time, such as recreationists. These uses can be modified by governmental incentives or regulatory action, but the degree of control is much less than that for centrally managed uses.

Table 7. Land and water uses defined and classified for analysis.

		Decision Center[1]	General Goal[2]	Model Quantified
	Land Uses			
1.	Commercial logging	CO	E	+
2.	Firewood cutting	D	RE	+
3.	Phosphate mining	CP	E	-
4.	Oil and gas exploration	CO	E	-
5.	Cattle grazing	CO	E	+
6.	Sheep grazing	CO	E	+
7.	Deer habitat	N		+
8.	Elk habitat	N		+
9.	Moose habitat	N		+
10.	Hunting	D	RE	+
11.	Hiking - dispersed camping	D	RN	+
12.	Concentrated camping	CP	RN	+
13.	Roads	CP	E	+
14.	Snowmobiling	D	RE	+
15.	Summer off-road vehicle use	D	RE	+
16.	Buildings	CP	E	-
17.	Archaeologic & historical resources	CP	RN	-
	Water Uses			
W1	Fish habitat	N		+
W2	Fishing	D	RN	+
W3	Runoff for downstream use	N		+
W4	Quality of runoff	N		+

[1]CO = centrally managed, occasional use; CP = centrally managed permaanent use; D = dispersely selected use; N = natural use.

[2]E = primarily economic goal; RE = high energy recreational use; RN = low energy recreational use.

N. Natural uses, resulting from physical or ecological processes. Here, the planning role is largely one of protecting process productivity from undue interference by the first two classes of uses. Natural process productivity is primarily achieved through maintaining good habitat for fish or wildlife and by a watershed with good yield of high quality runoff.

As to the user goals for the centrally managed and dispersely selected use, they generally divide between being primarily economic

(E) and primarily environmental (R). The designation R is used because the environmental values are primarily enjoyed recreationally. These recreational uses can be further subdivided to low energy uses that blend into the natural environment (RN) and high energy uses that tend to be more disruptive (RE).

The decision to incorporate a use into the planning model was based on whether the amount of use was primarily determined by factors within the scope of this analysis. A negative classification meant that the amount of the use was judged as determined by exogenous considerations.

Measurement

Land and water use measurement requires definition of what is to be measured, units of measurement, and a procedure for making the estimates. The definition concepts, use units, and estimation procedures followed in this study are presented below for each of the 21 uses on Table 7. Figure 4 provides photographs showing selected uses. The year 1980 was selected for the measurements as a recent year for which data were available and conditions were about average.

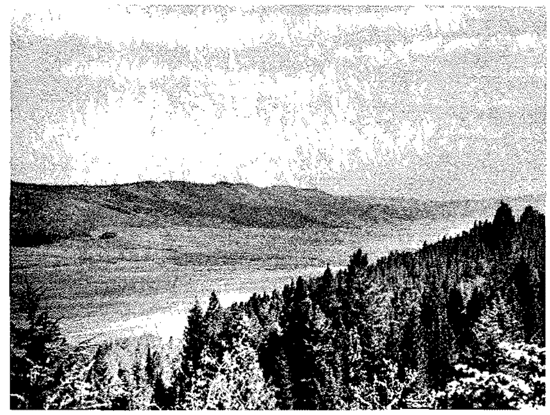
1. Commercial Logging

Concept: Logs are harvested for commercial profit. Three concepts must be considered in measuring use of an area for commercial timber production, a) currently harvestable timber, b) long term average annual yield, and c) timber actually being harvested. Burt and Cummings (1977) explore long-run equilibrium and the socially optimal rate of utilization as alternative management policies. The actual harvest determines the income of the loggers and the interactions with the other uses. The currently harvestable timber sets an upper limit to what can be cut this year, and the long term yield sets a lesser upper limit to what can be cut on a sustained basis. Actual harvest is currently less than sustained yield, and harvest data are more easily obtained than are yield data. Logging was thus measured in harvest units for both theoretical and practical reasons.

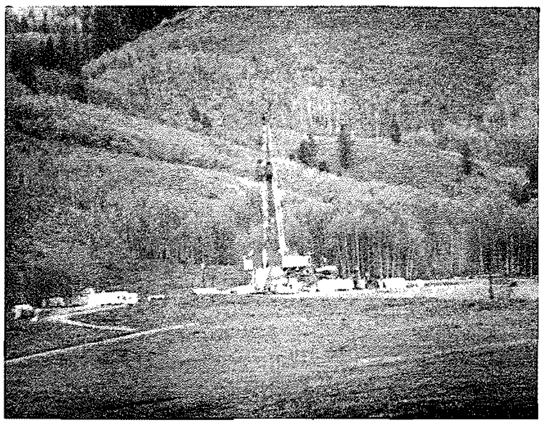
Units: Board feet (ft^2 x in) of lumber harvested.

Estimating Total Amount: Harvest data obtained from the Forest Service are in Table 8. Severe logging occurred in the 1950s; and from then to 1972 very little timber was cut except for posts and poles. Annual harvest (reported by designated sale areas comprising several cutting sites) from Forest Service land since 1973 has averaged about 2,500 MBF. Some additional timber has been harvested from non-Forest Service lands, but amounts are small because most timber of commercial

Moose habitat



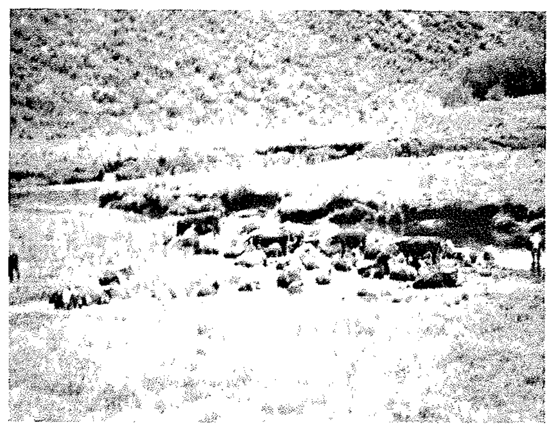
View seen while hiking



Oil and gas exploration

Phosphate mining

Commercial logging



Cattle grazing

Figure 4. Photographs of Upper Valley uses.

Table 8. Estimates of the magnitudes of selected uses in the Upper Blackfoot area.

Use	Present Use (South East Idaho)	1980 Study Area Use	1980 Study Area Per Capita Use (Carbon County)[h]	Miner Induced Use (Study Area) 1980	Projected Use, Without Mine (Study Area) 1990	Projected Use In Study Area With Mine - 1990[q]
Total Recreation	22.8×10^{6} days[a]	57,860 days[c]	6.9/capita	6,038 days[i]	86,790 visitor days[o]	93,000 visitor days
Fishing	1,494,000 days[a]	2,000 days[d]	.24/capita	210 fishing days[f]	3,000 fishing days[o]	3,210 fishing days
Hunting	501,000 days[a]	3,910 days[d]	.47/capita	411 hunting days[i]	5,865 hunting days[o]	6,276 hunting days
Snowmobiling	108,000 days[a]	1,650 days[e]	.20/capita	105 days[j]	2,475 days	2,580 days
Camping	1,193,000 days[a]	17,600 days[e]	2.1/capita	1,470 days[k]	26,400 days[o]	27,870 days
Hiking	1,495,000 days[a]	700 days[e]	.083/capita	58 days[k]	1,050 days[o]	1,108 days
ORV	83,600 days[b]	9,196 days[b-l]	1.09/capita	954 days[i]	13,794 days[o]	14,649 days
Timber Harvest	23,000 MBF est[f-l]	2,523 MBF[f]	N/A	NONE	1,875 MBF[p]	1,875 MBF[p]
Phosphate Mining	----	3.25×10^{6} Ave. tons/yr.[g]	N/A	3.7×10^{7} Ave. tons/yr.[l]	5.3×10^{6} Ave. tons/yr.[m]	7.93×10^{7} Ave. tons/yr.[n]

Table 8. (Continued).

[a]Development of phosphate resources in S. E. Idaho. 1976. Department of Interior and Department of Agriculture. pg. 1-254.

[b]Development of phosphate resources in S. E. Idaho. p 1-333. (Used 1974 figure for pleasure driving, assuming that with the rise in gas prices, the use today is about the same.

[b-1]Multiplied total figure by percent of study area in National Forest (11%).

[c]Development of phosphate resources in S. E. Idaho. 1976. (Used 1974 figure for recreational use for National Forest in S. E. Idaho and assumed 5% growth until 1980 (pg. 1-253). Then multiply by 11% (percentage of study area in National Forest).

[d]Idaho Fish and Game.

[e]U.S.F.S. - Soda Springs. Recreation use information document.

[f]U.S.F.S. - Pocatello. Average timber production for last 8 years.

[f-1]Average timber production - 11%.

[g]Alumet, 1976 and Development of phosphate resources in S. E. Idaho. 1976. Sum of yearly production of mine of study area up to 1980.

[h]Alumet. 1976. Use divided by 1980 Caribon County population of 8,400.

[i]Alumet. 1976. (350 permanent employees. Used correction factor of 2.5 because employees would have a greater likelihood of using study area. (350)(2.5)(Per capita use Caribou County) = (miner induce use).

[j]Used correction factor of 1.5, because mine is shut down in winter.

[k]Used correction factory of 2 because camping is not an activity that is generally done after work as hunting and fishing.

[l]Development of phosphate resources in S. E. Idaho. 1976. Alumet 1976. (Sum of average yearly mine production up to 1980.)

[m]Alumet and Development of phosphate resources in S. E. Idaho. 1976. Same of average years mine production minus Diamond CK mine.

[n]Total production of phosphate in study area per year 1990.

[o]Development of phosphate resources in S. E. Idaho. 1976. 5% growth for 10 years calculated as a simple growth of 50%.

[p]U.S.F.S. - Pocatello. Average yearly production for 1981-1985.

[q]Projected use plus mine induced use 1990.

quality is in the National Forest. Harvest locations are varied from year to year under the general guidance of a five-year plan. Mining activities and fluctuations in lumber prices cause variations from the uniform annual cutting rates suggested by the plan.

2. Firewood Cutting

Concept: Firewood cutting is done both as a recreational activity and for the value of the wood. The firewood is largely cut on National Forest land from conifers killed by bark beetle or other infestations. Lesser amounts come from timber sale slash piles. The current annual harvest is far below the death rate for the trees, and was employed to define use for the same reasons presented above for commercial logging.

Units: Cords (128 ft^3) of firewood cut.

Estimating Total Amount: Forest Service data on permits granted to households by the Soda Springs District within the past several years were used to estimate the amount of firewood being taken from the study area annually. Personnel there estimated that 75 to 80 percent of total permits were for firewood cutting in the study area. Their knowledge of the area was also used in estimating wood taken without permit on Forest Service lands or on Bureau of Land Management, state, and private lands where permits are not required. Resulting figures are in Table 9.

3. Phosphate Mining

Concept: Phosphate ore is mined and hauled out of the study area for processing. With current mining costs and phosphate prices, the operation is commercially profitable for ore bodies with a P_2O_5 content exceeding 20 percent and a stripping ratio (depth of overburden to ore thickness) less than 3. A number of such locations have been identified. Mine development responds to rising prices on the world phosphate market and requires establishment of access, site preparation, setting up the mining equipment, and making ore processing arrangements. Site selection depends on development cost, stripping cost, and ore quality. These factors (except for relatively minor interactions with other uses that affect development and stripping costs) are largely exogenous to this study.

Units: Tons of ore.

Estimating Total Amount: The environmental impact statement (EIS) (U. S. Department of the Interior 1977) maps potentially profitable locations to mine, provides descriptive information on the sites, and projects

Table 9. Estimated firewood cutting.

Year	Number of Permits	Basis	Amount of Wood taken (cords)	(MBF)
1977		free	1627	2,500
1978	1,275	free	2075	3,188
1979	1,885	free	2944	4,524
1980	1,000	free	1621	2,491
	1,621	fee	1842	2,831

future production rates. These production rates were used even though recent weakness in the world economy has caused production rates to lag EIS expectations.

4. Oil and Gas Exploration

Concept: While oil or gas has not been found in sufficient amounts to justify commercial production in the study area, a promising location in the Overthrust Belt continues to prompt exploratory drilling.

Units: Holes as a 0-1 binary variable.

Estimating Total Amount: Two wells were drilled in the study area during 1980. The Idaho Division of State Lands provided sufficient description of the two locations to identify specific land units. Neither well was located on federal land.

5. Cattle Grazing

Concept: Beef cattle are brought into the area to forage for summer feed on both public and private land. Permits, specifying number of animals, time period, and location, are required for grazing on public lands and seem to be holding grazing amounts well within the limits of forage productivity. Private landowners spread stream flows during spring snowmelt periods over the meadowlands in Upper Valley for increased forage growth, but hay is not cut. Following the principles presented above for logging, the food eaten by the cattle was taken as the measure of use.

Units: Annual cattle animal-unit-months. One AUM equals 720 lbs. of feed.

Estimating Total Amount: The Forest Service and Bureau of Land Management supplied estimates of the number of animals, gross cattle AUMs on their land, and maps of areas where cattle are allowed to graze. Private land owners were asked their herd size and to estimate grazing AUMs in their fields.

6. Sheep Grazing

Concept: Shepherds bring sheep into the study area for summer pasture on Forest Service land reserved for them by the grazing permit system. The food eaten by these sheep was taken as a reasonable measure of use.

Units: Annual sheep animal-unit-months. One sheep AUM equals 0.2 cattle AUM or 144 lbs of feed.

Estimating Total Amount: The Forest Service and Bureau of Land Management supplied estimates of the number of animals, gross sheep AUMs, and maps of areas where sheep grazing is permitted. The Forest Service also supplied information on landowners with flocks.

7. Deer Habitat

Concept: A number of methodologies have been proposed for assessing wildlife habitat (Whitaker and McCuen 1976; Hawes and Hudson 1976). Deer browse primarily on hardwood twigs. Heavy snows bury twigs, restrict animal movement, and hence force deer to feed at lower elevations. This situation would suggest winter food availability to limit the number of deer that an area can support, however, during most winters deer are forced entirely out of the study area to lower elevations (Kuck 1979). For this reason and to have a better basis for defining tradeoffs between livestock and native animals, the ability of the study area to support deer was also estimated in units of forage eaten. This choice also facilitates use of the Idaho inventory data on the availability of habitat defined by species preferences for vegetation and elevation.

Units: Annual deer animal-unit-months. One deer AUM equals 0.25 cattle AUM or 180 lbs of feed.

Estimating Total Amount: Data from Forest Service deer surveys for the Idaho Fish and Game study area (about six times the size of the area covered in this study) are shown on Table 10. These data on numbers of deer at various elevations and in various cover types provide a basis for estimating relative numbers of deer in the watershed by season. These estimates can then be summed over the year to estimate annual AUMs.

Table 10. Dear, elk, and moose counts for Idaho Fish and Game study area.

	Vegetation Type						Elevation				
	CONIF	ASPEN	MOUNT BRUSH	SAGE	RIPA GRASS	WILLOW	6,000-6,500	6,500-7,000	7,000-7,500	7,500-8,000	>8,000
Deer											
WINTER 1977	0	0	0	0	0	0	0	0	0	0	0
SPRING 1977	0	0	0	0	0	0	0	0	0	0	0
SUMMER 1977	5	12	0	0	0	0	0	6	2	0	0
FALL 1977	2	7	0	0	0	0	0	3	6	1	0
WINTER 1978	0	3	29	11	0	2	40	15	4	0	0
SPRING 1978	8	31	17	24	0	1	42	35	20	9	0
SUMMER 1978	42	78	6	11	0	3	26	60	45	26	7
FALL 1978	92	76	2	6	0	0	9	39	59	56	16
WINTER 1979	23	18	43	27	0	3	61	25	29	0	0
SPRING 1979	77	154	13	163	0	5	214	184	92	0	0
SUMMER 1979	44	47	10	14	0	0	14	33	46	17	1
DAIR* 1978	129	399	591	152	0	43	414	680	188	12	0
FAIR+ 1979	87	83	1940	867	26	202	1,276	663	484	154	29
Elk											
WINTER 1977	8	8	0	0	0	0	0	0	0	0	0
SPRING 1977	44	47	0	9	2	0	0	0	0	0	0
SUMMER 1977	61	81	0	3	0	0	0	48	37	9	6
FALL 1977	19	12	0	3	0	0	10	33	25	32	0
WINTER 1978	13	11	21	35	4	3	7	17	56	19	1
SPRING 1978	16	51	9	41	6	1	2	42	40	16	0
SUMMER 1978	36	142	6	12	0	2	2	49	38	10	1
FALL 1978	39	34	0	3	0	0	2	38	47	9	4
WINTER 1979	35	13	7	17	1	1	2	30	55	11	2
SPRING 1979	15	52	5	56	1	0	6	57	31	5	1
SUMMER 1979	13	90	4	6	0	1	7	48	27	18	0
DAIR* 1978	139	169	46	7	0	0	0	183	137	41	0
FAIR+ 1979	201	48	213	287	0	6	22	187	277	210	67
Moose											
WINTER 1977	2	1	0	0	0	0	0	0	0	0	0
SPRING 1977	14	10	2	1	0	1	0	0	0	0	0
SUMMER 1977	15	28	1	1	0	0	0	2	7	3	0
FALL 1977	9	5	0	0	0	0	0	4	7	2	1
WINTER 1978	26	10	1	1	0	1	5	34	2	2	1
SPRING 1978	9	33	1	1	0	0	6	36	11	1	1
SUMMER 1978	38	40	3	3	0	1	7	47	22	16	5
FALL 1978	43	19	0	0	0	0	2	11	28	18	4
WINTER 1979	16	6	4	1	0	0	11	10	10	1	0
SPRING 1979	19	17	1	2	0	0	1	23	16	6	1
SUMMER 1979	11	18	0	0	0	0	0	0	0	0	0
DAIR* 1978	30	18	1	0	0	0	0	13	28	8	0
FAIR+ 1979	129	67	12	2	0	35	13	121	85	20	6

* Air survey, Dec., 1978
+ Air survey, Feb.-Mar. 1979
Note: Other figures are for radio collared animals, and thus lower.

8. Elk Habitat

Concept: Elk, like deer, feed on hardwood twigs and are largely forced out of the study area in winter. Consequently, the measurement method described above for deer was used again..

Units: Number of elk AUMs. One elk AUM equals two thirds of a cattle AUM or 480 lbs of feed.

Estimating Total Amount: The elk data on Table 10 were used in the same manner as that described above for deer.

9. Moose Habitat

Concept: Moose concentrate in riparian shrub areas and are also forced to lower elevations by deep winter snows. Hence, the measurement principle of food consumed was again used.

Units: Number of moose AUMs. One moose AUM is the same as a cattle AUM or 720 lbs of feed.

Estimating Total Amount: The moose data on Table 10 were again applied in the same manner as those for the other big game species.

10. Hunting

Concept: Nielsen and Catton (1971) proposed an information retrieval system for organizing information on the relevant literature on the sociological determinants of forest recreation. For example, hunters seek deer, elk, and small bird and game species, partly for food but, as assumed for this study, primarily for recreation. The recreational value of hunting varies among species (Holbrook 1970) as seen by the fact that hunters go much further for rare or exotic species. In principle, species hunted should be differentiated during data collection; however, in the Upper Blackfoot Area, deer and elk hunting so dominate the activity that the effort is not justified.

Units: Hunter-days defined as days any part of which is spent in hunting.

Estimating Total Amount: The Forest Service estimates that 3,910 user days of hunting occurred in the watershed in 1980 and that this number will increase to 5,865 by 1990 (Table 8). The agency also indicates that over 75 percent of the hunting takes place in the Diamond Creek portion of the study area and about two thirds of that use occurs on the east side of the creek.

11. Hiking - Dispersed Camping

Concept: Many people visit a remote area to observe nature or be alone. They walk or camp in secluded spots for the recreation experience and to enjoy the scenic beauty (Arthur and Roster 1976). Hikers follow roads, walk along trails, or (in the low intensity situation of the Upper Blackfoot) go across country and leave defined paths for their recreation experience. Winter travel may be by skiing. Backpackers and people traveling by horse or by motor vehicle may camp overnight along their route. The campers who spend their nights outside developed campgrounds typically follow side roads along tributary streams to sites that afford adequate firewood and privacy. Hikers and cross country skiers can follow roads, walk along trails, or go across country. The study area has a fairly extensive network of trails, probably livestock routes, even though trail development and maintenance has been miminal except on the Lander Cutoff of the Oregon Trail. The Forest Service now has a trail development and management plan. The most likely hiking routes are along established trails and low grade roads.

Units: Hiker-days, defined as days any part of which is spent in traveling by foot, except as incidental to the other defined uses for this study, or as nights spent outside designated campground areas.

Estimating Total Amount: The Forest Service estimated 700 hiker days in 1980 and projected an increase to 1,050 hiking days in 1990. Dispersed camping was estimated at 7,000 user days in 1980 to increase to 10,500 in 1990.

12. Concentrated Camping:

Concept: Two campgrounds have been established in the study area. The Mill Creek site is located at the upstream end of the Narrows, and the Diamond Creek site is about 15 miles further upstream on Diamond Creek. The Forest Service has no plans for expanding developed camping facilities. Frissell and Duncan (1965) characterize campsite deterioration and propose a methodology for estimating campsite durability.

Units: Camper-days defined as nights spent in the designated campground area. In contrast to the other recreation activities, camping is constrained by campground capacity. Bultena and Klessig (1969) discuss the values people seek in camping. Capacity can be measured in campsites per campground or the maximum number of persons that can be accommodated at one time (PAOT).

Estimating Total Amount: The Mill Canyon campground has 10 campsites and a maximum PAOT of 65. The Forest Service estimated total camper-days in 1975 at 6,600 and in 1980 at 7,600. The Diamond Creek site does not have individually designated campsites and occupies a slightly larger area. The Forest Service specifies its maximum PAOT at 100. Use in 1975 was estimated at 3,800 and at 2,600 in 1980. Demand at both sites is forecast to increase at about 5 percent annually.

13. Roads

Concept: Roads provide the routes for traveling to preferred use areas. A route was classified as a road if it was judged to be passable with a four-wheel drive vehicle during summer periods after the snow is melted and no rain has fallen for at least 24 hours.

Units: Roads were measured in miles and classified according to quality. Road quality categories were paved, gravel, dirt and passable by ordinary vehicle, and dirt and passable only by four wheel drive vehicle. The highest class of road in a unit was also recorded.

Estimating Total Amount: The information on roads was gathered from Forest Service maps as supplemented by site inspections.

14. Snowmobiling

Concept: Snowmobiling in the area is predominantly recreational, and it was considered exclusively so for this analysis. Snowmobilers often follow roads or trails but also travel across country in areas without heavy forestation.

Units: Snowmobiling-days, defined as days any part of which is spent snowmobiling.

Estimating Total Amount: About half of the snowmobiling estimated to be taking place in the Soda Springs District (Table 8) is believed to occur in the study area. In 1980 the amount was estimated at 1,650 user days (projected to increase to 2,475 user days by 1990) on roads (350 user days), trails (400 user days), and open areas (900 user days).

15. Summer Off Road Vehicles (ORVs)

Concept: Many people enjoy driving in remote areas for recreation. Others drive for monitoring livestock or tending other commercial uses. Both two and four-wheel ORVs are used.

Units: User days, defined as days any part of which is spent touring in ORVs.

Estimating Total Amount: The 1980 ORV use was estimated at 2,000 user days and projected to increase to about 3,000 by 1990.

16. Buildings

Concept: Buildings were defined as fixed residential structures, and thus excluded mining sheds, corrals, and other such structures. Movable house trailers and other temporary residential structures that do not stay long at any one site were also excluded.

Units: Counted buildings.

Estimating Total Amount: Twelve buildings were identified from maps, aerial photos, field inspections, and conversations with Forest Service personnel. There is little likelihood of more building in the near future. Forest Service personnel are not issuing special use permits for residential structures, and building on private lands is restricted due to poor drainage for septic tanks (Southeast Idaho Council of Governments 1977). Existing residences are only seasonally occupied since the entire area is often inaccessible in winter. In the summer, several dozen mobile homes and motorized campers are moved into the area and used by recreationists or miners, herders, or lumberjacks working nearby.

17. Archaeological or Historical Sites

Concept: Many types of archaeologic, historic, geologic, or other sites of special value were sought and evaluated but only the route of the Lander Cutoff of the old Oregon Trail and Lane's Grave were identified as significant.

Units: Number of identified sites.

Estimating Total Amount: Lander Cutoff is named after Frederick W. Lander, a Department of Interior employee sent in 1857 to survey an alternate route to the Oregon Trail from South Pass, Wyoming, to Fort Hall, Idaho. The alternate route was needed because heavy use on the Trail had depleted forage along the way. The cutoff traverses the north portion of the study area, before joining Idaho Highway 34. Portions of the original road are still discernible, and the Forest Service has fenced off two short stretches. Lane's Grave is found in the north part of the study area, near where the Lander Cutoff crosses Lane's Creek. The fenced gravesite contains three graves in a row. The two outer graves are unmarked, but a headstone marking the center grave bears the inscription: J. W. Lane, Died July 18, 1859 AD-50 yrs 2 mos. The story behind the three graves remains a mystery.

W1. Fish Habitat

Concept: Streams vary considerably in the amount and type of fishery they support. All of the third order and larger streams identified for this study are large enough to support fish. Thurow (1980) listed 13 species of fish present in the Blackfoot River drainage. The drainage has historically supported a high-quality cutthroat trout fishery, and trout needs were used for defining habitat quality. Habitat can be indexed empirically from numbers of observed fish or theoretically by comparing stream characteristics to known species needs. Actual data on fish locations are needed to verify fish habitat preferences, and habitat characteristics are the factors directly affected by land and water use.

Units: Fish habitat was quantified by a habitat quality index.

Estimating Total Amount: The Idaho Department of Fish and Game (Thurow 1980) began a three year study of the fish in the Blackfoot River drainage in 1978 and took a fish census. For this study, habitat quality was measured by an index developed from five characteristics observed for each land unit containing or bordered by a third or higher order stream. Cutthrout trout need dependable flow, pools, cobbles in the stream bed and vegetative cover on the stream banks. They are harmed as sediment clogs their environment. Consequently:

$$\text{Fish habitat} = \text{FLOW} * \text{POOL-RIFFLE} * \text{SUBSTRATE} * \text{COVER} * \text{STREAM MILES}/(3.5 * \text{SEDIMENTATION}) \qquad (7)$$

where flow was crudely estimated in terms of adequacy to support an adult fish; the pool-riffle ratio was an index on the amount of pool in the stream and was taken as reaching a maximum value (1.0) at 45 percent pool; the substrate rating ranged from 1 to 4 for silt to cobble; cover was the percent of streambank under vegetative cover; the sedimentation rating ranged from 1 to 3 with increasing sedimentation; and stream miles was the length of third and higher order streams within or bordering on a unit.

W2. Fishing

Concept: Recreationists can pursue a wide variety of stream life forms. In the Upper Blackfoot drainage, the activity is limited to trout fishing.

Units: Angler days, defined as days any part of which is spent fishing.

Estimating Total Amount: Thurow (1980) estimated 1999 angler days in the area during the 1978 season. The Forest Service estimated 1980 use at 2,000 angler days, projected to increase to 3,000 by 1990. Thurow's figures are broken down by reach in Table 11.

W3. Runoff

Concept: Runoff volumes increase with the greater precipitation and lower evaporation rates generally associated with higher elevations. They are also increased by reductions in consumptive use by vegetation. Reduced vegetation also favors earlier spring snowmelt. Flows from the basin are stored in Blackfoot Reservoir for irrigation use. The extra runoff flows downstream through a series of reservoirs on the Snake and Columbia Rivers to the Pacific Ocean and has a large economic value from the hydroelectric power generated on the way (Hastay et al. 1971).

Units: Acre-feet/acre.

Estimating Total Amount: The average annual runoff from the study area is gaged (Table 2) as 111,500 acre-feet or 13.0 inches over the area. Runoff varies considerably from year to year. At the Henry gaging station above the Blackfoot Reservoir, it ranged from a low of 51,810 acre-feet in 1977 to a high of 179,600 acre-feet in 1971.

W4. Water Quality

Concept: Water quality evaluation depends on the uses to be made of the water. In the context of a wildland watershed, water quality is determined by variables affecting instream uses including fish habitat, aesthetic and recreational values, and downstream uses such as potable water supplies, irrigation, and reservoir renewal. The parameters best used to measure quality vary with needs from site to site.

Units: Nondimensional indices constructed to represent the severity of the adverse effect caused by a given degradation in water quality.

Estimating Total Amounts: Records of measured water quality parameters were obtained for 13 sampling sites in or near the study area. Additional samples were collected and analyzed by project personnel. By using the collected data, two indexing approaches were tried. Mahmood (1981) and Mahmood and Messer (1982) describe their effort of combining the available data statistically to retain as much content as possible in a water quality index. The second approach was to construct indices known to be

Table 11. Angler census by stream reach.

Stream	Angler Days (1978)
Blackfoot River	
Section 5	779
Section 6	246
Diamond Creek	651
Lanes Creek	137
Sheep Creek	80
Spring Creek	60
Misc. Tributaries	46

affected by existing land uses and detrimental to existing water uses. The indices constructed were concentrations of phosphorus and nitrogen (because of their known contribution to eutrophication of downstream reservoirs) and sediment load (because of the adverse impact of sediment on fish habitat).

CHAPTER 4

PATTERNS OF CHARACTERISTICS AND USES WITHIN THE STUDY AREA

Introduction

The previous chapter described the Upper Blackfoot Watershed and the uses made of the area. Obviously, neither the physical characteristics nor the uses are uniformly distributed over the area as a whole but rather the many characteristics and many uses are each distributed in their own unique pattern. The topic of this chapter is measurement of those patterns so that relationships among them can be established for planning applications (Equation 5).

The spatial characterization of a watershed requires decisions on the detail to use, the measurement grid (from uniform squares to areas contained within irregularly shaped boundaries), and the physical characteristics and uses to measure. For planning, these decisions cannot be finalized ahead of time but rather should be approached iteratively balancing measurement effort against results obtained. Within this trial-and-error process, however, it is much easier to start with small and reasonably homogeneous units and then aggregate into larger ones as the original detail is found not to be needed, than to start with larger and more diverse units only to find them too coarse and be required to return to the field to make more refined measurements.

Delineation of Study Units

Economic development planning requires units at least as large as counties. Environmental analysis must consider much smaller units because topography, soils, vegetation, and the ecologic system they support vary greatly over short distances and control the environmental impact of a given use and thus the public interest in regulating that use. Individual users, whether considering sites for major investment in land development or an hour of recreation, examine specific locations. Sometimes their choice is based on such local site specific conditions as views or trees, but as long as the sites being compared are within an environmentally homogeneous area, the public interest would be indifferent. The size of study units selected to define spatial patterns for the Upper Blackfoot River was the smallest found to be homogeneous with respect to key environmental factors.

For this study, the principle of land unit delineation by environmental homogeneity was applied by using Forest Service mapping of areas homogeneous according to the definitions outlined on Table 3. These definitions essentially developed out of Forest Service experience as to the maximum spatial resolution useful to them as land managers. Specific descriptions of how the total study area was subdivided follow.

Water Planning Units - Runoff and water quality are determined by the size and physical characteristics of the tributary watershed. Therefore, the total Upper Blackfoot watershed was first subdivided along drainage boundaries. Each resulting water planning unit contains a reach of stream and the watershed area directly tributary to that reach.

a. Reach of stream. Because research suggests that streams smaller than third order are not able to support fish, only streams of third or higher order were identified. This was done from the Forest Service map of the Caribou National Forest (scale: 0.5 inch = 1 mile) as shown on Figure 5. The total stream length of 97 miles was subdivided among 38 reaches, where a reach is defined by junctions of streams of second or higher order. Boundaries based on these junctions were modified, however, for some streams of higher order. Two (water planning units) of the ten fourth order reaches drained such small areas that they were assigned to an adjacent upstream or downstream reach (leaving 36 reaches). The areas draining directly into fifth or sixth order streams were relatively long and heterogeneous. It was decided to subdivide them along drainage divides between second order tributary streams. An additional 19 reaches were thus identified. The resulting 55 stream reaches varied in length from about 1/8 mile to over 4 miles.

b. Tributary watershed area. Tributary watershed boundaries were drawn to show the areas contributing flow to each of these 55 reaches. These boundaries are shown by the dashed lines on Figure 6.

Land Planning Units - The water planning units were further subdivided based on Forest Service land types defined by physiographic and topographic features and (in some cases) predominant vegetative type. The 40 land types found in the study area are shown in Table 3. The mapping of these units within the National Forest was done by the Forest Service. Their procedures were duplicated as closely as possible in mapping lands outside the National Forest.

A land planning unit was defined as a contiguous area of a given land type entirely within a given watershed planning unit. An area less than 40 acres was combined with the adjoining unit in the same watershed of most similar land type. A total of 343 land planning units were defined as shown on Figure 6.

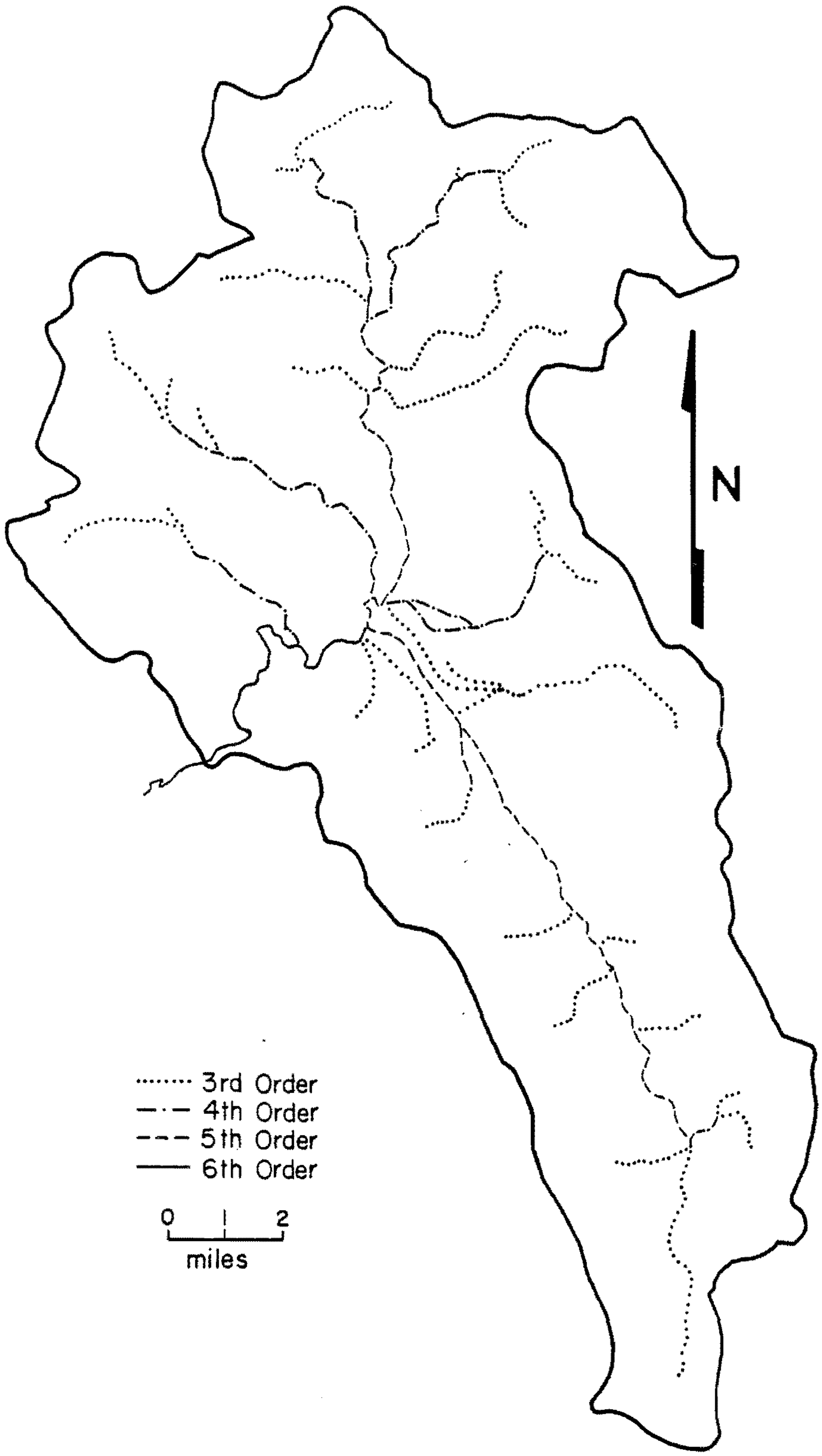


Figure 5. Third and higher order streams in the Upper Blackfoot drainage.

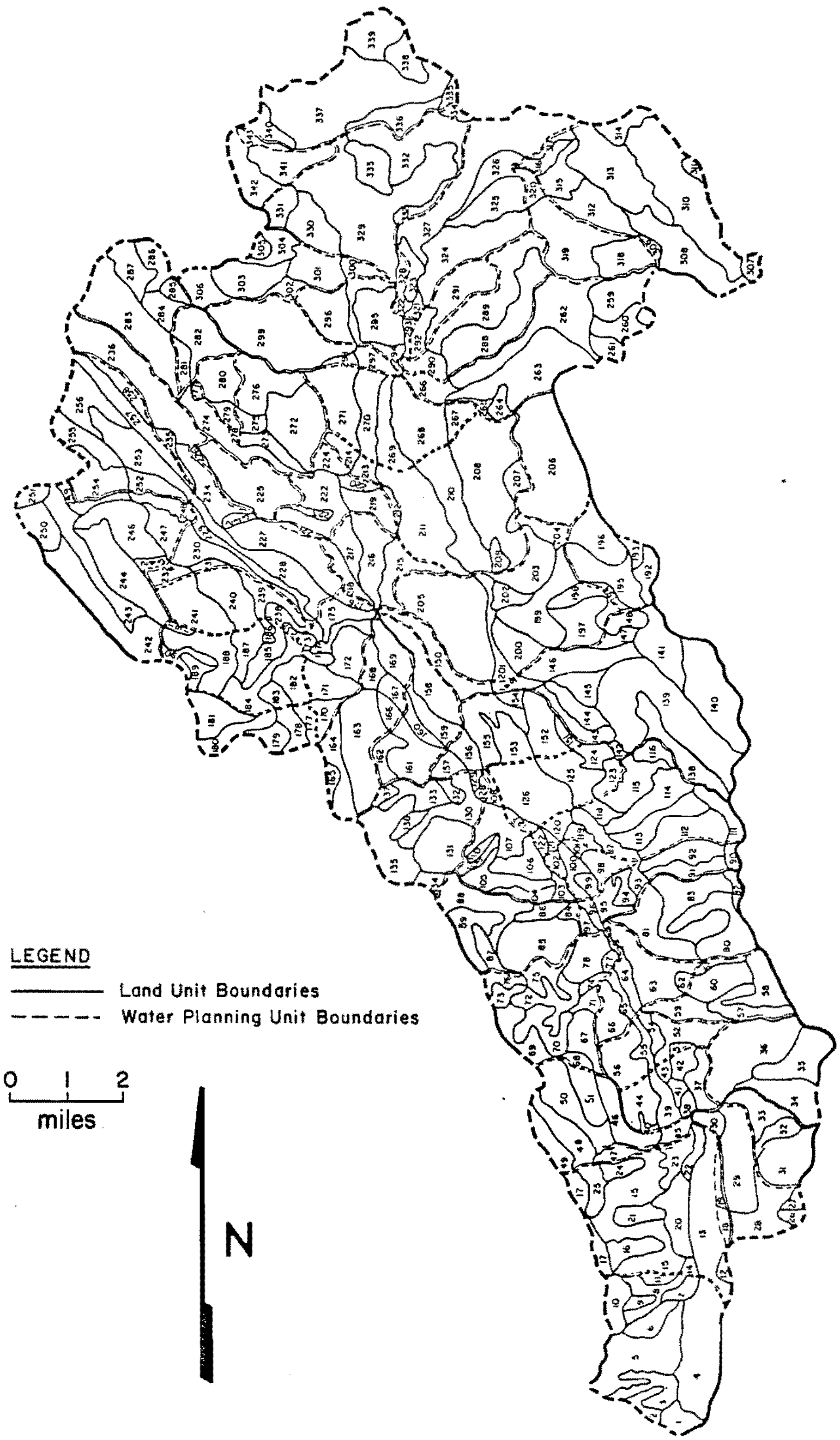


Figure 6. Land units in the Upper Blackfoot watershed.

Spatial Patterns of Physical Characteristics

Portrayal of the spatial patterns of the physical characteristics of the study area required definition of the attributes to be measured and then measurement of indicators of those attributes for the 343 land units. Attributes were considered for measurement if they were believed useful for estimating 1) the probability a centrally managed use will be undertaken, 2) the amount of dispersed use to expect, 3) population densities of fish or wildlife, 4) the desirability from the public viewpoint of promoting or denying specific uses, or 5) the magnitude of the interaction among pairs of uses.

Specific attributes were hypothesized from theoretical constructs or empirical relationships. Measurement methods were selected through interaction with users and managers. The process sought attributes:

1. Related to a use, impact, or interaction. An attribute may be useful in selecting a use or affect how people feel about use by others.

2. Amenable to measurement. Alternate measurement methods can be used for estimating the magnitude of a given indicator, and the information gained by more precise and costly measurement needs to be examined to determine whether the extra effort is worthwhile. Also, indicators may either be measured directly or be represented by easier-to-measure surrogates. For example, in an area where winter snow depth increases with elevation, elevation might be tried as a surrogate indicator of snow depth.

An attribute may be measured as a single number or as a vector of two or more numbers. Because the same indicator may be used in formulating two or more indices or as surrogates for different attributes, the total number to be measured (for which measurements can be afforded) is generally fewer than the number of indices needed for land and water planning. Furthermore, the logic for using a given attribute may vary greatly among indices.

The first step in composing a list of attributes was to enumerate land unit characteristics that should logically be included in relationships for estimating or evaluating land or water uses, impacts, or interactions. Measurement methods were then specified for each proposed characteristic. Similar measurements can be compromised in a single indicator meeting multiple needs in the interest of study economy. The resulting list was then classified between two groups according to ease of measurement with the idea that the second group need only be measured should the set of attributes in the first group suggest that they will be needed.

The 18 site attributes considered for establishing indices of reasonability (Equation 2) for the 21 uses (Table 7) are presented in Table 12. The 37 data items (with extra items for multidimensional indicators) measured are listed in Table 13. The measurements for the 37 items for each of the 343 units are recorded in Table 14.

Table 12. Definition of attributes for reasonability indexing (Equation 2).

Indicator	Attribute, measurement method for indicator
A1	Land area, square miles planimetered from a working map of a scale of 1 inch = 1 mile. The conversion from the planimeter reading to area required division by a conversion factor of 0.106, which was performed by computer.
A2	Land classification, numbered 1 to 40 as defined by Table 2 and indicated on Forest Service maps. The Forest Service land classification system was extended to non-Forest Service lands by using a steroscopic viewer to examine aerial photographs to compare visible surface features with those on land units already classified by the Forest Service or features named in the classification system. Relevant surface features included land contours, aspect, vegetation, and moisture (wet areas are darker). Most of the units so identified were in the valley bottom lands and wet or dry alluvial.
A3	Vegetation type, tenths of the area in conifer (subdivided between commercial and noncommercial timber), aspen, mountain shrubs, sagebrush and grass, riparian grass, or riparian willow (not recorded but equaling the residual) respectively as estimated using the Forest Service classification and map (1 inch = 1/2 mile). The coverage was extended to nonforest land using black and white aerial photos supplemented by some unsystematic, spot ground checking.
A4	Land ownership, fifths of the area as determined by transferring a BLM land ownership map to the working map showing land units. Ownership was classified as USFS, other public (including BLM and state) or private.
A5	Road type, classified according to the quality of the road surface into paved, gravel, dirt 1, dirt 2, and none (assigned values 4 through 0, respectively). Unit is coded with the highest quality road found within it on the Forest map. Road conditions were largely confirmed by observation. The first three road types are generally usable by passenger vehicles when dry.
A6	Road length, miles of mapped roads in unit as measured by digitizer to nearest 1/10 mile.
A7	Road distance, in miles, of shortest route (using only roads of an equal or higher quality) from unit to Narrows, using digitizer on the Forest map. Most visitors to the watershed enter by this route, and the attribute thus measures travel distance to population centers.

Table 12. Continued.

Indicator	Attribute, measurement method for indicator
A8	Stream length, of third order or higher within (or bounding) a unit, in miles as measured, using the digitizer on the Forest map.
A9	Stream order, the highest order in a unit, as determined on the Forest map (third order or higher).
A10	Stream slope, approximated by calculating stream slope by subtracting unit minimum (A16) from maximum stream elevation (A18) and dividing by stream length (A7). (Units containing third or higher order streams only.)
A11	Tributary area, estimated from planimetered tributary drainage area at lowest point of units with third or higher order streams, using Forest map.
A12	Use restrictions, recorded as the decile of a land unit restricted to a given use. Thus 0 means the unit is not restricted to that use, and a value of 10 means the use is excluded from the unit. Only uses that are reasonably controlled by legal access were included. Measurements were made by transferring to working maps the relevant information on EIS and Forest Service mine lease maps, Forest Service firewood cutting and travel maps, BLM surface and minerals ownership map, Forest Service grazing allotments map, and Forest Service and EIS oil and gas lease maps. Wildlife experts had designated a mapped area as critical habitat for elk. The restrictions below follow general Forest Service policy even though they may not be specifically followed in the Blackfoot study area. 1. Commercial logging - restricted on mine lease land with active mines, on campgrounds, and where roads are closed. Closed roads, outside of mine areas, are usually in area with erosion problems or critical habitat. 2. Firewood cutting - restricted on active mine lease areas, campgrounds, active timber sale areas, restricted travel areas, and private land. 3. Phosphate mining - restricted where no lease has been approved. (Mining is not restricted on land with privately owned mineral rights, regardless of existing leases.) 4. Oil and gas exploration - restricted where no lease has been approved. (No known restrictions in study area.)

Table 12. Continued.

Indicator	Attribute, measurement method for indicator
	5. Cattle grazing - restricted from sheep allotments, mining areas, campgrounds, critical habitat areas. (Does not cover non-USFS land.)
	6. Sheep grazing - restricted from cattle allotments, mining areas, campgrounds, critical habitat areas. (Does not cover non-USFS land.)
	7. Hunting - restricted from active mine lease areas and private land.
	8. Hiking - restricted from active mine lease areas and private land.
	9. Roads - restricted from designated roadless or primitive areas. (None in study unit.)
	10. Snowmobiling - restricted from active mine lease areas, designated critical habitat areas, and private land.
	11. Off road vehicles - restricted from active mine lease areas, designated critical habitat or erosion hazard areas (usually restrictions on leaving road or trail with vehicle), and private land.
	12. Buildings - restricted from roadless or primitive areas and archeological resource areas.
	13. Fishing - restricted from active mine lease areas and private land. (Technically, the water and streambed are public property and use cannot be denied, but where access to the stream bank is denied, fishing is restricted as a practical matter.)
A13	Dead trees, interpreted from Forest Service color aerial photos. Areas of apparent dead trees were recorded on the working map and spot checked on the ground. The photo identifications were accurate but not complete - additional areas of dead trees were seen on the ground. The data were recorded as a percent of the area with significant numbers of dead trees.
A14	Phosphorus outcrop, indicated as present (1) or not (0) in a unit as ascertained by using phosphate EIS map.
A15	Archeologic or historic site, determined from BLM unit plan report (Lane's Grave and Lander's cutoff).

Table 12. Continued.

Indicator	Attribute, measurement method for indicator
A16	Minimum elevation, nearest 100 feet estimated for the lowest spot in the land unit from contours on USGS quadrangle maps.
A17	Maximum elevation, nearest 100 feet estimated for the highest spot in the land unit from contours on USGS quadrangle maps.
A18	Maximum elevation of stream (for units with third or higher order streams), lowest elevation of adjacent upstream unit or elevation where two second order streams join to form a third order stream.

The attributes identified in Table 12 are either easily measured or readily obtainable from secondary sources. They include general land, vegetation, and ownership classification; road access descriptors; stream size and slope; the presence of legal restrictions to various uses; factors making an area suited or unsuited for a use; and elevation range and slope. None are costly to measure, and collectively they provide information that can go a long way toward predicting the suitability of a land unit for each of the uses.

The indicators from Table 13 originally proposed for use in reasonability index construction are outlined in Table 15. After collecting the data (Table 14), even this relatively simple outline proved more complex than could be supported with the limited information on use by land unit. The indicators actually used for assessing the reasonability of a given land unit for a given use are stated and combined into indices in Table 16. The resulting reasonability assessment (binary value of IR_{ui} in Equation 2) for each land use for each of the 343 land units are given in Table 17. Water uses were not covered because those occurring in the Upper Blackfoot Watershed are not explicit products of land use planning.

The 25 more difficult to quantify site attributes considered for employment in Equation 5 for estimating the intensity of a given use in a given unit are presented in Table 18. The measurements for the 343 units are recorded in Table 19. The attributes from Tables 13 and 18 originally proposed for estimating use intensities are shown in Table 20. Some uses cause impacts of significant public concern (Equation 6) and whose magnitude depends on other attributes of the land unit. Attributes suggested for consideration for this purpose are shown by use in Table 21, but this analysis was not taken further.

Table 13. Data items for calculating reasonability attributes.

Attribute	Number	Mnemonic	Units	Data Item Definition
-	1	UNITNO1	-	Number of unit from Figure 1
A1	2	UNITSQMI	0.01 mi^2	Land area in the unit
A2	3	UNITYPE	-	Land type class as defined by Table 2
A3	4	COMTIMBR	Tenths	Decile of area with commercial conifer timber
A3	5	NCOMTMBR	Tenths	Decile of area in conifer but not commerical timber
A3	6	ASPEN	Tenths	Decile of area in aspen
A3	7	MBRUSH	Tenths	Decile of area in mountain brush
A3	8	SAJGRASS	Tenths	Decile of area in sagebrush and grass
A3	9	RIPGRASS	Tenths	Decile of area in riparian grass
A3	10	CONIF	Tenths	Decile of area in conifers
A4	11	FSOWN	Fifths	Fifths in Forest Service ownership
A4	12	PUBOWN	Fifths	Fifths in BLM or state land
A4	13	PRIVOWN	Fifths	Fifths in private ownership
A5	14	ROADTYPE	-	Classified as defined on Table 12
A6	15	ROADLTH	0.1 mi	Length of mapped road in the unit
A7	15	ROADIST	0.1 mi	Road distance to narrows
A8	16	STRMLNTH	0.01 mi	Length of third or higher order stream
A9	17	STRMORDR	-	Highest Horton stream order
A10 - calculated from other data				
A11	18	DRANSQMI	0.01 mi^2	Drainage area tributary to largest stream leaving unit
A12	19	NOLOG	Tenths	Decile of area with logging restriction
A12	20	NOFRWOOD	Tenths	Decile of area with fire-wood cutting restriction
A12	21	NOPHOS	Tenths	Decile of area with phosphate mining restriction
A12	22	NOOG	Tenths	Decile of area with oil or gas exploration restriction
A12	23	NOCOWS	Tenths	Decile of area with cattle grazing restriction
A12	23	NOSHEEP	Tenths	Decile of area with sheep grazing restriction
A12	24	NOHUNT	Tenths	Decile of area with hunting restriction

Table 13. Continued.

Attribute	Number	Mnemonic	Units	Data Item Definition
A12	25	NOHIKE	Tenths	Decile of area with hiking restriction
A12	26	NOROADS	Tenths	Decile of area designated roadless
A12	27	NOSNOMO	Tenths	Decile of area with restriction against snowmobiles
A12	28	NOORVS	Tenths	Decile of area with restriction against off-road vehicles
A12	29	NOBUILD	Tenths	Decile of area with no building permitted
A12	30	NOFISH	Tenths	Decile of area with fishing restriction
A13	31	BEETKILL	Hundredths	Percent of area in dead trees
A14	32	OUTCROPP	0-1	1 if phosphate ore outcrop exists
A15	34	RELIC	0-1	1 for suspected archeological or historical sites
A16	35	MINELEV	100 ft	Minimum elevation in unit
A17	36	MAXELEV	100 ft	Maximum elevation in unit
A18	37	STRMHGT	100 ft	Elevation where stream enters unit

Table 14. Easily measured indicators by land units.

	Land Unit Numbers																							
UNITNO1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
UNITSQMI	32	20	73	144	126	30	13	38	9	34	11	10	111	8	142	29	35	10	59	27	16	18	26	19
UNITYPE	34	17	29	26	17	24	1	28	29	7	29	28	26	1	29	28	7	32	18	27	28	3	1	28
COMTIMBR	-1	-1	-1	-1	-1	10	9	0	10	4	4	2	6	6	15	2	2	4	6	6	4	8	6	10
NCOMTMBR	-1	-1	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASPEN	0	0	0	0	0	0	0	4	0	4	6	8	4	0	0	4	4	6	4	0	4	0	0	0
MBRUSH	0	0	0	0	0	0	0	4	0	2	0	0	0	0	0	4	4	0	0	2	2	0	0	0
SAJGRASS	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
RIPGRASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONIF	10	10	10	9	9	10	9	2	10	4	4	2	6	6	10	2	2	4	6	6	4	8	6	10
FSOWN	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
PUBOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRIVOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROADTYPE	1	1	1	1	1	0	1	0	0	0	0	1	2	1	0	0	0	0	0	2	0	2	2	2
ROADLTH	5	2	11	17	13	0	3	0	0	0	0	4	15	2	2	0	0	0	0	13	0	4	7	0
ROADIST	232	232	232	210	210	205	200	200	200	205	200	204	190	195	195	195	195	204	190	190	195	175	184	187
STRMLNTH	0	0	0	94	121	0	43	0	0	0	0	0	0	35	0	0	0	0	0	49	0	22	18	0
STRMORDR	0	0	0	3	3	0	3	0	0	0	0	0	0	3	0	0	0	0	0	3	0	3	3	0
DRANSQMI	0	0	0	40	395	0	520	0	0	0	0	0	0	55	0	0	0	0	0	74	0	92	94	0
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFRWOOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOPHOS	5	0	7	0	6	10	4	9	10	8	10	10	3	0	8	4	2	10	10	7	10	0	8	9
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	10	10	10	10	9	9	2	8	10	10	7	10	7	0	9	10	10	10	10	2	10	0	0	10
NOSHEEP	0	0	0	0	1	1	8	2	0	0	3	0	3	10	1	0	0	0	0	8	0	10	10	0
NOHUNT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOHIKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOORVS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BEETKILL	20	20	20	20	20	-1	20	20	-1	-1	20	-1	20	20	-1	-1	-1	-1	-1	20	-1	0	0	0
OUTCROPP	1	0	1	1	1	0	0	0	0	1	0	0	1	0	1	1	0	0	1	0	1	1	0	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	77	76	74	72	73	73	72	74	74	78	75	76	70	71	71	72	82	77	78	70	71	70	69	71
MAXELEV	85	81	81	87	82	83	73	84	82	85	81	82	78	72	84	83	88	83	80	74	82	72	71	76
STRMHGT	0	0	0	74	74	0	73	0	0	0	0	0	0	72	0	0	0	0	0	71	0	70	70	0

	Land Unit Numbers																							
UNITNO1	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
UNITSQMI	25	9	10	65	93	17	70	20	45	51	75	141	33	9	27	7	8	18	7	42	21	43	13	51
UNITYPE	32	29	28	32	18	3	32	28	18	26	28	37	27	3	26	28	2	3	27	10	1	28	29	32
COMTIMBR	6	10	6	10	7	9	10	6	10	10	0	4	4	4	8	0	0	0	4	10	9	4	8	6
NCOMTMBR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASPEN	4	0	4	0	2	0	0	4	0	0	6	5	5	2	0	10	0	2	0	4	0	2	2	4
MBRUSH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
SAJGRASS	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	1	0	1	0	0	0	0	0
RIPGRASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONIF	6	10	6	10	7	9	10	6	10	10	4	4	4	0	8	0	0	0	4	10	9	4	8	6
FSOWN	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
PUBOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRIVOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROADTYPE	0	0	0	0	1	2	1	0	0	1	1	1	3	3	1	0	3	3	0	0	2	1	0	1
ROADLTH	0	0	0	0	1	6	8	0	0	4	9	9	0	3	5	0	2	4	0	0	2	6	0	10
ROADIST	196	220	220	220	175	173	215	215	176	195	195	191	164	166	181	187	163	160	160	187	169	187	194	196
STRMLNTH	0	0	0	0	0	46	0	0	113	0	0	96	40	47	0	0	22	0	22	0	46	73	0	0
STRMORDR	0	0	0	0	0	4	0	0	3	0	0	4	4	5	0	0	5	0	5	0	3	3	0	0
DRANSQMI	0	0	0	0	0	63	0	0	15	0	0	22	43	253	0	0	201	0	204	0	38	36	0	0
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFRWOOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOPHOS	2	10	10	10	10	6	10	10	10	10	10	8	1	1	10	10	9	6	10	10	7	10	10	2
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	10	10	10	0	9	2	10	10	10	10	10	9	2	5	0	10	0	0	0	10	0	10	10	10
NOSHEEP	0	0	0	0	1	10	0	0	0	0	0	1	10	10	10	0	10	10	10	0	10	0	0	0
NOHUNT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOHIKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOORVS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BEETKILL	1	-1	-1	-1	-1	30	-1	-1	-1	10	10	30	20	50	50	30	20	30	0	30	30	0	0	0
OUTCROPP	1	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	75	79	80	76	70	70	77	75	70	72	72	70	74	69	69	72	69	69	69	61	70	70	74	75
MAXELEV	85	85	84	84	80	75	86	83	82	84	87	86	69	69	72	76	70	70	70	81	70	82	81	83
STRMHGT	0	0	0	0	0	70	0	0	81	0	0	72	70	70	0	0	69	0	69	0	70	73	0	0

Note: -1 indicates no available information

Table 14. Continued.

	Land Unit Numbers																							
UNITNO1	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
UNITSQMI	30	73	38	47	5	15	14	57	45	52	39	51	10	8	85	36	19	39	51	12	46	45	13	49
UNITYPE	7	38	82	27	3	2	27	10	29	7	27	28	29	28	27	3	26	10	30	32	38	29	10	36
COMTIMBR	6	4	6	2	0	6	9	8	8	4	4	2	0	0	2	4	8	4	6	6	4	10	9	2
NCOMTMBR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASPEN	0	0	4	4	0	0	0	2	2	4	2	5	10	4	6	0	2	6	0	4	0	0	0	6
MBRUSH	4	0	0	0	0	0	0	0	0	2	1	2	0	6	0	0	0	0	4	0	6	0	0	2
SAJGRASS	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
RIPGRASS	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONIF	6	4	6	2	0	6	9	8	0	4	4	2	0	0	2	4	8	4	6	6	4	10	9	2
FSOWN	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
PUBOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRIVOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROADTYPE	1	1	0	3	3	3	0	0	0	0	3	0	0	0	3	3	0	0	0	0	0	0	0	3
ROADLTH	10	0	0	5	1	3	0	0	0	0	1	0	0	0	5	11	0	0	0	0	0	0	0	0
ROADIST	201	203	187	161	157	160	160	160	161	161	163	161	163	163	147	144	144	144	144	144	144	144	144	144
STRMLNTH	0	0	0	0	0	64	45	0	0	0	100	35	0	0	144	50	0	0	0	0	0	0	0	17
STRMORDR	0	0	0	0	0	5	5	0	0	0	3	3	0	0	5	5	0	0	0	0	0	0	0	3
DRANSQMI	0	0	0	0	0	212	204	0	0	0	25	16	0	0	246	256	0	0	0	0	0	0	0	20
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFRWOOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOPHOS	1	10	10	8	10	10	10	10	9	10	2	9	10	4	8	10	10	10	10	10	10	10	10	10
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	10	10	10	4	2	0	10	10	10	10	5	10	10	10	3	0	7	10	10	10	10	10	10	10
NOSHEEP	0	0	0	6	10	10	0	0	0	0	5	1	5	0	7	1	3	0	0	0	0	0	0	0
NOHUNT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOHIKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOORVS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BEETKILL	0	-1	-1	30	0	30	30	30	10	10	20	20	0	0	20	20	20	-1	-1	-1	-1	-1	-1	-1
OUTCROPP	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	81	73	77	68	69	68	68	69	73	73	68	71	77	70	67	68	69	70	72	80	82	77	71	70
MAXELEV	89	90	83	77	70	69	74	82	84	89	75	87	88	76	77	68	72	80	82	83	89	85	78	84
STRMHGT	0	0	0	0	0	70	69	0	0	0	71	78	0	0	68	68	0	0	0	0	0	0	0	72

	Land Unit Numbers																							
UNITNO1	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
UNITSQMI	15	8	32	11	15	44	8	75	75	8	101	7	101	20	24	67	47	8	36	39	19	18	25	15
UNITYPE	28	26	29	7	1	27	2	29	27	7	28	27	29	38	7	28	29	7	29	28	27	4	3	2
COMTIMBR	0	0	6	4	9	4	0	6	5	2	2	10	8	0	0	4	8	0	10	4	2	6	0	0
NCOMTMBR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASPEN	4	0	4	0	0	6	0	4	0	6	4	0	2	9	0	5	1	6	0	2	0	4	0	0
MBRUSH	6	0	0	6	0	0	0	0	1	2	4	0	0	0	10	0	0	4	0	4	0	0	0	0
SAJGRASS	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	8	0	9	0
RIPGRASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONIF	0	9	6	4	9	4	0	6	5	2	2	10	8	0	0	4	8	0	10	4	2	6	0	0
FSOWN	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4
PUBOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRIVOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
ROADTYPE	0	0	0	0	2	1	3	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0
ROADLTH	0	0	0	0	3	1	1	0	6	0	0	0	0	8	0	0	0	0	0	0	0	0	5	2
ROADIST	144	144	144	144	149	140	140	140	140	140	140	127	127	127	127	105	127	127	127	132	132	127	127	127
STRMLNTH	0	23	0	0	26	48	14	0	76	0	0	0	0	89	0	20	0	0	0	0	0	0	50	30
STRMORDR	0	3	0	0	3	3	5	0	3	0	0	0	0	3	0	3	0	0	0	0	0	0	5	5
DRANSQMI	0	26	0	0	28	26	284	0	26	0	0	0	0	24	0	18	0	0	0	0	0	0	325	326
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFRWOOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOPHOS	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	10	10	10	10	0	7	0	10	8	10	10	10	10	10	10	10	10	10	10	10	5	0	0	0
NOSHEEP	0	0	0	0	10	3	10	0	2	0	0	0	0	0	0	0	0	0	0	0	5	10	10	10
NOHUNT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOHIKE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	0	0	0	0	8	6	10	0	0	0	0	8	2	3	0	0	0	0	0	0	0	0	2	10
NOORVS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BEETKILL	0	-1	-1	-1	30	30	30	-1	15	-1	15	30	30	0	0	-1	-1	0	-1	-1	-1	-1	0	0
OUTCROPP	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	82	71	74	83	67	67	67	71	68	82	70	67	69	67	78	69	74	82	70	70	69	68	67	67
MAXELEV	84	73	84	86	69	79	68	89	77	85	88	69	75	72	84	79	84	88	83	82	72	69	68	67
STRMHGT	0	70	0	0	67	71	67	0	68	0	0	0	0	69	0	70	0	0	0	0	0	0	67	67

Note: -1 indicates no available information

Table 14. Continued.

	Land Unit Numbers																								
UNITNO1	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121
UNITSQMI	10	30	12	27	8	12	11	21	45	42	47	9	11	8	32	73	50	67	54	19	48	15	16	15	8
UNITYPE	27	27	3	2	4	27	27	29	28	14	29	3	32	29	14	29	28	29	27	14	27	39	26	3	26
COMTIMBR	6	4	0	0	4	10	9	10	0	10	-1	0	0	0	4	10	4	8	2	0	6	0	-1	0	10
NCOMTMBR	0	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	-1	0	0
ASPEN	4	6	0	0	0	0	0	0	10	0	6	0	6	10	0	0	2	0	4	10	4	10	4	4	0
MBRUSH	0	0	0	0	0	0	0	0	0	0	0	0	4	0	6	0	4	2	4	0	0	0	0	0	0
SAJGRASS	0	0	6	4	6	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	4	6	0
RIPGRASS	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
CONIF	6	4	0	0	4	10	9	10	0	10	4	0	0	0	4	10	4	8	2	0	6	0	2	0	10
FSOWN	5	5	0	3	5	5	5	5	5	4	2	0	3	3	5	5	5	5	5	5	5	5	3	0	3
PUBOWN	0	0	0	0	0	0	0	0	0	1	3	1	2	2	0	0	0	0	0	0	0	0	0	0	1
PRIVOWN	0	0	5	2	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	2	5	1
ROADTYPE	0	3	3	3	3	0	4	0	0	0	0	3	0	0	0	0	1	0	0	0	1	1	3	3	0
ROADLTH	0	0	5	7	4	0	3	0	0	0	0	1	0	0	0	0	1	0	0	0	9	0	4	7	0
ROADIST	127	124	221	122	119	122	127	127	127	112	105	98	104	104	135	135	135	135	130	130	127	121	130	112	112
STRMLNTH	0	0	58	55	21	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	0
STRMORDR	0	0	5	5	5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0
DRANSQMI	0	0	355	376	400	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	382	0
NOLOG	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
NOFRWOOD	0	0	0	0	0	0	0	0	1	4	8	10	3	2	0	0	0	0	0	0	1	0	4	10	5
NOPHOS	10	5	10	10	8	10	10	10	9	6	2	0	7	8	10	10	10	10	10	10	2	8	2	0	5
NOOG	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
NOCOWS	10	0	0	0	0	10	10	10	10	8	2	0	5	5	10	10	10	10	10	10	0	5	5	0	0
NOSHEEP	0	10	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	5	10	0	0
NOHUNT	0	0	0	0	0	0	0	0	1	4	8	10	3	2	0	0	0	0	0	0	1	0	4	10	5
NOHIKE	0	0	0	0	0	0	0	0	1	4	8	10	3	2	0	0	0	0	0	0	1	0	4	10	5
NOROADS	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
NOSNOMO	10	0	0	10	5	0	10	0	1	4	8	10	3	2	0	0	0	0	0	0	1	0	4	10	5
NOORVS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	10	5
NOBUILD	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
NOFISH	0	0	0	0	0	0	0	0	1	4	8	10	3	2	0	0	0	0	0	0	1	0	4	10	5
BEETKILL	15	15	0	0	15	15	15	5	0	10	10	0	-1	-1	-1	-1	-1	5	5	10	-1	0	15	0	15
OUTCROPP	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
RELIC	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
MINELEV	64	67	67	67	67	67	67	69	69	70	66	66	69	68	80	77	70	72	70	80	68	68	67	66	66
MAXELEV	74	71	67	67	69	67	68	79	80	77	75	66	82	77	88	83	82	82	84	84	71	70	68	67	67
STRMHGT	0	0	67	67	67	0	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	0

	Land Unit Numbers																								
UNITNO1	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147
UNITSQMI	20	22	55	58	12	8	7	50	79	9	39	13	91	10	8	70	230	128	75	9	38	36	45	72	17
UNITYPE	28	11	39	3	29	3	3	26	32	31	28	28	11	38	15	7	36	37	19	28	26	38	26	40	32
COMTIMBR	0	4	0	0	-1	0	0	-1	9	2	2	0	6	10	0	6	8	4	2	0	10	4	6	2	6
NCOMTMBR	0	0	0	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASPEN	10	6	4	0	0	0	0	2	0	7	7	2	4	0	10	2	2	4	2	10	0	6	2	2	4
MBRUSH	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	2	0	2	1	0	0	0	0	0	0
SAJGRASS	0	0	6	10	0	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
RIPGRASS	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
CONIF	0	4	0	0	10	0	0	7	9	2	2	0	6	10	0	6	8	4	2	0	10	4	6	2	6
FSOWN	5	5	3	0	0	0	0	4	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
PUBOWN	0	0	0	1	5	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRIVOWN	0	0	2	4	0	5	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROADTYPE	0	0	1	3	0	3	3	3	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0
ROADLTH	0	0	0	12	7	2	2	13	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ROADIST	130	104	117	104	104	97	95	105	105	105	100	105	105	105	91	134	134	134	134	134	134	149	149	139	134
STRMLNTH	0	0	0	150	0	43	43	17	0	29	17	0	0	0	0	0	0	52	101	0	0	0	0	215	0
STRMORDR	0	0	0	5	0	3	3	3	0	3	3	0	0	0	0	0	0	3	3	0	0	0	0	3	0
DRANSQMI	0	0	0	406	0	34	35	34	0	27	24	0	0	0	0	0	0	36	50	0	0	0	0	70	0
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	.0	0	6	0	0	0	0	0	0	0
NOFRWOOD	0	0	5	10	10	10	10	2	0	0	0	0	6	0	0	0	0	6	0	0	0	0	0	0	0
NOPHOS	10	10	5	0	0	0	0	8	10	10	10	10	6	10	10	10	10	10	10	10	10	10	10	10	10
NOOG	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
NOCOWS	10	9	7	0	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10	4	6	9	9	10
NOSHEEP	0	1	0	0	0	0	0	0	0	0	0	0	6	1	2	0	0	0	0	0	6	4	1	1	0
NOHUNT	0	0	5	10	10	10	10	2	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
NOHIKE	0	0	5	10	10	10	10	2	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
NOROADS	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
NOSNOMO	0	0	5	10	10	10	10	2	0	0	0	0	6	0	0	0	0	5	0	0	0	0	0	0	0
NOORVS	0	0	5	10	10	10	10	2	0	0	0	0	6	0	0	0	0	5	0	0	0	0	0	0	0
NOBUILD	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
NOFISH	0	0	5	10	10	10	10	2	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
BEETKILL	-1	0	0	0	10	0	0	10	10	10	20	0	-1	-1	0	5	5	-1	-1	0	-1	-1	-1	-1	-1
OUTCROPP	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
RELIC	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
MINELEV	70	69	65	65	66	65	65	66	69	79	68	78	71	69	75	77	70	73	70	79	66	67	67	66	70
MAXELEV	83	81	77	66	71	66	66	76	82	82	74	80	78	76	76	84	85	87	79	82	80	80	80	75	73
STRMHGT	0	0	0	66	0	66	66	66	0	68	68	0	0	0	0	0	0	73	73	0	0	0	0	70	0

Note: -1 indicates no available information

Table 14. Continued.

	Land Unit Numbers																							
UNITNO1	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171
UNITSQMI	18	9	19	64	8	53	8	68	27	25	84	41	14	58	32	114	49	17	19	21	27	46	25	38
UNITYPE	40	3	2	11	39	3	2	2	3	26	2	3	16	26	16	16	11	39	26	16	31	3	11	34
COMTIMBR	2	0	0	0	0	0	0	0	0	10	0	0	4	10	10	6	6	0	0	2	-1	0	6	-1
NCOMTMBR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	0	-1
ASPEN	4	0	0	10	2	0	0	0	0	0	0	0	2	0	0	0	2	6	0	4	2	0	4	2
MBRUSH	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SAJGRASS	0	8	2	0	3	8	10	8	10	0	4	4	4	0	0	4	2	4	10	3	5	8	0	2
RIPGRASS	0	0	0	0	0	2	0	2	0	0	6	6	0	0	0	0	0	0	0	1	1	2	0	0
CONIF	2	0	0	0	0	0	0	0	0	10	0	0	4	10	10	6	6	0	0	2	2	0	6	6
FSOWN	5	0	0	5	1	0	0	0	2	5	0	2	4	5	5	5	5	5	5	3	0	0	5	3
PUBOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRIVOWN	0	5	5	0	4	5	5	5	3	0	5	3	1	0	0	0	0	0	2	2	5	5	0	2
ROADTYPE	0	1	0	0	1	1	1	1	3	3	0	3	2	1	0	1	0	0	0	0	1	3	0	0
ROADLTH	0	2	0	0	11	3	3	0	0	4	0	12	12	8	0	6	0	0	0	0	3	13	0	0
ROADIST	134	134	56	127	122	122	131	126	91	91	56	85	85	85	85	73	73	73	68	68	67	68	73	73
STRMLNTH	0	50	259	0	0	0	0	126	0	0	290	31	0	0	0	13	0	0	0	26	6	107	0	0
STRMORDR	0	3	5	0	0	0	0	5	0	0	3	3	0	0	0	3	0	0	0	3	3	3	0	0
DRANSQMI	0	71	200	0	0	0	0	443	0	0	19	10	0	0	0	16	0	0	0	21	21	25	0	0
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	0	0	0	0	0	0
NOFRWOOD	0	10	10	0	6	10	10	10	6	0	10	8	2	0	0	2	3	0	0	5	10	10	0	7
NOPHOS	10	0	0	10	4	0	0	0	6	10	0	3	4	10	10	8	7	10	10	6	0	0	10	3
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	10	0	0	0	0	0	0	0	0	10	0	5	10	10	10	10	10	10	10	7	0	0	10	5
NOSHEEP	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0
NOHUNT	0	10	10	0	6	10	10	10	6	0	10	8	2	0	0	2	3	0	0	5	10	10	0	7
NOHIKE	0	10	10	0	6	10	10	10	6	0	10	8	2	0	0	2	3	0	0	5	10	10	0	7
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	0	10	10	0	6	10	10	10	6	0	10	8	2	0	0	2	3	0	0	5	10	10	0	7
NOORVS	0	10	10	0	6	10	10	10	6	0	10	8	2	0	0	2	3	0	0	5	10	10	0	7
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	0	10	10	0	6	10	10	10	6	0	10	8	2	0	0	2	3	0	0	5	10	10	0	7
BEETKILL	-1	0	0	0	0	0	0	0	0	10	0	0	10	10	10	10	10	-1	0	10	10	0	-1	-1
OUTCROPP	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	73	65	64	70	65	65	65	65	65	65	64	65	65	66	69	66	69	74	66	65	65	65	68	65
MAXELEV	79	65	65	73	71	65	65	65	65	75	65	66	67	74	76	78	78	77	72	69	68	65	76	68
STRMHGT	0	66	65	0	0	0	0	0	65	0	0	64	65	0	0	0	69	0	0	0	66	66	65	0

	Land Unit Numbers																							
UNITNO1	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195
UNITSQMI	50	16	28	24	9	20	24	26	32	45	34	17	59	26	8	32	67	18	23	7	23	12	11	69
UNITYPE	31	18	2	7	39	11	40	5	18	39	34	40	18	2	3	5	34	26	38	39	33	6	40	10
COMTIMBR	0	0	0	0	0	2	0	0	4	0	-1	-1	-1	0	0	0	6	8	0	0	8	10	10	10
NCOMTMBR	0	0	0	0	0	0	0	0	0	0	-1	-1	-1	0	0	0	0	0	0	0	0	0	0	0
ASPEN	0	0	0	0	0	8	4	2	0	2	2	2	2	0	0	0	4	0	4	0	2	0	0	0
MBRUSH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	10	0	0	0	0
SAJGRASS	10	8	2	9	10	0	6	8	1	5	0	6	3	0	0	10	0	0	4	0	0	0	0	0
RIPGRASS	0	2	8	1	0	0	0	0	0	2	8	0	0	0	10	0	0	0	0	0	0	0	0	0
CONIF	0	0	0	0	0	2	0	0	8	0	3	2	4	0	0	0	6	8	0	0	8	10	10	10
FSOWN	0	0	0	0	0	5	5	3	3	5	3	5	3	2	0	5	5	5	5	5	5	5	5	5
PUBOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PRIVOWN	5	5	5	5	5	0	0	2	2	0	2	0	2	3	5	0	0	0	0	0	0	0	0	0
ROADTYPE	1	0	3	3	3	0	0	0	0	3	0	0	3	3	0	3	3	0	0	0	0	0	0	0
ROADLTH	0	0	1	10	2	0	0	0	0	11	0	0	7	5	0	1	0	0	0	0	0	0	0	0
ROADIST	72	57	60	57	56	0	0	0	0	0	1	1	3	5	10	10	15	15	15	15	139	139	139	140
STRMLNTH	0	0	66	80	0	0	0	0	12	97	0	0	74	144	0	0	0	0	0	0	0	0	0	0
STRMORDR	0	0	6	6	0	0	0	0	6	6	0	0	6	6	0	0	0	0	0	0	0	0	0	0
DRANSQMI	0	0	962	953	0	0	0	0	1142	1142	0	0	1142	1123	0	0	0	0	0	0	0	0	0	0
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	8	10	0	0	0	0	0
NOFRWOOD	10	10	10	10	10	0	0	0	3	1	6	1	5	6	10	5	7	8	10	0	0	0	0	0
NOPHOS	0	0	0	0	0	10	10	10	7	9	4	8	5	5	0	2	3	2	1	10	10	10	10	10
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	0	0	0	0	0	10	10	10	10	10	5	10	5	5	4	10	10	10	10	10	10	10	10	10
NOSHEEP	0	0	0	0	0	0	0	0	5	1	0	0	0	5	0	5	7	6	10	10	0	0	0	0
NOHUNT	10	10	10	10	10	0	0	0	3	1	6	1	5	6	10	1	3	6	9	0	0	0	0	0
NOHIKE	10	10	10	10	10	0	0	0	3	1	6	1	5	6	10	1	3	6	9	0	0	0	0	0
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	10	10	10	10	10	0	0	0	3	1	6	1	5	6	10	1	3	6	9	0	0	0	0	0
NOORVS	10	10	10	10	10	0	0	0	3	1	6	1	5	6	10	1	3	6	9	0	0	0	0	0
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	10	10	10	10	10	0	0	0	3	1	6	1	5	6	10	1	3	6	9	0	0	0	0	0
BEETKILL	0	0	0	0	0	-1	0	0	0	0	5	0	0	0	0	10	10	-1	0	0	-1	-1	-1	-1
OUTCROPP	1	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	64	64	64	64	65	70	67	66	64	64	65	67	64	64	64	64	65	67	67	73	77	75	75	68
MAXELEV	68	65	65	65	68	73	75	68	68	72	73	69	71	65	64	67	75	76	78	76	82	78	79	78
STRMHGT	0	0	65	65	0	0	0	0	64	64	0	0	64	64	0	0	0	0	0	0	0	0	0	0

Note: -1 indicates no available information

Table 14. Continued.

	Land Unit Numbers																							
UNITNO1	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219
UNITSQMI	65	61	32	92	47	27	21	50	19	208	196	30	213	14	113	155	8	13	25	54	66	30	29	42
UNITYPE	37	32	40	26	40	3	38	31	37	4	37	37	30	38	3	2	5	3	30	2	5	16	39	5
COMTIMBR	0	0	2	4	-1	0	0	0	6	0	8	6	4	0	0	0	0	0	-1	0	0	-1	0	0
NCOMTMBR	2	0	0	2	-1	0	0	1	0	0	[illegible]	0	0	0	0	0	0	0	-1	0	0	-1	0	0
ASPEN	0	0	0	0	4	0	4	4	0	0	0	4	4	0	0	0	0	0	8	0	0	4	4	0
MBRUSH	4	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SAJGRASS	2	0	6	2	4	8	4	2	2	4	1	0	2	10	6	4	2	10	0	2	6	2	6	6
RIPGRASS	2	0	0	0	0	2	0	0	0	0	0	0	0	0	4	6	8	0	0	8	4	0	0	4
CONIF	2	10	2	6	2	0	0	1	6	0	8	6	4	0	0	0	0	0	2	0	0	4	0	0
FSOWN	5	5	5	5	2	0	4	5	5	0	5	5	2	3	0	0	0	0	0	0	0	0	1	0
PUBOWN	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0
PRIVOWN	0	0	0	0	1	5	1	0	0	5	0	0	2	2	5	5	5	5	5	5	5	4	3	5
ROADTYPE	0	0	0	0	1	1	0	0	0	1	0	0	1	0	1	0	0	3	3	0	3	0	3	3
ROADLTH	0	0	0	0	0	16	0	0	0	12	0	0	3	0	15	0	0	4	0	0	14	0	0	4
ROADIST	140	139	140	140	140	140	140	140	140	146	140	140	122	109	109	109	74	80	84	83	83	57	56	74
STRMLNTH	82	0	0	160	0	95	77	90	32	610	96	0	0	0	78	148	0	0	0	146	0	0	0	81
STRMORDR	3	0	0	4	0	3	4	4	4	5	3	0	0	0	3	5	0	0	0	5	0	0	0	4
DRANSQMI	17	0	0	42	0	72	68	48	42	200	23	0	0	0	33	435	0	0	0	899	0	0	0	109
NOLOG	0	0	0	0	0	0	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFRWOOD	0	0	0	0	5	10	10	10	10	10	0	0	5	5	10	10	10	10	10	10	10	10	10	10
NOPHOS	10	10	10	10	5	0	8	10	10	0	10	10	5	5	0	0	0	0	0	0	0	0	0	0
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	10	10	10	10	5	0	10	10	10	0	10	10	5	5	0	0	0	0	0	0	0	0	0	0
NOSHEEP	0	0	0	0	0	0	10	10	5	0	0	0	1	5	0	0	0	0	0	0	0	0	0	0
NOHUNT	0	0	0	0	5	10	2	0	0	10	0	0	5	5	10	10	10	10	10	10	10	10	10	10
NOHIKE	0	0	0	0	5	10	2	0	0	10	0	0	5	5	10	10	10	10	10	10	10	10	10	10
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	0	0	0	0	5	10	10	10	10	10	0	0	5	5	10	10	10	10	10	10	10	10	10	10
NOORVS	0	0	0	0	5	10	10	10	10	10	0	0	5	5	10	10	10	10	10	10	10	10	10	10
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	0	0	0	0	5	10	2	0	0	10	0	0	5	5	10	10	10	10	10	10	10	10	10	10
BEETKILL	-1	-1	-1	-1	-1	0	0	-1	-1	5	-1	-1	-1	0	0	0	0	0	10	0	10	5	0	0
OUTCROPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	70	68	73	65	65	65	65	67	70	64	60	74	66	67	64	64	64	65	65	64	64	65	65	64
MAXELEV	81	78	75	77	74	65	70	77	78	65	83	78	78	75	68	65	64	65	73	64	66	70	70	65
STRMHGT	64	0	0	67	0	65	65	70	64	65	75	0	0	0	65	65	0	0	0	64	0	0	0	65

	Land Unit Numbers																							
UNITNO1	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243
UNITSQMI	16	8	90	10	30	124	28	104	92	42	66	11	31	11	48	28	107	9	19	37	60	83	132	63
UNITYPE	3	39	16	38	30	15	39	39	5	2	3	5	34	39	39	38	16	18	2	3	5	34	26	5
COMTIMBR	-1	4	-1	0	-1	0	0	-1	0	0	0	0	8	0	0	0	2	-1	0	-1	0	6	2	0
NCOMTMBR	-1	0	-1	0	-1	0	0	-1	0	0	0	0	0	0	0	0	0	-1	0	-1	0	0	0	0
ASPEN	0	6	2	0	4	4	4	4	0	0	0	0	0	0	4	4	2	0	0	0	0	4	4	2
MBRUSH	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	4	0
SAJGRASS	8	0	1	10	2	6	6	6	9	10	10	10	0	10	6	6	4	4	2	6	10	0	0	8
RIPGRASS	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	6	8	4	0	0	0	0
CONIF	2	4	6	0	2	0	0	0	0	0	0	0	8	0	0	0	2	0	0	0	0	6	2	0
FSOWN	0	5	2	2	1	5	5	4	2	2	3	3	5	0	0	5	4	0	0	0	3	5	5	5
PUBOWN	0	0	0	0	0	0	0	0	1	0	0	0	0	5	3	0	1	0	0	0	0	0	0	0
PRIVOWN	5	0	3	3	4	0	0	1	2	3	2	2	0	0	2	0	0	5	5	5	2	0	0	0
ROADTYPE	3	0	0	0	1	1	0	2	3	3	3	0	0	2	0	1	1	0	0	3	3	0	1	1
ROADLTH	4	0	6	0	4	3	1	0	2	12	2	0	0	0	0	1	52	0	2	7	17	0	12	25
ROADIST	77	83	74	74	88	100	65	58	57	49	44	44	39	61	66	76	114	42	42	42	39	39	27	39
STRMLNTH	66	0	0	0	54	0	0	0	59	243	0	0	0	0	0	0	0	0	100	0	0	0	0	0
STRMORDR	4	0	0	0	4	0	0	0	4	4	0	0	0	0	0	0	0	0	6	0	0	0	0	0
DRANSQMI	104	0	0	0	93	0	0	0	119	119	0	0	0	0	0	0	0	0	1104	0	0	0	0	0
NOLOG	0	0	0	0	0	3	10	0	0	0	0	0	0	0	2	0	8	0	0	0	0	0	6	10
NOFRWOOD	10	0	5	5	9	3	10	2	3	6	7	8	5	0	2	0	9	10	10	10	6	2	7	10
NOPHOS	0	10	5	5	1	7	0	3	3	6	8	10	10	10	6	10	1	0	10	0	6	10	4	0
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	0	0	1	4	0	7	10	1	0	2	9	0	0	0	0	0	9	0	0	0	0	2	10	10
NOSHEEP	0	1	1	0	0	7	10	7	5	5	10	10	10	10	10	10	8	0	0	0	6	8	7	10
NOHUNT	10	0	5	5	9	3	10	2	3	4	2	0	0	0	2	0	9	10	10	10	3	0	7	10
NOHIKE	10	0	5	5	9	3	10	2	3	4	2	0	0	0	2	0	9	10	10	10	3	0	7	10
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	10	0	5	5	9	3	10	2	3	4	2	0	0	0	2	0	9	10	10	10	3	0	7	10
NOORVS	10	0	5	5	9	3	10	2	3	4	2	0	0	0	2	0	9	10	10	10	3	0	7	10
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	10	0	5	5	9	3	10	0	2	4	2	0	0	0	1	0	9	10	10	0	3	0	7	10
BEETKILL	0	0	10	20	20	20	0	0	0	0	0	0	15	10	0	0	-1	0	0	0	15	15	10	0
OUTCROPP	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	65	70	64	69	65	66	69	65	64	65	65	65	67	66	66	66	68	64	64	65	64	66	68	67
MAXELEV	65	75	71	73	70	72	71	74	67	65	66	66	78	72	72	70	78	66	64	65	67	77	77	72
STRMHGT	65	0	0	0	64	0	0	0	65	65	0	0	0	0	0	0	0	0	64	0	0	0	0	0

Note: -1 indicates no available information

Table 14. Continued.

	Land Unit Numbers																							
UNITNO1	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267
UNITSQMI	96	11	85	40	30	36	43	30	35	79	57	48	72	64	25	63	45	17	142	158	17	9	34	18
UNITYPE	39	34	26	3	2	5	34	26	3	5	5	3	16	38	16	17	21	13	23	34	26	31	5	31
COMTIMBR	0	6	10	2	-1	2	6	6	0	0	0	6	5	4	4	6	9	9	7	9	10	-1	-1	-1
NCOMTMBR	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	-1	-1
ASPEN	4	4	0	0	0	4	4	4	0	0	6	2	1	2	0	0	0	0	0	0	0	0	4	2
MBRUSH	6	0	0	0	0	2	0	0	0	0	2	0	2	2	0	0	0	0	2	0	0	0	0	0
SAJGRASS	0	0	0	8	3	0	0	0	10	9	2	2	2	2	3	4	0	0	0	0	0	0	0	0
RIPGRASS	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONIF	0	6	10	2	2	2	6	6	0	0	0	6	5	4	4	6	9	9	7	9	10	10	6	8
FSOWN	5	5	5	4	2	5	4	3	2	3	5	2	2	3	5	5	5	5	4	4	4	0	0	0
PUBOWN	0	0	0	0	0	0	1	2	0	0	0	0	2	1	0	0	0	0	0	1	1	0	0	2
PRIVOWN	0	0	0	1	3	0	0	0	3	2	0	3	1	1	0	0	0	0	1	0	0	5	5	3
ROADTYPE	0	0	0	0	0	1	0	0	2	2	1	0	2	1	1	0	1	1	2	1	0	1	2	0
ROADLTH	0	0	0	0	0	1	0	0	15	12	10	0	9	2	11	0	0	5	15	2	0	0	8	0
ROADIST	49	49	70	69	69	86	86	86	69	76	80	76	79	76	88	182	187	182	182	182	99	99	90	99
STRMLNTH	0	0	0	0	111	36	0	0	110	140	0	0	0	0	0	0	0	0	133	193	0	0	94	0
STRMORDR	0	0	0	0	3	3	0	0	3	3	0	0	0	0	0	0	0	0	3	3	0	0	3	0
DRANSQMI	0	0	0	0	48	41	0	0	44	26	0	0	0	0	0	0	0	0	26	45	0	0	52	0
NOLOG	1	0	0	0	0	0	10	10	0	0	0	0	2	3	7	0	0	0	0	0	0	0	0	0
NOFRWOOD	1	5	2	10	1	0	10	10	0	0	0	5	8	5	8	0	0	0	2	2	1	10	10	10
NOPHOS	9	10	1	10	10	10	0	0	10	10	10	5	2	5	3	10	10	10	8	8	9	0	0	0
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
NOCOWS	10	5	10	5	0	10	0	0	0	0	5	5	2	5	8	0	0	0	0	0	10	0	0	0
NOSHEEP	9	5	0	5	10	0	0	0	10	10	5	10	10	10	8	10	10	10	9	8	0	0	0	0
NOHUNT	1	0	0	0	0	0	10	10	0	0	0	5	8	5	8	0	0	0	2	2	1	10	10	10
NOHIKE	1	0	0	0	0	0	10	10	0	0	0	5	8	5	8	0	0	0	2	2	1	10	10	10
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	1	0	0	0	0	0	10	10	0	0	0	5	8	5	8	0	0	0	2	2	1	10	10	10
NOORVS	1	0	0	0	0	0	10	10	0	0	0	5	8	5	80	0	0	0	2	2	1	10	10	10
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	1	0	0	0	0	0	10	10	0	0	0	5	8	5	8	0	0	0	2	2	1	10	10	10
BEETKILL	0	20	10	10	10	10	-1	0	0	0	0	0	-1	20	20	10	10	10	20	20	-1	-1	20	-1
OUTCROPP	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0
MINELEV	67	69	66	65	65	67	68	67	65	65	66	66	67	66	69	74	72	72	67	67	70	72	65	67
MAXELEV	77	76	76	68	66	69	73	74	67	68	70	69	69	72	73	86	80	76	75	78	78	76	68	77
STRMHGT	0	0	0	0	67	67	0	0	65	65	0	0	0	0	0	0	72	0	72	70	0	0	67	0

	Land Unit Numbers																							
UNITNO1	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291
UNITSQMI	102	49	81	81	111	30	75	11	57	8	3	17	49	22	72	160	33	10	32	44	147	123	31	81
UNITYPE	5	2	31	31	31	38	16	16	11	11	38	16	11	16	11	16	21	38	10	10	34	23	4	23
COMTIMBR	0	0	1	-1	-1	0	4	6	6	10	0	0	4	5	8	6	8	6	10	4	5	3	2	2
NCOMTMBR	0	0	0	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASPEN	0	0	1	8	7	0	0	0	4	0	0	0	5	0	2	2	2	4	0	2	0	2	6	2
MBRUSH	0	0	0	0	0	2	2	4	0	0	5	4	0	0	0	2	0	0	0	4	0	0	0	6
SAJGRASS	10	9	8	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0
RIPGRASS	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0
CONIF	0	0	1	2	2	0	4	6	6	10	0	0	4	5	8	6	8	6	10	4	5	3	2	2
FSOWN	0	0	0	1	5	5	5	5	5	5	5	5	5	5	5	4	5	5	5	5	3	3	0	3
PUBOWN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	2	3	2
PRIVOWN	5	5	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
ROADTYPE	2	2	3	0	1	1	1	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0
ROADLTH	16	0	0	0	15	2	0	0	8	0	16	3	17	0	0	8	0	0	0	0	0	0	0	0
ROADIST	99	90	87	87	104	100	103	108	108	103	103	103	103	103	103	110	110	110	110	110	99	99	99	87
STRMLNTH	127	143	0	0	57	123	134	0	0	0	0	55	24	39	0	172	0	0	0	0	180	71	35	0
STRMORDR	5	5	0	0	4	4	4	0	0	0	0	4	3	3	0	3	0	0	0	0	3	3	3	0
DRANSQMI	420	409	0	0	82	71	42	0	0	0	0	48	5	9	0	24	0	0	0	0	15	27	367	0
NOLOG	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
NOFRWOOD	10	10	10	9	1	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	4	3	10	2
NOPHOS	0	0	0	2	1	10	10	10	10	10	10	10	10	10	10	7	10	10	10	10	6	7	0	8
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	0	0	0	1	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	0	0	0
NOSHEEP	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	4	7	0	8
NOHUNT	10	10	10	9	1	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	4	3	10	2
NOHIKE	10	10	10	9	1	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	4	3	10	2
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	10	10	10	9	1	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	4	3	10	2
NOORVS	10	10	10	9	1	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	4	3	10	2
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	10	10	10	9	1	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	4	3	10	2
BEETKILL	0	0	-1	15	20	0	20	-1	-1	20	0	0	-1	-1	20	20	20	-1	-1	-1	20	20	20	0
OUTCROPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	65	65	65	66	66	66	66	67	68	69	67	67	68	69	70	69	70	74	70	70	67	66	65	66
MAXELEV	68	65	67	76	78	70	71	71	76	70	70	72	76	74	77	80	75	78	80	83	75	75	70	76
STRMHGT	65	65	0	0	66	67	69	0	0	0	0	68	69	69	70	70	0	0	0	0	69	67	66	0

Note: -1 indicates no available information

Table 14. Continued.

	Land Unit Numbers																							
UNITNO1	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315
UNITSQMI	16	4	56	72	47	25	17	183	22	54	20	66	31	10	45	18	108	9	197	4	70	140	28	47
UNITYPE	4	5	3	2	8	3	31	10	3	31	10	26	38	10	10	9	35	30	25	15	23	4	24	12
COMTIMBR	0	0	0	0	-1	0	-1	-1	0	-1	10	8	0	6	10	0	4	10	4	6	6	6	6	4
NCOMTMBR	0	0	0	0	-1	0	-1	-1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ASPEN	0	0	0	0	4	0	2	4	0	2	0	0	2	0	0	8	4	0	4	4	2	2	2	4
MBRUSH	0	0	0	0	0	0	0	0	0	2	0	0	8	4	0	2	2	0	2	0	0	0	0	0
SAJGRASS	10	8	8	4	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	2	2
RIPGRASS	0	2	2	6	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONIF	0	0	0	0	6	0	8	5	0	5	10	8	0	6	10	0	4	10	4	6	6	6	6	4
FSOWN	0	0	0	0	3	0	0	4	0	4	5	5	5	5	0	5	5	5	5	5	3	2	2	0
PUBOWN	5	0	3	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0
PRIVOWN	0	5	2	3	2	4	5	1	5	1	0	0	0	0	0	0	0	0	0	0	0	1	1	5
ROADTYPE	0	0	3	3	0	3	2	2	3	2	1	1	1	1	1	1	1	0	1	0	0	9	1	1
ROADLTH	0	0	0	9	0	7	1	16	7	7	3	7	3	1	2	0	10	0	11	0	0	26	0	9
ROADIST	87	87	99	104	98	98	98	102	115	120	120	120	120	120	110	205	199	185	190	190	166	185	172	166
STRMLNTH	35	12	0	130	0	76	0	66	32	89	0	75	24	0	0	0	0	0	0	0	0	14	0	0
STRMORDR	3	5	0	5	0	3	0	3	3	3	0	3	3	0	0	0	0	0	0	0	0	3	0	0
DRANSQMI	37	325	0	288	0	23	0	18	25	23	0	11	15	0	0	0	0	0	0	0	0	47	0	0
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFRWOOD	10	10	10	10	6	10	10	1	10	4	0	0	0	0	0	0	0	0	0	0	4	6	5	10
NOPHOS	0	0	0	0	4	0	0	9	0	6	10	10	10	10	10	10	10	10	10	10	6	9	5	0
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	0	0	0	0	0	0	0	9	0	6	10	10	10	10	10	10	10	10	10	10	0	0	0	0
NOSHEEP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	4	6	10
NOHUNT	10	10	10	10	6	10	10	1	10	4	0	0	0	0	0	0	0	0	0	0	4	4	5	10
NOHIKE	10	10	10	10	6	10	10	1	10	4	0	0	0	0	0	0	0	0	0	0	6	4	5	0
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	10	10	10	10	6	10	10	1	10	4	0	0	0	0	0	0	0	0	0	0	4	4	5	10
NOORVS	10	10	10	10	6	10	10	1	10	4	0	0	0	0	0	0	0	0	0	0	4	4	5	10
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	10	10	10	10	6	10	10	1	10	4	0	0	0	0	0	0	0	0	0	0	4	4	5	10
BEETKILL	0	0	0	0	5	0	10	20	0	15	10	10	0	20	20	-1	10	10	-1	-1	10	10	-1	-1
OUTCROPP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RELIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MINELEV	66	66	65	65	67	65	66	67	66	67	62	69	69	74	73	79	72	77	67	77	69	68	69	68
MAXELEV	67	66	66	66	77	66	76	78	68	76	78	78	75	76	78	83	86	86	80	80	78	73	77	70
STRMHGT	65	66	0	66	0	66	0	72	67	69	0	73	70	0	0	0	0	0	0	0	0	68	0	0

	Land Unit Numbers																							
UNITNO1	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339
UNITSQMI	21	12	64	140	19	17	11	23	132	61	39	189	9	285	57	32	137	47	17	9	46	296	34	35
UNITYPE	12	14	30	23	12	4	4	5	23	12	2	12	5	3	31	26	14	1	16	16	14	16	22	22
COMTIMBR	0	0	10	5	2	0	0	2	-1	0	0	0	0	0	-1	-1	0	-1	-1	-1	0	0	-1	0
NCOMTMBR	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	-1	-1	0	-1	-1	-1	0	0	-1	0
ASPEN	2	4	0	4	2	0	0	4	3	0	0	0	0	0	4	4	2	5	6	4	0	0	8	10
MBRUSH	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0
SAJGRASS	6	4	0	0	4	6	2	2	0	8	2	9	4	8	0	0	8	0	2	2	8	8	0	0
RIPGRASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
CONIF	0	0	10	5	2	0	0	2	3	0	0	0	0	0	4	6	0	2	2	4	0	0	2	0
FSOWN	0	0	5	4	0	0	0	0	3	1	0	0	0	0	3	4	0	0	0	0	0	0	2	3
PUBOWN	0	0	0	1	2	2	2	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
PRIVOWN	5	5	0	0	3	3	3	5	1	3	5	5	5	5	1	1	5	5	5	5	5	5	3	2
ROADTYPE	1	1	0	2	0	0	0	0	0	2	2	2	0	3	0	0	1	0	0	1	1	4	4	4
ROADLTH	5	1	0	17	0	0	0	0	0	9	18	28	0	28	0	0	3	0	0	2	10	43	8	7
ROADIST	159	160	170	170	166	104	104	128	127	146	146	127	128	128	128	128	180	128	127	127	186	148	183	189
STRMLNTH	113	0	0	46	52	18	56	0	38	72	90	31	33	34	0	0	0	23	0	0	65	214	0	0
STRMORDR	3	0	0	3	5	4	4	0	4	4	4	4	4	4	0	0	0	4	0	0	3	3	0	0
DRANSQMI	85	0	0	21	23	128	275	0	126	94	89	113	144	118	0	0	0	67	0	0	52	46	0	0
NOLOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFRWOOD	10	10	0	2	10	10	10	10	2	2	10	10	10	10	4	3	10	10	10	10	10	10	10	10
NOPHOS	0	0	10	8	0	0	0	0	8	8	0	0	0	0	6	7	0	0	0	0	0	0	0	0
NOOG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOCOWS	0	0	10	0	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0	0	0	0	0	6
NOSHEEP	0	0	0	9	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOHUNT	10	10	0	2	10	10	10	10	2	2	10	10	10	10	4	3	10	10	10	10	10	10	10	10
NOHIKE	10	10	0	2	10	10	10	10	2	2	10	10	10	10	4	3	10	10	10	10	10	10	10	10
NOROADS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOSNOMO	10	10	0	2	10	10	10	10	2	2	10	10	10	10	4	3	10	10	10	10	10	10	10	10
NOORVS	10	10	0	2	10	10	10	10	2	2	10	10	10	10	4	3	10	10	10	10	10	10	10	10
NOBUILD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NOFISH	10	10	0	2	10	10	10	10	2	2	10	10	10	10	4	3	10	10	10	10	10	10	10	10
BEETKILL	0	0	10	10	-1	0	0	10	10	0	0	0	0	0	25	20	0	-1	-1	-1	0	0	-1	0
OUTCROPP	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
RELIC	0	0	0	2	1	0	0	0	0	1	2	1	0	1	0	0	1	1	0	0	0	0	0	0
MINELEV	67	68	72	68	68	67	66	66	67	67	67	66	66	67	67	69	67	67	69	68	67	67	69	68
MAXELEV	68	68	86	68	68	68	67	68	76	68	67	68	67	68	77	76	70	70	70	70	68	68	71	73
STRMHGT	68	0	0	68	68	67	67	0	67	67	68	67	67	67	0	0	0	67	0	0	67	67	0	0

Note: -1 indicates no available information

Table 14. Continued.

	Land Unit Numbers			
UNITNO1	340	341	342	343
UNITSQMI	36	66	60	6
UNITYPE	22	12	26	26
COMTIMBR	0	0	0	0
NCOMTMBR	0	0	0	0
ASPEN	0	0	4	6
MBRUSH	0	2	2	0
SAJGRASS	4	6	4	0
RIPGRASS	6	2	0	4
CONIF	0	0	0	0
FSOWN	0	0	1	0
PUBOWN	0	2	3	2
PRIVOWN	5	3	1	3
ROADTYPE	3	3	0	0
ROADLTH	1	1	0	0
ROADIST	145	138	145	145
STRMLNTH	0	69	0	0
STRMORDR	0	3	0	0
DRANSQMI	0	13	0	0
NOLOG	0	0	0	0
NOFRWOOD	10	10	9	10
NOPHOS	0	0	1	0
NOOG	0	0	0	0
NOCOWS	0	0	0	0
NOSHEEP	0	0	0	0
NOHUNT	10	10	9	10
NOHIKE	10	10	9	10
NOROADS	0	0	0	0
NOSNOMO	10	10	9	10
NOORVS	10	10	9	10
NOBUILD	0	0	0	0
NOFISH	10	10	9	10
BEETKILL	0	10	10	10
OUTCROPP	0	0	0	0
RELIC	0	1	1	1
MINELEV	68	67	68	68
MAXELEV	71	70	75	73
STRMHGT	0	67	0	0

Note: -1 indicates no available information

A third set of attributes (designated by C_1 ..... C_p in Equation 3) would have a common value for the entire Blackfoot River watershed. Since they are constants for this study, the items listed in Table 22 are only proposed for use in assessing the applicability of the relationships reported in this study to other locations and were not quantified. Certain regional attributes defined on Table 23 are particularly relevant to estimation of an amount of use occurring in the study area (Table 22) and others are particularly relevant to estimation of the impact of the use that does occur on public concerns (Table 24). These two tables suggest relationships deserving further analysis.

Spatial Patterns of Use

The spatial patterns of the 21 uses are determined by choices made by users reacting to site attributes. Uses concentrate in favorable areas and avoid unfavorable ones. The 21 uses listed in Table 7 and whose estimated total magnitudes for the study area are enumerated in Table 9 and were disaggregated into use estimates for 1980 for each of the 343 land planning units shown in Figure 5. The disaggregation methods varied from use to use as follows:

Table 15. Proposed reasonability attributes by use.

Uses	Attributes
1. Commercial logging	A2 A3 A4
2. Firewood cutting	A3 A4 A7 A13
3. Phosphate mining	A14
5. Cattle grazing	A3 A4
6. Sheep grazing	A3 A4
10. Hunting	A2 A4 A16
11. Hiking - dispersed camping	A3 A4 A5
13. Roads	A7 A16
14. Snowmobiling	A3 A5 A16
15. Summer off-road vehicle use	A3 A5
16. Buildings	A5 A7 A16
17. Archaeologic & historical resources	A5
W1. Fish habitat	A9 A10
W2. Fishing	A3 A7 A9
W3. Runoff for downstream use	A3 A11
W4. Quality of runoff	A2 A14

Table 16. Constructed reasonability indices.

Use	Formula
1. Commercial logging	1. CONIF > 0.1
2. Firewood cutting	2. ROADTYPE > 0 and (CONIF + ASPEN > 0.1
3. Phosphate mining	3. OUTCROP=1
4. Oil and gas exploration	4. NOOG < 1.0
5. Cattle grazing	5. UNITYPE ≠ 1 or 6 or 13 (NONRANGE)
6. Sheep grazing	6. UNITYPE ≠ 1 or 6 or 13 (NONRANGE)
7. Deer winter feeding	7. MINELEV ≥ 65 or UNITNO1 = 180, 181, 184, 185
8. Elk winter feeding	8. MINELEV ≥ 68
9. Moose habitat	9. MINELEV ≥ 65 and (SAJGRASS + RIPGRASS) < 0
10. Hunting	10. REASDEER + REASELK + REASMOOSE > 0
11. Hiking - dispersed camping	11a. (hiking) TRAIL ≠ 0 or ESTHVAL < 3 or RELIC ≠ 0 b. (disp. camping) (ASPEN + CONIF) > 0 and ROADTYPE ≠ 0 and STRMORDR ≠ 0
12. Concentrated camping	12. UNITNO1 = 30, 188
13. Roads	13. ROADTYPE ≠ 0
14. Snowmobiling	14. ROADTYPE ≠ 0
15. Summer off-road vehicle use	15. ROADTYPE ≠ 0 or TRAIL ≠ 0 or (SAJGRASS + RIPGRASS) ≥ .30
16. Buildings	16. SEPTIC = 1
17. Archaeologic & historical resources	17. RELIC ≠ 0

Table 17. Identification of reasonable uses by land unit.

Land Unit	1 CL	2 FC	3 PM	4 OG	5 CT	6 SH	7 DR	8 EL	9 MS	10 HU	11* HC	12 CC	13 RD	14 SN	15 OR	16 BD	17 AH
	Use (Defined on Table 6)																
1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0
2	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
3	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0
4	1	1	1	1	1	1	1	1	1	1	2	0	1	1	1	0	0
5	1	1	1	1	1	1	1	1	1	1	2	0	1	1	1	0	0
6	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
7	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
8	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
9	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
10	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
11	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
12	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
13	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0
14	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
15	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
16	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
17	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
18	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
19	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
20	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
21	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
22	1	1	1	1	1	1	1	1	1	1	2	0	1	1	1	0	0
23	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
24	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
25	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
26	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
27	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
28	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
29	1	0	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0
30	1	1	0	1	1	1	1	1	1	1	2	1	1	1	1	0	0
31	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
32	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
33	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
34	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
35	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
36	1	1	1	1	1	1	1	1	1	1	2	0	1	1	1	0	0
37	1	1	1	1	1	1	1	1	1	1	2	0	1	1	1	0	0
38	0	1	1	1	1	1	1	1	1	1	2	0	1	1	1	0	0
39	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
40	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
41	0	0	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
42	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
43	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
44	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0

0 - Use is not reasonable
1 - Use is reasonable
* - For use 11, 2 is reasonable for both hiking and dispersed camping, 1 is reasonable for one of the two, 0 is reasonable for neither.

Table 17. Continued.

Land Unit	Use (Defined on Table 6) 1 CL	2 FC	3 PM	4 OG	5 CT	6 SH	7 DR	8 EL	9 MS	10 HU	11* HC	12 CC	13 RD	14 SN	15 OR	16 BD	17 AH
45	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
46	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
47	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
48	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0
49	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
50	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0
51	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
52	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0
53	0	0	0	1	1	1	1	1	0	1	1	0	1	1	1	0	0
54	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
55	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
56	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
57	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
58	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
59	1	1	1	1	1	1	1	1	1	1	2	0	1	1	1	0	0
60	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
61	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
62	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
63	1	1	1	1	1	1	1	0	1	1	2	0	1	1	1	0	0
64	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
65	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
66	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
67	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
68	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
69	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
70	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
71	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
72	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
73	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
74	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
75	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
76	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
77	1	1	0	1	1	1	1	0	1	1	2	0	1	1	1	0	0
78	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
79	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
80	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
81	1	1	1	1	1	1	1	1	1	1	2	0	1	1	1	0	0
82	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
83	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
84	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
85	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
86	0	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
87	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
88	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0

0 - Use is not reasonable
1 - Use is reasonable
* - For use 11, 2 is reasonable for both hiking and dispersed camping, 1 is reasonable for one of the two, 0 is reasonable for neither.

Table 17. Continued.

Land Unit	Use (Defined on Table 6) 1 CL	2 FC	3 PM	4 OG	5 CT	6 SH	7 DR	8 EL	9 MS	10 HU	11* HC	12 CC	13 RD	14 SN	15 OR	16 BD	17 AH
89	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
90	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
91	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
92	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
93	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
94	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
95	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
96	0	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
97	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0
98	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	0	0
99	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
100	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
101	1	1	0	1	1	1	1	0	1	1	2	0	1	1	1	0	0
102	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
103	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
104	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
105	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
106	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
107	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
108	0	0	0	1	1	1	1	0	0	1	0	0	1	1	1	0	0
109	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
110	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
111	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
112	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
113	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
114	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
115	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
116	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
117	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	0
118	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
119	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
120	0	1	0	1	1	1	1	0	1	1	2	0	1	1	1	0	0
121	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
122	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
123	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
124	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
125	0	1	1	1	1	1	0	0	1	1	0	0	1	1	1	0	0
126	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
127	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
128	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
129	0	0	0	1	1	1	0	0	0	1	0	0	1	1	1	0	0
130	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
131	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
132	1	0	0	1	1	1	1	1	1	1	0	0	1	0	0	0	0

0 - Use is not reasonable
1 - Use is reasonable
* - For use 11, 2 is reasonable for both hiking and dispersed camping, 1 is reasonable for one of the two, 0 is reasonable for neither.

Table 17. Continued.

Land Unit	1 CL	2 FC	3 PM	4 OG	5 CT	6 SH	7 DR	8 EL	9 MS	10 HU	11* HC	12 CC	13 RD	14 SN	15 OR	16 BD	17 AH
	Use (Defined on Table 6)																
133	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
134	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
135	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
136	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
137	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
138	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
139	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
140	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
141	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
142	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
143	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
144	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
145	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
146	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
147	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
148	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
149	0	0	0	1	1	1	0	0	1	1	0	0	1	1	1	0	0
150	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
151	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
152	0	1	1	1	1	1	0	0	1	1	0	0	1	1	1	0	0
153	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
154	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
155	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
156	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
157	1	1	0	1	1	1	0	0	1	1	0	0	1	1	1	0	0
158	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
159	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
160	1	0	0	1	1	1	0	0	1	1	0	0	1	0	0	0	0
161	1	0	0	1	1	1	1	0	1	1	0	0	1	0	0	0	0
162	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
163	1	0	1	1	1	1	1	0	1	1	0	0	1	0	0	0	0
164	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
165	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
166	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0
167	1	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0
168	1	1	0	1	1	1	0	0	1	1	0	1	1	1	1	0	0
169	0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	0	0
170	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
171	1	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0
172	0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	0	0
173	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
174	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
175	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
176	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0

0 - Use is not reasonable
1 - Use is reasonable
* - For use 11, 2 is reasonable for both hiking and dispersed camping, 1 is reasonable for one of the two, 0 is reasonable for neither.

Table 17. Continued.

Land Unit	Use (Defined on Table 6) 1 CL	2 FC	3 PM	4 OG	5 CT	6 SH	7 DR	8 EL	9 MS	10 HU	11* HC	12 CC	13 RD	14 SN	15 OR	16 BD	17 AH
177	1	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
178	0	0	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0
179	0	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
180	1	0	0	1	1	1	1	0	0	1	1	0	0	0	0	0	0
181	0	1	0	1	1	1	1	0	0	1	2	0	1	1	1	0	0
182	1	0	1	1	1	1	0	0	1	1	1	0	0	0	0	0	0
183	1	0	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0
184	1	1	0	1	1	1	1	0	0	1	2	0	1	1	1	0	0
185	0	0	0	1	1	1	1	0	0	1	1	0	1	0	0	0	0
186	0	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0
187	0	0	0	1	1	1	0	0	0	0	1	0	0	1	1	0	0
188	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	0	0
189	1	0	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0
190	0	0	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0
191	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
192	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
193	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
194	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
195	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
196	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
197	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
198	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
199	1	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0
200	1	1	0	1	1	1	0	0	1	1	0	0	1	1	1	0	0
201	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
202	0	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0
203	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
204	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
205	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
206	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
207	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
208	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	0	0
209	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0
210	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
211	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
212	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
213	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
214	1	1	0	1	1	1	0	0	1	1	0	0	1	1	1	0	0
215	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
216	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
217	1	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0
218	0	1	0	1	1	1	0	0	1	1	0	0	1	1	1	0	0
219	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
220	1	1	0	1	1	1	0	0	1	1	1	0	1	1	1	0	0

0 - Use is not reasonable
1 - Use is reasonable
* - For use 11, 2 is reasonable for both hiking and dispersed camping, 1 is reasonable for one of the two, 0 is reasonable for neither.

Table 17. Continued.

Land Unit	1 CL	2 FC	3 PM	4 OG	5 CT	6 SH	7 DR	8 EL	9 MS	10 HU	11* HC	12 CC	13 RD	14 SN	15 OR	16 BD	17 AH
221	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
222	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
223	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	0	0
224	1	1	0	1	1	1	0	0	1	1	1	0	1	1	1	0	0
225	0	0	1	1	1	1	1	0	1	1	0	0	1	0	0	0	0
226	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
227	0	1	1	1	1	1	0	0	1	1	0	0	1	1	1	0	0
228	0	0	1	1	1	1	0	0	0	0	0	0	1	1	1	0	0
229	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
230	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
231	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
232	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
233	0	0	1	1	1	1	1	0	0	1	0	0	1	1	1	0	0
234	0	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
235	0	0	0	1	1	1	1	0	1	1	0	0	1	0	0	0	0
236	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0
237	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
238	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
239	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
240	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
241	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
242	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0
243	0	1	1	1	1	1	1	0	1	1	0	0	1	1	1	0	0
244	0	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0
245	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
246	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
247	1	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0
248	1	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0
249	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
250	1	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
251	1	0	1	1	1	1	1	0	1	1	1	0	0	0	0	0	0
252	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
253	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
254	0	1	0	1	1	1	1	0	1	1	0	0	1	1	1	0	0
255	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
256	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	0	0
257	1	1	0	1	1	1	1	0	1	1	0	0	1	1	1	0	0
258	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	0
259	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
260	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	1
261	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
262	1	1	0	1	1	1	1	0	1	1	2	0	1	1	1	0	0
263	1	0	0	1	1	1	1	0	1	1	1	0	1	0	0	0	0
264	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0

0 - Use is not reasonable
 - Use is reasonable
* - For use 11, 2 is reasonable for both hiking and dispersed camping, 1 is reasonable for one of the two, 0 is reasonable for neither.

Table 17. Continued.

Land Unit	Use (Defined on Table 6) 1 CL	2 FC	3 PM	4 OG	5 CT	6 SR	7 DR	8 EL	9 MS	10 HU	11* HC	12 CC	13 RD	14 SN	15 OR	16 BD	17 AH
265	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
266	1	1	0	1	1	1	0	0	1	1	1	0	1	1	1	0	0
267	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
268	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
269	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
270	1	1	0	1	1	1	0	0	1	1	0	0	1	1	1	0	0
271	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
272	1	1	0	1	1	1	1	0	1	1	2	0	1	1	1	0	0
273	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
274	1	1	0	1	1	1	1	0	1	1	2	0	1	1	1	0	0
275	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
276	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
277	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
278	0	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
279	0	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
280	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
281	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
282	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
283	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
284	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
285	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
286	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
287	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
288	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
289	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
290	1	0	0	1	1	1	0	0	1	1	0	0	0	0	0	0	0
291	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
292	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0
293	0	0	0	1	1	1	1	0	0	1	0	0	0	0	0	0	0
294	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
295	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
296	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
297	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0
298	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
299	1	1	0	1	1	1	1	0	1	1	2	0	1	1	1	0	0
300	0	0	0	1	1	1	1	0	0	1	1	0	1	1	1	0	0
301	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
302	1	0	0	1	1	1	1	1	1	1	1	0	1	0	0	0	0
303	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
304	0	0	0	1	1	1	1	1	1	1	1	0	1	0	0	0	0
305	1	0	0	1	1	1	1	1	1	1	1	0	1	0	0	0	0
306	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
307	0	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
308	1	0	0	1	1	1	1	1	1	1	1	0	1	0	0	0	0

0 - Use is not reasonable
1 - Use is reasonable
* - For use 11, 2 is reasonable for both hiking and dispersed camping, 1 is reasonable for one of the two, 0 is reasonable for neither.

Table 17. Continued.

Land Unit	1 CL	2 FC	3 PM	4 OG	5 CT	6 SH	7 DR	8 EL	9 MS	10 HU	11* HC	12 CC	13 RD	14 SN	15 OR	16 BD	17 AH
309	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
310	1	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
311	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
312	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
313	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
314	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
315	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	0
316	0	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
317	0	1	0	1	1	1	1	1	1	1	0	0	1	1	1	0	0
318	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
319	1	1	0	1	1	1	1	1	1	1	2	0	1	1	1	0	0
320	1	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0
321	0	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
322	0	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0
323	1	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0
324	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0
325	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
326	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
327	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
328	0	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0
329	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
330	1	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0
331	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0
332	0	1	0	1	1	1	1	0	1	1	1	0	1	1	1	0	0
333	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	1
334	1	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	1
335	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	0	0
336	0	0	0	1	1	1	1	0	0	1	0	0	1	1	1	0	0
337	0	0	0	1	1	1	1	0	0	1	0	0	1	1	1	0	0
338	1	1	0	1	1	1	1	1	1	1	0	0	1	1	1	0	0
339	0	1	0	1	1	1	1	1	1	1	0	0	1	1	1	0	0
340	0	0	0	1	1	1	1	1	0	1	0	0	1	1	1	0	0
341	0	0	0	1	1	1	1	0	1	1	1	0	1	1	1	0	1
342	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1
343	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	1

0 - Use is not reasonable
1 - Use is reasonable
* - For use 11, 2 is reasonable for both hiking and dispersed camping, 1 is reasonable for one of the two, 0 is reasonable for neither.

Table 18. Definition of additional indicators for estimating use intensity (Equation 5).

Attribute	Mnemonic	Units	Definition and Measurement Method
B1	FSREST	Fifths	Fifths of area in which firewood cutting is restricted
B2	FSFEE	Fifths	Fifths of area in which a fee is charged for firewood cutting
B3	FSFREE	Fifths	Fifths of area in which firewood cutting is free
B4	PASTCUTS	Percent	Percent of area which has apparently been logged
B5	MAINRTE	-	Location on main through route. Areas that contain the main through route were either marked (1) for the road from Wayan to the narrows or (2) for the road from the south end of study area to the narrows, or (7) on the narrows road, including the confluence of roads 1 and 2. Other areas were marked either 3 (low land), 4(canyon), 5 (ridges), or 6 (other upland types). Low land includes Mountain Valley Bottom types (land types 01-06). Canyons included canyonland types (land types 18-21). Ridges included both Ridgeland (land types (07-09) and escarpments (land type 38-39). Other upland types, included higher elevation areas or steeper sloped areas such as in side slopes (land types 24-35) and mountain slopes 36 and 37, and unstable scarp dip at upland (14-17).
B6	SODADIST	Miles	For land units with roads, the distance in miles from highest quality road in the unit to Soda Springs.
B7	DEERVIEW	# Deer	Sitings of deer from Idaho Dept. of Fish and Game aerial survey.
B8	ELKVIEW	# Elk	Sitings of elk from Idaho Dept. of Fish and Game aerial survey.
B9	MOOSVIEW	# Moose	Sitings of moose from Idaho Dept. of Fish and Game aerial survey.

Table 18. Continued.

Attribute	Mnemonic	Units	Definition and Measurement Method
B10	ANGDAYS	Angler Days	Allocated angler days from Idaho Dept. of Fish and Game survey and fishing disaggregation formula.
B11	TRAILMI	Miles	Miles of mapped trails in land unit.
B12	ESTHVAL	-	Aesthetic quality of site, a function of visual variety, using DCPU Aesthetic Values map: 1 = distinctive, 2 = common, 3 = minimal.
B13	LANDEXP	-	Land unit exposure, in degrees on a circle of 2 miles radius from unit centroid from which the (barren) centroid can be seen. The centroid was judged not visible if it failed the "rule of 1/4's:" 1) subtract centroid elevation from radius elevation and divided by 4, 2) subdivide radius into fourths, 3) if the elevation difference between the radius and any 1/4 radius exceeds $\frac{e_{cent} - e_{rad}}{4}$ then it fails the rule (view is obstructed).
B14	LANDOM		Land unit dominance, in miles of gravel road from which unit centroid is visible. Centroid is not visible if a) the road is tree-lined, or b) if the vector from the road to unit centroid fails the rule of 1/4's
B15	LANDVIEW		Landscape view, in degrees within a circle of 2 miles radius where elevations of 8,000 ft or more are visible from the unit centroid.
B16	FISHCOVR		Protective cover for fish. Fraction of length with overhanging vegetation or snags. (Summer site visit.)

Table 18. Continued.

Attribute	Mnemonic	Units	Definition and Measurement Method
B17	SUBSTRT		Predominant substrate. 4 = cobble, 3 = gravel, 2 = sand, 1 = silt. Mixed size is coded with .5.
B18	SILTED		Degree to which siltation is apparent heavy siltation=3, medium siltation=2, light or negligible=1 (0=no third order stream).
B19	POOL	Percent	Percent of third order and higher stream reach in pools
B20	RUN	Percent	Percent of third order and higher stream reach in run (relatively smooth, medium velocity surface flow).
B21	RIFFLE	Percent	Percent of third order and higher stream reach in ripple (ripples and relatively high velocity broken flow).
B22	SPRTFISH		Volume of water sufficient to support adult fish (1=sufficient, 0=not sufficient.
B23	WILLOW	Percent	Percent of streambank length for third order or higher streams in riparian willow
B24	AUMS		Cattle animal unit months of available feed
B25	SEPTIC		Access to safe drinking water, soil suitable for septic tank. 0 = neither, 1 = borderline on at least one, 2 = both ok (see A2)

Table 19. Measurements of second level indicators by land units.

Land Unit Numbers

UNITNO1	1	2	3	4	5	6	7	8	9	10	11	12
FSREST	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	5	5	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	50	50	50	40	60	40	40	40	40	40	40	30
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	10	10	0	0	0	0	0	0	0
TRAILMI	0	50	20	70	0	0	0	0	0	0	0	0
ESTHVAL	1	1	1	1	1	1	1	1	1	1	1	2
LANDEXP	0	0	0	0	0	0	0	0	0	0	0	0
LANDOM	0	0	0	0	0	0	0	0	0	0	0	25
LANDVIEW	0	0	0	0	73	40	0	0	360	360	55	43
FISHCOVR	0	0	0	75	75	0	50	0	0	0	0	0
SUBSTRT	0	0	0	10	10	0	30	0	0	0	0	0
SILTED	0	0	0	3	3	0	1	0	0	0	0	0
POOL	0	0	0	80	80	0	50	0	0	0	0	0
RUN	0	0	0	10	10	0	0	0	0	0	0	0
RIFFLE	0	0	0	10	10	0	50	0	0	0	0	0
SPRTFISH	0	0	0	1	1	0	0	0	0	0	0	0
WILLOW	0	0	0	1	1	0	1	0	0	0	0	0
AUMS	243	166	102	74	428	402	8	241	31	113	38	11
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2

UNITNO1	13	14	15	16	17	18	19	20	21	22	23	24
FSREST	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	5	5	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	50	50	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	20	80	30	30	40	20	20	20	30	10	10	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	0	0
TRAILMI	0	0	50	40	0	0	0	30	0	0	20	70
ESTHVAL	2	1	1	2	2	2	2	2	2	2	2	2
LANDEXP	0	0	0	0	0	0	0	0	0	0	0	0
LANDOM	25	25	0	0	0	0	25	25	25	125	0	0
LANDVIEW	47	0	160	228	360	76	25	0	174	0	0	0
FISHCOVR	0	60	0	0	0	0	0	75	0	90	50	0
SUBSTRT	0	30	0	0	0	0	0	25	0	30	30	0
SILTED	0	2	0	0	0	0	0	2	0	2	3	0
POOL	0	40	0	0	0	0	0	35	0	20	50	0
RUN	0	0	0	0	0	0	0	5	0	0	50	0
RIFFLE	0	60	0	0	0	0	0	60	0	80	0	0
SPRTFISH	0	0	0	0	0	0	0	0	0	0	0	0
WILLOW	0	4	0	0	0	0	0	2	0	2	2	0
AUMS	697	6	471	195	116	550	316	175	107	561	140	126
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2

UNITNO1	25	26	27	28	29	30	31	32	33	34	35	36
FSREST	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	5	5	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	50	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	30	30	30	30	20	0	20	20	20	20	30	20
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	1	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	0	0
TRAILMI	50	0	20	30	80	0	40	0	0	10	10	10
ESTHVAL	2	2	2	2	2	2	2	2	2	2	2	2
LANDEXP	0	0	0	0	0	0	0	0	0	0	0	0
LANDOM	0	0	0	0	0	0	0	0	0	0	0	0
LANDVIEW	318	360	360	90	0	0	360	280	0	360	360	26
FISHCOVR	0	0	0	0	0	80	0	0	90	0	0	90
SUBSTRT	0	0	0	0	0	30	0	0	35	0	0	30
SILTED	0	0	0	0	0	3	0	0	1	0	0	1
POOL	0	0	0	0	0	60	0	0	10	0	0	20
RUN	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	0	0	0	0	40	0	0	90	0	0	80
SPRTFISH	0	0	0	0	0	0	0	0	0	0	0	0
WILLOW	0	0	0	0	1	1	0	0	0	0	0	1
AUMS	65	50	110	346	514	467	289	164	188	211	612	960
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2

Land Unit Numbers

UNITNO1	37	38	39	40	41	42	43	44	45	46	47	48
FSREST	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	5	5	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	50	0	50	0	0	0	50	30	50	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	0	0	0	10	0	90	90	40	0	20	20	30
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	3	0	0
ANGDAYS	0	0	0	0	130	0	130	0	0	250	0	0
TRAILMI	0	80	0	0	0	0	0	40	0	60	30	80
ESTHVAL	2	2	2	2	2	2	2	2	2	2	2	2
LANDEXP	0	0	0	0	0	0	0	0	0	0	0	0
LANDOM	50	175	1	25	200	100	175	0	250	0	0	0
LANDVIEW	0	0	0	0	0	0	0	0	0	273	51	262
FISHCOVR	90	75	0	0	60	0	70	0	70	60	0	0
SUBSTRT	30	30	0	0	30	0	35	0	20	35	0	0
SILTED	2	2	0	0	1	0	1	0	3	1	0	0
POOL	50	45	0	0	20	0	45	0	20	20	0	0
RUN	0	5	0	0	0	0	0	0	0	0	0	0
RIFFLE	50	50	0	0	80	0	55	0	80	80	0	0
SPRTFISH	0	0	0	0	1	0	1	0	0	0	0	0
WILLOW	1	4	0	0	9	8	5	0	1	2	0	0
AUMS	249	179	292	44	377	531	49	69	15	305	44	165
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2

UNITNO1	49	50	51	52	53	54	55	56	57	58	59	60
FSREST	0	0	0	5	0	0	0	0	0	0	0	0
FSFEE	5	5	5	0	5	5	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	50	50	50	0	0	0	0	50	50
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	30	30	20	90	0	0	90	90	0	10	90	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	2	0	1	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	320	240	0	0	0	0	0
TRAILMI	0	40	80	20	10	10	0	0	40	20	10	10
ESTHVAL	2	2	2	2	2	2	2	2	2	2	2	2
LANDEXP	0	0	0	0	0	0	0	0	0	0	0	0
LANDOM	0	0	0	140	80	80	0	0	0	0	75	0
LANDVIEW	360	360	318	0	24	0	0	73	300	360	0	30
FISHCOVR	0	0	0	0	0	90	70	0	0	0	99	99
SUBSTRT	0	0	0	0	0	10	35	0	0	0	30	30
SILTED	0	0	0	0	0	3	1	0	0	0	3	3
POOL	0	0	0	0	0	95	45	0	0	0	0	0
RUN	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	0	0	0	0	5	55	0	0	0	99	99
SPRTFISH	0	0	0	0	0	1	1	0	0	0	0	0
WILLOW	0	0	0	2	0	4	1	0	0	0	1	1
AUMS	101	278	144	350	140	670	16	217	326	392	289	767
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2

UNITNO1	61	62	63	64	65	66	67	68	69	70	71	72
FSREST	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	5	5	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	90	50	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	80	0	80	0	80	80	90	30	90	90	80	90
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	1	0	0	0	0	0	0	0	1
ANGDAYS	0	0	790	280	0	0	0	0	0	0	0	0
TRAILMI	80	30	60	10	10	80	80	30	50	40	10	80
ESTHVAL	2	2	2	2	2	2	2	2	2	2	2	2
LANDEXP	0	0	0	0	0	0	0	0	0	0	0	0
LANDOM	0	0	50	200	1	0	0	0	0	0	0	0
LANDVIEW	360	0	0	0	0	0	21	360	360	360	0	0
FISHCOVR	0	0	75	75	0	0	0	0	0	0	0	-1
SUBSTRT	0	0	30	30	0	0	0	0	0	0	0	35
SILTED	0	0	2	2	0	0	0	0	0	0	0	9
POOL	0	0	50	50	0	0	0	0	0	0	0	-1
RUN	0	0	0	0	0	0	0	0	0	0	0	-1
RIFFLE	0	0	50	50	0	0	0	0	0	0	0	-1
SPRTFISH	0	0	1	1	0	0	0	0	0	0	0	1
WILLOW	0	0	2	6	0	0	0	0	0	0	1	0
AUMS	48	128	569	62	140	148	98	47	177	173	51	94
SEPTIC	2	2	2	2	2	2	2	2	0	2	2	2

Table 19. Continued.

	Land Unit Numbers																	
UNITNO1	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	0	80	90	30	80	80	0	90	70	0	80	60	70	70	80	80	80	90
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	3	0	0	1	0	0	2	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRAILMI	0	30	70	0	30	40	0	30	70	10	30	10	0	0	0	20	30	20
ESTHVAL	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
LANDEXP	0	0	0	0	0	0	0	0	15	0	60	0	0	0	0	0	60	0
LANDOM	0	0	0	0	100	50	100	0	200	0	150	200	0	150	0	0	150	0
LANDVIEW	360	0	150	0	0	0	0	360	0	360	20	0	0	0	360	70	20	360
FISHCOVR	0	-1	0	0	-1	-1	3	0	0	0	0	0	0	90	0	90	60	0
SUBSTRT	0	35	0	0	35	35	9	0	2	0	0	0	0	30	0	30	0	0
SILTED	0	9	0	0	9	9	1	0	0	0	0	0	0	2	0	2	0	0
POOL	0	0	0	0	-1	-1	0	0	0	0	0	0	0	10	0	10	0	0
RUN	0	0	0	0	-1	-1	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	0	0	0	-1	-1	0	0	90	0	0	0	0	90	0	90	0	0
SPRTFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WILLOW	0	1	0	0	1	0	10	0	2	0	0	0	0	1	0	1	0	0
AUMS	116	32	123	43	11	33	335	500	445	29	149	40	486	416	90	513	149	26
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	Land Unit Numbers																		
UNITNO1	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	2	0	3
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	90	80	60	60	0	0	60	50	0	0	0	60	60	60	70	70	40	0	40
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	2	0	0	0	0	2	1	0	3	0	0	0
ANGDAYS	0	0	0	0	520	300	0	0	860	560	210	0	0	0	0	0	0	0	0
TRAILMI	0	30	0	20	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0
ESTHVAL	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
LANDEXP	0	15	0	30	0	35	20	10	40	22	20	65	45	45	0	45	80	50	0
LANDOM	0	50	0	200	50	250	150	50	100	200	300	500	100	100	50	100	500	550	0
LANDVIEW	280	360	0	20	0	12	0	20	0	0	0	0	0	0	0	15	10	20	0
FISHCOVR	0	0	0	0	90	90	0	0	90	75	75	0	90	0	0	0	0	0	0
SUBSTRT	0	0	0	0	30	30	0	0	30	30	30	0	30	0	0	0	0	0	0
SILTED	0	0	0	0	2	2	0	0	2	3	3	0	3	0	0	0	0	0	0
POOL	0	0	0	0	50	50	0	0	50	50	50	0	0	0	0	0	0	0	0
RUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	0	0	0	50	50	0	0	50	50	50	0	99	0	0	0	0	0	0
SPRTFISH	0	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0
WILLOW	0	0	0	0	1	10	0	0	4	6	0	0	1	0	0	0	0	0	0
AUMS	123	265	65	388	764	670	82	224	363	215	241	72	72	79	347	317	180	144	56
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	Land Unit Numbers																
UNITNO1	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	3	5	5	5	5	5	5	5	5	3	0	3	0	5	5	3	0
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	40	0	70	70	70	60	70	60	50	90	0	0	40	50	60	0	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	4	4	2	3	0	0	0	0	0	0	7	0	1	0
MOOSEVIEW	0	0	0	0	0	4	0	0	0	0	0	0	6	1	0	0	1
ANGDAYS	0	0	0	0	0	0	0	0	0	0	340	0	0	0	0	0	500
TRAILMI	0	40	50	20	0	0	0	20	0	0	0	0	0	0	0	0	0
ESTHVAL	3	2	2	2	2	2	3	2	2	2	2	2	2	2	3	3	3
LANDEXP	0	0	50	0	0	0	0	35	22	30	6	70	30	60	8	68	50
LANDOM	0	0	150	0	0	0	0	500	100	250	500	200	200	500	50	150	600
LANDVIEW	0	360	360	40	200	200	360	20	0	0	20	20	200	180	0	0	15
FISHCOVR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUBSTRT	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	30
SILTED	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2
POOL	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0	0	10
RUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	0	0	0	0	0	0	0	0	0	90	0	0	0	0	0	90
SPRTFISH	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
WILLOW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUMS	42	220	249	343	728	183	128	224	51	95	230	320	360	135	148	193	893
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	Land Unit Numbers																	
UNITNO1	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	0	0	0	4	5	4	5	5	5	5	5	5	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	50	50	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	0	0	0	30	40	30	40	50	50	0	40	70	10	0	90	0	90	80
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRAILMI	0	0	0	20	0	0	0	0	0	0	0	0	50	10	40	0	0	0
ESTHVAL	2	3	3	3	3	3	3	3	3	3	3	2	2	2	2	3	3	3
LANDEXP	55	90	90	30	0	0	0	0	0	12	0	0	0	18	18	0	18	65
LANDOM	0	200	200	0	0	0	0	0	0	0	0	0	0	0	0	0	100	300
LANDVIEW	45	0	0	0	60	0	25	450	20	25	0	360	180	180	65	360	10	180
FISHCOVR	0	70	70	75	0	75	50	0	0	0	0	0	0	0	90	0	0	0
SUBSTRT	0	35	35	35	0	35	10	0	0	0	0	0	0	53	35	0	0	0
SILTED	0	1	1	1	0	1	3	0	0	0	0	0	0	2	3	0	0	0
POOL	0	10	10	25	0	25	75	0	0	0	0	0	0	50	25	0	0	0
RUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	90	90	75	0	75	25	0	0	0	0	0	0	50	75	0	0	0
SPRTFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WILLOW	0	0	0	1	1	1	1	0	0	0	0	0	0	0	3	0	0	0
AUMS	47	130	100	172	303	85	354	101	415	214	69	237	84	935	638	64	128	122
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 19. Continued.

	Land Unit Numbers																							
UNITNO1	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	0	0	5	1	0	0	0	0	5	0	2	4	5	5	5	5	5	5	3	0
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	80	0	80	90	60	0	70	0	0	0	0	0	20	0	0	20	20	30	20	30	20	10	10	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	3	10	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	50	0	0	800	0	0	0	0	0	0	0	0	0	0
TRAILMI	0	60	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ESTHVAL	3	3	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
LANDEXP	50	0	40	40	10	155	87	28	60	115	160	102	95	120	125	150	110	0	0	0	0	140	130	90
LANDOM	200	0	0	350	100	500	200	150	500	600	600	500	0	500	100	0	0	0	0	0	0	0	0	0
LANDVIEW	0	0	65	50	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FISHCOVR	0	80	0	0	70	0	0	0	0	0	0	0	0	10	50	0	0	0	95	0	0	0	9	95
SUBSTRT	0	35	0	0	35	30	0	0	0	0	30	0	0	30	35	0	0	0	30	0	0	0	30	30
SILTED	0	3	0	0	3	2	0	0	0	0	2	0	0	1	1	0	0	0	1	0	0	0	1	1
POOL	0	25	0	0	25	50	0	0	0	0	50	0	0	40	10	0	0	0	20	0	0	0	10	10
RUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	75	0	0	75	50	0	0	0	0	50	0	0	60	90	0	0	0	80	0	0	0	90	90
SPRTFISH	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
WILLOW	2	2	0	0	2	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUMS	154	244	58	61	142	431	436	30	806	197	555	418	112	922	619	173	268	294	46	450	78	86	182	209
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	Land Unit Numbers											
UNITNO1	169	170	171	172	173	174	175	176	177	178	179	180
FSREST	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	0	5	3	0	0	0	0	0	5	5	0	3
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	50	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	0	10	0	0	0	0	0	0	60	50	0	40
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	680	520	0	0	0	0	470
TRAILMI	0	0	0	0	0	0	0	0	0	0	0	0
ESTHVAL	3	1	3	3	3	3	3	3	1	1	1	1
LANDEXP	135	38	40	15	40	30	55	105	0	0	0	0
LANDOM	50	200	50	50	50	250	200	300	0	50	50	50
LANDVIEW	0	0	0	0	0	0	0	0	0	0	0	0
FISHCOVR	95	0	0	0	0	0	0	0	0	0	0	75
SUBSTRT	30	0	0	0	0	30	30	0	0	0	0	35
SILTED	1	0	0	0	0	3	3	0	0	0	0	3
POOL	30	0	0	0	0	50	50	0	0	0	0	20
RUN	0	0	0	0	0	50	50	0	0	0	0	60
RIFFLE	70	0	0	0	0	0	0	0	0	0	0	20
SPRTFISH	0	0	0	0	0	1	1	0	0	0	0	1
WILLOW	0	0	0	0	0	0	0	0	0	0	0	1
AUMS	605	223	147	381	61	648	90	36	182	108	484	147
SEPTIC	2	2	2	2	2	3	3	2	2	2	2	2

	Land Unit Numbers											
UNITNO1	181	182	183	184	185	186	187	188	189	190	191	192
FSREST	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	3	5	3	2	0	5	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	50	0	0	10	0	0	0	60	70	0	0	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	740	0	0	800	40	0	0	0	0	0	0	0
TRAILMI	0	0	0	0	0	0	20	40	0	10	0	0
ESTHVAL	1	1	1	1	1	1	1	1	1	1	1	2
LANDEXP	0	0	0	0	45	35	50	35	0	0	0	33
LANDOM	0	0	0	50	150	150	50	150	0	0	0	0
LANDVIEW	0	0	0	0	0	0	0	0	0	0	0	360
FISHCOVR	75	0	0	75	40	0	0	0	0	0	0	0
SUBSTRT	35	0	0	35	30	0	0	0	0	0	0	0
SILTED	3	0	0	3	3	0	0	0	0	0	0	0
POOL	20	0	0	20	55	0	0	0	0	0	0	0
RUN	60	0	0	30	25	0	0	0	0	0	0	0
RIFFLE	20	0	0	30	10	0	0	0	0	0	0	0
SPRTFISH	1	0	0	1	1	0	0	0	0	0	0	0
WILLOW	1	0	0	1	10	0	0	0	0	0	0	0
AUMS	186	132	73	244	862	115	516	275	74	56	27	41
SEPTIC	2	2	3	3	3	3	2	2	2	2	2	2

	Land Unit Numbers																							
UNITNO1	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	5	5	5	5	5	5	2	0	4	5	5	0	5	5	2	30	0	0	0	0	0	0	0
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	80	80	90	80	70	80	70	90	0	0	70	80	0	0	90	50	0	0	0	0	0	20	0	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	6	0	0	0	0	0	0
ELKVIEW	0	0	0	0	7	2	5	0	9	40	24	1	0	0	0	14	6	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	6	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	630	0
TRAILMI	0	0	80	80	0	0	0	0	10	70	70	60	0	60	70	0	0	0	0	0	0	0	0	0
ESTHVAL	2	2	2	2	3	3	3	3	3	3	0	3	3	3	3	3	3	3	3	3	3	3	3	3
LANDEXP	0	0	0	0	0	38	10	0	15	18	0	0	125	0	0	20	130	175	175	120	170	110	170	195
LANDOM	0	0	0	0	0	0	50	0	300	100	0	0	500	0	0	150	350	300	400	200	200	200	100	50
LANDVIEW	18	0	18	10	0	15	0	0	0	0	7	0	0	65	10	0	0	0	15	0	0	0	0	0
FISHCOVR	0	0	0	90	0	0	90	0	90	90	90	90	90	90	0	0	0	10	10	0	0	0	10	0
SUBSTRT	0	0	0	30	0	0	30	0	30	32	35	35	35	35	0	0	0	30	30	0	0	0	30	0
SILTED	0	0	0	1	0	0	1	0	1	1	1	1	1	9	0	0	0	2	3	0	0	0	3	0
POOL	0	0	0	-1	0	0	-1	0	-1	40	20	20	40	-1	0	0	0	10	40	0	0	0	30	0
RUN	0	0	0	-1	0	0	-1	0	-1	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	0	0	-1	0	0	-1	0	-1	60	80	80	60	-1	0	0	0	90	60	0	0	0	70	0
SPRTFISH	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
WILLOW	0	0	0	0	0	0	2	0	0	2	2	2	6	0	0	0	0	0	0	0	0	0	0	0
AUMS	5	39	192	308	205	109	311	162	417	0	0	88	166	913	84	124	0	727	540	130	201	47	230	7
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 19. Continued.

	Land Unit Numbers																							
UNITNO1	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	3	0	0	0	0	0	0	0	2
FSFEE	0	1	0	0	5	2	2	1	5	5	4	2	2	1	0	2	5	5	5	5	0	0	0	1
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	0	0	0	0	90	20	0	20	40	0	90	90	0	0	0	0	90	0	10	40	0	0	0	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	160	0	0	0	0	0	0	0	0	50	50	0	0	0	0	0	0	0	0	0	0	0
TRAILMI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ESTHVAL	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
LANDEXP	160	205	110	97	18	72	0	20	0	3	100	40	5	0	10	0	50	20	0	0	22	28	10	65
LANDOM	50	0	150	0	0	100	0	25	0	150	300	100	50	75	175	150	200	100	0	0	200	150	50	150
LANDVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FISHCOVR	0	0	10	10	0	0	0	70	0	0	0	70	10	0	0	0	0	0	0	0	0	0	0	0
SUBSTRT	0	0	30	30	0	0	0	30	0	0	0	30	30	0	0	0	0	0	0	0	0	30	0	0
SILTED	0	0	1	1	0	0	0	2	0	0	0	3	3	0	0	0	0	0	0	0	0	3	0	0
POOL	0	0	30	30	0	0	0	65	0	0	0	60	50	0	0	0	0	0	0	0	0	50	0	0
RUN	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0
RIFFLE	0	0	70	70	0	0	0	25	0	0	0	40	50	0	0	0	0	0	0	0	0	0	0	0
SPRTFISH	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0
WILLOW	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AUMS	230	112	633	245	34	706	42	60	807	116	223	62	44	626	167	319	69	155	58	870	36	432	596	204
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	3	3	3	2	2	2	2	2	2	3	3	3	2

	Land Unit Numbers												
UNITNO1	241	242	243	244	245	246	247	248	249	250	251	252	253
FSREST	1	0	0	0	3	2	5	5	0	0	0	0	0
FSFEE	4	5	5	5	2	3	9	9	5	5	5	5	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	50	50	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	80	0	0	40	0	40	0	0	0	0	0	0	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	100	150	0	0	0	0
TRAILMI	0	0	0	0	0	0	0	0	0	0	0	0	0
ESTHVAL	3	3	3	3	3	3	3	3	3	3	2	3	3
LANDEXP	15	0	28	0	0	0	0	0	0	13	0	0	0
LANDOM	250	0	0	0	0	0	300	200	0	0	0	100	25
LANDVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0
FISHCOVR	0	0	0	0	0	0	0	80	70	0	0	99	99
SUBSTRT	0	0	0	0	0	0	0	10	10	0	0	30	30
SILTED	0	0	0	0	0	0	0	3	3	0	0	3	3
POOL	0	0	0	0	0	0	0	99	95	0	0	0	0
RUN	0	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	0	0	0	0	0	0	0	5	0	0	99	99
SPRTFISH	0	0	0	0	0	0	0	1	1	0	0	0	0
WILLOW	0	0	0	0	0	0	0	5	2	0	0	0	0
AUMS	384	54	416	395	47	366	911	115	677	89	62	325	952
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2

	Land Unit Numbers										
UNITNO1	254	255	256	257	258	259	260	261	262	263	264
FSREST	0	0	0	0	0	0	0	0	0	0	0
FSFEE	5	2	2	4	5	5	5	5	4	4	5
FSFREE	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	50	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0
SODADIST	20	0	0	30	30	20	20	0	10	60	50
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	2	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	0
TRAILMI	0	0	0	0	0	0	80	0	50	10	0
ESTHVAL	3	3	3	3	3	4	4	1	1	1	3
LANDEXP	0	0	0	0	0	0	0	18	10	0	0
LANDOM	0	0	0	25	50	100	50	125	200	0	0
LANDVIEW	0	0	0	0	0	60	30	30	0	10	60
FISHCOVR	0	0	0	0	0	0	95	0	95	80	0
SUBSTRT	0	0	0	0	0	0	30	0	10	35	0
SILTED	0	0	0	0	0	0	1	0	2	1	0
POOL	0	0	0	0	0	0	10	0	90	20	0
RUN	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	0	0	0	0	0	90	0	10	80	0
SPRTFISH	0	0	0	0	0	0	0	0	0	0	0
WILLOW	0	0	0	0	0	0	1	0	1	1	0
AUMS	582	185	883	395	208	995	59	5	200	235	24
SEPTIC	2	2	2	2	2	2	2		2	2	2

	Land Unit Numbers																							
UNITNO1	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	4	3	4	1	5	1
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	2	1	4	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	0	50	0	50	0	0	30	30	0	50	40	40	40	30	40	50	50	60	70	60	70	70	70	60
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	30	0	30	630	0	0	20	280	340	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRAILMI	0	40	0	0	0	0	0	0	20	10	0	0	0	0	0	0	0	0	50	0	0	0	0	0
ESTHVAL	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
LANDEXP	28	95	55	65	90	30	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	25
LANDOM	100	500	150	300	350	100	25	0	0	0	0	0	0	0	0	0	0	0	25	25	0	0	0	50
LANDVIEW	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FISHCOVR	0	10	0	10	10	0	0	90	90	90	0	0	0	0	95	95	95	90	90	0	0	0	0	20
SUBSTRT	0	30	0	30	30	0	0	30	30	30	0	0	0	0	35	35	35	0	30	0	0	0	0	30
SILTED	0	3	0	3	3	0	0	2	2	2	0	0	0	0	1	1	1	0	9	0	0	0	0	2
POOL	0	25	0	40	60	0	0	60	65	65	0	0	0	0	10	10	10	0	10	0	0	0	0	25
RUN	0	0	0	0	10	0	0	10	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	0	75	0	60	30	0	0	30	25	25	0	0	0	0	90	90	90	0	90	0	0	0	0	75
SPRTFISH	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WILLOW	0	0	0	0	0	0	0	1	2	4	0	0	0	5	6	1	1	0	0	0	0	0	0	3
AUMS	58	578	137	554	122	619	170	921	110	608	105	523	37	150	185	533	207	775	570	90	34	174	241	347
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 19. Continued.

	Land Unit Numbers																							
UNITNO1	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	2	3	0	0	0	5	4	0	0	0	0	3	1	0	0	0	0	4	4	0	0	0	0	0
FSFREE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	20	0	0	0	0	0	0	0	0	0	0	70	0	0	0	0	0	60	70	0	0	0	0	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	3	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0
TRAILMI	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ESTHVAL	2	2	2	3	3	2	1	2	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3
LANDEXP	120	140	40	90	100	35	40	120	50	180	130	90	60	70	90	100	190	70	50	50	300	45	45	5
LANDOM	400	400	100	200	350	0	100	500	200	600	900	200	300	350	150	450	600	400	250	150	900	200	200	150
LANDVIEW	20	20	20	0	0	90	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FISHCOVR	20	0	0	20	0	0	10	10	20	20	0	20	20	20	10	50	50	0	0	0	50	0	0	10
SUBSTRT	30	0	0	30	0	0	10	10	30	30	0	30	30	30	30	10	10	0	0	0	10	0	0	10
SILTED	3	0	0	3	0	0	3	3	1	1	0	1	1	3	2	3	3	0	0	0	3	0	0	3
POOL	10	0	0	1	0	0	0	0	40	40	0	40	40	60	40	50	50	0	0	0	50	0	0	50
RUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	0	0	0	50	0	0	0
RIFFLE	90	0	0	90	0	0	99	99	60	60	0	60	60	40	60	0	0	0	0	0	0	0	0	95
SPRTFISH	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0
WILLOW	1	0	0	2	2	0	1	2	4	8	2	2	2	8	1	6	2	0	0	0	0	0	0	0
AUMS	904	309	719	317	94	396	289	288	259	173	345	0	806	885	878	68	346	473	84	43	18	130	72	425
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

	Land Unit Numbers																							
UNITNO1	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312
FSREST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FSFEE	3	0	3	0	0	0	0	0	0	0	1	0	2	0	0	0	5	0	0	0	0	0	0	3
FSFREE	0	0	0	0	0	0	0	3	0	0	3	0	2	5	5	5	0	5	5	5	5	5	5	0
PASTCUTS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAINRTE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SODADIST	60	0	60	0	0	0	0	50	0	0	50	0	60	40	30	0	30	20	0	0	20	20	0	0
DEERVIEW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELKVIEW	0	1	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MOOSEVIEW	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ANGDAYS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRAILMI	0	0	0	0	0	0	0	0	0	10	20	0	40	0	80	0	0	10	0	0	0	50	10	0
ESTHVAL	2	3	2	3	3	3	3	3	3	3	2	2	3	2	2	2	2	2	2	2	2	2	2	2
LANDEXP	85	90	28	125	80	80	50	165	81	68	60	35	130	0	0	85	30	0	30	60	180	75	50	70
LANDOM	700	600	100	500	650	650	200	200	300	300	50	300	550	0	0	450	0	0	100	150	600	400	400	200
LANDVIEW	5	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	360	165	360	50	70	20
FISHCOVR	20	10	0	25	25	0	25	0	25	0	80	10	10	0	10	10	0	0	0	0	0	0	0	0
SUBSTRT	30	30	0	30	30	0	30	0	30	0	30	30	30	0	30	30	0	0	0	0	0	0	0	0
SILTED	2	3	0	2	2	0	2	0	1	0	1	3	3	0	3	3	0	0	0	0	0	0	0	0
POOL	25	25	0	40	40	0	40	0	10	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0
RUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RIFFLE	75	75	0	60	60	0	60	0	50	0	99	90	99	0	99	99	0	0	0	0	0	0	0	0
SPRTFISH	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WILLOW	2	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0
AUMS	38	475	333	245	58	848	642	391	389	130	919	331	302	88	292	137	46	200	44	267	12	938	19	752
SEPTIC	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Table 20. Land unit attributes proposed for forecasting use intensity (Equation 5).

Uses	Attributes
1. Commercial logging	A3 B4 (A17-A16) B5 A4
2. Firewood cutting	A13 A7 A4 (A17+A16)/2 A12 B1 B2 B3
3. Phosphate mining	A14 (A17-A16) (A17+A16)/2 A12
4. Oil and gas exploration	A12
5. Cattle grazing	A2 A3 (A17-A16) A4 A12 B24
6. Sheep grazing	A2 A3 A4 A12 B24
7. Deer habitat	(A17+A16)/2 A3
8. Elk habitat	(A17+A16)/2 A3
9. Moose habitat	A2 A3
10. Hunting	A2 (A17+A16)/2 A12 B7
11. Hiking - dispersed camping	A3 A4 A7 (A17-A16) B15 B12 B18 A12 B11
12. Concentrated camping	A2 A3 A4 A7 B12 B15
13. Roads	A4 A7 (A17-A16)(A17+A16)/2 B5 B15
14. Snowmobiling	A2 A3 A4 A7 (A17+A16)/2 (A17-A16) A12
15. Summer off-road vehicle use	A2 A3 A4 (A17+A16)/2 (A17-A16) A12
16. Buildings	A2 A4 A7 B25 (A17+A16)/2 (A17-A16) A12 B12 B15
17. Archaeologic & historical resources	B12 B15 A15
W1. Fish habitat	A9 A10 A11 B16 B17 B18 B19 B20 B21 B22 B23
W2. Fishing	A4 A7 A8 A9 B17 B19 A12 B10 B22
W3. Runoff for downstream use	A2 A3 (A17+A16)/2
W4. Quality of runoff	A2 A3 A14

Table 21. Land unit attributes proposed for forecasting public impact (Equation 6).

Uses	Attributes
1. Commercial logging	B18 B13 B14 A2
2. Firewood cutting	A13 B13
3. Phosphate mining	B18 B13 B14 A2
4. Oil and gas exploration	A2
5. Cattle grazing	A2
6. Sheep grazing	A2
13. Roads	B5
15. Summer off-road vehicle use	A2
16. Buildings	B14

Table 22. Suggested attributes pertaining to the study area as a whole.

Attribute	Characteristic Measured and Measurement Method
C1	General profitability of lumbering, price of lumber of the sort produced in the watershed.
C2	Distance from sawmill (Afton, Wyoming; Montpelier, Soda Springs and Pocatello, Idaho).
C3	Total local lumber available.
C4	Local economic impact of logging as determined by an economic multiplier.
C5	Need of region for economic stimulation (current unemployment rate).
C6	Size of local lumber industry. Percentage of county employment in wood products industry.
C7	Population pressure demand for recreation activity as estimated by a gravity model ($\Sigma P/d^n$).
C8	General profitability of firewood cutting. Price of firewood per cord: \$60.00 unsplit and delivered, \$80.00 split and delivered.
C9	Price of competing fuels. Price per BTu of predominate fuel type in area. City of Soda Springs (electric): \$1.18 x 10^{-3}/Btu. Utah Power and Light (electric): \$0.73 x 10^{-3}/Btu. Intermountain Fuel (gas): \$5.4 x 10^{-4}/Btu.
C10	Priority of national goal to use domestic energy sources. Percentage of fuel needs being imported.
C11	General profitability of phosphate. Sale price of product phosphate and any associated by-products.
C12	General cost of phosphate processing including pollution control at the plant.
C13	General cost of phosphate mining including cost of restoring mined areas to meet environmental standards.
C14	Local economic impact of phosphate mining as determined by an economic multiplier.
C15	Size of local phosphate industry. Percentage of county employment in phosphate mining industry.

Table 22. Continued.

Attribute	Characteristic Measured and Measurement Method
C16	Percentage of national phosphate needs imported.
C17	General profitability of oil and gas development. Price of imported oil per barrel.
C18	General cost of oil refining. Cost of refining the type of oil found in this area.
C19	General cost of oil and gas exploration. Average cost of restoring exploration sites to meet environmental standards.
C20	General profitability of cattle ranching. Price of beef.
C21	Access to good range in the area.
C22	Competitive position of cattle ranching in this area. Percentage of annual feed requirements grown locally.
C23	Local economic impact of ranching. Ranching economic multiplier.
C24	Importance of ranching to local economy. Percentage of county employment in ranching.
C25	General profitability of sheep herding. Price of wool.
C26	Access to good sheep grazing in the area.
C27	Prevalence of good winter big game habitat at lower elevations.
C28	Ecological balance for deer population. Current area deer population divided by population in an ecologically balanced situation.
C29	Importance to public of maintaining a deer population.
C30	Importance to public of elk. Statistics on number of vistors who come to see elk.
C31	Importance to public of moose.
C32	Local economic impact of people coming to see wildlife as determined by an economic multiplier.

Table 23. Proposed regional attributes for forecasting use intensity (g_u function).

Uses	Attributes
1. Commercial logging	C1 C2 C3
2. Firewood cutting	C7 C8 C9 C43
3. Phosphate mining	C11 C12 C13
4. Oil and gas exploration	C17 C18 C19
5. Cattle grazing	C20 C21 C22
6. Sheep grazing	C25 C26
7. Deer habitat	C27
8. Elk habitat	C27
9. Moose habitat	C27
10. Hunting	C27 C7 C43
11. Hiking - dispersed camping	C7 C35 C36 C43
12. Concentrated camping	C7 C35 C37 C43
13. Roads	C40
14. Snowmobiling	C41 C35 C7 C43
15. Summer off-road vehicle use	C42 C7 C43
16. Buildings	C45 C46 C35
17. Archaeologic & historical resources	C35 C7 C43
W1. Fish habitat	
W2. Fishing	C7 C43
W3. Runoff for downstream use	C51
W4. Quality of runoff	

Table 24. Proposed regional attributes for forecasting public impact (h_u function).

Uses	Attributes
1. Commercial logging	C4 C5 C6
2. Firewood cutting	C10
3. Phosphate mining	C14 C5 C15 C16
4. Oil and gas exploration	C10
5. Cattle grazing	C23 C24
6. Sheep grazing	C23
7. Deer habitat	C28 C29
8. Elk habitat	C30
9. Moose habitat	C31 C32
10. Hunting	C32
11. Hiking - dispersed camping	C32
12. Concentrated camping	C32 C38
13. Roads	C39
14. Snowmobiling	C32
15. Summer off-road vehicle use	C32 C44
16. Buildings	C47
17. Archaeologic & historical resources	C32
W1. Fish habitat	C48 C49
W2. Fishing	C32
W3. Runoff for downstream use	C50
W4. Quality of runoff	C52

1. Commercial logging

Estimates of the amount of timber harvested in 1980 were based on records of past timber sales and plans for future sales as obtained from the Forest Service. Over the past eight years, the harvest has averaged about 2,500 MBF. For grouping harvests according to sales, commercial logging was taken as a 0-1 variable according to whether a harvest was sequenced next in the Forest Service 5-year plan. Two sites were evaluated as possibilities for being next. One was the timber that would be harvested with the opening of the Diamond Creek mine. The other was the Smoky Canyon sale area as shown on the Forest Service timber harvest planning map. For these two areas, the harvest by land unit was calculated (but not used in the optimization model except for firewood as described below) as follows:

a. The sale area was estimated from the Forest Service map digitizer.

b. By assuming uniform distribution of the timber over a sale area, the total timber volume was divided by the area to give MBF per acre.

c. The portion of each land unit (Figure 6) in the sale area was estimated (in tenths).

d. The portion was multiplied by the land unit area and the average MBF/acre to estimate the harvest from the land unit.

2. Firewood cutting

Firewood cutting was allocated according to the amount of material present, physical access, and legal access. An index combining these indicators was used as follows to allocate cutting among study area units:

a. Material present. The availability of wood for the cutting was estimated from three variables: vegetative cover, beetle kill, and commercial logging. From assumptions on representative tree size, stand density, and percentage of dead trees, the estimates of material availability were

74.31 cords/conifer acre x 5% dead = 3.72 c/CA

57.29 cords/aspen acre x 10% dead = 5.73 c/AA

74.31 cords/beetle kill acre

1.0 cord/MBF commercial harvest

b. Physical access was represented by an index constructed to first increase and then decrease as the density of roads increased.

$$P_a = \frac{RDMI/SQMI}{4} - \left(\frac{RDMI/SQMI}{8} \right)^2 \quad . . . . \quad (8)$$

c. Legal access to firewood was designated by a binary variable taken as 0 on private property, active mines, and areas where vehicle use is restricted.

d. Combining these three factors, the unit use index is

$$I_{2,i} = ([((\text{UNITSIZE} * \%\ \text{CONIF}) - (\text{UNITSIZE} * \%\ \text{BEETKILL})/100)$$

$$* \text{CORD/CONIFACRE} + (\text{UNITSIZE} * \%\ \text{BEETKILL}/100$$

$$* \text{CORD/BEETACRE}) + (\text{UNITSIZE} * \%\ \text{ASP}/100 * \text{CORD/ASPACRE})]$$

$$* (100 - \%\ \text{RESTRICT}/100) * \left[\frac{\text{RDMI/SQMI}}{4} - \left(\frac{\text{RDMI/SQMI}}{8}\right)^2 \right]$$

$$+ (\text{SALEBDFT}/1{,}000 * \text{UNITSIZE IN/SALESIZE}) \quad \ldots \quad (9)$$

The total firewood cutting was allocated proportional to this index.

3. Phosphate mining

Mine lease areas, acres disturbed, and pit boundaries were taken from the phosphate EIS and the Greiner Inc. impact study for the six operating or scheduled mines wholly or partially in the study area. The projected ore extraction over the mine life was divided by the pit size for average tons/pit acre. This was multiplied by the acres of pit in a unit to estimate tons per unit as illustrated for the Diamond Creek Mine in Table 25.

4. Oil and gas exploration

The two exploratory holes drilled in 1980 were in land units 292 and 337.

5. Cattle grazing

The distribution of cattle grazing within areas where cattle are allowed to graze was assumed to be proportional to range productivity estimated in dry weight of annual forage production from information in Table 3. The division of the study area between cattle and sheep allotments is shown on Figure 7. Annual dry weights per unit area were taken as 2,500 for VH, 1,500 for H, 750 for M, 375 for L, and 150 for VL. First, potential productivity was estimated as P_i, the annual production potential of unit i in pounds per acre. Each P_i was calculated by multiplying the above dry weight by the area of the unit and dividing the dry weight of one AUM. The maximum grazing allocation (all animals) for a unit was taken as 0.6 P_i based on an assumption that no more than 60 percent of the dry weight of forage produced should be consumed to maintain healthy range conditions.

The Forest Service data on cattle grazing provided total AUMs for large "allotments" only partly within the boundaries of the Upper Blackfoot study area. Allotment AUMs were assigned to the study area

Table 25. Estimated phosphate production from the Diamond Creek Mine.

PIT SIZE	AVERAGE TONS/ACRE	LAND UNITS	MINE ACRES	TONS/UNIT
400 ac	143,750	101	24	3.45×10^6
		117	2	0.29×10^6
		119	70	10.06×10^6
		120	36	5.17×10^6
		125	26	3.73×10^6
		126	159	22.86×10^6
		152	23	3.31×10^6
		153	58	8.34×10^6

proportional to the fraction of the allotment area within the study area based on the assumption that average range conditions prevail over large areas. AUMs were assigned to land units within the study area proportional to land unit range productivity (the product of P_i and area).

6. Sheep grazing

Sheep grazing was distributed over the land units by the method described above for cattle with the same estimates of range productivity but different designated allotment areas.

7. Deer winter feeding

The index originally proposed for allocating big game grazing among land units had of the form:

$$I_{k,i} = P_i \quad (b_1 + b_2 L_i + b_3 V_{k,i}) \qquad \text{. . . . .} \qquad (10)$$

where

$I_{k,i}$ = grazing by species k in unit i

P_i = AUM production potential of unit i

L_i = average elevation of unit i

$V_{k,i}$ = preference of species k for vegetation growing in unit i and defined by summing species preferences over the six vegetation types used in this study with the formula

$$V_{k,i} = \sum_{j=1}^{6} w_{k,j} \; T_{j,i} \qquad \text{. . . . .} \qquad (11)$$

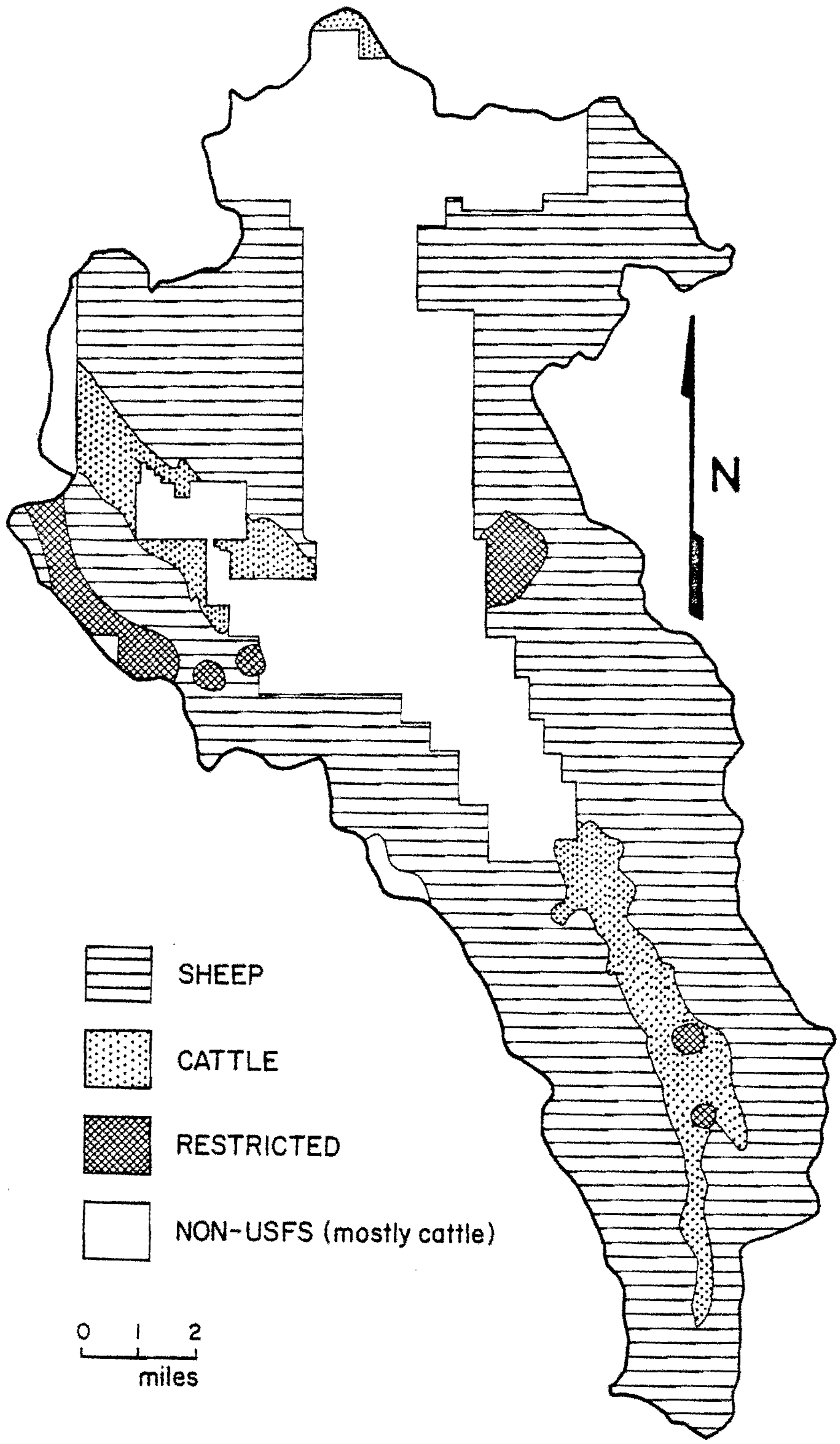


Figure 7. Cattle and sheep grazing allotments in the Upper Blackfoot watershed.

where

$w_{k,j}$ = weighted preference of species k importance for vegetation type j

$t_{j,i}$ = fraction of unit i in vegetation type j

Data on the locations of big game sitings (Table 10) were analyzed in an attempt to estimate b_1, b_2, and b_3. The information proved insufficient to be conclusive, but vegetation preference appeared to be the dominant factor. Consequently, b_1 and b_2 were taken as zero, and b_3 was taken as unity.

The vegetation weightings estimated from the siting data were as shown on Table 26.

The species grazing preference index was used to allocate range forage residual to cattle and sheep use. The residual amounts could also be checked for sufficiency in supporting current game populations. Deer grazing totals from the Wildlife Survey were distributed over the land units proportional to the values computed for $I_{k,i}$ from Equation 10.

8. Elk winter feeding

Elk feeding was distributed among land units using the coefficients shown in Table 26 to compute the $I_{k,i}$. Elk are shown to feed relatively more on grass and less on brush than do deer.

9. Moose habitat

Moose feeding was also distributed among land units by the same procedure. Moose were generally found among the trees and may feed largely on willow.

10. Hunting

The Forest Service estimated hunting for 1980 for the northern portion of the study area (890 hunter days in units 205 through 343), the southern portion east of Diamond Creek (2000 hunter days), and the southern portion west of Diamond Creek (1020 hunter days). These hunter days were disaggregated to land units proportional to a weighting index, based on unit size, use restrictions, maximum elevation, and unit type, and having the form:

$$I_{10,i} = \frac{(\text{unit mi}^2)(\%\text{not restricted})[(-16{,}000\ (\text{max. elv.}) - 0.1 + (\text{type})]}{\text{base area}} \qquad \ldots \quad (12)$$

The rationale for the functional form combined the concepts:

a. Size - the larger the unit, the more hunting.

b. Restriction - the fewer the restrictions, the more hunting.

c. Elevation - the higher the elevation, the less the hunting.

Table 26. Species preferences of vegetation types.

Vegetation Type	Species		
	Deer	Elk	Moose
CONF	0.278	0.335	0.629
ASPEN	0.181	0.278	0.223
MBRUSH	0.357	0.102	0.063
SAJGR	0.062	0.054	0.007
RIPGR	0.000	0.147	0.000
WILLOW	0.122	0.084	0.077

d. Land types - some land types are better hunting areas than others due to better accessibility and habitat. Land types (defined on Table 3) were weighted from these considerations as follows:

Number	Weight
1-3, 18-21, 38-40	0.0
14-17, 36-37	0.3
10-13, 22, 23	0.5
7-9, 25-35	1.0

11. Hiking - dispersed camping

Hiking in a unit was estimated as proportional to a use index calculated from road type, aesthetic attractiveness, restrictions, stream presence, vegetation, elevation, and ownership:

$I_{11,i}$ = Total DC&H days

* (SQMI/160) * AESTHETICS * RESTRICT * ROADTYPE *

STREAMPRES * AV ELEV. * VEG * OWNERSHIP . . (14)

where

SQMI/160 = proportion of study area in unit

AESTHETICS = 1.0, 0.5, or 0.05 if the highest Forest Service aesthetic class is 1 (distinctive), 2 (average), or 3 (minimal), respectively

RESTRICT = fraction of area restricted to hiking

ROAD TYPE = 0.01 if road type is paved or none and there are no trails

= 0.11 if road type is paved or none and there are trails

= 0.75 if road type is gravel and there are no trails

= 0.85 if road type is gravel and there are trails

= 0.90 if road type is graded dirt and there are no trails

= 1.0 if road type is graded dirt and there are trails

= 0.5 if road type is four wheel drive dirt and there are no trails

= 0.6 if road type is four wheel drive dirt and there are trails

STREAMPRES = 1.0 if a third or higher order stream is present, and 0.5 otherwise

AV ELEV. = 1.0 if the unit average equals the study area average (7,475 feet) and declines toward 0.25 as the unit average diverges from the area average

VEGETATION = 0.9 if riparian grass is dominant

= 0.8 if aspen is dominant

= 0.5 if conifer is dominant

= 0.1 if sage and grass are dominant

= 0.01 if mountain brush or willow is dominant

OWNERSHIP = proportion of unit publicly owned

12. Concentrated camping

The Forest Service reports campground use for the two developed sites. Estimates, however, are subject to significant error and probably on the high side.

13. Roads

Maps showing road locations were directly used to assign road lengths by types to land units.

14. Snowmobiling

The index hypothesized for allocating snowmobiling among land units judged the primary factors to be the presence of trails and roads, distance to the Narrows, aesthetic class, elevation, and restrictions. Specifically:

$$I_{14,i} = \text{Total snowmobile days} * (1 - \%\ \text{restricted}/100) * \text{ROAD TYPE} * \text{ROAD DISTANCE} * \text{AESTHETIC VALUE} * (\text{Maximum elevation}/100) \quad (14)$$

Road type indicators were 1.0 for paved, 0.8 for gravel, 0.4 for dirt (passenger), 0.25 for dirt (four wheel drive), 0.2 for trail, and 0 for none. Road distance indicators ranged between 0 and 1.0, with minimum values assigned to units very close or very far from the Narrows. The aesthetic value indicator was taken as 1.0 for distinctive, 0.66 for common, and 0.33 for minimal. The elevation indicator suggests that snowmobilers prefer the better views from higher elevations other factors being equal.

15. Summer ORV

The index used to allocate ORV use was based on area, road type, use restrictions, aesthetic class, and elevation. Specifically,

$$I_{15,i} = \text{Total ORV days} * (\text{area}/160) * \text{ROAD TYPE } (1 - \% \text{ restricted}/100) * \text{AESTHETIC CLASS} * \text{ELEVATION} \quad . \; . \; . \quad (15)$$

Road type was assigned 0.0 for paved, 0.5 for gravel, 0.75 for dirt (passenger), 1.0 for dirt (four wheel drive), 1.0 for trail, and 0 for none. Aesthetic class was assigned 1.0 for distinctive, 0.75 for common, and 0.50 for minimal. Elevation was assigned a value between 1.0 and 0.75 based on a comparison of a unit's elevation with that of the study area as a whole. Units with average elevation less than or equal to the study area average of 7,475 were assigned 1.0. Units with a higher average elevation were assigned a number according to the formula

$$i = -0.00023 \bar{E} + 1.966. \quad . \; . \; . \; . \; . \; . \; . \; . \quad (16)$$

16. Buildings

The 12 counted buildings were directly assigned to the land units in which they were located.

17. Archeological or historical sites

Lane's Grave was identified with the land unit in which it is located, and a map showing the route of the Lander Cutoff was used to identify the land units crossed.

W1. Fish Habitat

The fish habitat quality index (Equation 7) was constructed from observed characteristics of a water unit (stream reach) and provided values that could be directly assigned to the land units through which the stream flows. Fish populations were assumed to be proportional to stream length for a given value of the habitat index.

W2. Fishing

The 1978 census estimates of fishing activity were subdivided into seven reaches (Table 11). Estimates of fishing intensity per unit stream length in each of the 55 reaches identified for analysis were based on information on a fishing intensity index constructed from information on fish population and factors affecting access to the streams including restrictions placed by property owners, distances from the nearest road, streamside vegetation, and flow. The angler days within the seven reaches defined for the census were allocated to the 55 water units in proportion to the ratio of the unit length to the reach length, weighted according to the fishing intensity index.

W3. Runoff

The distribution of average annual runoff among source land units was estimated by applying the Kentucky Watershed Model (Ross 1970). The model was initially calibrated for the 2.70-square mile Stewart Creek Catchment. The simulation used hourly precipitation amounts recorded at Henry, Idaho, and daily minimum and maximum temperatures recorded at Soda Springs. Hargreaves and Samani's (1982) method was used to estimate daily evaporation from the temperature data. The calibration was based on matching 25 flow measurements taken during the summer of 1976. In that year, the earliest measurement was 1.7 cfs on May 4. The flow peaked from snowmelt at 10.0 cfs on June 2 and receded through the summer to 1.5 cfs on September 23. No flow measurements were made during the winter.

For modeling purposes, the Stewart Creek Catchment was divided into two elevation zones, one averaging 1300 feet higher than the Henry gage and the other 2300 feet higher. Model parameters were adjusted by trial and error until the simulations matched the available recorded flows. Of the model parameters, the snowmelt degree-day factor had the primary influence on the timing and magnitude of the runoff peak, and the soil depth and permeability had the primary influence on the annual runoff volume. The 25 recorded flows and corresponding synthesized flows for the accepted calibration, listed in Table 27, had a correlation coefficient (r^2) of 0.902.

The land cover changes in the Upper Blackfoot likely to most significantly affect runoff are timber cutting that removes the conifers, grazing of cut areas afterwards, and mining. For each cover situation, a set of hypothetical model parameter values shown in Table 28 was used to simulate the runoff volumes, flood peaks, and low flows shown in Table 29. Assumptions used in hypothesizing values for the model parameters were 1) interception is approximately equally divided between the conifer forest and understory growth, 2) mining disturbs the earth to the point of doubling the available volume of depression storage, 3) grazing reduces depression storage to two thirds to three fourths of its former value, 4) mining breaks up underlying impervious layers and triples active soil moisture storage, 5) transpiration rates are reduced to 70 percent of their former value by cutting timber, 50 percent by grazing, and 10 percent by mining, 6) mining loosens the soil and increases infiltration rates by a factor of four thirds, and 7) grazing reduces infiltration rates by half (Hawkins and Gifford 1979).

The hydrologic effects of mining, lumbering, and grazing vary with precipitation rates and elevation (principally because shorter seasons reduce total evapotranspiration). The relationship was investigated by

Table 27. Results from 1976 Stewart Creek hydraulic simulation.

Date	Recorded Flow	Simulated Flow
May 4	1.7	0.4
6	2.5	0.4
11	4.3	5.0
13	4.8	4.6
17	6.1	5.5
19	7.5	8.2
25	9.3	10.5
27	9.6	9.9
Jun 2	10.0	11.9
9	9.9	9.4
15	9.2	9.1
22	7.8	8.5
29	7.3	7.0
Jul 9	6.6	5.7
13	5.6	5.2
20	5.1	4.8
27	4.0	4.3
Aug 3	3.4	3.9
10	3.8	3.5
18	3.3	3.1
26	3.1	2.8
Sep 2	2.4	2.5
9	1.7	2.2
16	1.6	2.0
23	1.5	1.8

Table 28. Stanford Watershed Model parameter values for run groups L, M, N, and P.

	Forest L	Cut M	Mined N	Grazed P
VINTMR (Interception)	0.20	0.10	0.00	0.10
BUZC (Surface detention)	0.20	0.20	0.40	0.15
SUZC (Seasonal surface detention)	0.15	0.15	0.30	0.10
LZC (Soil moisture storage)	1.00	1.00	3.00	1.00
ETLF (Evapotranspiration)	0.20	0.14	0.02	0.10
BMIR (Infiltration)	7.50	7.50	10.00	3.75

Table 29. Analysis of runoff variation with elevation and cover.

Run	Precipitation Multiplier for Henry Data	Elevation above Soda Springs (1000 feet)	Fraction in Conifer Forest	Annual Runoff (in.)	Peak Flow (cfs)	Low Month (sfd)
Present Conifer Forest						
L1	0.97	0.30	0.90	6.47	6.4	22.6
L2	0.97	1.40	0.90	7.22	7.6	26.2
L3	1.26	0.30	0.90	9.50	10.1	41.9
L4	1.26	2.50	0.90	10.34	10.5	47.1
L5	1.26	2.50	0.90	11.28	11.2	52.7
L6	1.55	1.40	0.90	13.62	18.5	68.6
L7	1.55	2.50	0.90	14.60	15.6	76.8
L8	1.80	1.40	0.90	16.53	23.4	89.7
L9	1.80	2.50	0.90	17.87	21.4	98.8
With Logging						
M1	0.97	0.30	0.00	10.23	18.0	32.8
M9	1.80	2.50	0.00	23.58	41.1	95.6
With Mining						
N1	0.97	0.30	0.00	8.27	10.7	32.9
N9	1.80	2.50	0.00	21.00	33.2	114.9
With Grazing of Cut Areas						
P1	0.97	0.30	0.00	10.58	38.8	24.6
P9	1.80	2.50	0.00	24.59	82.8	74.2

simulating ranges of average annual precipitation amounts in the Blackfoot from 17.25 to 32.00 inches, and elevations from 300 to 2500 feet higher than the Soda Springs temperature gage. Precipitation is correlated with elevation, but other factors such as aspect and exposure also have a large influence. Consequently, different precipitation amounts were hypothesized for given elevations.

Three elevations and four precipitation totals (Table 29, L1-L9) were used to simulate total annual runoff, the highest flow peak (snowmelt runoff), and the runoff volume during the driest summer month. Combinations with high precipitation at low elevation and low precipitation at high elevation were excluded. A regression of the simulated annual runoff on precipitation in inches (P) and elevation in feet (E) estimated the annual runoff volume from a conifer forest in inches (R') to be

$$R' = -10.10 + 0.000832\,E + 0.640\,P \qquad (17)$$

with a correlation coefficient (r^2) of 0.998. A regression of the simulated annual flow peak (cubic feet per second) on the same two variables gave

$$Q' = -13.36 + 0.000829\,E + 0.803\,P \qquad (18)$$

with $r^2 = 0.982$. For low flows (monthly runoff in second foot days), the relationship was

$$L' = -88.45 + 0.00524\,E + 4.352\,P \qquad (19)$$

with $r^2 = 0.996$.

The above results show all three relationships to be highly linear. Consequently, rather than simulate all nine points for land cover changes, only the two extreme points were simulated, and the linear relationships found for conifer forest were assumed to represent the pattern of variation for the intermediate situations. The consequent procedure for estimating R, Q, and L for watersheds with other cover characteristics was to multiply the above equation by constants.

For a catchment with the trees removed (M on Table 29), it was thus assumed that runoff can be estimated as a simple multiple of the runoff from the conifer forest:

$$R = F_R\,R' \qquad (20)$$

where, based on points L1, L9, M1, and M9,

$$F_R = -0.228\,R' + 1.727 \qquad (21)$$

For catchment cover that combines conifer forest and other vegetation, with C defined as the decimal fraction of the catchment with conifer cover,

$$R_m = (F_R + C - C\,F_R)\,R' \qquad (22)$$

Because a value for R' can be interpolated for any precipitation and elevation from Table 29, this equation provides an unverified but reasonable basis for estimating runoff from all possible combinations of annual precipitation, elevation, and cover.

For snowmelt flood peaks, the terminology used was

$$Q = F_Q Q' \qquad (23)$$

where

$$F_Q = -0.0651 Q' + 3.223 \qquad (24)$$

Also,

$$Q_m = (F_Q + C - C F_Q) Q' \qquad (26)$$

The same three equations were also used for low flows with

$$F_L = -0.0064 L' + 1.595$$

From these equations, one can estimate the hydrologic effect of cutting conifer forest from a portion of the watershed. For example, by applying Equation 22 (or the corresponding equations for Q and L) with C_1 as the conifer fraction before cutting and C_2 as the fraction afterwards, R_{m_2} may be obtained by placing C_2 in Equation 22, and R_{m_1} by placing C_1. The increase in annual runoff is

$$\Delta R = R_{m_2} - R_{m_1} \qquad (27)$$

For estimating the effects of mining a catchment presently covered with conifer, the assumed relationship was

$$R = M_R R' \qquad (28)$$

where

$$M_R = -0.0088 R' + 1.337 \qquad (29)$$

If the catchment has some other cover before mining,

$$R = M_R R'/F_R \qquad (30)$$

For mixed conifer cover,

$$R = C M_R R' + (1 - C) M_R R'/F_R \qquad (31)$$

For flood peaks and low flows, the relationships to be used in place of Equation 29 are

$$M_Q = -0.0137 Q' + 1.775 \qquad (32)$$

$$M_L = -0.0039 L' + 1.549 \qquad (33)$$

For estimating the effects of grazing (assuming grazing does not pertain to conifer forests),

$$R = G_R F_R R' \qquad (34)$$

where

$$G_R = 0.000749 R' + 1.02 \qquad (35)$$

if the grazing intensity consumes all available AUM. For a lesser grazing intensity

$$G_i = G_a/G_m \qquad (36)$$

where G_a AUM out of G_m total are actually consumed. The annual runoff volume from an area grazed at intensity G_i was estimated as

$$R_i = (1 + G_i G_R - G_i) F_R R' \qquad (37)$$

For flood peaks and low flows, the relationships to be used in place of Equation 35 are

$$G_Q = 0.0150 Q' + 1.188 \qquad (38)$$

$$G_L = 0.000478 L' + 0.734 \qquad (39)$$

Multipliers from these relationships are summarized in Table 30.

W4. Water Quality

The water quality in a given stream reach represents an integration of upstream effects, pollutant loadings and dilution occurring within the reach itself, and biogeochemical transformations occurring within the reach. Although the water quality data base for the study area was much better than that existing in most wildland watersheds, Doebley and Messer (1981) found the following problems with interpreting the effects of tributary land use on water quality:

1. Annual variability in stream discharge influenced water quality at least as much as land use.

2. Variations in water quality could not be adequately described by mixing and dilution processes.

3. Chemical variability among closely spaced sites along a stream reach, resulting from ungaged groundwater inputs and stream ecosystem biogeochemistry, makes all but the most highly controlled studies of land use effects within-reach water quality highly suspect.

The result was that extensive statistical analyses gave few high correlations between land use and water quality parameters in any of the downstream reaches.

An additional problem was encountered in defining water quality. A nutrient that could contribute to good water quality for fish habitat or irrigation water could be detrimental to offsite use in a reservoir. Alternatively, parameters such as suspended solids may be detrimental to

Table 30. Hydrologic multipliers with land use change.

Cover	Location	
	Low and Dry	High and Wet
Mean Annual Runoff, Conifer in.	6.47	17.87
With cutting, multiply by	1.58	1.32
With mining, multiply by	1.28	1.18
With cutting and grazing, multiply by	1.63	1.37
Annual Snowmelt Flood Peak, cfs	6.2	20.8
With cutting, multiply by	2.82	1.87
With mining, multiply by	1.69	1.49
With cutting and grazing, multiply by	4.09	3.31
Low Monthly flow	22.6	98.8
With cutting, multiply by	1.45	0.96
With mining, multiply by	1.46	1.16
With cutting and grazing, multiply by	1.09	0.75

both fish habitat and reservoir siltation, but the order of magnitude of the corresponding impacts could be significantly different. Mahmood and Messer (1982) attempted to circumvent this problem by creating a single-valued multivariate statistical water quality index for the study streams. In this index, the criterion for decreasing water quality was the difference between a group of weighted water quality variables in a specific stream reach (normalized according to their standard deviations) and the mean values for all reaches in the study area. The index appeared to be a good predictor of invertebrate biomass in a stream reach, and an example of how the index could be used in a linear programming model was given. However, insufficient data were available to calibrate the model for the study area. Consequently W4 was judged to be too complex for further detailed simulation in this study.

Tabulation of Use by Land Unit

The disaggregated use data are given in the 20 (W4, water quality excluded) by 343 matrix of Table 31. As is obvious from the above descriptive material on the methods of estimation, many gross approximations were made. Table 31, however, does provide a general notion as to the pattern of spatial variability of use over the total area.

Table 31. Estimated 1980 uses by land unit.

Land Unit	CL[1]	FC[2]	PM[3]	CT[4]	SH[4]	DR[5]	EL[5]	MS[5]	HU[6]	HC[7]	RD	SN[8]	OR[9]	FH[10]	FI[11]	RN[12]
1	0	135	0	0	24	4	22	41	14	56	.5	9	17	-	-	178
2	0	55	0	0	17	18	91	170	3	35	.2	6	12	-	-	111
3	0	297	0	0	10	8	50	93	31	128	1.1	21	43	-	-	405
4	0	422	0	11	96	31	93	187	83	507	1.7	41	84	4.3	1	844
5	0	329	0	0	143	183	545	1097	22	444	1.3	36	67	5.6	1	739
6	0	0	0	0	40	16	83	155	13	1	0	2	0	-	-	168
7	0	70	0	1	1	0	0	1	1	46	.3	4	7	17.4	0	59
8	0	0	0	0	24	63	63	39	30	2	0	2	0	-	-	293
9	0	0	0	0	3	1	6	12	4	0	0	1	0	-	-	52
10	0	0	0	0	11	17	26	25	30	2	0	2	0	-	-	244
11	0	0	0	0	4	2	8	9	9	1	0	1	0	-	-	82
12	0	13	0	0	11	3	13	12	9	15	.4	2	4	-	-	73
13	0	264	0	14	56	16	76	107	82	176	1.5	76	37	-	-	699
14	0	29	0	1	1	0	0	1	0	27	.2	2	4	17.1	0	47
15	0	18	0	0	47	19	98	182	60	5	.2	8	33	-	-	78[illegible]
16	0	0	0	0	19	49	49	30	23	1	0	1	5	-	-	226
17	0	0	0	0	12	29	29	18	27	1	0	1	0	-	-	270
18	29	0	0	0	6	2	7	8	8	0	0	0	0	-	-	70
19	21	0	0	0	32	9	41	57	4	1	0	2	0	-	-	373
20	0	166	0	10	7	18	19	30	16	87	1.3	19	11	11.7	0	172
21	0	0	0	0	11	16	25	24	14	0	0	1	0	-	-	110
22	-	30	0	28	28	21	43	94	1	57	.4	12	6	6.3	0	4
23	0	38	0	1	1	1	1	2	1	83	.7	18	11	2.3	0	166
24	0	0	0	0	13	5	26	49	8	0	0	1	3	-	-	99
25	0	0	0	0	18	4	17	24	19	0	0	1	4	-	-	170
26	33	0	0	0	5	1	6	12	4	0	0	0	0	-	-	52
27	36	0	0	0	11	3	14	18	8	0	0	0	2	-	-	69
28	228	0	0	0	35	9	45	84	28	1	0	2	11	-	-	363
29	327	12	0	0	51	21	60	106	8	2	.1	4	16	-	-	562
30	6	169	0	28	19	15	44	88	1	54	.6	12	6	8.9	0	88
31	244	103	0	0	29	9	48	90	30	61	.8	13	31	-	-	447
32	69	0	0	0	16	6	27	38	15	0	0	1	0	-	-	127
33	159	0	0	0	19	6	31	58	2	2	0	2	0	66.0	0	290
34	182	91	0	0	21	7	36	67	22	45	.4	10	22	-	-	332
35	209	105	0	0	61	29	102	119	58	105	.9	14	33	-	-	477
36	49	148	0	19	77	17	90	125	130	395	.9	27	62	55.4	0	900
37	0	0	0	0	25	0	4	27	29	139	0	20	7	14.6	0	211
38	0	1	0	28	0	5	13	25	0	5	.3	6	3	15.1	0	60
39	0	212	0	20	0	4	16	28	8	24	.5	5	11	-	-	175
40	0	0	0	4	0	2	9	6	0	0	0	0	0	-	-	42
41	0	0	0	38	0	48	14	71	0	0	.2	5	2	8.6	13	54
42	0	2	0	53	0	57	24	87		0	.4	11	4	-	-	115
43	0	0	0	5	0	4	3	8	2	0	0	0	0	15.4	13	42
44	0	0	0	0	7	6	28	40	3	1	0	2	7	-	-	266
45	0	66	0	1	2	4	1	2	1	66	.[illegible]	14	7	4.6	0	133
46	0	27	0	0	30	97	101	130	35	76	.[illegible]	8	19	32.9	25	478
47	0	46	0	0	4	1	5	9	9	0	.8	1	2	-	-	85
48	0	66	0	0	16	7	35	49	37	45	1.0	10	2	-	-	326
49	0	51	0	0	10	25	25	25	15	27	1.0	6	12	-	-	193
50	0	0	0	0	28	4	20	37	0	64	0	14	32	-	-	465
51	0	0	0	0	14	6	26	42	28	1	0	1	7	-	-	242
52	0	43	0	32	4	14	24	34	31	99	.5	29	15	-	-	302
53	0	0	0	14	0	18	76	0	0	11	.1	3	1	-	-	30
54	0	64	0	67	0	46	52	134	1	40	.3	9	5	2.7	32	97
55	0	0	0	1	1	3	9	18	8	0	0	1	0	31.5	24	91
56	0	0	0	0	22	8	39	63	4	1	0	2	0	-	-	362
57	0	0	0	0	33	1	6	4	5	1	0	2	8	-	-	290
58	0	0	0	0	30	26	40	38	46	1	0	2	9	-	-	322
59	0	12	0	13	16	15	23	29	31	102	.1	23	12	15.6	0	248
60	0	0	0	0	77	59	73	39	53	3	0	2	9	5.4	0	326
61	0	0	0	0	5	2	7	19	6	0	0	0	2	-	-	66

Table 31. (Continued).

Land Unit	CL	FC	PM	CT	SH	DR	EL	MS	HU	HC	RD	SN	OR	FH	FI	RN
62	0	0	0	0	13	20	15	4	4	0	0	0	1	-	-	54
63	0	36	0	46	11	27	50	50	74	358	.5	51	26	44.0	79	543
64	0	107	0	106	0	89	62	29	1	2	1.1	22	11	10.4	28	229
65	0	0	0	13	1	3	13	102	13	0	0	1	3	-	-	121
66	0	0	0	0	15	6	27	43	3	1	0	1	7	-	-	248
67	0	0	0	0	10	17	17	40	8	1	0	2	9	-	-	326
68	0	0	0	0	5	2	8	4	9	0	0	0	2	-	-	78
69	0	0	0	0	18	54	43	44	2	0	0	2	8	-	-	296
70	0	0	0	0	17	6	31	28	19	1	0	2	8	-	-	290
71	0	0	0	0	5	3	9	17	1	0	0	1	2	-	-	85
72	0	0	0	0	10	8	15	63	14	207	0	30	15	5.5	0	314
73	0	0	0	0	12	36	28	3	8	0	0	1	0	-	-	97
74	0	0	0	0	3	2	5	4	4	0	0	0	1	26.1	0	48
75	0	0	0	0	12	5	22	41	24	0	0	1	6	-	-	305
76	0	0	0	0	4	13	10	11	5	0	0	0	0	-	-	73
77	0	95	0	1	0	0	1	9	1	40	.3	2	5	-	0	97
78	0	19	0	0	3	7	30	4	35	2	.1	1	8	18.7	0	284
79	0	0	0	34	0	47	13	6	0	0	.1	0	2	6.3	0	48
80	0	0	0	10	40	11	51	692	55	1	0	3	13	-	-	477
81	0	73	0	0	44	35	42	72	37	199	.6	46	23	62.7	0	483
82	0	0	0	0	3	4	6	8	8	0	0	0	1	-	-	54
83	0	0	0	109	6	169	169	58	79	3	0	4	18	-	-	646
84	0	104	0	99	5	1	5	8	3	0	.5	0	1	-	-	42
85	0	183	0	2	37	14	69	7	69	2	.6	3	0	-	-	646
86	0	14	0	6	36	5	13	57	2	1	.8	1	3	22.3	0	127
87	0	0	0	0	9	44	25	4	4	0	0	1	0	-	-	151
88	0	0	0	0	51	31	86	42	62	4	0	3	12	5.0	0	427
89	0	0	0	0	18	3	16	38	16	1	0	2	8	-	-	646
90	0	0	0	0	3	6	6	8	5	0	0	0	1	-	-	48
91	0	0	0	0	12	5	25	37	15	1	0	1	0	-	-	229
92	0	0	0	0	27	64	65	14	28	0	0	1	7	-	-	247
93	0	0	0	0	6	3	6	24	3	0	0	1	0	-	-	121
94	0	0	0	35	4	11	49	24	1	0	0	1	3	-	-	115
95	0	0	0	75	0	22	25	7	0	13	.5	12	8	18.3	52	163
96	0	0	0	67	0	95	26	58	0	0	.2	0	0	11.0	30	97
97	0	0	0	6	2	2	7	6	8	0	0	0	0	-	-	66
98	0	0	0	22	0	5	21	280	24	64	0	18	7	-	-	193
99	0	0	0	36	0	23	12	12	0	6	.5	0	4	21.3	86	79
100	0	0	0	121	0	113	46	22	0	1	.7	0	6	11.1	56	175
101	0	30	0	24	0	4	14	19	0	4	.4	3	2	4.2	21	54
102	0	0	0	4	4	2	9	69	5	0	0	0	0	-	-	79
103	0	59	0	4	3	2	7	24	7	0	.3	0	0	1.7	0	73
104	0	0	0	0	8	3	14	27	9	0	0	1	0	-	-	132
105	103	0	0	0	35	15	61	59	24	1	0	2	0	-	-	290
106	331	0	0	21	11	11	57	53	0	0	0	1	0	-	-	266
107	430	22	0	14	4	7	32	44	7	0	.3	0	0	-	-	302
108	0	0	0	14	3	5	9	24	0	0	.1	0	1	-	-	60
109	193	0	0	2	22	9	10	9	4	0	0	0	0	-	-	73
110	155	0	0	1	25	1	6	0	3	0	0	0	0	-	-	54
111	0	0	0	0	34	75	59	27	4	0	0	1	6	-	-	205
112	0	0	0	0	25	10	50	93	31	1	0	3	13	-	-	465
113	0	5	0	0	34	84	84	68	36	1	.1	9	22	-	-	320
114	0	0	0	0	23	32	51	71	38	1	0	3	0	-	-	429
115	0	0	0	0	18	45	45	29	42	2	0	2	0	-	-	344
116	0	0	0	0	13	6	25	18	3	0	0	0	0	-	-	120
117	0	6	0	11	11	7	33	46	32	38	.9	8	19	-	-	308
118	0	0	0	0	5	3	10	7	1	21	0	3	6	-	-	97
119	0	7	0	8	2	2	8	7	5	20	.4	6	2	-	-	103
120	0	0	0	23	0	9	25	12	0	0	.7	0	0	.3	-	97
121	0	12	0	2	2	1	6	14	2	0	.1	0	0	-	-	54
122	0	0	0	4	0	1	6	12	0	0	0	0	0	-	-	60
123	0	0	0	0	13	6	27	19	12	1	0	1	0	-	-	127

Table 31. (Continued).

Land Unit	CL	FC	PM	CT	SH	DR	EL	MS	HU	HC	RD	SN	OR	FH	FI	RN
124	0	0	0	0	15	7	27	35	2	0	0	0	0	-	-	139
125	0	0	0	5	15	8	23	1	1	0	0	3	7	-	-	350
126	0	0	0	89	0	30	57	3	0	0	1.2	0	0	.4	150	374
127	0	0	0	5	0	2	9	16	0	0	.7	0	0	-	-	79
128	0	0	0	13	0	4	9	0	0	0	.2	0	0	19.6	0	54
129	0	0	0	10	0	3	7	0	0	0	.2	0	0	19.6	0	42
130	0	30	0	5	12	11	32	57	33	11	1.3	12	8	10.2	0	320
131	1803	0	0	0	30	17	51	102	46	0	0	2	9	-	-	507
132	193	41	0	2	8	4	12	14	9	0	.2	0	0	17.4	0	60
133	789	23	0	0	35	18	50	56	38	20	.1	13	8	.6	0	248
134	180	0	0	0	10	41	26	6	5	0	0	0	0	-	-	85
135	2063	0	10	0	41	27	124	173	3	0	0	1	0	-	-	580
136	2362	0	0	0	21	1	7	13	0	0	0	0	0	-	-	66
137	87	0	0	0	7	2	10	7	1	0	0	0	0	-	-	48
138	0	0	0	0	24	34	53	63	57	1	0	3	0	-	-	447
139	0	0	0	0	8	13	63	103	47	4	0	9	40	-	-	1473
140	0	0	0	0	94	126	195	189	34	7	0	2	11	12.4	0	821
141	0	0	0	0	64	80	69	119	4	0	0	3	13	24.0	0	483
142	0	0	0	0	6	3	13	9	6	0	0	0	0	-	-	60
143	0	0	0	0	13	5	26	49	16	0	0	1	0	-	-	242
144	0	0	0	0	12	5	25	28	3	0	0	1	0	-	-	229
145	0	0	0	0	15	14	27	52	34	0	0	1	0	-	-	290
146	0	0	0	0	24	23	36	45	4	3	0	7	21	45.4	0	459
147	0	0	0	0	6	3	12	2	12	0	0	1	3	-	-	109
148	0	0	0	0	6	15	15	9	1	1	0	1	0	-	-	115
149	0	0	0	13	1	11	9	11	0	0	.2	0	0	9.2	0	61
150	0	0	0	43	0	98	32	141	0	0	0	0	0	1.1	0	121
151	0	0	0	0	44	21	87	60	3.7	0	0	1	0	-	-	411
152	0	0	0	2	2	4	13	6	0	0	1.1	0	1	-	-	54
153	0	0	0	81	8	26	58	2	0	0	.3	0	0	-	-	338
154	0	0	0	20	0	7	14	1	0	0	.3	0	0	-	-	54
155	0	0	0	156	0	56	125	5	0	0	0	0	0	.5	5	435
156	0	0	0	42	0	14	27	1	0	0	0	0	2	-	-	175
157	393	120	0	0	11	3	17	32	0	3	.4	7	4	-	-	157
158	0	0	0	192	0	60	190	3	0	0	0	0	0	23.6	60	537
159	0	0	0	62	0	17	55	1	0	4	1.2	0	1	10.2	0	260
160	4	47	0	9	9	4	14	17	0	0	1.2	0	0	-	-	91
161	142	168	0	1	26	8	75	73	25	0	.8	1	0	-	-	362
162	8	0	0	0	29	9	44	82	4	0	0	1	0	-	-	205
163	29	55	1.7	0	105	31	117	177	8	0	.6	2	0	7.9	0	731
164	13	0	8.4	0	45	14	59	85	2	0	0	1	0	-	-	314
165	4	0	0	0	8	3	7	5	1	0	0	0	0	-	-	109
166	5	0	0	1	8	2	5	0	1	0	.1	0	0	-	-	121
167	3	14	0	14	5	6	22	19	2	0	.8	0	0	13.8	0	133
168	0	0	0	21	0	7	24	20	0	0	.3	0	0	3.2	0	175
169	0	0	0	71	0	23	51	2	0	0	1.3	0	0	74.1	0	296
170	7	0	0	0	22	7	35	49	2	1	0	1	0	-	-	163
171	2	0	0	14	2	5	23	33	7	0	0	0	0	-	-	242
172	0	0	0	38	0	13	24	1	0	0	0	0	0	-	-	320
173	0	0	0	6	0	2	4	0	0	0	0	0	0	-	-	102
174	0	0	0	65	0	19	70	1	0	0	.1	0	0	.2	68	181
175	0	0	0	9	0	3	6	0	0	0	1.0	0	0	.2	52	151
176	0	0	0	4	0	1	2	0	0	0	.2	0	0	-	-	60
177	0	0	0	0	18	6	27	25	2	1	0	1	0	-	-	127
178	0	0	0	0	11	3	10	5	1	0	0	1	0	-	-	151
179	0	0	0	0	48	14	35	110	0	0	0	2	0	-	-	169
180	0	20	0	0	15	7	19	37	1	2	1.1	1	0	2.2	47	205
181	155	32	0	0	19	10	17	11	1	43	1.1	37	12	18.0	374	290
182	0	0	0	12	1	5	23	38	9	0	0	1	0	-	-	217
183	0	0	0	4	3	2	7	6	1	0	0	1	0	-	-	109
184	20	14	0	12	12	13	30	44	2	157	.7	27	9	13.7	280	380

Table 31. (Continued).

Land Unit	CL	FC	PM	CT	SH	DR	EL	MS	HU	HC	RD	SN	OR	FH	FI	RN
185	5	0	0	60	26	166	45	245	0	0	.5	0	0	.9	204	169
186	0	0	0	12	0	3	12	0	0	0	0	0	0	-	-	48
187	93	2	0	16	36	17	31	2	0	15	1.0	0	12	-	-	205
188	229	.5	0	0	28	5	25	34	34	124	.1	43	19	-	-	447
189	61	0	0	0	7	9	14	19	4	0	0	0	0	-	-	115
190	54	0	0	0	6	11	13	5	0	0	0	0	1	-	-	145
191	5	0	0	0	3	34	20	3	0	0	0	0	0	-	-	44
192	0	0	0	0	4	1	6	10	16	0	0	1	0	-	-	145
193	0	0	0	0	0	0	1	1	1	0	0	0	0	-	-	78
194	0	0	0	0	4	2	8	14	1	0	0	0	0	-	-	72
195	0	0	0	0	19	9	48	89	3	1	0	3	12	-	-	441
196	0	0	0	0	31	106	90	43	7	0	0	2	11	60.1	0	416
197	0	0	0	0	20	8	42	79	26	0	0	1	0	-	-	392
198	0	0	0	0	11	15	16	10	1	0	0	1	0	-	-	205
199	0	0	0	0	31	27	47	96	37	0	0	2	0	117.3	0	586
200	0	0	0	6	10	7	24	21	1	3	0	2	6	-	-	302
201	0	0	0	42	0	13	30	1	0	0	1.6	0	0	69.6	0	175
202	0	0	0	0	0	6	9	10	1	0	0	0	0	65.8	0	133
203	0	0	0	0	0	19	44	60	29	0	0	0	0	60.8	0	320
204	0	0	0	0	9	11	19	40	2	0	0	0	0	21.6	0	121
205	0	0	0	317	0	515	357	1120	0	0	1.2	0	0	521.6	0	1328
206	0	0	0	0	91	48	226	403	21	1	0	4	23	82.1	0	1256
207	0	0	0	0	8	9	41	58	7	0	0	1	4	-	-	193
208	0	10	0	6	6	12	51	60	66	15	.4	10	28	-	-	1365
209	0	0	0	0	0	2	3	0	0	0	0	0	0	-	-	91
210	0	0	0	173	0	52	139	4	0	0	1.5	0	0	2.2	0	725
211	0	0	0	354	0	111	349	6	0	0	.8	0	0	4.0	0	990
212	0	0	0	13	0	3	13	0	0	0	0	0	0	-	-	54
213	0	0	0	20	0	7	13	1	0	0	.4	0	0	-	-	85
214	0	0	0	5	0	2	7	6	0	0	0	0	0	-	-	157
215	0	0	0	23	0	36	133	1	0	0	0	0	0	3.5	63	344
216	0	0	0	11	0	30	81	2	0	0	1.4	0	0	-	-	423
217	0	0	0	63	0	9	36	42	0	0	0	0	0	-	-	193
218	11	0	0	24	0	4	12	6	0	0	0	0	0	-	-	187
219	0	0	0	1	2	19	51	1	0	0	.4	0	0	5.9	16	266
220	0	0	0	43	28	8	21	17	0	0	.4	0	0	4.8	0	103
221	33	0	0	2	2	1	6	7	1	0	0	0	0	-	-	54
222	209	36	.8	6	0	23	103	155	8	0	.6	1	0	-	-	574
223	24	0	0	2	2	1	3	0	0	0	0	0	0	-	-	67
224	23	20	0	6	0	3	6	7	2	1	.4	0	1	13.0	0	193
225	336	3	0	16	65	36	104	48	7	0	.3	2	0	-	-	791
226	72	0	0	0	12	3	8	4	0	0	.1	0	0	-	-	118
227	322	0	0	258	64	15	43	21	2	3	0	28	18	-	-	664
228	144	1	0	206	0	47	96	4	0	3	.2	0	9	9.9	5	592
229	31	2	0	104	0	37	69	4	0	1	1.2	0	4	6.5	5	272
230	160	1	0	163	0	34	64	3	0	1	.2	0	8	-	-	423
231	27	0	0	17	0	6	11	1	0	0	0	0	0	-	-	73
232	106	0	0	2	30	15	24	33	18	0	0	1	0	-	-	199
233	0	0	0	0	7	1	3	0	0	0	0	4	0	-	-	73
234	82	0	0	3	12	7	20	10	1	0	0	1	0	-	-	308
235	97	4	0	7	1	2	7	3	1	0	.1	1	0	-	-	181
236	327	172	0	87	0	104	124	83	2	0	5.2	1	3	-	-	682
237	0	0	0	0	4	1	3	0	0	0	0	0	0	-	-	60
238	0	0	0	0	43	13	47	0	0	0	.2	0	0	1.2	0	121
239	0	0	0	0	60	17	45	1	0	0	.7	0	0	-	-	235
240	52	3	0	0	120	31	59	3	0	1	1.7	0	6	-	-	386
241	283	0	0	10	29	12	57	80	61	0	0	2	0	-	-	531
242	0	40	9.41	0	5	111	111	68	31	6	1.2	4	10	-	-	845
243	0	0	17.4	0	42	34	83	26	0	0	2.5	0	0	-	-	403
244	164	0	0	0	40	114	87	28	4	0	0	2	0	-	-	614
245	38	0	0	0	5	2	7	11	8	0	0	0	0	-	-	70
246	260	0	0	4	33	11	59	109	36	0	0	2	0	-	-	543

Table 31. (Continued).

Land Unit	CL	FC	PM	CT	SH	DR	EL	MS	HU	HC	RD	SN	OR	FH	FI	RN
247	112	0	0	73	18	23	58	47	1	0	0	1	0	-	-	281
248	0	0	0	112	0	108	68	191	1	0	0	0	0	3.8	10	192
249	0	5	0	10	58	94	97	109	3	10	.1	4	9	1.2	15	230
250	0	0	6.2	9	0	6	29	41	0	0	0	0	0	-	-	275
251	0	0	.25	6	0	4	21	29	0	0	0	0	0	-	-	193
252	12	3	0	132	0	18	34	2	0	2	1.5	0	3	15.6	0	223
253	216	25	0	195	0	40	82	4	0	5	1.2	27	8	20.7	0	507
254	0	14	0	29	29	69	151	72	3	8	1.0	5	17	-	-	363
255	0	23	0	118	0	27	115	167	1	0	.9	0	15	-	-	308
256	89	42	0	88	0	84	118	127	3	2	.9	5	0	-	-	459
257	197	15	0	40	0	31	43	42	2	3	.2	3	3	-	-	411
258	87	58	0	0	21	3	11	13	0	0	1.1	0	8	-	-	163
259	0	0	0	99	0	39	128	165	3	0	0	2	1	-	-	405
260	0	0	0	6	0	4	11	22	3	80	0	9	20	5.8	0	272
261	0	75	0	0	0	0	1	1	1	30	.5	5	11	-	-	102
262	0	57	0	120	0	319	409	608	38	716	1.5	117	20	9.9	0	906
263	0	10	0	24	0	34	102	204	73	9	.2	7	9	115.8	0	1008
264	0	0	0	2	0	2	12	22	7	0	0	0	63	-	-	109
265	0	0	0	6	0	3	13	24	0	0	0	0	30	-	-	60
266	0	0	0	52	0	20	93	130	0	0	.8	0	0	2.1	3	217
267	0	0	0	14	0	5	25	40	0	0	0	0	0	-	-	115
268	0	0	0	155	0	53	99	5	0	0	1.6	0	0	3.4	3	652
269	0	0	0	112	0	41	85	4	0	0	.3	0	0	3.4	63	314
270	0	0	0	62	0	15	38	30	0	0	1.7	0	0	-	-	362
271	315	0	0	16	1	25	111	103	7	0	0	0	0	-	-	519
272	410	0	0	18	74	53	142	162	99	282	0	20	40	18.7	2	712
273	117	26	0	11	0	19	12	10	0	11	1.0	6	13	38.0	28	193
274	289	0	0	61	0	120	8	165	8	118	0	13	29	41.3	34	477
275	44	0	0	10	0	19	19	19	2	0	0	0	0	-	-	73
276	197	0	0	52	0	17	77	108	4	1	0	2	0	-	-	362
277	29	0	0	4	0	2	10	19	0	0	0	0	0	-	-	48
278	11	0	0	2	0	4	2	2	0	0	0	0	0	-	-	18
279	66	0	0	18	0	45	20	31	1	0	0	1	0	34.0	0	109
280	190	0	0	53	0	23	63	87	5	3	0	2	0	14.8	0	314
281	84	0	0	21	0	7	16	34	2	1	0	1	0	24.1	0	205
282	223	0	0	78	0	20	99	161	5	1	0	3	0	-	-	459
283	560	50	0	157	0	156	244	288	28	197	.8	21	49	36.1	0	1026
284	128	0	0	9	0	2	9	15	2	1	0	1	0	-	-	211
285	40	0	0	3	0	2	7	10	1	0	0	0	0	-	-	66
286	124	0	0	17	0	4	22	41	1	1	0	1	0	-	-	205
287	172	0	0	24	0	37	37	30	3	0	0	2	0	-	-	284
288	0	0	0	21	14	55	74	156	38	3	0	3	0	12.3	0	942
289	0	0	0	73	31	146	237	373	28	3	0	3	0	4.9	0	785
290	0	0	0	0	47	18	75	66	0	0	0	0	0	1.2	0	196
291	0	0	0	5	28	383	296	148	20	0	0	2	0	-	-	519
292	0	0	0	24	0	8	16	1	0	0	0	0	0	3.6	0	103
293	0	0	0	6	0	2	4	0	0	0	0	0	0	1.2	0	24
294	0	0	0	85	0	27	61	2	0	0	0	0	0	-	-	356
295	0	0	0	164	0	51	162	3	0	0	.9	0	0	26.5	0	459
296	0	21	0	29	10	14	65	90	14	0	.4	0	0	-	-	302
297	0	0	0	39	0	13	28	1	0	0	.7	0	0	10.6	0	163
298	0	0	0	13	0	5	23	37	0	0	.1	0	0	-	-	107
299	0	24	0	9	83	42	117	177	15	521	1.6	112	69	24.9	0	1171
300	0	0	0	33	0	11	24	1	0	0	.7	0	0	.6	0	139
301	0	32	0	15	15	61	77	26	30	10	.7	11	9	4.8	0	344
302	0	55	0	0	9	3	14	86	1	0	.3	1	0	-	-	127
303	0	108	0	0	29	20	40	7	34	116	.7	12	29	1.2	0	423
304	0	2	0	0	14	47	31	9	1	0	.3	1	0	.4	0	199
305	0	17	0	0	5	9	9	58	1	0	.1	0	0	-	-	66
306	0	60	0	0	20	6	31	165	2	40	.2	9	20	-	-	290
307	0	0	0	0	4	9	14	7	13	25	0	3	7	-	-	115

Table 31. (Continued).

Land Unit	CL	FC	PM	CT	SH	DR	EL	MS	HU	HC	RD	SN	OR	FH	FI	RN
308	0	88	0	0	27	53	83	80	95	3	1.0	4	19	-	-	694
309	0	0	0	0	1	1	3	5	4	0	0	0	0	-	-	60
310	0	55	0	0	194	389	599	581	173	277	1.1	37	87	-	-	1262
311	0	0	0	0	2	1	5	7	1	0	0	0	1	-	-	24
312	0	0	0	38	38	39	167	242	12	1	0	2	0	-	-	447
313	0	111	0	57	133	124	335	561	6	3	2.6	3	0	.5	0	894
314	9	9	9	6	25	11	68	98	8	12	0	3	6	-	-	181
315	0	0	0	72	0	27	113	133	0	0	.9	0	0	-	-	302
316	0	0	0	32	0	25	29	12	0	0	.5	0	0	3.2	0	133
317	0	0	0	9	0	8	10	33	0	0	.1	0	0	-	-	79
318	0	0	0	0	40	4	18	542	27	1	0	2	0	-	-	411
319	0	35	0	3	26	127	359	48	50	706	1.7	115	62	.2	0	894
320	0	0	0	29	0	23	32	48	0	0	0	0	0	.3	0	121
321	0	0	0	26	0	31	17	38	0	0	0	0	0	1.5	0	109
322	0	0	0	17	0	36	12	51	0	0	0	0	0	4.6	0	73
323	0	0	0	35	0	28	46	66	0	0	0	0	0	-	-	145
324	0	0	0	20	80	344	357	444	45	6	0	4	0	3.1	0	845
325	0	0	0	65	16	72	60	71	0	3	.9	17	11	2.0	0	392
326	0	0	0	88	0	202	66	289	0	0	1.8	0	0	4.3	0	248
327	0	0	0	288	0	159	185	115	0	0	2.8	0	0	1.3	0	1208
328	0	0	0	7	0	23	9	32	0	0	0	0	0	1.5	0	60
329	0	0	0	435	0	341	287	338	0	0	2.8	0	0	1.5	5	1866
330	0	0	0	19	28	56	86	83	30	0	0	1	0	-	-	362
331	0	0	0	4	4	5	22	31	16	0	0	0	0	-	-	205
332	0	0	0	104	0	29	70	22	0	0	.3	0	0	-	-	676
333	0	0	0	2	0	2	2	2	0	0	0	0	0	1.0	0	302
334	0	0	0	13	0	5	20	18	0	0	0	0	0	-	-	109
335	0	0	0	7	0	3	11	13	0	0	.2	0	0	-	-	60
336	0	0	0	42	0	14	31	1	0	0	1.0	0	0	.4	4	356
337	0	0	0	226	0	61	116	6	0	0	4.3	0	0	1.2	7	1896
338	0	0	0	52	0	21	92	86	0	0	.8	0	0	-	-	217
339	0	0	0	53	0	23	95	66	0	0	.7	0	0	-	-	229
340	0	0	0	55	0	15	49	1	0	0	.1	0	0	-	-	229
341	0	0	0	101	0	124	63	11	0	0	.1	0	0	.4	0	423
342	0	0	0	22	1	30	35	14	3	0	0	0	0	-	-	386
343	0	0	0	2	0	1	3	2	0	0	0	0	0	-	-	36

1 Commercial logging - activity during study period

2 5322 MBF est. harvest. 1980

3 tons per unit over mine life

4 1 AUM = 720 lbs. dry weight/month

5 preference index x AUM's

6 3910 days

7 7,700 days (7.00 camping)

8 1650 days

9 2000 days

10 Quality weighted habitat index

11 2,000 days

12 average in acre feet

CHAPTER 5

INTERACTIONS AMONG USES

Introduction

The primary political motivation for land use planning has been to reduce adverse external effects from land uses by property owners. Harm inflicted on neighbors generated a rationale for protecting the overall public interest through oversight preventing undesirable and unnecessary adverse impacts of market-based land use patterns on society and the environment. In pursuit of this lofty goal, planning practice has not yet gone much beyond making qualitative judgments on compatibility. Tools permitting quantitative tradeoffs are needed. Optimal resolution of the conflicts among uses requires quantitative estimation of the 1) benefits from land use (assumed largely convertible to economic units), 2) public values to be protected (assumed largely environmental in the Upper Blackfoot area), and 3) interactions among uses. All three types of estimates are incorporated in the modeling described in the next chapter. An initial exploration of the types of interaction occurring among uses of high mountain areas, a simplified approach to their quantification, and a series of applications follow here.

Interaction Classification

Interactions among land uses can be classified according to whether they are within or between uses, within or among land units, size scale of relevant units, simultaneous or time lagged, additive or multiplicative, complementary or competitive, or associated with a technical (including environmental) or social causative linkage. By way of illustration, interactions occur among different uses on the same land unit (a herd of cattle drinking while people are fishing), among the same use on different land units (both cattlemen and fishermen being more likely to use a good unit if it is not isolated from other good areas), or among different uses on different units (hiking attractiveness being affected by mining on the opposite hillside). They may be caused by simultaneous use or be associated with time lags (effects on hiking continuing after mining operations cease). Interactions may have a greater impact than the additive effects of individual uses (recreation visitation being increased by complementary activities by amounts that exceed direct proportionality to those other uses). The land units on which interactions are analyzed may be small homogeneous areas, such as those shown on Figure 6, areas as large as the entire Upper Blackfoot region covered by this study, or even larger. The causative relationships vary with land use size (multiple interferences between cattle and fishing at many locations in a large area having a different impact than localized encounters). The interactions may be either positive (the imparting use encourages more absorbing use) or negative (discourages). The causative relationship may be either technical (physical effect of vegetative change on the quantity and quality of runoff) or social (pecuniary or psychological factors affecting desire to visit high mountain areas).

The relative importance of an interaction varies with the physical and ecological context of a region, with the social and cultural background of the people who visit it, with the regional economy and its national role, and with the uses occurring and their relative magnitudes. For long run improvement of land use planning methodology, research is needed to develop better understanding of all the interactions among land uses and how they vary spatially in different contexts and time frames. Simple judgments on compatibility need to be replaced with quantitative information on kinds and degrees of interaction.

As a beginning in this direction, the exploratory effort of this study concentrated on interactions among different simultaneous uses on the same small unit for two reasons. These direct interactions are simpler to identify and easier to incorporate in regional modeling and thus the logical starting point for building toward a better understanding of the total interactive framework among land uses.

Also, most current uses of the Upper Blackfoot study area are at relatively low intensities, and thus the interactions explored in this study are at relatively low levels of the two principal uses within a context of low levels for all the other uses as well. Effects that are additive at low intensities tend to become interactive at higher intensities, and thus interactions are expected to be greater and causally more complicated in more intensely used areas. For example, we can expect population and technological growth to increase popular expectations on the quality of mountain environments.

Identification of Simultaneous, Local Interactions

The identification of local interactions among different uses simultaneously occurring on common land units in the Upper Blackfoot study area was done by systematic expert evaluation of each element in the matrix of Figure 8. Each use is considered as having the potential for both imparting and absorbing impacts. The matrix elements represent specific pairs of imparting and absorbing uses to be analyzed for a significant interactive relationship. The diagonal represents interactions among users engaged in the same activity (the effect one grazing cow has on another's available forage) as handled by the relationships for estimating use intensity (Equation 3).

A number of factors have to be considered in estimating the magnitude of an interaction among uses. The magnitude may be governed primarily by the intensity of the imparting use. It may also be

Absorbing Use

Imparting Use	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	W1	W2	W3	W4
1. Commercial logging		D			D	D				T2	D		T3D	D	D	D	D	D	T2	T2	T1
2. Firewood cutting					T3	T3				T2	T2	T2			T2	T3			T2		
3. Phosphate mining	T1 T2	T1			T1	T1	T1	T1	T1	T1 T2	T1 T2	T1 T2	T3D	T1 T2	T1 T2	TD	TD	TD	T1 T2	T2	T1
4. Oil and gas exploration										T1 T2	T2		D	T2	T2	T2 T3		T4	T2		
5. Cattle grazing						T1	T1	T1	T1		T1	T1			T2	T2		T4	T1	T2	T1
6. Sheep grazing					T1		T1	T1	T1			T1			T2	T2		T1 T4		T2	T1
7. Deer habitat					T1	T1		T1	T1	T2						D					
8. Elk habitat					T1	T1	T1		T1	T2	T2			T2		D					
9. Moose habitat					T1	T1	T1	T1			T2			T2		T2		T1 T4			
10. Hunting		T2	T3		T3		T2	T2			T2	T2			T2	T3			T2		
11. Hiking - dispersed camp.		T2	T3									T2				T3			T2		
12. Concentrated camping	T1	T2							T1	T1 T2	T2		T3D		T2	T2 T3		T1	T2		
13. Roads	D	D							T3	D	D	D		D	D	D	TD	T3	D		T1
14. Snowmobiling							T1	T1	T1												
15. Summer off-road vehicle use		T2	T3						T1			T2	D			T3			T2 T3		T1
16. Buildings	T1		T1		T1	T1	T1	T1	T1	T1		T3	T3D	T1	T1			T3 T4	T1		
17. Archaeologic & historical res.	T1	T2	T1	T1	T1	T1				T1	T2	T2	T3D			T2			T2		
W1. Fish habitat					T2	T2					T2	T2				T2			T2		
W2. Fishing		T2	T3						T3	T2	T2	T2			T2	T3					
W3. Runoff for downstream use																		T2			T2
W4. Quality of runoff												T2						T2			

Figure 8. Classification of impacts by primary causative relationship.

influenced by local land attributes (impact of off road vehicle use on fish habitats varying with soil erodibility). An element may contain more than one interactive process (commercial timber cutting may improve firewood cutting by leaving slash piles and harm firewood cutting by removing trees). Interactive processes may be quite different at one combination of intensities of the imparting and absorbing uses than they are at another combination or in one context of intensities of other uses than they are in another context.

Figure 8 classifies the major relationship types as:

T1: The imparting use physically (directly or through some ecological interrelationship) prevents or makes the absorbing use less profitable or otherwise less desirable.

T2: The imparting use induces an increase in the amount of the absorbing use through such varied mechanisms as firewood cutters who also fish, roads required to serve commercial logging operations, or camping at sites with a good view of feeding elk or moose.

T3: The imparting use hampers by congestion or causes security problems for people involved in the absorbing use. Clark et al. (1971) have found motivations for vandalism to include entertainment, convenience, disregard, ignorance, and interference with personal goals.

T4: The use changes runoff volumes or water quality and thereby impacts other users of that water.

D: One or more of the above relationships is important but specific attributes of the land unit need to be measured to forecast the magnitude of the effect. Relationships of this sort are presented in Table 32, and attributes for those relationships not previously defined in Tables 12 or 18 are defined in Table 33.

Often, it is assumed that activities (say A_1 and A2) are competitive over the full range of their production as shown in Figure 9a. However, in many cases, both complementary and supplementary relationships exist between activities at a given site. In Figure 9a, A_1 and A_2 are shown to be competitive over the full range of their production in that an increase in A_2 from n to m requires giving up ba of A_1 or vice versa. The more general situation is depicted in Figure 9b in which increasing A_2 from 0 to n results in a complementary increase of ab in A_1 at n level of A2. Increasing A2 from n to p does not affect A_1, and the two activities become supplemental. Further increasing A_2 reduces A1 and the two have become competitive.

The diagramming of a specific interactive relationship requires analysis of the processes governing physical interactions and the collection of information on how people perceive social interaction situations. The relationship may be affected by indexable site

Table 32. Attributes associated with specific interactions.

Imparting Use	Absorbing Use	Attributes
1. Commercial logging	2. Firewood cutting	B4
	5. Cattle grazing	B9, A2
	6. Sheep grazing	B4, A2
	13. Roads	A5, A6
	16. Buildings	B29
	W1. Fish habitat	B24, B3
3. Phosphate mining	13. Roads	A5, A6, D1
	16. Buildings	B29
	17. Archaeologic & historical resources	B19
	W1. Fish habitat	B24, B3, B18
4. Oil and gas exploration	13. Roads	A5, A6
8. Elk habitat	16. Buildings	B8
12. Concentrated camping	13. Roads	A5, A6
13. Roads	1. Commercial logging	A5
	2. Firewood cutting	A5
	10. Hunting	A5
	11. Hiking - dispersed camping	A5
	12. Concentrated camping	A5
	14. Snowmobiling	A5, D4
	15. Summer off-road vehicle use	A5
	16. Buildings	A5, D3
	17. Archaeologic & historical resources	A5, B19
	W2. Fishing	A5, A9
15. Summer off-road vehicle use	13. Roads	A5
16. Buildings	13. Roads	A5
17. Archaeologic & historical resources	13. Roads	A5, D2

Table 33. Additional attributes considered in interaction analysis.

No.*	Attribute	Indicator
D1	Route available to transport ore	1 = available for transport
D2	Fragility of relic	1 = presence of known adverse effect
D3	Amount of landscaping	Number of planted shrubs
D4	Winter access	1 = normally open in winter

*Number used to specify attribute on Table 32.

factors and the intensities of other uses. In general, one could conceive a multidimensional interactive diagram with one axis for each use, but development of the concept is not practical.

Analysis of Major Interactions

In this study, exploration of the interactions was based on experience, expectation, and qualitative observation. The model presented in Chapter 6 provides a basis for identifying sensitive interactions for further study.

For a first pass, for model development, Figure 10 identifies a reduced set of the interactions on Figure 8 deserving examination in the context of the Upper Blackfoot study area by direction and type of causal linkage. These interactions are numbered on Figure 11 and discussed by number below.

1. Phosphate Mining on Other Commercial Use. Opening a phosphate mine requires cutting all the commercial timber in the area (PT) but then eliminates commercial timber operations thereafter (NT). After mining, an area could potentially return to commercial timber production. For modeling, phosphate mining was assumed to require immediate harvest of all commercial timber and prevent harvest thereafter. The effect of mining on firewood cutting is much the same except that it was assumed that it would be impractical to strip the firewood remaining after a timber harvest before mining and thus only the second (NT) effect was considered. Cattle and sheep grazing would also be excluded while mining is underway.

2. Grazing on Runoff. The hydrologic modeling was used to estimate the effects of grazing on runoff volumes, peaks, and low flows given an annual precipitation and grazing intensity. The results are in Equations 34 through 39.

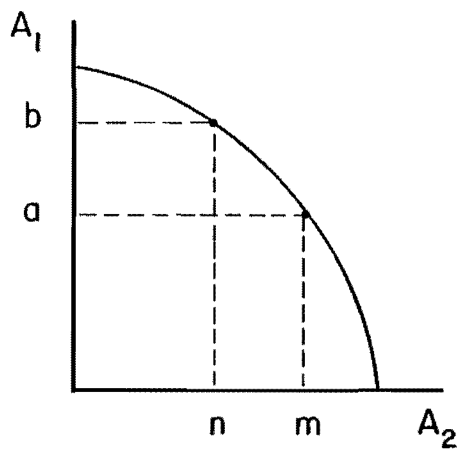


Figure 9a. Production possibilities curve for strictly competitive activities.

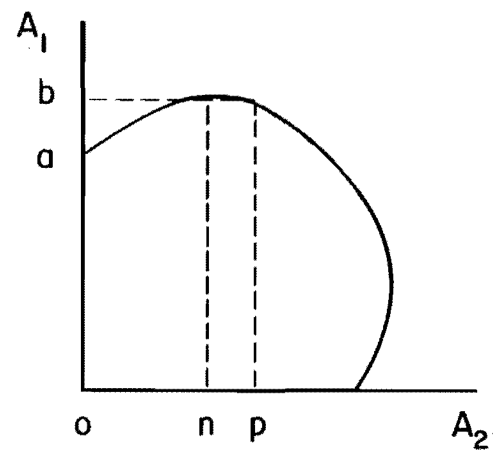


Figure 9b. Production possibilities curve for activities with complementary, supplementary, and competitive relationships.

Absorbing

Imparting	CL	FC	P	O&G	C	S	D	E	M	Hn	Hk	Cm	R	Sn	ORV	B	H	FH	F	R	WO
CL		PT NT			PT	PT				PS	NS		PT	PT PS	PT PS			NT	PS	PT	NT
FC										PS	PS	PS			PS				PS		
P	PT NT	NT			NT	NT	NT	NT	NT	NT PS	NT PS	NT PS	PT	NT PS	NT PS	NT		NT	NT PS	PT	NT
O&G										NT PS	NT PS	PS		NT PS	NT PS				NT PS		
C							NT	NT	NT		NS	NS			PS			NT	NS	PT	NT
S							NT	NT			NS	NS			PS			NT		PT	NT
D					NT	NT		NT	NT	PT						NS					
E					NT	NT	NT		NT	PT	PS			PS							
M					NT	NT	NT	NT			PS			PS					NS		
Hn		PS	NS	NS	NS		PT	PT	NS		PS	PS			PS	NS	NS		PS		
Hk		PS	NS	NS								PS				NS	NS		PS		
Cm	NT	PS								NT	PS		PT		PS				PS		
R	PS	PS							NT	PS	PS	PS		PS	PS			NT	PS		NT
Sn							NT	NT	NT												
ORV		PS	NS	NS					NT		NS	PS	NT			NS	NS	NT	PS		NT
B	NT		NT				NT	NT	NT	NT											
H	NT		NT								PS	PS			PS						
FH											PS								PT		
F		PS								PS	PS	PS			PS						
R																		PT			PT
WQ															PS			PT			

Direction of Impact (first letter) P = positive; N = negative
Causative Relationship (second letter) T = technical; S = social

Figure 10. Classification of interactions by direction and technical or social cause.

Imparting \ Absorbing	CL	FC	P	O&G	C	S	D	E	M	Hn	Hk	Cm	R	Sn	ORV	B	H	FH	F	R	WQ
CL		5 3			9 3	9 3				16 3			4 3	33 1	16, 18 1,2			43 2	16 1	50 3	49 3
FC										17 2	6 2	28 2			36 2				6 2		
P	1 3	1 1			1 3	1 3	14 3	14 3	14 3	16, 18 3	16, 18 3	16, 29 3	31 3	18, 33 3	16, 18 2,3	40 2		43 2	16, 18 3	46 3	49 3
O&G										16, 18 1	16, 18 1	16 1		18, 33 1	16, 18				16 1		
C						10 3	10 3	10 3	10 3		22 3	22 2			37 1			44 2	22 1	2 3	3
S					10 3		10 3	10 3	10 3		22 3	22 2			37 1			44 2		2 3	49 3
D					10 3	10 3		10 3	10 3	19 3	23 3					41 2					
E					10 3	10 3	10 3		10 3	19 3	23 3			34 1							
M					10 3	10 3	10 3	10 3			23 3			34 1					22 1		
Hn	6 2	8 1	8 1	8 1		12 1	12 1	8 1			24 2	24 2			24 2	42 2	42				
Hk	6 2	3 1	8 1									24 2			24 2	42 2	42				
Cm	2,3 2	6 2								18 2	24 2				38 2						
R	4 3	7 3							15 1	20 3	20 3	7 1		35 3	35 3			43 2	20 3		49 3
Sn							13 1	13 1	13 1												
ORV		6 2	8 1	8 1					15 1		25 1	24	32 3			42 2	42	43 1			49 2
B	3 2						14 1	14 1	14 1	21 1											
H	3 2										26 2	24			39 1						
FH																			45 3		
F		6 2								17 2	27 2	24			24 2						
R					11 3	11 3												47 1			48 1
WQ																					

Key: Numbers in upper left are used for discussion in the text. Numbers in lower right indicate whether that interaction was incorporated into the model (3), reflected in procedures leading to model input (2), or excluded (1).

Figure 11. Numbering of specific interactive relationships.

3. Permanent Developments on Commercial Lumber. Campgrounds, buildings, and historical sites generally preclude commercial timber harvest from the immediate area, largely because of the greater desirability of saving trees for their aesthetic value. A reasonable protected area needs to be designated for each site.

4. Roads on Commercial Lumber. Roads are required to service commercial lumber operations, and the cost of providing necessary access must be considered in deciding whether or not to open a new area for logging. Road cost depends on topography, soil conditions, and distance of new construction required. After the timber is cut, the road may either be left open (affecting a number of other uses) or closed (causing some additional cost). For this study, specific road costs were estimated for specific situations.

5. Commercial Lumber on Firewood Cutting. Commercial timber harvest leaves slash that can be used for firewood. The amount depends on the relative amounts of trees profitable for lumber and smaller trees and brush in the area and on the timber cutting method. For this study, 0.5 cord of firewood per 1000 board feed of lumber was assumed.

6. Recreation on Firewood Cutting. People who visit an area for hunting, hiking, camping, ORV touring, or fishing are more likely to cut firewood than people who would otherwise stay home; they are already in the area. Recreationists need to be questioned to derive a relationship.

7. Roads on Firewood Cutting. Road access is required to haul cut firewood away, but people vary in the type of vehicle that they own and willingness to drive on rough roads. The interaction should ideally be approached through a relationship defining the effect of poorer road quality in reducing cutting, but this study used a simple judgment as to whether or not the access was sufficient for firewood cutting to occur.

8. Recreationists on Commercial Activity. Hunting, hiking, and offroad vehicle use may interfere with mining, oil and gas exploration, and cattle ranching by attracting people who commit acts of vandalism or who advocate land use management practices that restrict commercial activity. The extent of these problems can be probed by questionnaire.

9. Timber Cutting on Grazing. Cutting out the trees increases the growth of forage for cattle and sheep with clear cutting having a greater positive effect than does more scattered removal of the conifers (Miller and Krueger 1976). For quantities, one can estimate the number of board feet removed from an acre of ground and how many AUMs would then be produced from the grass that would start to grow on the area.

10. Competition among Animals for Food. Cattle, sheep, deer, elk, and moose theoretically compete for food as they graze an area of land. Overall, cattle, elk, and moose require about the same amount of food with that amount being about 5 times the amount required by

deer or sheep. The competition, however, is limited by the fact that various animals differ in food preferences (food compatibility index by Stoddard, Smith, and Box 1975) and in thoroughness with which they remove plants when feeding. Miller and Krueger (1976) found no direct competition for forage between big game and cattle as long as the cattle were not overusing the range. The summation of the food consumed thus only provides a starting point for estimating the total animal populations the vegetation an area can support, and a more detailed analysis would need to account for season, condition of the range, and type of vegetation.

11. Water Quality on Camping and Fish Habitat. Water quality deterioration can harm fish habitat and make streamside locations less pleasant for campsites. Aesthetics and drinking water safety can both be affected. The water samples taken in the Blackfoot area do not show pollutant concentrations that would cause problems in the study area. The primary problem is the nutrient loading of downstream reservoirs.

12. Hunting on Deer and Elk. Obviously, hunters remove the game they kill from the animal population grazing on the watershed, and this reduces the AUMs of food consumed. Removal rates can be estimated from statistics on the number of animals killed per hunter day. Since both the hunters and the animals wander over large areas, adjacent units will also be affected.

13. Snowmobiling on Deer, Elk, or Moose. Snowmobiling has been known to cause deer to move out of sight of the vehicles (Bury et al. 1976). Elk appear somewhat more sensitive. However, these interactions were considered minimal because of low levels of activity and the fact that much of the browsing is at night. Petrie's (1971) survey in Canada suggests that the situation may actually be more upsetting to conservationists than to the animals. Lindsay (1974) found the greatest conflict imparted by snowmobilers to be on homeowners. In Upper Valley the issue would be whether harm was found when people reoccupied their buildings in the spring.

14. Land Closure on Deer, Elk, or Moose. Mining and building remove areas from forage production for native animals. The effect is probably smaller than it is on cattle and sheep because the effect of the physical removal of foodstuffs is likely less than that of institutional restrictions against grazing. Buildings are so few in the Upper Blackfoot area that any effect would be quite minimal. Mining temporarily destroys large areas of forage, and the AUMs removed from production provide a good estimate of this interaction.

15. Roads on Moose. Road construction also removes a certain amount of land from forage production, but these quantities are small for narrow dirt roads passing through forested areas. Moose were identified for consideration as a possible additional problem because the primary moose habitat is in willow areas along the larger streams also followed by the roads. Large amounts of traffic could potentially disturb the moose or the habitat, but this did not turn out to be a problem in the study area.

16. Commercial Activity Increasing Hunting. Jobs bring people into an area where many of them will hunt. The quantitative effect

can be estimated from information on the number of employees per commercial unit, the number of hunters per employee family, and the average hunter days such people spend in the area.

17. Firewood Cutting on Hunting and Fishing. People who come into the area to cut firewood may also hunt or fish during the trip. Data on firewood cutting during deer season, however, did not indicate that significant numbers of people were combining these recreation purposes.

18. Commercial Activity Decreasing Recreation Activities. Commercial mining operations act to prevent hunting or hiking near the mine sites and create an environment where hiking and dispersed camping are less attractive anyway. Hunting is restricted in the immediate vicinity of campgrounds for safety reasons and because of game being scared away by concentrations of people. Mine operators were questioned as to experiences with trespassers into restricted areas, and this did not seem to be a significant problem.

19. Deer and Elk on Hunting. The presence of more game animals would logically make an area more attractive to hunters. Good deer and elk habitat could attract hunters, probably to a lesser extent, even though the animal populations were not high. Since hunters spread out over many land units, this interaction aggregates over larger areas than many. Questionnaires can provide data on preferences and areas of hunting activity, and these could be correlated with data on habitat quality.

20. Roads on Hunting and Fishing. Road access is a significant factor influencing hunting and fishing locations. If information on the locations of hunting and fishing is available, correlation techniques can be used to determine the significant factors and estimate the relative influence of roads. Poor roads may also make good trails that facilitate hiking. Much of the dispersed camping in the area requires road access for bringing vehicles or equipment into the area.

21. Buildings on Hunting. Regularly occupied buildings would discourage hunting in the vicinity, and cabins may facilitate hunting activity. Both relationships were determined to be insignificant in the Upper Blackfoot study area.

22. Cattle and Sheep on Camping and Fishing. Cattle and sheep disrupt camping, and cattle drinking in numbers disrupts fishing. Moose may have a similar effect. Large animals would be kept out of dedicated campgrounds and would quickly encourage dispersed campers to move elsewhere. As an approach for quantifying the relationship, one might examine the relationship between dispersed camping in user days and the feed value of vegetation in an area in AUMs. If the feed is primarily grazed by cattle and sheep, one would expect a negative slope to the line, suggesting less camping the more an area resembles a cow pasture.

23. Game Animals on Dispersed Camping. The correlation between user days and AUMs mentioned under 22 would be expected to be more

positiv where game animals were the primary grazers. Elk herds are not exp :ted to cause campers to leave to the degree cattle would.

24. Hunting, Dispersed Camping, and Offroad Vehicles. Many people ıo enter an area for recreational purposes can be expected to engage ı more than one activity during the day and then stay over-night e :her at one of the dedicated campgrounds or dispersed among other s :es. People who come in family units or other groups may split d :ing their recreation day with various members selecting differe : activities. They may use offroad vehicles to get about. In order t quantify these interactions, hunters need to be asked whether they st , overnight in the area and, if so, whether in a dedicated campgro ıd or elsewhere and whether they use an offroad vehicle. Hikers ıd dispersed campers need to be asked whether they are over-nightin (perhaps after a vacancy opens) at a campground or driving an offroad ehicle. People staying at campgrounds can be asked about hiking. Overall, analysis of this interaction requires collection of data ›n multiple activities by recreation visitors.

25. Offroad Vehicles on D Camping. Offroad vehicle use generat ; noise that awakens si and is generally disturbing to people .siting remote areas to get away from congestion. This specifi conflict is just one manifestation of a more general one between ›eople visiting an area in search of solitude and other people desirin "higher technology" activities requiring vehicles, chain saws, g ıs, etc (Bury et al. 1976).

26. Historical Sites on Hiking. Some people may come through the are purposefully following the Old Oregon Trail or to visit Lane's ave or some other specific site. A questionnaire would be require to quantify the extent of this effect.

27. Dispersed Camping on Fishing. A scenic and comfortable site affords pecial relaxation where people seek to camp and fish together. These c ıplementarities are among recreationists seeki rimative experie e whereas those under 24 are among "higher te y" recreat ›n activities and those under 25 are conflicts n the two. A three kinds of interactions need to be probed by asking recreat ›nists about the experience they are seeking and their reac-tion to ›eople engaged in other activities. Crowding becomes another factor ı more densely used areas, but it is not currently a factor in the Upp Blackfoot Basin.

28. Firewood Cutting on Camping. People who cut firewood may also st overnight in a campground and burn wood in the process. In derivin a relationship between firewood cutting and the size (number of camp .tes) of a facility like a campground, one needs to convert capacit to a use rate where the capacity greatly exceeds the use rate, a it does for the other uses in the Upper Blackfoot study area. Capacit is not a constraining factor and use equals demand. For larger ›mands capacity limits use during peak periods, and a capacity-use rel ionship needs to be derived (James and Lee 1971, pp. 405-7).

29. Phosphate Mining on Campgrounds. Close and visible presence of an o :rating or, to a lesser extent, a closed mine area detracts from ca ›ground attractiveness. In an area with few campgrounds and

many possible sites, the reasonable policy is to avoid locating campgrounds in areas where the mines are visible.

31. Phosphate Mining on Roads. Phosphate mines require access roads for bringing miners and equipment into the area and for taking the ore out. New roads have to be constructed or improved for much heavier traffic than would otherwise be necessary as new mines are opened.

32. Offroad Vehicles on Roads. The steep dirt roads of the study area rut quickly, particularly when wet, with vehicular traffic. Where the vehicles leave the road, tire marks add to erosion, runoff, and sedimentation problems. A relationship expressing the annual cost of maintaining roads in acceptable condition as a function of vehicular traffic and such other independent variables as slope and soil characteristics would be part of expressing this interaction. Regulations could prohibit offroad vehicles from areas where they would lead to undue erosion and where the erosion would cause significant harm to downstream fish habitat. A comprehensive analysis would recognize that regulation is never completely successful and that enforcement costs need to be weighed against benefits.

33. Commercial Activities on Snowmobiling. The commercial activities close down during the severe Idaho winters, but some people enter the area to snowmobile. The effect is analogous to that of commercial activity on hunting (number 16) but different because the recreation is outside the time for seasonal jobs in the watershed and thus associated instead with employment induced indirectly in nearby towns.

34. Elk and Moose on Snowmobiling. Some snowmobilers may seek out elk and moose wintering in the lower meadows and adjacent areas of willow brush as part of their recreation experience. The effect could be quantified by questioning snowmobilers or perhaps observing the effects of the presence of the animals on snowmobile track patterns.

35. Roads on Snowmobiles or Offroad Vehicles. Whether in winter or summer, roads are the main locations for vehicular activity. Both summer ORVs and winter snowmobile traffic can be examined for the fraction of the activity occurring on roads. The roads are probably more of a factor in directing locations for vehicular activity than they are in increasing total usage of the area. Potential policies on road use should be framed in this light.

36. Firewood Cutting on Offroad Vehicles. Offroad vehicles permit a firewood cutter to haul his wood out of more remote areas, and hence attractive firewood sources in remote areas may induce ORVs into the area. A survey would need to examine the extent to which ORVs are being used for this purpose.

37. Offroad Vehicle Use by Ranchers. People watching over cattle and sheep operations often use vehicles for access into remote areas (bringing salt, finding animals, etc.). Ranching operations could be analyzed to estimate the amount of offroad vehicle traffic generated per AUM of grazing in the area.

38. Camping on Offroad Vehicles. Campgrounds can become the center of activity for people going into more remote areas during the day by means of offroad vehicles. A survey of the types of vehicles driven by campers would be a starting point for estimating the extent of this activity.

39. Historical Sites on Offroad Vehicles. People following the Old Oregon Trail (either exactly or approximately) or visiting some other site of historical significance may go on foot, by horseback, or by two or four-wheeled vehicle. In this case, the traffic was light and not judged to be worth the trouble of more detailed analysis.

40. Phosphate Mining on Buildings. Buildings are required near an operating phosphate mine for caretaking and service functions. Workers are induced to live closer to the site. Because of the lack of winter access to Upper Valley, the permanent residential and commercial support activities are outside the study area, and temporary summer trailers were counted with dispersed camping.

41. Deer on Buildings. Deer can be quite destructive to landscaping during winter periods with deep snow when available browsing runs short; however, in the study area, the buildings were closed for the winter and generally not landscaped.

42. Technology Recreation on Buildings. The presence of hunters, hikers, and offroad vehicles is often associated with an increased incidence of unpleasant confrontations and vandalism. For this interaction, one might estimate adverse impacts as a linear multiple of recreation use, with the coefficient possibly varying with the type or intensity level of use.

43. Erosion on Fish Habitat. Activity that disturbs the ground surface, including lumbering, mining, road construction, and the rutting of roads by vehicular traffic, add to soil erosion by amounts varying with soil erodability and climate. Muddy water is harmful to most fish species, and the sediments left deposited in the stream can ruin the habitat for a long time afterwards.

44. Cattle and Sheep on Fish Habitat. If not enclosed, livestock drink from the stream, often walking down into the water and causing the banks to slough. This activity gradually changes the shape of the stream channel and also contributes to turbidity and siltation of fish habitat downstream. Hydraulic and ecologic observations at livestock watering areas are needed to quantify this interaction.

45. Fish Habitat on Fishing. Good fish habitat attracts fish, and fish attract fishing activity, other factors being equal. Of the other factors, access is probably the most important, with a good habitat near a road being fished much more than is an equally good one at a more remote location.

46. Mining on Runoff. The relationships summarized in Table 30 were used to estimate the effects of mining on runoff.

47. Runoff on Fish Habitat. The volume and time pattern of runoff has important effects on fish habitat with larger streams able to support a greater variety of species. The variation in land use

expected in the Blackfoot catchment, however, is not expected to cause large enough variations (much smaller than natural fluctuations from year to year) in runoff to make a significant change in habitat except in a few localized areas immediately downstream from mines or temporarily after timber cutting (Mahmood and Messer 1982).

48. Runoff on Water Quality. Most erosion and pollutant loading is associated with major storm events. Most of the effect of land use on both runoff quantity and quality is associated with disturbances to vegetative cover or the land surface. Gaged data on several small catchments in the study area were analyzed statistically for relationships between runoff and water quality (Doebley and Messer 1981).

49. Erosion on Water Quality. Most of the phosphorus, nitrogen, and other nutrients and pollutants washed into a stream are associated with soil disturbances that expose material once deeper underground to be leached by surface runoff. Data on disturbances and water quality need to be examined for this purpose.

50. Clearing on Runoff. The analysis based on varying parameters within the Stanford Watershed Model according to how they are altered by clearing showed average runoff increases with clearing ranging from 32 percent at higher elevations with wetter climates to 58 percent in lower and drier areas (Table 29). One would also expect greater percentage increases in dry than during wet years.

The Data Problem

A number of researchers have explored the sociological determinants of outdoor or forest recreation. Nielsen and Catton (1971) developed an information retrieval system for compiling relevant literature. Hendee and Harris (1970) explored recreationist attitudes and believed users to be less willing to respond to management measures to control behavior than they actually were probably because the manager contacts are biased toward more negative individuals. Walter and Schofield (1977) presented the central task of wilderness recreation resource management as reconciling diverse objectives, and Pendse and Wyckoff (1974) probed techniques for tradeoffs among environmental goods. The state of the art is still groping for practical methodology, but all agree that specific analysis requires specific local data.

The questionnaire of Appendix A was prepared to explore the interactions among visitors participating in firewood cutting, hunting, hiking and dispersed camping, concentrated camping, snowmobiling, offroad vehicle use, and fishing. The questions sought information on the attributes influencing locations chosen for recreation, amounts of recreation use, feelings of people in the community about the desirability of various watershed uses (for estimating M_{ui} in Equation 34), and perceived complementaries and competitions among uses. Actual recreationists in the Upper Blackfoot study area proved too few to collect a meaningful sample. As an alternative approach, known recreationists were identified in the towns, but the study area proved to provide such a small part of their total recreation experience that targeting their responses to relationships in the study area was questionable. In the end, this attempt at data gathering was abandoned; but the interviewing scheme outlined in Appendix A provides a foundation for future efforts.

Conclusion

Interactions are key to land use planning. The analysis of the kinds of interactions that occur and the wide variety of linkages between impacting and absorbing uses presented in this chapter, however, proved that, even in the relatively less interactive high mountain watershed context, a great deal of research is needed to quantify these relationships and achieve planning objectivity. In fact the many topics suggested in the pages of this chapter are so many and varied that the obvious immediate need is for prioritization. Such a basis is sought in the next chapter through a model to quantify how optimal land use patterns vary with interaction magnitudes.

CHAPTER 6

APPLICATION OF OPTIMIZATION MODEL

Introduction

Optimization modeling is an inherently iterative process. Since comprehensive optimization would encompass the universe, a realistic modeler must select some primary values and relationships, incorporate them into his model, evaluate the results, and modify the model as necessary to have relationships applied in range, add important factors previously omitted, and otherwise achieve results that match those experienced in real situations.

The scope covered by a given model should be determined by what is important in the real world being modeled, the current understanding of real world relationships, and the issues of interest to those applying the model. The universe may theoretically be approached through one large model or a number of smaller models. A model of more limited scope facilitates probing specific issues in greater depth.

For the Upper Blackfoot study area, one could conceive of separate models for evaluating groups of related uses. Separation makes sense for uses that are not particularly interactive with others (e.g., oil and gas exploration with snowmobiling) but is absurd for such decisions as allocating pasture to cattle without considering the needs of sheep. One could also conceive of a model covering all the uses but taking the area as a whole as just one land unit. Separation of land units and the separation of uses are both ultimately based on judgments of minimizing the importance (from the viewpoint of the model application at hand) of the interactions between them.

Several other considerations are also important in defining the internal land unit size and the overall geographical scope of a model:

1. Smaller internal land unit sizes require greater locational specificity in the data, and this is only acquired at a cost. Data acquisition cost should be compared with the benefit gained from better analysis of local interactions.

2. Smaller land units are easier to characterize in that they have specific identifiable properties and do not have to be represented by averages that try to represent widely heterogeneous situations.

3. Many uses need to be permitted somewhere in a larger area but need not be included in every smaller area. One needs to cover a larger area to ensure that such necessary uses are provided somewhere.

4. Forest Service land managers think in terms of land use over larger areas than do property owners.

Model Overview

One useful tool is the generation of a range of Pareto optimum alternatives for consideration in the planning process (Bishop et al. 1976). Generating these alternatives becomes geometrically more difficult with increases in the complexity of the physical system or the number of competing objectives under consideration. Various mathematical programming techniques have been successful, and linear programming has proved to be particularly useful (Zelany 1974). It was therefore decided to generate noninferior land management alternatives through application of a mixed-integer linear programming (LP) model.

The purpose of the LP model is to determine the optimal mix of uses and locations within the study area. The optimization is done with regard to some objective function, such as maximization of the net present worth of the uses, subject to constraints on the availability of resources and the all-or-nothing character of such decisions as opening mines, building roads, or expanding campgrounds. The general form of the model is

$$\max c'x \qquad \text{(40)}$$

subject to:

$$Ax \lesseqgtr b$$

and

$$I_j = 0,1 \qquad j = 1, \ldots, 5$$

The application in this study optimizes over the total Blackfoot study area among the uses determined to be sufficiently interactive and important for analysis and considers both economic (primarily of the user) and environmental (primarily of the public) objectives.

Inclusion of Uses in the Optimization Model

Table 7 lists 17 land and 4 water uses for analysis. In preparing a model to determine the optimal mix of uses for the Upper Blackfoot watershed, four of the land uses were judged as better set exogeneously to the model or as consequences of other choices in the model. Specifically:

4. Oil and gas exploration is based on evaluations of geologic conditions that are outside the scope of the model, and the current level of exploration in the watershed has relatively small interactions with other uses or environmental impacts.

13. Existing road capacity is generally sufficient to serve the needs for access to the area, and new needs are tied to specific expansion of other uses (new phosphate mines for example) and are best evaluated along with those uses.

16. Buildings are not a significant use in the area.

17. No archaeological resources were identified, and the only significant historical resources were associated with the Old Oregon Trail. This isolated segment of a long trail is a relatively minor historical attraction, and analysis of its development for tourism did not seem worth the effort.

W4. No effort was made to associate either economic value or energy consumption (the surrogate used to index environmental impact) with the water quality indices, and thus this use was not explicitly brought into the optimization.

Objective Function

For the remote high mountain setting of the Upper Blackfoot River watershed, the primary values associated with use of the area were judged to be economic and environmental. Economic values were measured in monetary units. After considerable deliberation, it was decided to measure environmental impact in units of energy expended in using an area based on the hypothesis that the degree of environmental disruption is roughly proportional to the amount of energy spent in logging, mining, livestock management, recreation, etc. In the objective function, monetary benefits were to be maximized, and environmental impacts were to be minimized. Hence, the objective function (expanded from Equation 4) has the form:

$$V_t = \sum_{u=1}^{m} V_u \sum_{i=1}^{n} IP_{ui} - \sum_{u=1}^{m} E_u \sum_{i=1}^{n} IP_{ui} \quad . . . . \quad (41)$$

where the E_u represent marginal adverse environmental impacts and the function is summed over the m uses considered on n units. Economic multipliers (M_{ui} in Equation 4) were not brought into the analysis, and V_u and E_u were assumed to be constants over all units. Estimation of the two sets of objective function coefficients (V_u and E_u) is described below.

Economic Coefficients

The uses were classified into the categories of commercial products, animal feed, recreation, and water. Separate methods were used to estimate the coefficients for the four categories.

1. The commercial products are lumber and phosphate ore. Based on current market prices for products of the quality produced in the Upper Blackfoot watershed, the value of 1000 board feet of lumber was estimated at $50, and the value of a ton of phosphate ore was estimated at $25.

2. The monetary value of cattle and sheep grazing was estimated from the equivalent feed value of hay to be $5 per AUM. Deer, elk, and moose were judged to have different grazing habits than do livestock and thus to remove $4 worth of livestock feed per AUM utilized.

3. The economic values of recreation activities (firewood cutting, hunting, hiking dispersed camping, concentrated camping, snowmobiling, ORVs, and fishing) were estimated by constructing a demand curve based on visitation-distance relationships derived from estimates of the number of visitors by activity in an average year and the distribution of population living within 90 miles (James and Lee 1971, Chapter 16). By using travel cost to develop a demand curve, the economic value of a recreation day is estimated as

$$U_v = \frac{C}{n-1} \bar{D} \qquad (42)$$

where C, n, and D are defined by the three following equations. C is the cost per mile of travel to the site in dollars per visitor day spent there and estimated by summing the various cost components with the relationship:

$$C = \frac{2.42}{bp} \left(m + \frac{t}{v}\right) \qquad (43)$$

where 2.42 is an average ratio of round trip road distance to one-way air distance

m is the variable vehicle operation cost in dollars per mile

t and v estimate the value of time spent in travel by dividing the value of a vehicle hour of travel time in dollars by the mean vehicle velocity in miles per hour

b and p account for the number of visitor days spent at the site per round trip by automobile with b being the average number of days those traveling together remain at the site and p being the average number of passengers per vehicle.

In Equation 42, n is the exponent in the gravity model used to estimate visitation

$$V = KP/D^n \quad \ldots\ldots\ldots\ldots \quad (44)$$

where K and n are estimated by regression based on data from many communities on the number of visitors (V) of a total population (P) traveling (D) miles to the site. A larger value of n from the regression implies that a larger share of the visitors are coming from nearby. Finally, D is the average travel distance to the site estimated as:

$$\bar{D} = \frac{\sum_{i=1}^{m} P_i D_i}{\sum_{i=1}^{m} D_i} \quad \ldots\ldots\ldots\ldots \quad (45)$$

over m communities of origin.

From an analysis of a map of the area within 90 miles of the study area, 1970 census data, and data collected by Idaho on the home locations of people coming into the area for various recreation activities (Table 34), values of D were calculated from Equation 45 and n from Equation 44. The calculations of U_V are based on Equation 43 and shown in Table 35. The values of m are based on a marginal vehicle operating cost of 15 cents per mile for autos and 17.25 cents for trucks. Percentages coming by truck or pickup were estimated as 95 for hunting, 90 for snowmobiling or ORVs, 85 for firewood cutting, camping or fishing, and 80 for hiking.

4. The economic value of water as it flows through the Colombia River system to the Pacific was estimated at about $5.00 per acre foot by Hastay et al. (1971). Escalation to 1980 prices gives a value of $17.30. Most of the above value is from hydroelectric power generation and thus only minimally affected by water quality.

Environmental Coefficients

Energy expended by man in his activities on a land area disrupt the environment. The environmental coefficients were taken as the fuel consumption per unit of use and were assumed not to apply to natural uses (big game feeding, fish habitat, and water yield). Petroleum fuel is by far the largest energy source used by activities in the area, and petroleum consumption can be estimated more readily than the total work involved and partially supplied by a multitude of lesser energy sources. Details on the estimation of petroleum consumptions by use are in Appendix B, and the results are listed in Table 36.

Table 34. Travel distance relationships for various recreation activities.

Population and Visitation Distribution

Range (miles)	0-30	30-60	60-90
P	21000	205000	14400
D (miles)	21	47	76
Snowmobile, ORV, hiking (percent)	90	7	2
Fishing and camping (percent)	85	10	4
Hunting and firewood (percent)	80	14	5

*Approximately 1 percent of the visitation for all activities originated from distances greater than 90 miles.

Table 35. Calculations of activity values per visitor day.

	m $/mi	t $/hr	b	p	C $/mi	n	D mi	Uv $/vd
Firewood cutting	0.169	3.50	1.0	3.5	0.266	3.79	28.3	2.7
Hunting	0.171	3.50	1.5	3.0	0.287	3.79	28.3	2.9
Hiking, Disp. Camping	0.168	3.50	0.5	2.0	0.576	4.62	24.8	3.9
Conc. Camping	0.169	3.50	2.2	3.5	0.221	4.04	26.7	1.9
Snowmobiling	0.170	3.50	0.5	3.0	0.387	4.62	24.8	2.7
ORVs	0.170	3.50	0.5	3.0	0.387	4.62	24.8	2.7
Fishing	0.169	3.50	0.4	2.0	0.723	4.04	26.7	6.4

Table 36. Objective function coefficients.

Use	Unit	Economic	1000 Btus
Commercial logging	1000 bd. ft.	50	305
Firewood cutting	vis.day (cord)	2.7	338
Phosphate mining	ton	25	217
Cattle grazing	AUM	5	12
Sheep grazing	AUM	5	59
Deer feeding	AUM	4	
Elk feeding	AUM	4	
Moose feeding	AUM	4	
Hunting	vis.day	2.9	109
Hiking - dispersed camping	vis.day	3.9	94
Concentrated camping	vis.day	1.9	43
Snowmobiling	vis.day	2.7	101
ORVs	vis.day	2.7	195
Fishing	vis.day	6.4	108
Water yield	AF	17.3	

Aggregated Land Planning Units

The 343 land planning units proved too many for optimization with the data refinement available for this project, and aggregation into larger areas was necessary. In evaluating the differences that need to be preserved in distinguishing among aggregated land units, the two land characteristics judged to be most important were habitat quality for big game and erosion potential. Other major differences were preserved by distinguishing among the three major drainage divisions of the study area.

The aggregation procedure followed was:

1. Habitat preference indexes were calculated for deer, elk, and moose on each land unit. Preference indices are a function of vegetation, with coefficients based on animal observation data from the Idaho Department of Fish and Game. The index values were then divided into low, middle, and high ranges.

2. Erosion potential for each unit was assigned in accord with Forest Service land type classifications (Table 3) to low, medium, or high.

3. The study area was divided into three major watersheds: a) Diamond Creek, b) Lanes Creek except its Sheep Creek tributary, and c) Blackfoot River with Angus and Sheep Creeks.

4. Land units within each of these three larger areas were grouped by erosion potential and animal preference as shown in Table 37. The 18 aggregated land planning units are shown on Figure 12.

Model Constraint Equations

The modeling to optimize land use over the Upper Blackfoot study area followed the basic linear programming format of Equation 41. The objective functions were optimized subject to constraints growing out of the interaction matrix and described use-by-use below.

A typical constraint represents a limitation or capacity of a resource on a particular use on a specific land unit. For example, the grazing constraint in land unit 3 can be expressed as:

$$CAT_3 + 25.8\ I_{Ph} - 0.000325\ LOG_3 + SHE_3 \leq 1288.8 \quad . . . \quad (46)$$

where

CAT_3 is the AUMs allocated to cattle

SHE_3 is the AUMs allocated to sheep

Table 37. Definition of aggregate land use units.

Diamond Creek Number	Lanes Creek Number	Blackfoot Number	Definition
1	7	13	Medium erosion potential with no high habitat rating for deer, elk or moose
2	8	14	Medium erosion potential with a high habitat rating for deer, elk, or moose
3	9	15	High erosion potential with no high habitat rating for deer, elk or moose
4	10	16	Low erosion potential with a high habitat rating for deer, elk, or moose
5	11	17	High erosion potential with a high habitat rating for deer, elk, or moose
6	12	18	Low erosion potential with no high habitat rating for deer, elk, or moose

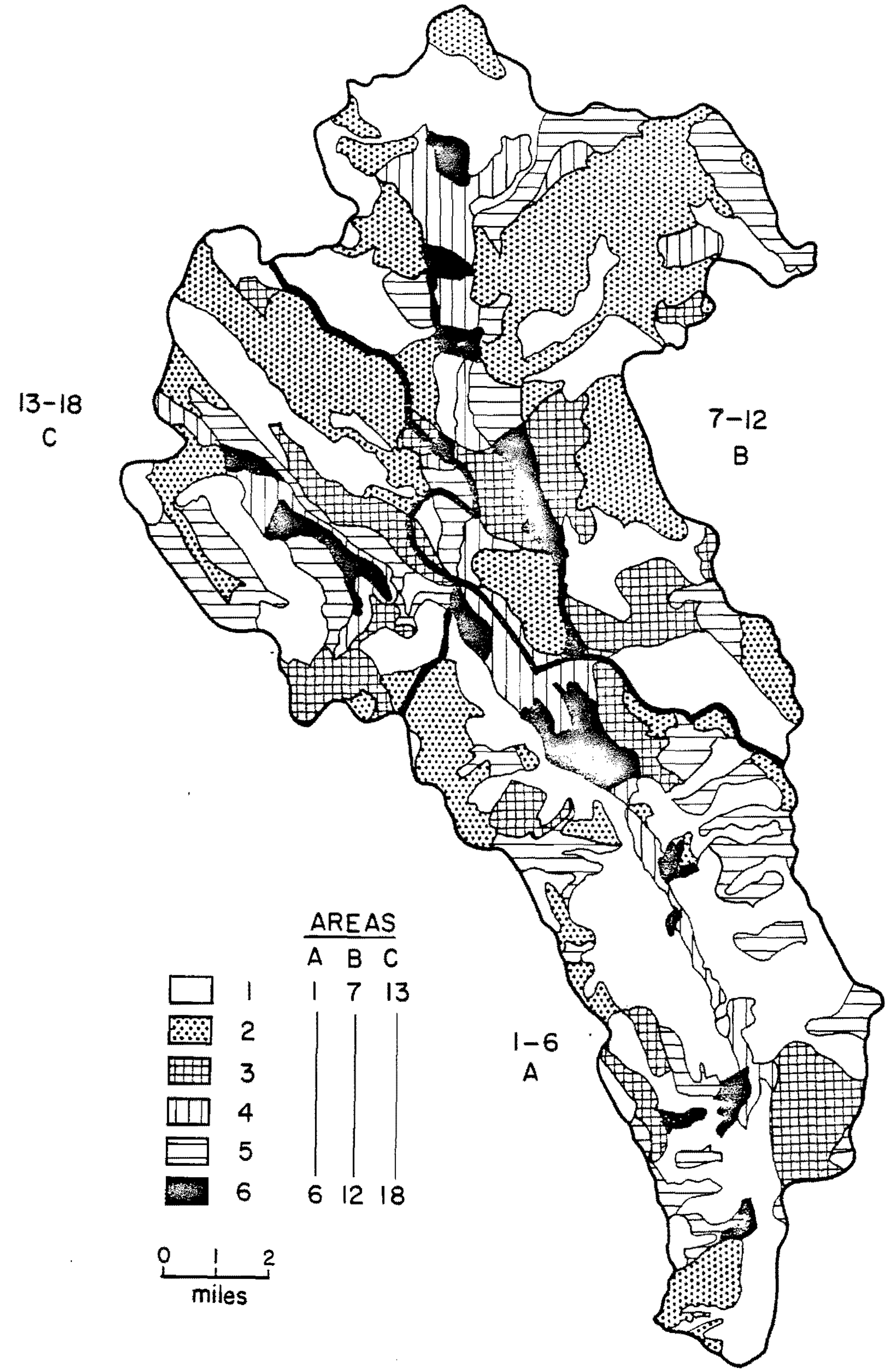


Figure 12. Aggregated land units in the Upper Blackfoot watershed.

I_{ph} is a binary variable designating construction (I_{ph} = 1) or non-construction (I_{ph} = 0) of the new phosphate mine

LOG_3 is the amount of commercial logging in the land unit.

The right hand side value of 1288.8 is an estimate of the present number of AUMs available for cattle and sheep in unit 3.

The coefficients translate competing or complementary uses into effects on grazing AUMs. For example, construction of a new phosphate mine will cause a loss of 25.8 AUMs while commercial logging will lead to a gain of 0.000325 AUMs per board foot of timber cut.

Other constraints reflect competitive or complementary uses on a land unit. An example is between timber production and firewood availability. Typically, timber harvesting leaves waste wood material, called slash, that has no value as commercial timber but which makes suitable firewood. Therefore, when timber is harvested, the firewood supply will be increased by an amount related to the quantity of timber produced. For example,

$$FIRE_5 - 0.001\ LOG_5 \leq 1270 \qquad (47)$$

where

$FIRE_5$ is the number of cords of firewood removed in land unit 5

LOG_5 is the number of board feet of timber extracted from land unit 5

The coefficient of LOG_5 states that each 1000 board-feet of timber produces 1 cord of slash suitable for firewood. Specific equations by purpose are discussed below.

1. Commercial logging

Logging occurs in sale areas designated by the Forest Service either as part of their overall harvesting plan or as part of clearing the land before mining. One constraint equation is introduced for each sale. For timber sales:

$$RLOG_k: \quad LOG_k - LOG_{k_{max}}\ ICL_k + \sum_i \sum_m P_{im}\ PR_m \leq 0 \qquad (48)$$

For phosphate mine settlement sales:

$$RCLPH_{\ell k}: \quad LOGPH_{\ell k_{max}}\ IPH_{\ell} - LOG_k \leq 0 \qquad (49)$$

i = index on land units

ℓ = index on new phosphate mines

k = index on timber sales

m = index on projects to mitigate logging impacts

LOG_k = amount of timber to be harvested, kth sale

$LOG_{k_{max}}$ = maximum potential harvest, kth sale

I_{CL_k} = 0, 1 for kth sale

P_{im} = maximum board feet lost due to mitigation projects, land unit i

PR_m = fraction of mth project utilized

$LOGPH_{\ell k_{max}}$ = maximum commercial timber on ℓth new phosphate mine

I_{PH_ℓ} = 1, 0 for ℓth new mine

In applying these equations, the timber sale (LOG_k) sites (land units covered) and amounts (of timber to be harvested) must be decided and specified in advance. The Forest Service timber harvest plan was obtained and used for this purpose. The maximum potential harvest (LOG_{kmax} or $LOGPH_{\ell k_{max}}$) is based on the timber productivity potential (Table 3) and current cutting practices. Restrictions against cutting around campgrounds, buildings, and historical sites would have to be deducted. The model does not cover the gradual recovery of the forest for another harvest because of the emphasis here on short term analysis. Where needed, one can incorporate time by calculating expected changes in variables over a given period and entering these as data for successive model runs.

2. Firewood cutting

Firewood cutting in a unit is assumed to be constrained by available wood, and the total amount of firewood cut in the study area is assumed to be constrained by demand.

$$RFIRE_j: \quad FIRE_j \leq F_{jp} + b_{jk}LOG_k + \Sigma d_{jm}\, I_{R_m} - \Sigma C_{j_\ell}\, I_{PH_\ell} \quad . \quad . \qquad (50)$$

$$RFCUT_j: \quad \Sigma FIRE_j \leq FIRE_d - r_jPERM_j \quad . \quad . \quad . \quad . \quad . \quad . \qquad (51)$$

j = index on aggregated firewood units

k = index on logging sales

ℓ = index on new phosphate mines

m = index on new road networks

$FIRE_j$ = amount of firewood available in ith unit

F_{jp} = amount of presently accessible firewood in ith unit

b_{jk} = amount of firewood added on ith unit from kth logging sale (typically 1.0 cord per 1000 bd ft)

$C_{j\ell}$ = amount of firewood lost from restrictions around new phosphate mine ℓ

d_{jm} = amount of firewood gained from mth road network

$FIRE_d$ = firewood demand projection, based on population and heating costs

$PERM_j$ = firewood cutting permit cost in ith unit x cords under permit

r_j = firewood not taken per dollar permit cost in ith unit

LOG_k = timber harvested, kth sale

Secondary demands for firewood associated with visitors who are coming primarily for other recreation uses were not estimated because they would be small compared with the primary demand which was taken as a function of the population in the surrounding area and the cost of alternate energy sources. Survey data on complementarities among uses would be required to quantify any secondary demands. Information on road density may provide a useful index for estimating, r_j, the amount of firewood not taken.

3. Grazing - cattle, sheep, deer, elk, moose

The modeling of feeding by livestock and big game on the range was done in two parts. The first equation estimates the total food available for livestock from the range productivity potential (Table 3) on lands not restricted from grazing by mining, food eaten by big game, plus additional range production achieved by logging and range augmentation projects. The second equation limits total consumption by the five animal groups to the food produced. Other limitations are that livestock cannot eat more than 60 percent of the available food and that the food allotted to big game in the total study area has to be enough to supply their needs.

$$AUM: \quad AUM = \sum_j A_{pj} + \sum_j \sum_k g_{jk} G_k - \sum_j \sum_\ell a_j \quad IPH_\ell - \sum_j DW_j - \sum_j EW_j$$

$$- \sum MW_j + \sum \sum h_{jk} LOG_k \qquad . \; . \; . \; . \; . \; . \; . \; . \; . \qquad (52)$$

$$GR_j: \quad CAT_j + SHE_j - A_{pj} - \sum_j g_{jk} G_k + \sum_\ell a_{j_\ell} I_{PH_\ell} + DW_j +$$

$$EW_j + MW_j - \sum_k h_{jk} LOG_k \leq 0$$

$$(CAT_j + SHE_j \leq .6 \text{ AUM}) \quad \ldots\ldots\ldots \quad (53)$$

$$DW: \quad \sum_j DW_j \geq D \quad \ldots\ldots\ldots \quad (54)$$

$$EW: \quad \sum_j EW_j \geq E \quad \ldots\ldots\ldots \quad (55)$$

$$MW: \quad \sum_j MW_j \geq M \quad \ldots\ldots\ldots \quad (56)$$

j = index on aggregated unit

k = index on grazing enhancement/control projects

ℓ = index on new phosphate mines

AUM = total AUM production

A_{pj} = present AUM production, jth aggregated unit (from productivity potential)

g_{jk} = increment in AUMs realized from kth enhancement, jth unit

G_k = fraction of kth enhancement project actually undertaken

a_{j_ℓ} = AUMs lost in jth unit if ℓth new phosphate mine becomes active

I_{PH_ℓ} = integer variable on ℓth new phosphate mine

DW_j = AUMs allotted to deer, jth unit

EW_j = AUMs allotted to elk, jth unit

MW_j = AUMs allotted to moose, jth unit

LOG_k = amount of timber harvested, kth sale

h_{jk} = AUMs added from kth timber sale (AUM/bd ft)

CAT_j = AUMs reserved for cattle, jth unit } up to 60% AUM

SHE_j = AUMs reserved for sheep, jth unit }

D = total deer AUMs

E = total elk AUMS

M = total moose AUMs

In these equations, all AUMs are in cattle units; and suitable conversions must be made for other species. The present AUM production is estimated from median of productivity potential range for land unit type. Forest Service documents suggest that 85-90 percent of study area is producing at range potential. AUMs added when cut timber is replaced by range are estimated in AUM/bd ft and expressed in h_{jk}. It was assumed that all range productivity would be lost from areas around phosphate mines even though technically game could still utilize undisturbed areas restricted to cattle and sheep. Big game are allocated AUMs according to the preference indices for the unit. Unused potential can be used to increase either domestic or game use. The preference indices assume that the plant composition in a cow AUM is the same as that for other animals.

4. Hunting

The hunting equations match supply and demand. The supply is determined by available game and hunting sites. The demand is allocated regionally and increased by new mining or logging employment opportunities in the area.

(supply) $HUSUP_j$: $$HUS_j - \sum_m e_{jm} I_{Rm} - b_j DW_j - c_j EW_j + \sum_{\ell} f_j \; I_{PH} - \sum_{jek} a_{jk} LOG_k \leq HU_{jmax} \quad . \; . \; . \qquad (57)$$

(demand) $HUDEM_j$: $$HUS_j \geq HU_j \quad . \; . \; . \; . \; . \; . \; . \; . \; . \qquad (58)$$

$HUDEM_{tot}$: $$\sum_j HU_j \geq HU_{reg.dem.} + \sum_j V_{j\ell} \; I_{PH\ell} + \sum_j u_{jk} LOG_k \quad . \; . \; . \; . \; . \; . \; . \qquad (59)$$

j = index aggregated land unit

m = index on road network

ℓ = index on new phosphate mines

k = index on timber sale

HUS_j = defining variable

a_{jk} = change in hunting supply from kth timber sale

b_j = hunting opportunity from deer habitat

c_j = hunting opportunity from elk habitat

e_{jm} = net change in hunting in jth unit due to access from mth road network

$f_{j\ell}$ = change in hunting opportunity from ℓth new mine

u_{jk} = change in hunting demand from kth timber sale

$V_{j\ell}$ = change in hunting demand due to ℓth new mine.

DW_j = AUMs for deer, jth unit

EW_j = AUMs for elk, jth unit

HU_{jmax} = maximum hunting, jth unit

I_{PH_ℓ} = binary variable for ℓth new mine

I_{Rm} = binary variable for mth road network

$HU_{reg.dem.}$ = regional demand for hunting

Hunting demand was assumed to be primarily determined by population, and secondary demand associated with other recreational uses was not estimated. Hunters are assumed to hunt only where allowed.

5. Hiking - dispersed camping

The same supply and demand approach was used in modeling hiking and dispersed camping. The supply equation tries to capture factors encouraging or discouraging hikers coming to a given area. The demand equation adds hiking by miners entering the area to an allocated demand.

$$\text{(supply)}\quad HISUP_j:\ HIS_j - \sum_{k\epsilon j} h_{jk} - \sum_{n\epsilon j} f_{jn} I_{Rn} - g_j (cEW_j + dMW_j + eDW_j) + b_{jm} I_{PH_m} + CAT_j + SHE_j \leq HI_{jmax} \quad \ldots \quad (60)$$

$$\text{(demand)}\quad HIDEM:\ HIS_j \geq HI_j \quad \ldots\ldots\ldots\ldots \quad (61)$$

$$\Sigma HI_j \geq HI_{reg.dem.} + \sum_j V_{jm} I_{PH_m} \quad \ldots \quad (62)$$

j = index on aggregated units

g_j = hikers attracted by prospect of big game sitings

k = index on hiking improvement projects

m = index on new phosphate mines

n = index on nth road network

HIS_j = defining variable

h_{jk} = change in hiking in unit j from kth hiking project

H_k = fraction of kth hiking project undertaken

f_{jn} = change in hiking in unit due to nth road network

I_{R_n} = binary variable on nth road network

EW_j = elk AUMs in j

MW_j = moose AUMS in j

DW_j = deer AUMs in j

b_{jm} = hiking lost in j due to mth phosphate mine

I_{PH_m} = binary variable on mth phosphate mine

CAT_j = cattle AUMs in j

SHE_j = sheep AUMs in j

HI_{jmax} = maximum present hiking/dispersed camping in jth unit

HI_j = hiking demand in j

$HL_{reg.dem.}$ = hiking demand in study area

V_{jm} = hiking/dispersed camping demand induced by new mine m

Any extra use of the Oregon Trail due to its historical significance must be included in base indicators (HI_j). The disturbances from cattle and sheep; CAT_j and SHE_j, need coefficients (RVD/AUM) as do the attractions from big game, EW + DW + MW. Noise has an unknown relationship in this framework. Induced demands or mixed motive users are not distinguished.

6. Concentrated camping

The supply and demand relationships used for concentrated camping tried to estimate the demand to expand the facilities from an allocated regional demand and campground use by miners.

(supply) $CCSUP_j$: $CMPS_j - CMP_{expj} \leq CMP_{jpresent}$ . . . (63)

(demand) $CCDEM_j$: $CMP_j \leq CMPS_j$ . . . . (64)

$$\Sigma\, CMP_j \geq CMP_{reg.dem.} + \Sigma\, V_\ell\, I_{PH_\ell} \quad (65)$$

j = actual campground

$CMPS_j$ = defining variable

CMP_{expj} = expansion in campground capacity required to satisfy demand

CMP_j = present camping utilization

$CMP_{jpresent}$ = present camping availability

$CMP_{reg.dem.}$ = demand for camping in study area

V_ℓ = increase in camping

I_{PH_ℓ} = binary variable on new phosphate mine

While the Forest Service is not considering providing a new campground, the supply equation permits the supply to increase and identifies the point when demand becomes sufficient to warrant a new campground. Camping demand from firewood cutters is calculated in $CMP_{reg.dem.}$. Cattle and sheep are excluded from developed campgrounds. Any new campground is assumed to require road access.

7. Roads

The equations for roads compare current traffic capacity with that needed to service users and indicate an improvement project when needed.

ROD_j: $I_{Ph} - I_{R_1} - I_{R_3} \leq 0$ (new road provided for new phosphate mine)

$I_{Log} - I_{R_2} - I_{R_3} \leq 0$ (new road provided for new timber sale) . . . . (66)

$$I_R: \sum_{\ell}^{3} I_{R_\ell} \leq 1 \qquad (67)$$

ℓ = index on road networks

I_{R_ℓ} = binary variable on ℓth road network

It is difficult to isolate the cost of roads required to provide for a timber sale, but the model does require road access to a sale site. Road construction is the responsibility of commercial operators. Even though other use of mine roads is generally restricted, they would be included in I_{R_ℓ}. However, the proposed new mine at Diamond Creek would use a county road. Major sedimentation problems can be associated with unimproved roads. One possible sediment control project would be to close roads where erosion is a problem. Present restrictions on ORVs are factored into current use estimates. The model is not structured to add restrictions.

8. Snowmobiling

The same basic supply and demand structure is again used for snowmobiling.

supply $SSUP_j$: $$SNOS_j - \sum_{k \in j} S_{jk} SN_k - \sum_n t_{jn} I_{Rn} + r_{j\ell} I_{PH_\ell} \leq SNO_{jpres} \qquad (68)$$

demand $SDEM_j$: $$SNO_j \leq SNOS_j \qquad (69)$$

$$\Sigma SNO_j \geq SNO_{reg.dem.} + \Sigma V_\ell \, I_{PH_\ell} \qquad (70)$$

j = index on aggregated units

k = index on kth snowmobiling project

ℓ = index on ℓth new phosphate mine

n = index on nth road network

$SNOS_j$ = defining variable

S_{jk} = snowmobiling in j provided by kth project

SN_k = fraction of kth project undertaken

t_{jn} = snowmobiling in j provided by nth road network

I_{Rn} = binary variable on nth road network

SNO_{jpres} = maximum present snowmobiling in j

$SNO_{reg.dem.}$ = demand for snowmobiling in study area

V_ℓ = snowmobiling demand from new phosphate mines

I_{PH_ℓ} = binary variable on new phosphate mine

r = snowmobiling lost from new mine

Snowmobiling is mainly a function of the availability of roads, t_{jn}, especially roads with scenic loops. Increased demand is associated with miners coming into the area, and loggers and oil and gas explorers could be added if desired. Elk and moose viewing was assumed not to have a significant influence on use.

9. ORVs

The supply and demand equations for offroad vehicles were:

supply $ORSUP_j$: $$ORVS_j - \sum_{k \in j} o_{jk}\, OR_k - \sum r_{j\ell} I_{R_\ell} + \sum P_{jq}\, PH_q \leq ORV_{pres} \qquad (71)$$

demand $ORDEM_j$: $$ORV_j \leq ORVS_j \qquad (72)$$

$$\sum ORV_j \geq ORV_{reg.dem.} + \sum V_q\, PH_q \qquad (73)$$

q = index on phosphate mines

j = index on aggregated units

k = index on ORV opportunity from kth project

ℓ = index on road networks

$ORVS_j$ = defining variable

o_{jk} = increase in ORV opportunity in j from enhancement project k

OR_k = fraction of ORV project undertaken

$r_{j\ell}$ = change in ORV opportunity in j from road network ℓ

I_{R_ℓ} = binary variable on network ℓ

ORV_{pres} = current ORV opportunity

ORV_j = ORV demand in j

$ORV_{reg.dem.}$ = ORV demand in study area

V_q = ORV demand from new phosphate mines

PH_q = binary variable on new phosphate mines

ORV users are assumed to avoid restricted areas. Avoidance of these is included in the supply estimates, and adjustments would have to be calculated for projects that change restricted areas. The ORV increase from firewood cutting and other recreation and commercial uses of the study area were assumed covered in the primary demand estimates.

10. Fishing

Supply and demand for fishing were represented by the relationships.

supply $FISUP_j$: $FISSj - \sum_{k \in j} f_{jk}F_k - \sum_{m \in j} r_{jm}I_{Rm} - c_jFH_j \leq FIS_{jpres}$ . . . . (74)

demand $FIDEM_j$: $FIS_j \leq FISS_j$ . . . . (75)

$\sum_j FIS_j \geq FIS_{reg.dem.} + \sum V_\ell PH_\ell$ . . . . (76)

j = index on watershed unit

k = index on fishing enhancement project

m = index on road network

ℓ = index on new phosphate mines.

$FISS_j$ = defining variable

f_{jk} = increase in fishing enhancement project built

F_k = fraction of fishing enhancement project built

r_{jm} = increase in fishing opportunity in j from road network m

I_{Rm} = binary variable on road network m

C_j = change in fishing opportunity in j from change in fish habitat

FH_j = fish habitat in j

FIS_{jpres} = current fishing opportunity

FIS_j = fishing in j

$FIS_{reg.dem}$ = fishing demand in study area

V_ℓ = change in fishing demand from new mine ℓ

PH_ℓ = binary variable on new phosphate mines

11. <u>Fish habitat</u>

The index used to represent the quality of fishing habitat was

$$FHAB_j = FHAB_{pres} - SED_j - WQI_j \quad . . . . \quad (77)$$

where

$$FHAB_{pres} = (100 - \sqrt{(PRR - 45)^2}) \times SUBSTRATE \times SEDIMENT + COVER \quad . . . . \quad (78)$$

SED_j is Equation 35

$$WQI_j = 48.78 + .019\ (\%\ logged \times area) + .26\ (AUM/stream\ mile) \quad . . . . \quad (79)$$

j = index on watershed unit

SED_j = sedimentation index

WQI_j = Ramzi's water quality index

PRR = pool-riffle ratio

SUBSTRATE = predominant substrate

SEDIMENT = present sedimentation level

COVER = percent of cover in reach

The impacts by other uses on fish habitat are expressed via SED_j and WQI_j. Only roads were assumed to cause significant sedimentation. Logging and cattle grazing were assumed to add primarily to nutrient concentrations. ORV use away from roads was assumed not be causing problems.

12. <u>Runoff</u>

The hydrologic relationships derived through the watershed modeling, when converted to the form required by the model, were:

$$\text{yield:} \quad WYLD_j = WYLD_{jpres} + \sum_{\ell} b_{j\ell} I_{PH\ell} + \sum_{i} c_{ij}\ CAT_j + \sum_{\ell} s_{ij}\ SHE_j \quad . . . . \quad (80)$$

$$\text{peak flow:} \quad PFLO_j = PFLO_{pres} + \sum_{p} r_{jp} I_{Rp} + \sum_{\ell} p_{j\ell} I_{PH\ell} + \sum_{k} d_{jk}\ LOG_k \quad . . . . \quad (81)$$

i = index on land units

j = index on watershed units

k = index on timber sales

ℓ = index on new mines

$WYLD_{jpres}$ = present or baseline yield from j

a_{jk} = change in yield in j per 1,000 bd ft harvest from k

LOG_k = amount of harvest in timber sale k

$b_{j\ell}$ = change in yield in j from new phosphate mine ℓ

I_{PH_ℓ} = binary variable on new phosphate mine ℓ

CU_j = consumptive use in j

$PFLO_{jpres}$ = current peak flow in j

r_{jp} = change in peak flow in j from road network p

I_{Rp} = binary variables on road network p

C_{ij} = change in peak flow from cattle AUMs

CAT_i = cattle AUMs in i

S_{ij} = change in peak flow from sheep AUMs

SHE_i = sheep AUMs in i

$p_{j\ell}$ = increased yield from mine ℓ

d_{jk} = increased yield from timber sale k

Runoff impacts of surface disturbing uses are expressed in terms of peak flows and annual yields. Cattle and sheep impacts proved negligible at grazing levels actually occurring.

13. Water quality

Three water quality indices were constructed. Nutrient loadings were assumed as contributions from logging and mining added to base values. Sediment loadings were assumed to be also caused by cattle, sheep, and roads.

Nitrogen: $NIT_j = NIT_{baseline} + \Sigma\, a_{jk}\, LOG_k + \Sigma\, p_{j\ell}\, I_{PH\,\ell}$ . . . (82)

Phosphate: $PHO_j = PHO_{baseline} + \Sigma\, b_{jk}\, LOG_k + \Sigma\, q_{j\ell}\, I_{PH\,\ell}$ . . . (83)

Sediment: $SED_j = (1.02)\ FLO_j + SED_{baseline} + \Sigma\, c_{j,h}\, LOG_k$

$+ \Sigma\, r_{j\ell}\, I_{PH_\ell} + \Sigma\, d_{ij}\, CAT_i + \Sigma\, f_{ij}\, SHE_j + \Sigma\, S_{jk}\, IR_k$

. . . . . . (84)

i = index on land units

j = index on watershed units

k = index on timber sales

ℓ = index on new mines

m = index on road networks

NIT_{base} = baseline nitrogen index

PHO_{base} = baseline phosphate index

SED_{base} = baseline sediment index (12 mg/1)

LOG_k = timber harvest from kth sale

a_{jk} = change in nitrogen or j per 1000 bd ft from sale k (0)

b_{jk} = change in phosphate on j per 1000 bd ft from sale k (0)

c_{jk} = change in sediment on j per 1000 bd ft from sale k (0)

I_{PH_ℓ} = binary variable on new mine ℓ

$p_{j\ell}$ = change in nitrogen in j from new mine ℓ 0.2 mg/1/acre mine

$q_{j\ell}$ = change in phosphate in j from new mine ℓ 0.2 mg/1/acre mine

$r_{j\ell}$ = change in sediment in j from new mine ℓ 12 mg/1/acre

d_{ij} = sediment from cattle AUMs

CAT_i = cattle AUMs

F_{ij} = sediment from sheep AUMS

SHE_i = sheep AUMS

S_{jk} = sediment from road network k (1.0 per mi)

IR_k = binary variable on road network k

P_{jm} = sediment change from mitigation project

P_m = binary variable on sediment project m

FLO_j = flow in watershed j (flow in cfs)

The Modeling Process

The construction of a data file that describes the linear programming problem in a format compatible with commercially available solution packages can require extensive effort if done by hand. When the decision was made to use LP to generate Pareto optimal alternatives, little was known about the details, but it was obvious with 343 land units that the model could become quite large. Therefore, two computer programs were written to automate the process of model building and applied as illustrated in Figure 13.

The two programs were a preprocessor (that converts the raw data describing 343 land units into coefficients, right-hand sides, and bounds) and a matrix generator (that reads the output of the preprocessor and acts on a set of instructions to produce the desired LP problem file). Both programs were written in PL/I. The preprocessor is specific to this project in that it takes the raw data describing the Upper Blackfoot study area and generates the numerical values of the coefficients and right-hand sides of the equations for each land unit that makes up the linear model. Any change in the way these quantities are estimated is expedited by a programming change in the preprocessor. The computer programming is relatively simple and can be easily revised.

The more time consuming activity involved in producing a linear programming model is that required to specify the numeric values of the linear problem in the rigid format required by most LP packages. The process requires assignments of unique alphanumeric names to all rows and columns in the problem and of numeric quantities to all coefficients, bounds, and right-hand sides. For a problem of the size of that in this study, this amounted to the generation of several thousand records of alphanumeric data, with row and column names subscripted by use and unit. To speed the construction of this data set, a general purpose matrix generator (MG) was written and is reproduced in Appendix C. The MG reads and acts on instructions for rapidly generating row and column names, reading numeric information, performing simple computations on that data as necessary, and placing the results in a disk file in the proper LP format. The MG can handle binary and integer variables, as well as separable programming problems with convex sets. It generated the LP problems used in this study in less than 30 seconds of CPU time. Use of the MG facilitates rapid problem restatement as necessary and virtually eliminates the key stroke errors that typically plague models of this type.

The last step in the modeling process is the generation of a solution to the LP problem. This was done using the TEMPO linear programming package available on the University B-6800 computer.

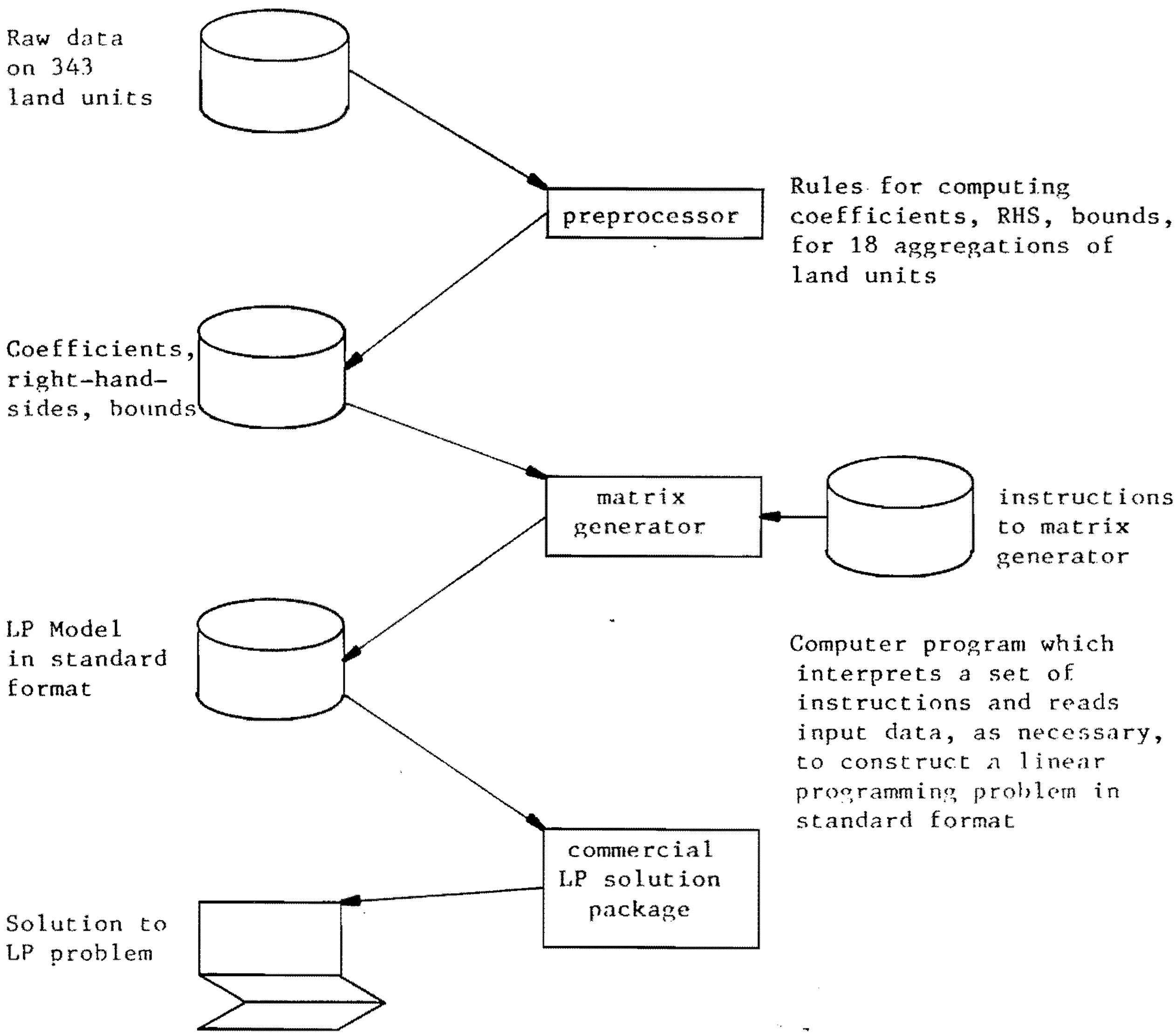


Figure 13. Construction of the linear programming model.

Results

The allocations of uses maximizing benefits are presented with the phosphate mine on Table 38 and without the mine on Table 39. The results minimizing energy consumption are presented on Table 40. As it turned out, phosphate mining completely dominates the other uses in terms of benefits, and a second optimization was run.

Without phosphate mining, the maximum benefit solution concentrates on logging development with associated firewood cutting and grazing by deer with associated hunting. Present observations and logical extrapolations favor a more mixed combination of activities. This information can be brought into the model by reducing the marginal economic values used for logging and deer to the lower values that would be associated with these high use rates. However, such adjustment runs did not seem warranted at this point because the analysis that could be consummated within the scope of this project proved to be heuristic rather than prescriptive. A prescriptive analysis would require careful review and revision of the entire process of data gathering now that an overall computational framework has been established.

Sensitivity Analyses

There is typically a wide range in the quality of the data available for planning. The values of some coefficients may be accurately known, while others may only be available as order-of-magnitude estimates. Since the solutions obtained from the model may be sensitive to coefficients and constraint values for which the estimates are uncertain, sensitivity analyses are desirable. Most commercially available linear programming software packages have procedures for conducting post-optimal sensitivity analyses on right-hand side values, on objective function coefficients, or on coefficients in the linear A-matrix. These procedures are collectively known as parametric analyses.

To perform a parametric analysis on a selected right-hand side, the constraint is written as

$$\sum_j a_{ij} \leq b_i + \alpha_i \Theta \quad \ldots \quad (85)$$

where

α_i is the size of increment to be considered on b_i

$\Theta = 1, \ldots, n$ are the numbers of the increments to be added

After each selected right-hand side is incremented by its particular α_i, the linear problem is resolved in a relatively few simplex iterations. The amount of change in the results indicates how sensi-

Table 38. Results of model optimization maximizing benefits with phosphate mine.

Benefit $928,000,000 — Energy 8,100,000,000,000 BTU

TYIELD = 165 — FHAB = 491 — NIT = 0.228 mg/l — PHO = 0.230 mg/l — SED = 190 mg/l

	Large Unit Uses																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CAT (AUM)	5863	650	0	0	0	0	4487	0	0	0	0	0	0	0	0	0	0	0
CMP (RVD)	0	0	0	200	0	0	0	0	0	0	0	0	120	0	0	0	0	0
DW (AUM)	396	723	105	771	905	1	447	3118	133	825	753	2	153	1026	6		390	11
EW (AUM)	1428	0	366	0	0	3	0	0	0	0	0	0	2	0	0	0	0	0
FIRE (cords)	8280	1983	1045	9	1318	0	29663	124911	15905	0	0	0	0	40958	13722	0	0	0
FISH (RVD)	89	125	0	0	63	0	62	8	0	165	12	0	267	13	3406	223	61	0
HI (RVD)	525	160	120	36	152	22	208	322	17	29	66	0	23	102	25	14	14	0
HU (RVD)	2546	1320	861	717	1475	93	1343	3569	342	735	905	2	415	1492	235	421	452	9
LOG (1000 bd ft)	397400	0	1045200	9200	48200	0	0	0	0	0	0	0	0	0	0	0	0	0
MW (AUM)	0	0	597	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
ORV (RVD)	3542	940	1890	372	922	80	4140	3500	570	0	1310	0	0	1190	100	360	740	0
SHE (AUM)	0	2382	1603	0	0	11	0	0	0	0	0	6	1898	0	0	0	0	0
SNO (RVD)	1322	611	320	263	803	42	602	956	249	0	248	0	275	628	256	277	454	0
YIELD (AF)	32	13	10	6	11	1	19	22	7	7	7	0	7	10	4	3	5	0

Table 39. Results of model optimization maximizing benefits without phosphate mine.

Benefit $3,210,656 — Energy 92,400,000,000 BTU

TYIELD = 165 — FHAB = 489 — NIT = 0.095 mg/1 — PHO = 0.097 mg/1 — SED = 190 mg/1

	Large Unit Uses																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CAT (AUM)	5926	587	0	0	0	0	4487	0	0	0	0	0	0	0	0	0	0	0
CMP (RVD)	0	0	0	200	0	0	0	0	0	0	0	0	120	0	0	0	0	0
DW (AUM)	396	723	105	771	905	1	447	3119	133	825	753	2	153	1026	69	425	390	11
EW (AUM)	1411	0	388	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FIRE (cords)	8280	1983	1045	9	1318	0	29663	124911	15905	0	0	0	0	40958	13722	0	0	0
FISH (RVD)	89	125	0	0	63	0	62	0	0	165	12	0	267	13	3406	223	61	0
HI (RVD)	514	160	121	36	152	22	208	322	17	29	66	0	23	102	25	14	14	0
HU (RVD)	2636	1325	876	717	1475	93	1343	3569	342	735	905	2	415	1492	235	421	452	9
LOG (1000 bd ft)	397400	0	1045200	9200	48200	0	0	0	0	0	0	0	0	0	0	0	0	0
MW (AUM)	0	0	592	0	0	6	0	0	0	0	0	2	0	0	0	0	0	0
ORV (RVD)	3542	940	1890	372	922	80	4140	3500	570	0	1310	0	0	1190	100	360	740	0
SHE (AUM)	0	2356	1629	0	0	11	0	0	0	0	0	6	1898	0	0	0	0	0
SNO (RVD)	1322	611	320	263	803	42	602	956	249	0	248	0	275	628	256	277	454	0
YIELD (AF)	32	13	10	6	11	1	19	22	7	7	7	0	7	10	4	3	5	0

Table 40. Results of model optimization minimizing energy consumption.

Benefit $2,236,023 Energy 19,800,000,000 BTU

TYIELD = 154 FHAB = 252 NIT = 0.095 mg/l PHO = 0.097 mg/l SED = 175 mg/l

Large Unit Uses

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CAT (AUM)	0	1073	0	6226	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CMP (RVD)	0	0	0	116	0	0	0	0	0	0	0	0	60	0	0	0	0	0
DW (AUM)	0	0	0	737	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EW (AUM)	717	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
FIRE (cords)	0	0	0	0	0	0	0	40000	0	0	0	0	0	0	0	0	0	0
FISH (RVD)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3000	0	0	0
HI (RVD)	498	0	86	35	0	0	39	222	13	3	42	0	18	69	23	0	2	0
HU (RVD)	2204	725	731	688	0	0	972	980	0	0	0	0	0	0	0	0	0	0
LOG (1000 bd ft)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MW (AUM)	600	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ORV (RVD)	3542	940	0	0	0	80	1468	3500	570	0	1310	0	0	1190	100	360	740	0
SHE (AUM)	3900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SNO (RVD)	0	272	0	0	0	42	602	956	0	0	0	0	0	628	0	0	0	0
YIELD (AF)	30	12	7	7	10	1	16	22	7	7	7	0	6	10	4	3	5	0

tive the solution (both the objective function and the model outputs) is to estimates of right-hand side values. Similar parametric methods are available for examining model sensitivity to objective function and A-matrix coefficients, though these are generally more costly to run. No parametric sensitivity analyses were performed on the LP model used in the study.

Another type of post-optimal analysis available on most commercial LP packages is RANGE analysis. This sensitivity analysis method requires no additional simplex computations. It produces information about the range over which the values of rows or columns can vary without changing the solution. For the LP model used in the study, one RANGE analysis was conducted. It was done from an optimization run which maximized dollar benefits from the study area while limiting energy consumption to 5.617×10^{10} Btu (a midpoint between its values for the solutions without mining on Tables 39 and 40). The RANGE analysis indicates that the solution is not sensitive to any of the objective function economic coefficients, except those for firewood and fish and moose habitat. For these variables, the amount of use appears to be sensitive to unit benefits on relatively few land units. No other obvious points of sensitivity were found though it should be remembered that this type of analysis does not provide information on model sensitivity to A-matrix coefficients.

Alternative Futures

The linear programming model also provides a capability to consider potential future states. A future state defines the combinations of constraints used in the linear programming model. For example, alternative futures may be specified by a set of demands for forest products or a set of production levels for the commercial uses including the amount of phosphate taken from each mine and the locations of oil and gas exploration.

Continuing with this example, demand estimates for forest products can be made from regional population projections and assumptions on regional per capita consumption of those products. If firewood consumption is now 0.01 cords per capita and in 20 years the population of the region will double and per capita consumption of firewood will increase by 30 percent due to rising energy prices, then the per annum demand for firewood 20 years hence becomes 2.6 times the present demand. This number could then be used in an alternative future. A slightly expanded approach is to use three alternative futures, perhaps, high demands/production levels, low demands/production levels, and probable demands/production levels.

Alternative futures can also be used to display the use consequences of various societal goals. The model can also evaluate diverse goals for reasonability and compatibility.

In formulating the alternative futures, care should be taken to avoid demand sets that are infeasible (logically impossible). The analysis might explore a subset of the noninferior surface by selectively and systematically varying a few parameters of a "probable" future and observing the nature and degree of shifts in optimal land management projects and the tradeoffs these imply.

CHAPTER 7

REVIEW AND CONCLUSIONS

Planning Complexity

This study provides an empirical example of the complexity of the diverse goals, activities, and interactions that belie the superficial simplicity in which comprehensive land use planning is often advocated. In the real world, many people engage in a variety of activities while pursuing diverse goals and thereby interact with one another in many ways. The principal need in planning to provide for an optimal mix of activities is to simplify this complexity, first by separating the important from the trivial (or at least minor) and then by providing a structure for identifying and examining the important tradeoffs.

Obviously, human goals are diverse. Each individual has a variety of goals and must weigh tradeoffs among them in decision making. Groups mean more goals, conflicting individual decisions, and political resolution of differences. In the high mountain context, the diversity of specific goals collapses into the two dominating general ones of economic gain and environmental amenity. The major differences in use preferences collapses into a conflict between economic development and environmental preservation.

People use (directly or in absentia) mountain areas to pursue both general goals through numerous activities. For this study, 21 activities or uses were defined and classified two ways (Table 7). Decision making can be dispersed or centralized, and the predominant goals can be economic or environmental. Also, these human activities occur in the context of various physical and ecological processes that can be considered as natural uses.

The planning complexity, however, comes less in defining the values or the activities than in identifying and quantifying interactions among activities. It is the interactions that cause participants in one activity to want another activity curtailed and that cumulatively set physical upper limits to use. However, these interactions have not been sufficiently well quantified for planning comparisons and uncertainty as to their nature and magnitude creates the primary constraint to planning objectivity.

Interaction Analysis

Interactions originate in both technical (physical) and social (psychological) relationships. Technical relationships affect other uses by changing the physical setting, and social relationships affect other uses by changing perceptions or the way people interface with one another within that setting. Both types of relationships may be either complementary (positive) or competitive (negative), and each activity both imparts and absorbs interactions. Using the three above activity classifications (human activity for economic gain, human activity for environmental contact, and natural uses), one can classify dominating interaction types as shown in Table 41.

As shown in Figure 9 and described in the associated text, technical interactions (primarily Interaction 1) can be either positive or negative. In aggregate, however, they tend to be negative and increasingly so with greater activity intensity. As greater amounts of an economic activity (lumbering, mining, or grazing) are undertaken, it tends to become increasingly competitive with other economic activities and with natural land uses. A few scattered mining or lumbering efforts can be separated from one another and absorbed much more easily by the environment than can major operations.

The effects of low levels of economic on environmental activities (Interaction 2) tend to be social in character and negative in direction. Economic activities tend to disrupt the environment in ways that reduce the satisfaction received by people pursuing environmental enjoyment. The effects of environmental activities on economic activities (Interaction 4) also tend to be social and negative. People visiting a high mountain watershed tend to interfere with local economic activities. The relationships tend to become increasingly competitive in both directions with greater activity intensity. Greater economic activity causes greater environmental disruption, and more environmental visitors create greater pressure to exclude economic activity from favorite areas.

The interactions among environmental activities (Interaction 5) are largely social in character and complementary at lower activity levels (recreationists prefer some other recreationists around to complete isolation and families are attracted to an area by possibilities for participating in more than one activity). However, they become competitive at high use levels (wilderness recreationists, while shunning complete isolation, have a low tolerance for crowding). In high mountain areas, one would expect environmental activity levels to be below the intensities at which the social relationships change from complementary to competitive. However, the empirical evidence is not clear, and different investigators have come to conflicting conclusions. Vaux and Williams (1977) found convenient access and aesthetic attractiveness to dominate the effects of congestion in explaining visitation to wilderness areas. Cicchetti and Smith (1973) stress the importance of going to a pristine wilderness where congestion is intolerable.

In reviewing the six interaction types in the reduced matrix of Table 41 (Interaction 1), one would expect the technical impacts to predominate in the area immediately surrounding economic development (separation of recreationists from mines or attraction of snowmobilers to roads for examples). However (Interaction 2), for the area as a whole, the negative social impacts of economic development on environmental activities may be even stronger. As one thinks along the

Table 41. Dominating types of interactions among combinations of activity groups.

Imparting Activity Group	Absorbing Activity Group (Table 7)		
	Economic (E)[a]	Environmental (R)	Natural (N)
Economic	1.[b] Negative Technical	2. Negative Social	3. Negative Technical
Environmental	4. Negative Social	5. Positive Social	6. Minimal

[a]Letters match Table 7.

[b]Numbers designate interactions discussed in the text.

spectrum of increasing activity intensity, economic uses can generally (Interaction 1) avoid one another at low intensities; and (Interaction 3) animals, fish, and runoff are relatively unaffected by use intensities that are very upsetting to wilderness recreationists. Also, low intensity activity by environmental users is (Interaction 4) unlikely to cause major harm to economic uses, and the (Interaction 5) particular set of environmental (recreation) uses occurring in Upper Valley are not highly complementary to one another. Certainly, (Interaction 6) the current low level of environmental use has little effect on the natural environment.

The negative technical impacts (Interaction 1) proved relatively easy to quantify for the planning model, generally in the form of restricting one use from an area already taken by another. However, separation becomes increasingly difficult with increased competition for land and water, and greater development intensities force planners toward multiple use designs that minimize conflicts between simultaneous or series uses among activities at the same location. Multiple use, already well engrained into Forest Service terminology, will be forced to move from multiple uses scattered over a watershed to multiple uses within a given land unit as natural resources become more fully developed. A better understanding of the interactions that occur at this level must be developed.

On another front, specific negative social impacts of economic on environmental activities (Interaction 2) are generally the first constraint to wilderness preservation that planners must face, but these constraints (like the tradeoffs above) are poorly understood. In the face of uncertainty, the tendency is to prevent all economic activity on principle rather than to weigh tradeoffs considering the economic loss associated with the environmental gain. For initial reconnaissance, Figure 9 identifies interactions that need to be watched for negative social impacts of economic on environmental activities. The primary impacts are those of lumbering, mining, and grazing on recreation. Recreation (Table 7) can be roughly divided between mechanized (firewood cutting, hunting, snowmobiling, and off-road vehicle use) activities and visits focused on a wilderness experience (hiking and camping, viewing the old Oregon Trail, and fishing). Seekers after a wilderness experience would generally be more sensitive to economic development, and these uses need to be particularly watched. They are shown in Figure 11 as impacts 16, 18, 22, and described in more detail in the accompanying text.

Negative social interactions are also significant in that they occur over areas much larger than land units and introduce many of the scoping issues discussed in the beginning sections of Chapter 5. Activities that are not wilderness oriented impact on wilderness activities over large areas and long time spans.

Recommendations for Continued Index Development

This study quantified goals, measured uses, and selected a combination of uses that maximized goal achievement. Yet, the exercise leaves a sense that optimality was not achieved. Probing shows the problem to be in representing interactions, the adverse effects of one use on another that initially motivated the comprehensive planning movement more than 50 years ago.

In fact, successful water and related land use planning is tied to understanding interactions among uses in a wide variety of local contexts. Once the interactions can be quantified, applications require data collection, indexing, analysis, and model building. The variety of contexts, volume of relevant information, and complexity of the relationships suggests a major research and implementation effort. However, available resources are limited; initiation of the systematic collection of many new data items is not now possible; and indexing efforts need to be directed toward cost effective contributions.

What directions are currently cost effective? The value of information to a decision maker is a function of its reliability and relevance. Reliability refers to the correspondence between the state of the world and what the information says is the state of the world. Relevance is determined by being perceived as germane (is it understandable? does it fit in a practical context?) and important (does it describe a feature of the world to which satisfaction of objectives is believed sensitive?).

Generating reliable information generally requires systematic measurement of carefully selected time series. For example, a wealth of data exists on the Upper Blackfoot, but we cannot feel very confident about model results. The data are not sufficient. The motivation to collect more time series, though, depends on the present perceived relevance of the data. Thus, a serious problem in inaugerating a good index system is that changing values may undermine data collection efforts by making them appear irrelevant over time.

This might lead one to recommend (or resign oneself to) less rigorous data collection because financial and political exigencies do not permit the luxury of full scientific rigor. In that case, one would want to focus on techniques for approximating desired indices with acceptable reliability.

Further review of the Upper Valley case study, however, suggests that the current need is not for an extensive program of indexing for planning applications. The greater present need is for research to develop indices suitable for scientific studies to develop relationships describing interactions and to develop models for defining collective interactive impacts. Such efforts do not have the high cost of nationwide data collection systems as they instead focus on specific areas for the limited times required to collect and analyze information for developing a needed understanding. They also draw attention to the real limitation to objective planning by demonstrating what is needed to make it a reality.

Contribution of this Study

The contribution of this study was in formulating and testing a structure that broke new conceptual ground even though it fell short of definitive quantification of desirable uses in the selected case study area. In the Upper Blackfoot study area, the demands for most uses are low. In fact, they are so low that decreasing marginal values are often more important than interactions in restricting activities. In other words, demands were insufficient for uses to reach levels at which interactions are significant.

This situation meant that interactions were difficult to quantify because the events to be observed occur infrequently. Even where observations could be made, the character of the interactions would be expected to change with increased use intensities. For example, the few hikers and fishermen are so dispersed that they are very difficult to locate and question to obtain needed information. When they can be found, their concepts of interaction are quite different than they would be if recreational crowding were severe. This quantification problem could be overcome, but the effort was not judged to be worthwhile in the context of this study.

The present uses of Upper Valley conflict little with the overall best public interest, a situation that can be expected to continue at least as long as market conditions depress mining and logging activity. If larger future demands should raise these activities to levels exceeding the public interest, regulations restricting use would probably provide the most effective control. Because both uses are controlled by centralized decision making (Table 7), such a regulatory program would not need to be structured to directly communicate with the public.

Reiterating, the major contribution of this study is a framework for analysis, a skeleton on which research needs can be identified and prioritized. Many needed techniques are obviously still in the developmental stage, and many more quantifications need refinement.

Major topics requiring refinement are 1) the estimation of technical impacts of economically motivated uses on each other and on the natural environment, 2) the perceptions of wilderness oriented recreationists of other uses occurring in the area, 3) characterization of the combination of attributes identifying the quality of an area for a use, and 4) characterization of overall planning models to represent the many levels and types of interactions.

It has become almost commonplace for modeling to go beyond the support capabilities of available data. The data that exist often do not match the needs of planning models. Because of the poor match, a great deal of the effort going into both model building and data collection is unproductive. A conscious effort is needed for better coordination between the two activities. Certainly, this study was halted by sparse information on where uses occur and how they interact with one another.

The important point here is that analytic models to identify and quantify tradeoffs are the planning tools of the future, and that too little effort is going into developing advanced information systems so that they can be used to collect and organize the data that will be needed. For example, remote sensing technology is moving forward rapidly, has many spinoffs that could be developed for water planning applications, and needs to be applied. Researchers at Utah State University can now count big game in specified areas by remote sensing.

Better data can give better results with existing models. However, as mountain areas become more intensively used, the uses will become more interactive. Perhaps input-output modeling concepts can be applied; more likely, some sort of nonlinear equation set will eventually be required. At this point, one can safely conclude that for the long run the development of nonlinear, interactive, dynamic models is just as important as additional data collection for better planning. But more sophisticated models cannot be developed without better data, and we must return to the theme of coordinating data gathering with model building.

Returning to the theme of this report, indexing has an important role in data collection, model building, and planning. For the present, the primary role should continue to be predictive (deriving relationships needed for planning) rather than evaluative (applied planning optimization). The modeling done for this study demonstrates that the definition of quantitative relationships needs to be given a higher priority than quantifying values people put on known situations. This study has provided a structure for formulating those indices and guiding the needed data gathering and analysis.

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APPENDIX A

Questionnaire Procedure

1. Select 10 people responsible for managing or acknowledged as experts with respect to each of the 8 specialized uses. These are commercial timber, cattle grazing, sheep grazing, wildlife habitat, fish habitat, phosphate mining, oil and gas exploration, and watershed runoff.

2. Identify 10 people each who engage in each of the 7 public uses. These are firewood gathering, hunting, hiking, camping, snow-mobiling, ORV use, and fishing. Total population questioned would thus be no more than 150.

3. The experts on specialized uses will be asked for information on their speciality use, what public uses they personally participate in, and for information on their preferences with respect to those public uses.

4. The participants identified with each of the public uses will be asked what other public uses they personally participate in and for information on their preferences with respect to those uses as well.

Information Sought from Questionnaire

1. Identification of attributes actually important to experts or those engaging in public uses.

2. Estimation of preferences by values for those attributes (or of ranges of values within which the use is favorably regarded).

3. Overall public regard toward (feeling of importance of each use) all 22 uses. The complete list of uses is relevant because of the need, for example, to differentiate between deer-habitat and cattle range preferences.

4. Perceived complementary or interference interactions with other uses.

Instructions

Each person being interviewed has been identified either with one of eight specialized uses (commerical logging, phosphate mining, oil and gas exploration, cattle grazing, sheep grazing, wildlife habitat, fish habitat, or watershed runoff), or one of seven public uses (firewood cutting, hunting, hiking and dispersed camping, concentrationed camping, snowmobiling, summer ORV use, or fishing).

1. Ask Question 1 with respect to that particular use.

2. Ask everyone Question 2 with respect to all seven public uses.

3. Ask everyone Question 3.

4. Many of those being interviewed with respect to a specialized use will respond to Question 2 that they also engage in public uses. For those that do so, ask whether they engage in that use in the Diamond Creek area. If so, ask Question 1 with respect to each use (to a maximum of 7) that they engage in regularly or occasionally. If not, ask why they do not use the Diamond Creek area and write a brief explanation on the Question 1 form.

Many of those being interviewed because of one public use will respond to Question 2 that they also engage in other public uses. For those that do so, follow the above procedure with respect to those other public uses (to a maximum of 6).

5. Ask everyone Question 4 (keeping in mind supplemental special topics where appropriate).

6. Use S or P code on upper right hand corner to indicate respondent type.

QUESTION 1: For people identified with

P-1 Firewood Cutting

Rate the following factors (beginning with 1 for the most important) according to their importance to you in deciding where to cut firewood. Comments on what sort of situation you particularly seek with respect to each factor would be helpful.

		Rating	Comments
A.	Number of dead trees in the immediate area	______	______
B.	Size of dead trees	______	______
C.	Distance from trees to place where you can drive	______	______
D.	Distance you have to drive to get to the location	______	______
E.	Price per cord that you would have to pay for firewood	______	______
F.	Ownership of the land	______	______
G.	______	______	______

Identify areas on the attached map where you have cut firewood in the last three years.

QUESTION 1: For people identified with

P-2 Hunting

Rate the following factors (beginning with 1 for the most important) according to their importance to you in deciding where to hunt. Comments on what sort of situation you particularly seek with respect to each factor would be helpful.

		Rating	Comments
A.	Predominant vegetation type	_____	_____________________
B.	Elevation	_____	_____________________
C.	Nearby stream	_____	_____________________
D.	Steepness of ground slope	_____	_____________________
E.	Ownership of the land	_____	_____________________
F.	_____________________	_____	_____________________

Identify the species that you have hunted during the last three years ____

____

QUESTION 1: For people identified with

P-3 Hiking and Dispersed Camping

Rate the following factors (beginning with 1 for the most important) according to their importance to you in deciding where to hike or camp along the trail. Comments on what sort of situation you particularly seek with respect to each factor would be helpful.

	Rating	Comments
A. Steepness of the ground slope	______	______
B. Predominant vegetation type	______	______
C. Elevation	______	______
D. Aesthetic quality of the site	______	______
E. Amount of visable landscape	______	______
F. Proximity to a running stream	______	______
G. Following a road or maintained trail	______	______
H. Ownership of the land	______	______
I. ______	______	______

Identify routes on the attached map where you have hiked and locations where you have camped in the last three years.

QUESTION 1: For people identified with

P-4 Concentrated Camping

Rate the following factors (beginning with 1 for the most important) according to their importance in your selection of a campground. Comments on what sort of situation you particularly seek with respect to each factor would be helpful.

	Rating	Comments
A. Predominant vegetation type	______	______
B. View of mountains round about	______	______
C. Aesthetic quality of the site	______	______
D. Elevation	______	______
E. Proximity to a running stream	______	______
F. ______	______	______

What specifically attracted you to a campground in the Diamond Creek area? ______

QUESTION 1: For people identified with

P-5 Snowmobiling

Rate the following factors (beginning with 1 for the most important) according to their importance in your selection of a place to snowmobile. Comments on what sort of situation you particularly seek with respect to each factor would be helpful.

	Factor	Rating	Comments
A.	Ownership of the land	______	______________________________
B.	Steepness of ground slope	______	______________________________
C.	Elevation	______	______________________________
D.	Predominant vegetation type	______	______________________________
E.	Aesthetic quality of the site	______	______________________________
F.	Following a road or trail	______	______________________________
G.	____________________	______	______________________________

Identify areas on the attached map where you have snowmobiled during the last three years.

QUESTION 1: For people identified with

P-6 Summer ORV Use

Rate the following factors (beginning with 1 for the most important) according to their importance in your selection of a route for driving your ORV. Comments on what sort of situation you particularly seek with respect to each factor would be helpful.

		Rating	Comments
A.	Ownership of the land	_____	_____
B.	Following a road or trail	_____	_____
C.	Elevation	_____	_____
D.	Aesthetic quality of the site	_____	_____
E.	Amount of visible landscape	_____	_____
F.	Steepness of the route	_____	_____

Identify areas on the attached map where you have driven your ORV in the last three years.

QUESTION 1: For people identified with

P-7 Fishing

Rate the following factors (beginning with 1 for the most important) according to their importance to you in deciding where to fish. Comments on what sort of situation you consider ideal with respect to each factor would be helpful.

	Rating	Comments
A. Size of stream	______	______
B. Flow velocity	______	______
C. Characteristics of the stream bed	______	______
D. Ownership of the land	______	______
E. ______	______	______

Identify areas on the attached map where you have fished during the last three years.

QUESTION 2. How frequently do you use the forest for each of the following activities?

Alternative Use	Regularly	Occasionally	Never
Firewood Gathering	____	____	____
Hunting	____	____	____
Hiking	____	____	____
Camping	____	____	____
Snowmobiling	____	____	____
ORV Use	____	____	____
Fishing	____	____	____

QUESTION 3: How desirable do you feel it to be for your community that each of the following uses occur within the Diamond Creek area?

Responses

Desirable and use should be increased	+2
Desirable but current use level about right	+1
Doesn't make much difference	0
Undesirable and should be restricted	-1
Highly undesirable and should be curtailed	-2

Uses

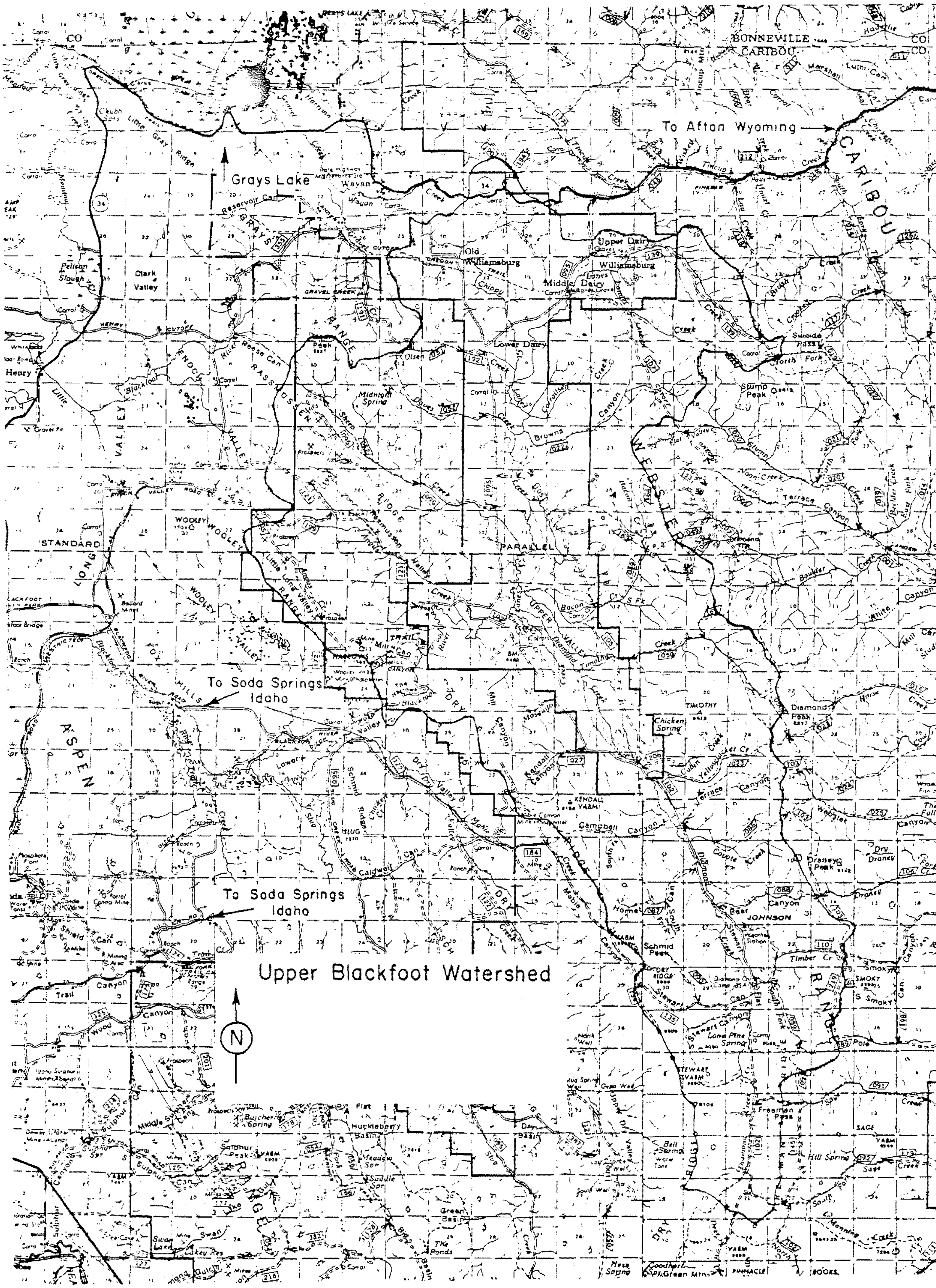
1. Commercial Logging ______
2. Firewood Cutting ______
3. Phosphate Mining ______
4. Oil and Gas Exploration ______
5. Cattle Grazing ______
6. Sheep Grazing ______
7. Quality Deer Habitat ______
8. Quality Elk habitat ______
9. Quality Moose habitat ______
10. Quality Crane habitat ______
11. Hunting ______
12. Hiking ______
13. Camping ______
14. Improved Roads ______
15. Snowmobiling ______
16. Summer Off-Road Vehicle Use ______
17. Building ______
18. Visitation to Historical Sites ______
19. Quality Fish Habitat ______
20. Fishing ______
21. Water Development for Livestock ______
22. Management to Increase Runoff for Downstream Use ______

QUESTION 4: For people identified with the particular use.

Use ______________________________

How do you feel that your use of the Diamond Creek area is affected by each of the following uses? For your own use, respond in terms of the same use by others nearby.

	Comple-mentary	Neutral	Unde-sirable	Because
1. Commercial Logging				
2. Firewood Cutting				
3. Phosphate Mining				
4. Oil and Gas Exploration				
5. Cattle Grazing				
6. Sheep Grazing				
7. Deer				
8. Elk				
9. Moose				
10. Crane				
11. Hunting				
12. Hiking				
13. Camping				
14. Improved Roads				
15. Snowmobiling				
16. Off-Road Vehicle Use				
17. Building				
18. Visitation to Historical Sites				
19. Fish				
20. Fishermen				
21. Livestock Water Development				
22. Runoff of Water for Use Downstream				



Upper Blackfoot Watershed
N
To Afton Wyoming
Grays Lake
To Soda Springs Idaho
To Soda Springs Idaho
BONNEVILLE
CARIBOU
Henry
STANDARD
PARALLEL
Wayan
Old Williamsburg
Upper Dairy
Williamsburg
Middle Dairy
Lower Dairy
Clark Valley
Pelican Slough

APPENDIX B

Estimation of Energy Consumption Coefficients

Energy consumption coefficients per use unit were estimated for the eleven commercial and recreational uses involving significant human activity in the watershed and by using information in Tables B1 through B4.

1. Commercial logging

Energy for logging is used in felling, bucking, skidding, and transporting to the mill. The basic equipment consists of a chain saw for felling and bucking, a caterpillar for skidding and loading, and a truck for hauling. Additional energy used in road construction was not included, although new roads are anticipated for Timber Creek and most other significant sites. Also, the energy use per MBF is sensitive to transportation distance.

Energy Consumption

chain saw	2 gal/day x 125,000 Btu/gal = 250,000 Btu/day
caterpillar	0.5 x 270 x 0.63 ÷ 7.2 = 11.8 gal/hr x 136,000 Btu/gal
truck	0.10 mi/load ÷ 6 mi/gal x 136,000 Btu/gal = 227,120 Btu/load

Timber Production

chain saw	2 tree/hr x 160 bd ft/tree x 7 hr/day = 2,240 bd ft/day
caterpillar	2.4 load/hr x 480 bd ft/load = 1,152 bd ft/hr
truck	3,000 bd ft/load

(250,000 ÷ 2,240) + (136,000 ÷ 1,152) + (227,120 ÷ 3,000) =
(111.6 + 118 + 75.7) x 1,000 bd ft/MBF = 305,300 Btu/MBF

2. Firewood cutting

Energy is used to cut and haul firewood. The typical equipment is a small chain saw and a pick-up truck.

Fuel consumption:

saw	0.75 qt/.67 hr = 0.3 gal/hr (3-4 in^3 engine)
pickup	10 mpg

Production cycle

saw	1 hr/cd
pickup	1 cd/trip (trip = 24 mi in study area)

Table B1. Load factors for fuel consumption.

Type of Equipment Used	Operating Conditions		
	Excellent	Average	Severe
Wheel-type, on paved road	0.25	0.30	0.40
Wheel-type, off highway	0.50	0.55	0.60
Crawler-track type	0.50	0.63	0.75
Power excavators	0.50	0.55	0.60

SOURCE: David A. Day. 1973. Construction Equipment Guide. New York: John Wiley & Sons, p. 35.

Table B2. Rail freight service and energy consumption, 1972.

Direct fuel consumed	
thousand bbl/day	252
million gal/year	3,874
trillion Btu/year	539
percentage of TDTE	2.93
Service rendered	
vehicle-miles/year	N/A
tons-miles/year	785,000 (million)
Average efficiency	
Btu/ton-mile	676
ton-miles/gal	204

Source: National Research Council, Transportation Research Board. 1977. Energy Effects, Efficiencies and Prospects for Various Modes of Transportation. Washington, D.C.

Table B3. Force conversions.

From \ To	Horsepower	Kilowatts	Metric Horsepower	Foot-Pounds/ sec	Kilocalories/ sec	Btu/ sec
Horsepower	1	0.7457	1.014	550	0.1781	0.7068
Kilowatts	1.341	1	1.360	102.0	737.6	0.9478
Metric horsepower	0.9863	0.7355	1	542.5	0.1757	0.6971
Foot-pounds/sec	1.82×10^{-3}	$1.356 \times 10_{-3}$	1.84 x 10-3	1	0.3238×10^{-3}	1.285×10^{-3}
Kilocalories/sec	5.615	4.187	5.692	3,088	1	3.968
Btu/sec	1.415	1.055	1.434	778.2	0.2520	1

SOURCE: D. B. Shonka, ed., Transportation Energy Conservation Data Book, 3rd ed. (Oak Ridge, Tennessee: Oak Ridge National Laboratory, Energy Division, February 1979; ORNL-5493 Special), p. A-9.

Table B4. Heat contents of fuels.

Coal	
Anthracite	25.4 x 10^6 Btu/short ton = 29.7 MJ/kg
Bituminous	26.2 x 10^6 Btu/short ton = 30.6 MJ/kg
Lignite	12.4 x 10^6 Btu/short ton = 14.5 MJ/kg
Bituminous and lignite	
Production average	25.5 x 10^6 Btu/short ton = 27.5 MJ/kg
Consumption average	22.8 x 10^6 Btu/short ton = 26.7/MJ/kg
Natural gas	
Wet	1,095 Btu/ft^3 = 40.79 MJ/kg
Dry	1,021 Btu/ft^3 = 38.04 MJ/kg
Liquid	95,800 Btu/gal = 3,569 MJ/kg
Crude petroleum	138,100 Btu/gal = 5,145 MJ/kg
Fuel oils	
Residual	149,700 Btu/gal = 41.73 MJ/l
Distillate	138,700 Btu/gal = 38.66 MJ/l
Automotive gasoline	125,000 Btu/gal = 34.84 MJ/l
AVGAS	124,000 Btu/gal = 34.56 MJ/l
Jet fuel (naphtha)	127,500 Btu/gal = 35.54 MJ/l
Jet fuel (kerosene)	135,000 Btu/gal = 37.63 MJ/l
Lubricants	144,400 Btu/gal = 40.25 MJ/l
Waxes	131,800 Btu/gal = 36.74 MJ/l
Asphalt and road oil	158,000 Btu/gal = 44.04 MJ/l
Petroleum coke	143,400 Btu/gal = 39.97 MJ/l

SOURCE: D. B. Shonka, ed., Transportation Energy Conservation Data Book, 3rd Ed. (Oak Ridge Tennesse: Oak Ridge National Laboratory, Energy Division, February 1979, ORNL-5493 Special), p. A-5.

SOURCE: Oak Ridge Associated Universities. 1980. Industrial Energy Use Data Book. Oak Ridge, Tennessee, pp. A-1, A-5.

Energy use

(0.3 gal/hr x 125,000 Btu/gal. x 1 hr/cd) +
125,000 Btu/gal x 1 trip/cd) = 337,500 Btu/cord.

3. Phosphate mining

The energy expended in phosphate mining depends on how much material must be moved what distance to extract a ton of phosphate and on the processing done at the site. On the average, 3.5 tons of overburden is moved for each ton of phosphate. The average ton is moved 1,500 ft on the site, either to the plant or to a waste dump. The primary earth moving equipment, as indicated in the EIS, is a bulldozer and scraper. Fuel consumption for these vehicles is calculated as a function of horsepower, operating conditions and time in use. Productivity depends on vehicle capacity, speed and distance in the work cycle, and operating conditions. Vehicle specifications from Stubbs (1959) were used in determining fuel consumption and operating cycles. Energy use in beneficiation was estimated from fuel estimates given in the EIS (V.II, 4-34), reduced by a factor of 34/58 to adjust for lowered post-EIS expectations.

Diamond Creek extraction

Fuel Consumption

dozer	0.5 x 270 x 0.63 ÷ 7.2 = 11.8 gal/hr x 136,000 Btu/gal
scraper	0.5 x 450 x 0.55 ÷ 7.2 = 17.2 gal/hr x 136,000 Btu/gal

Production

dozer	25 cycle/hr x 7.2S cu yd/cycle x 0.22 cu yds phos/cu yd x 2,300 lbs/cu yd ÷ 2,000 lbs/ton = 45.9 tons/hr
scraper	8.9 cycles/hr x 30 cu yd/cycle x 0.22 cu yds phos/cu yd x 2,300 lb/cu yd ÷ 2,000 lbs/ton = 67.6 tons/hr

(11.9 gal/hr x 136,000 Btu/gal ÷ 67.6 tons/hr) + (17.2 gal/hr x
136,000 Btu/gal ÷ 67.6 tons/hr) = 23,740 + 34,604 = 58,344 Btu/ton

Diamond Creek beneficiation

Consumption

[(4.5 x 108 kwh x 0.9478 Btu/sec x 3,600 sec/hr) + (230,000 gal x 125,000 Btu/gal) + (170,000 tons coal x 2.62 x 10^7 Btu/ton)] x 34/58 = 3.528 x 10^{12} Btu (over mine life)

Production

34/58 x 4.0 x 10^7 tons = 2.35 x 10^7 tons
3.528 x 10^{12} ÷ 2.35 x 10^7 = 150,127 Btu/ton

Transportation

12 mi x 676 Btu/ton-mi = 8,112 Btu/ton
58,344 + 150,127 + 8,112 = 216,583 Btu/ton

4. Cattle grazing

Energy expended in cattle grazing is determined by the transporation required to get the cattle to their range and to monitor them during the grazing season. Estimates were based on an average round trip of 22 miles to bring cattle into the study area and on one 30 mile maintenance trip per week per 140 AUM during the 3.5 months of the grazing season.

Consumption

cattle trailer	22 mi/load ÷ 6 mi/gal x 125,000 Btu/gal x 2 trips/ season = 916,667 Btu/season
pickup	30 mi/trip + 12 mi/gal x 125,000 Btu/gal x 12 trips/season = 5,750,000 Btu/season

Production

cattle trailer	40 head/season x 3.5 AUM/head = 140 AUM/season
pickup	700 AUM (200 head)

(916,667 Btu/season ÷ 140 AUM/season) + (3,750,000 Btu/season ÷ 700 AUM/season) 6,548 + 5,357 = 11,905 Btu/AUM

5. Sheep grazing

Estimation of the energy consumed in sheep grazing paralleled the approach for cattle, taking into account the following differences: more sheep can fit in a truck; one (cattle) AUM feeds more head of sheep; the sheep grazing season is shorter; sheep herders are continuously on site; trucking distances are shorter because of greater reliance on herding.

Consumption

sheep trailer	18 mi/load ÷ 6 mpg x 125,000 Btu/gal x 2 trips/season 750,000 Btu/season
pickup	30 mi/trip ÷ 12 mpg x 125,000 Btu/gal x 4 trips/ season 1,250,000 Btu/season
herder camp	60 days/season x 0.375 gal/day (kerosene) x 135,000 Btu/gal 3,037,500 Btu/season

Production

trailer	80 sheep/load x 2 sheep months/sheep x .2 AUM/sheep months 32 AUM

pickup	120 AUM	(300 head)
herder camp	120 AUM	(300 head)

(750,000 Btu/season ÷ 32 AUM/season) + (1,250,000 Btu/season ÷ 120 AUM/season) + (3,037,500 Btu/season ÷ 120 AUM/season)
23,438 Btu/AUM + 10,416 Btu/AUM + 25,313 Btu/AUM = 59,167 Btu/AUM

6. Hunting

Energy in hunting is expended in transportation and energy used on site. A pickup with camper is assumed.

Consumption

pickup	30 mi/trip ÷ 10 mi/gal x 125,000 Btu/gal = 437,500 Btu/trip
camper	255 gal/day x 135,000 Btu/gal x 1.5 days/trip = 50,625 Btu/trip

Production

pickup	3 hunters/trip x 1.5 days/hunter = 4.5 days/trip
camper	3 hunters/camper x 1.5 day/hunter = 4.5 days/trip

(437,500 ÷ 4.5) + (50,625 ÷ 4.5) = 108,472 Btu/day

7. Fishing

Energy in fishing is also expended in transportation and energy used on site. It was assumed that energy is used at the site in only 10 percent of the angler days.

Consumption

pickup	20 mi/trip ÷ 12 mpg x 125,000 Btu/gal = 208,333 Btu/trip
camping	0.25 gal/day x 135,000 Btu/gal x 1 day/trip = 33,750 Btu/trip

Production

pickup	anglers/trip x 1 day/angler = 2 days/trip
camping	0.1 camper/day

(208,333 Btu/trip ÷ 2 days/trip) + (33,750 Btu/camp x .1 camp/day)

= 104,167 + 3,375 = 107,542 Btu/day

8. Hiking/dispersed camping

Energy in hiking and dispersed camping is expended in transportation and energy used on site. Most of the user days are accounted for by miners spending the summer in Upper Valley in camper trailers, so camp site energy use is proportionately higher than would be expected in areas of predominantly recreational camping.

Consumption

pickup 24 mi/trip ÷ 10 mpg x 125,000 Btu/gal = 300,000 Btu/trip
camping .375 gal/day x 135,000 Btu/gal x 2.2 days/trip = 111,375 Btu/trip

Production

pickup 20 campers/trip x 2.2 days/camper = 4.4 days/trip
camping 2.0 campers/camp x 2.2 days/camp x 1 camp/trip = 4.4 days/trip

(300,000 ÷ 4.4) + (111,375 ÷ 4.4) = 93,494 Btu/day

9. Concentrated camping

Energy in concentrated camping is expended in transportation, energy use on site, and campground maintenance. Maintenance combines general campground cleanup and repair at the opening of the season and the routine upkeep (e.g., trash removal).

Consumption

camper/trailer 16 mi/trip ÷ 10 mi/gal x 125,000 Btu/gal = 200,000 Btu/trip
camping 0.375 gal/day x 135,000 Btu/gal x 2.2 days/trip = 111,375 Btu/trip

a) routine maintenance 20 mi/haul ÷ 10 mi/gal x 125,000 Btu/gal = 250,000

b) seasonal maintenance 20 mi/trip ÷ 8 mi/gal x 125,000 Btu/gal = 312,500

Production

camper/trailer 3.5 campers/trip x 2.2 days/camper = 7.7
camping 3.5 campers/trip x 2.2 days/camper = 7.7
maintenance a) 8 days/can x 15 cans/trip = 120 user days/haul
b) 1000 days/trip

(200,000 Btu/trip ÷ 7.7 days/trip) + (111,375 Btu/trip ÷ 7.7 days/trip) + (250,000 Btu/haul ÷ 120 days/haul) + (312,500 Btu/trip ÷ 1000 days/trip) = 25,974 + 14,464 + 2,083 + 313 = 42,834 Btu/day

10. Snowmobiling

Snowmobiling consumes energy in transporation of the snowmobile and its use on site.

Consumption

pickup 10 mi/trip ÷ 10 mpg x 125,000 Btu/gal = 125,000 Btu/tri
snowmobile 50 mi/trip ÷ 35 mi/gal x 125,000 Btu/gal = 178,571 Btu/
(440-500 cc engine)

Production

pickup	3 riders/trip x 1 day/rider = 3 days/trip
snowmobile	1.5 riders/veh x 1 day/rider x 2 veh/trip = 3 days/trip

(125,000 ÷ 3) + (178,571 ÷ 3) = 41,667 + 59,524 = 101,191 Btu/day

11. ORVs

Offroad vehicles may be either two or four wheeled. Motor bikes are assumed to be carried (not ridden) into the study area, and four wheel vehicles are assumed driven in.

a) Motorbikes

Consumption

transport	16 mi/trip ÷ 10 mi/gal x 125,000 Btu/gal = 200,000 Btu/trip
motorbike	40 mi/trip ÷ 35 mi/gal x 12S,000 Btu/gal = 142,857 Btu/trip

Production

transport	3 riders/trip x 1 day/rider = 3 a days/trip
motorbike	2.0 rider/bike x 1.5 bikes/trip x 1 day/rider = 3 days/trip

(200,000 ÷ 3) + (142,857 ÷ 3) = 66,667 + 47,619 = 114,286

b) Four wheel drive

Consumption

road	16 mi/trip ÷ 10 mi/gal x 125,000 Btu/gal = 200,000 Btu/trip
offroad	40 mi/trip ÷ 8 mi/gal x 125,000 Btu/gal = 625,000 Btu/trip

Production

road	3 rider/trip x 1 day/rider = 3 days/trip
offroad	3 rider/trip x 1 day/rider = 3 days/trip

(200,000 ÷ 3) + (625,000 ÷ 3) = 66,667 + 208,333
275,000 Btu/trip

APPENDIX C

Listing of General Purpose DL1 Matrix Generator

```
                                                                     /**/
                                                                     /**/
/*********************************************************************/
/*                                                                  */
/*      MGENERATOR:  THIS PROGRAM IS DESIGNED TO CREATE THE MPS     */
/*      DATA FILE FOR A MIXED INTEGER LINEAR PROGRAMMING MODEL.     */
/*                                                                  */
/*      THE PROGRAM WAS WRITTEN FOR U.W.R.L. PROJECT WG-249, WHICH  */
/*      WAS FUNDED BY THE OFFICE OF WATER RESEARCH AND TECHNOLOGY.  */
/*      IT IS, HOWEVER, A GENERAL PURPOSE PROGRAM AND CAN BE APPLIED */
/*      TO THE CONSTRUCTION OF ANY LINEAR PROGRAMMING MODEL.        */
/*                                                                  */
/*                                                                  */
/*      MGENERATOR HAS BEEN DESIGNED AND IMPLEMENTED BY M. MCKEE,   */
/*      DEPARTMENT OF CIVIL ENGINEERING, U.S.U.                     */
/*                                                                  */
/*      M. MCKEE                                                    */
/*      JUNE 20, 1981                                               */
/*                                                                  */
/*********************************************************************/
                                                                     /**/
                                                                     /**/
MGENERATOR:  PROC OPTIONS (MAIN);
DCL COMMANDS FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=84,
      BLOCKSIZE=2520,AREASIZE=450);
DCL MASTER FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=210,
      BLOCKSIZE=6300,AREASIZE=450);
DCL GFILE FILE INPUT ENV (KIND='DISK',MAXRECSIZE=84,BLOCKSIZE=2520,
      AREASIZE=450);
DCL REPORT FILE PRINT;
DCL INF FILE INPUT ENV (KIND='REMOTE');
DCL OTF FILE OUTPUT ENV (KIND='REMOTE',MAXRECSIZE=84);
DCL ROWS1 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=9,
      BLOCKSIZE=270,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL ROWS2 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=9,
      BLOCKSIZE=270,AREASIZE=450);
DCL ROWS3 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=9,
      BLOCKSIZE=270,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL ROWS4 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=9,
      BLOCKSIZE=270,AREASIZE=450);
DCL COLUMNS1 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL COLUMNS2 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450);
DCL COLUMNS3 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL COLUMNS4 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450);
DCL INT1 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL INT2 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450);
DCL INT3 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL INT4 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450);
DCL BIV1 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL BIV2 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450);
DCL BIV3 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL BIV4 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450);
DCL RHS1 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL RHS2 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450);
DCL RHS3 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL RHS4 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=28,
      BLOCKSIZE=840,AREASIZE=450);
DCL BOUNDS1 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=30,
      BLOCKSIZE=900,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL BOUNDS2 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=30,
      BLOCKSIZE=900,AREASIZE=450);
DCL BOUNDS3 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=30,
      BLOCKSIZE=900,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL BOUNDS4 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=30,
      BLOCKSIZE=900,AREASIZE=450);
```

```
DCL SEP1 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=36,
      BLOCKSIZE=1080,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL SEP2 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=36,
      BLOCKSIZE=1080,AREASIZE=450);
DCL SEP3 FILE RECORD OUTPUT ENV (KIND='DISK',MAXRECSIZE=36,
      BLOCKSIZE=1080,AREASIZE=450,AREAS=100,SAVEFACTOR=999);
DCL SEP4 FILE RECORD INPUT ENV (KIND='DISK',MAXRECSIZE=36,
      BLOCKSIZE=1080,AREASIZE=450);
DCL GREEN FILE OUTPUT ENV (KIND='DISK',MAXRECSIZE=84,BLOCKSIZE=2520,
      AREASIZE=450,AREAS=1000,SAVEFACTOR=999);
DCL DEBUG BIT (1) INIT ('0'B);
DCL LISTING BIT (1) INIT ('0'B);
DCL EOF BIT (1) INIT ('0'B);
DCL NOW_ZERO BIT (1);
DCL 1 ROW_REC,
       2 ROW_TYPE CHAR (1),
       2 ROW_NAME CHAR (8);
DCL 1 COL_REC,
       2 COL_NAME CHAR (8),
       2 ROW_NAME CHAR (8),
       2 COEFF CHAR (12);
DCL 1 RHS_REC,
       2 RHS_NAME CHAR (8),
       2 ROW_NAME CHAR (8),
       2 VALUE CHAR (12);
DCL 1 BOUND_REC,
       2 BOUND_TYPE CHAR (2),
       2 BOUND_NAME CHAR (8),
       2 COL_NAME CHAR (8),
       2 VALUE CHAR (12);
DCL 1 SEP_REC,
       2 COL_NAME CHAR (8),
       2 ROW_NAME CHAR (8),
       2 COEFF CHAR (12),
       2 SEP_SET CHAR (8);
DCL COMMAND_LINE CHAR (84);
DCL ACHAR CHAR (1);
DCL CFIELD(7) CHAR (12);
DCL CLENGTH(7) FIXED;
DCL NDEX FIXED DEC INIT (0);
DCL IDO(5) FIXED DEC;
DCL IPOINTER FIXED DEC INIT (0);
DCL FSTACK(4) FLOAT DEC;
DCL ISTACK(4) FIXED;
DCL (#ROWS,#COLS,#ICOLS,#BCOLS,#RHS,#BNDS,#SEP) FIXED DEC;
DCL 1 XIN,
       2 IDATA FIXED,
       2 XDATA(34) FLOAT DEC;
                                                                    /**/
                                                                    /**/
/******************************************************************/
/*                                                                */
/*      MAIN COMPUTATION BEGINS HERE.                             */
/*                                                                */
/******************************************************************/
                                                                    /**/
                                                                    /**/
#ROWS,#COLS,#ICOLS,#BCOLS,#RHS,#BNDS,#SEP = 0;
ISTACK(*) = 0;
FSTACK(*) = 0;
IDO(*) = 0;
PUT FILE (OTF) EDIT ('DO YOU WISH DEBUG OUTPUT? (Y OR N)',' ')
                    (COL(1),A);
GET FILE (INF) EDIT (ACHAR) (COL(1),A(1));
IF ACHAR = 'Y' THEN DEBUG = '1'B;
PUT FILE (OTF) EDIT ('DO YOU WISH A "BCDOUT" LISTING? (Y OR N)',' ')
                    (COL(1),A);
GET FILE (INF) EDIT (ACHAR) (COL(1),A(1));
IF ACHAR = 'Y' THEN LISTING = '1'B;
LOOP:  CALL INTERP;
   IF EOF THEN GO TO FIN1;
   NDEX = NDEX + 1;
GO TO LOOP;
                                                                    /**/
                                                                    /**/
/******************************************************************/
/*                                                                */
/*      INTERP:  THIS SUBROUTINE READS A COMMAND FROM THE COMMAND */
/*      FILE, INTERPRETS IT, AND CALLS THE APPROPRIATE SUBROUTINE */
/*      TO EXECUTE THE COMMAND.                                   */
/*                                                                */
/******************************************************************/
                                                                    /**/
                                                                    /**/
INTERP:  PROC;
DCL (I,CPOINTER) FIXED;
DCL ACHAR CHAR (1);
DCL SWITCH_IS_ON BIT (1) INIT ('0'B);
ON ENDFILE (COMMANDS) GO TO ESET;
```

```
READ FILE (COMMANDS) INTO (COMMAND_LINE) INDEX (NDEX);
IF DEBUG THEN PUT FILE (REPORT) SKIP (3) EDIT (NDEX,COMMAND_LINE)
                      (COL(1),F(8),COL(10),A);
CFIELD(*) = ' ';
CPOINTER = 0;
CLENGTH(*) = 0;
DO I = 1 TO 84;
   ACHAR = SUBSTR(COMMAND_LINE,I,1);
   IF ACHAR = ';' THEN GO TO TRAFFIC;
   ELSE IF ACHAR = ' ' THEN DO;
      IF SWITCH_IS_ON THEN SWITCH_IS_ON = '0'B;
   END;
   ELSE DO;
      IF ¬SWITCH_IS_ON THEN DO;
         SWITCH_IS_ON = '1'B;
         CPOINTER = CPOINTER + 1;
      END;
      CLENGTH(CPOINTER) = CLENGTH(CPOINTER) + 1;
      SUBSTR(CFIELD(CPOINTER),CLENGTH(CPOINTER),1) = ACHAR;
   END;
END;
TRAFFIC:  IF DEBUG THEN PUT FILE (REPORT) DATA (CFIELD,CLENGTH,
                      CPOINTER);
   IF CPOINTER = 0 THEN RETURN;
   ELSE IF INDEX(CFIELD(1),'DO') > 0 THEN CALL DOLOOP;
   ELSE IF INDEX(CFIELD(1),'IFTHEN') > 0 THEN CALL IFTHEN;
   ELSE IF INDEX(CFIELD(1),'ENTER') > 0 THEN CALL HENTER;
   ELSE IF INDEX(CFIELD(1),'POP') > 0 THEN DO;
      IF INDEX(CFIELD(1),'I') > 0 THEN CALL POP('1'B);
      ELSE CALL POP('0'B);
   END;
   ELSE IF INDEX(CFIELD(1),'PUSH') > 0 THEN DO;
      IF INDEX(CFIELD(1),'I') > 0 THEN CALL PUSH('1'B);
      ELSE CALL PUSH('0'B);
   END;
   ELSE IF INDEX(CFIELD(1),'READ') > 0 THEN CALL HREAD;
   ELSE IF INDEX(CFIELD(1),'GET') > 0 THEN CALL HGET;
   ELSE IF INDEX(CFIELD(1),'+') > 0 THEN CALL PLUS;
   ELSE IF INDEX(CFIELD(1),'-') > 0 THEN CALL MINUS;
   ELSE IF INDEX(CFIELD(1),'*') > 0 THEN CALL MULTIP;
   ELSE IF INDEX(CFIELD(1),'/') > 0 THEN CALL DIVID;
   ELSE IF INDEX(CFIELD(1),'**') > 0 THEN CALL EXPON;
   ELSE IF INDEX(CFIELD(1),'ROWS') > 0 THEN CALL ROWS;
   ELSE IF INDEX(CFIELD(1),'RHS') > 0 THEN CALL RHS;
   ELSE IF INDEX(CFIELD(1),'BNDS') > 0 THEN CALL BOUNDS;
   ELSE IF INDEX(CFIELD(1),'COLS') > 0 THEN CALL COLUMNS;
   ELSE IF INDEX(CFIELD(1),'COMMENT') > 0 THEN CALL COMMENT;
   ELSE IF INDEX(CFIELD(1),'END') > 0 THEN CALL SORTIT;
   ELSE PUT FILE (REPORT) SKIP (5) EDIT ('BAD INSTRUCTION****',
                  COMMAND_LINE) (COL(1),A,COL(5),A);
RETURN;
ESET:  EOF = '1'B;
   RETURN;
END INTERP;
                                                                  /**/
                                                                  /**/
/*********************************************************************/
/*                                                                   */
/*      DOLOOP:  THE DOLOOP SUBROUTINE ACTS IN THE HGENERATOR        */
/*      INTERPRETOR AS A DO-LOOP.                                    */
/*                                                                   */
/*********************************************************************/
                                                                  /**/
                                                                  /**/

DOLOOP:  PROC;
DCL (#LINES,I1,I2,NMEMORY1,NMEMORY2) FIXED;
IPOINTER = IPOINTER + 1;
GET STRING (CFIELD(2)) LIST (#LINES);
GET STRING (CFIELD(3)) LIST (I1);
GET STRING (CFIELD(4)) LIST (I2);
NMEMORY1 = NDEX + 1;
NMEMORY2 = NDEX + #LINES;
DO IDO(IPOINTER) = I1 TO I2;
   DO NDEX = NMEMORY1 TO NMEMORY2;
      CALL INTERP;
   END;
END;
IPOINTER = IPOINTER - 1;
NDEX = NDEX - 1;
RETURN;
END DOLOOP;
                                                                  /**/
                                                                  /**/
/*********************************************************************/
/*                                                                   */
/*      HENTER:  THIS SUBROUTINE ENTERS A NUMBER FROM THE COMMAND    */
/*      RECORD INTO THE STACK.                                       */
/*                                                                   */
/*********************************************************************/
```

```
                                                                        /**/
                                                                        /**/
HENTER:  PROC;
DCL I FIXED;
IF SUBSTR(CFIELD(2),1,1) = 'I' THEN DO;
   CALL PUSH('1'B);
   IF SUBSTR(CFIELD(2),2,1) = ',' THEN DO;
      GET STRING(SUBSTR(CFIELD(2),3,10)) LIST (I);
      ISTACK(1) = IDO(I);
   END;
   ELSE GET STRING(SUBSTR(CFIELD(2),2,11)) LIST (ISTACK(1));
END;
ELSE DO;
   CALL PUSH('0'B);
   IF SUBSTR(CFIELD(2),1,1) = ',' THEN DO;
      GET STRING (SUBSTR(CFIELD(2),2,11)) LIST (I);
      FSTACK(1) = IDO(I);
   END;
   ELSE GET STRING(CFIELD(2)) LIST (FSTACK(1));
END;
RETURN;
END HENTER;
                                                                        /**/
                                                                        /**/
/*********************************************************************/
/*                                                                   */
/*      POP:  THIS SUBROUTINE POPS THE STACK ONCE.                   */
/*                                                                   */
/*********************************************************************/
                                                                        /**/
                                                                        /**/
POP:  PROC (IPOP);
DCL I FIXED;
DCL IPOP BIT (1);
IF IPOP THEN DO;
   DO I = 1 TO 3;
      ISTACK(I) = ISTACK(I + 1);
   END;
END;
ELSE DO;
   DO I = 1 TO 3;
      FSTACK(I) = FSTACK(I + 1);
   END;
END;
RETURN;
END POP;
                                                                        /**/
                                                                        /**/
/*********************************************************************/
/*                                                                   */
/*      PUSH:  THIS SUBROUTINE PUSHES THE STACK ONCE.                */
/*                                                                   */
/*********************************************************************/
                                                                        /**/
                                                                        /**/
PUSH:  PROC (IPUSH);
DCL I FIXED;
DCL IPUSH BIT (1);
IF IPUSH THEN DO;
   DO I = 4 BY -1 TO 2;
      ISTACK(I) = ISTACK(I - 1);
   END;
END;
ELSE DO;
   DO I = 4 BY -1 TO 2;
      FSTACK(I) = FSTACK(I - 1);
   END;
END;
RETURN;
END PUSH;
                                                                        /**/
                                                                        /**/
/*********************************************************************/
/*                                                                   */
/*      HREAD:  THIS SUBROUTINE READS A SPECIFIED RECORD FROM THE    */
/*      MASTER DATA FILE AND ENTERS THE DESIGNATED ELEMENT FROM THE  */
/*      RECORD INTO THE STACK.                                       */
/*                                                                   */
/*********************************************************************/
                                                                        /**/
                                                                        /**/
HREAD:  PROC;
DCL (REC#,I,ENTRY#) FIXED;
DCL REC_POINTER FIXED DEC STATIC;
IF SUBSTR (CFIELD(2),1,1) = 'I' THEN DO;
   GET STRING (SUBSTR(CFIELD(2),3,CLENGTH(2) - 2)) LIST (I);
   REC# = IDO(I);
END;
ELSE GET STRING(CFIELD(2)) LIST (REC#);
```

```
IF SUBSTR(CFIELD(3),1,1) = 'I' THEN DO;
   GET STRING (SUBSTR(CFIELD(3),3,CLENGTH(3) - 2)) LIST (I);
   ENTRY# = IDO(I);
END;
ELSE GET STRING (CFIELD(3)) LIST (ENTRY#);
IF REC_POINTER ¬= REC# THEN DO;
   REC_POINTER = REC#;
   READ FILE (MASTER) INTO (XIN) INDEX (REC#);
END;
FSTACK(1) = XDATA(ENTRY#);
RETURN;
END HREAD;
                                                                    /**/
                                                                    /**/
/**********************************************************************/
/*                                                                    */
/*     HGET:  THIS SUBROUTINE READS THE NEXT NUMBER IN THE FILE       */
/*     'GFILE' AND PLACES IT IN THE STACK.  INPUT IS LIST-DIRECTED.   */
/*     THE 'SKIP' OPTION CAUSES THE PRESENT RECORD TO BE SKIPPED      */
/*     IN 'GFILE' AND THE NUMBER TO BE TAKEN FROM THE FOLLOWING       */
/*     RECORD.                                                        */
/*                                                                    */
/**********************************************************************/
                                                                    /**/
                                                                    /**/
HGET:  PROC;
DCL #REM FIXED DEC INIT (0) STATIC;
DCL X FLOAT DEC;
IF CLENGTH(2) > 0 THEN DO;
   IF INDEX(CFIELD(2),'SKIP') > 0 THEN GET FILE (GFILE) SKIP(1)
                 LIST (X);
   ELSE IF INDEX(CFIELD(2),'REMOTE') > 0 THEN DO;
      #REM = #REM + 1;
      PUT FILE (UTF) EDIT ('REMOTE DATA INPUT REQUEST #',#REM,':',
                 CFIELD(3),' ') (COL(1),A,F(5),2 A);
      GET FILE (INF) LIST (X);
   END;
END;
ELSE GET FILE (GFILE) LIST (X);
IF INDEX(CFIELD(1),'I') > 0 THEN DO;
   CALL PUSH('1'B);
   ISTACK(1) = X;
END;
ELSE DO;
   CALL PUSH('0'B);
   FSTACK(1) = X;
END;
RETURN;
END HGET;
                                                                    /**/
                                                                    /**/
/**********************************************************************/
/*                                                                    */
/*     THE FOLLOWING FIVE SUBROUTINES PERFORM ARITHMETIC ON THE       */
/*     ELEMENTS OF THE STACK.                                         */
/*                                                                    */
/**********************************************************************/
                                                                    /**/
                                                                    /**/
PLUS:  PROC;
DCL X FLOAT DEC;
DCL I FIXED;
IF INDEX(CFIELD(1),'I') > 0 THEN DO;
   I = ISTACK(2) + ISTACK(1);
   CALL POP('1'B);
   ISTACK(1) = I;
END;
ELSE DO;
   X = FSTACK(2) + FSTACK(1);
   CALL POP('0'B);
   FSTACK(1) = X;
END;
RETURN;
END PLUS;
                                                                    /**/
                                                                    /**/
MINUS:  PROC;
DCL X FLOAT DEC;
DCL I FIXED;
IF INDEX(CFIELD(1),'I') > 0 THEN DO;
   I = ISTACK(2) - ISTACK(1);
   CALL POP('1'B);
   ISTACK(1) = I;
END;
ELSE DO;
   X = FSTACK(2) - FSTACK(1);
   CALL POP('0'B);
   FSTACK(1) = X;
END;
```

```
RETURN;
END MINUS;
                                                                  /**/
                                                                  /**/
MULTIP:  PROC;
DCL X FLOAT DEC;
DCL I FIXED;
IF INDEX(CFIELD(1),'I') > 0 THEN DO;
   I = ISTACK(2) * ISTACK(1);
   CALL POP('1'B);
   ISTACK(1) = I;
END;
ELSE DO;
   X = FSTACK(2) * FSTACK(1);
   CALL POP('0'B);
   FSTACK(1) = X;
END;
RETURN;
END MULTIP;
                                                                  /**/
                                                                  /**/
DIVID:  PROC;
DCL X FLOAT DEC;
DCL I FIXED;
IF INDEX(CFIELD(1),'I') > 0 THEN DO;
   I = ISTACK(2) / ISTACK(1);
   CALL POP('1'B);
   ISTACK(1) = I;
END;
ELSE DO;
   X = FSTACK(2) / FSTACK(1);
   CALL POP('0'B);
   FSTACK(1) = X;
END;
RETURN;
END DIVID;
                                                                  /**/
                                                                  /**/
EXPON:  PROC;
DCL X FLOAT DEC;
DCL I FIXED;
IF INDEX(CFIELD(1),'I') > 0 THEN DO;
   I = ISTACK(2) ** ISTACK(1);
   CALL POP('1'B);
   ISTACK(1) = I;
END;
ELSE DO;
   X = FSTACK(2) ** FSTACK(1);
   CALL POP('0'B);
   FSTACK(1) = X;
END;
RETURN;
END EXPON;
                                                                  /**/
                                                                  /**/
/*******************************************************************/
/*                                                                 */
/*      ROWS:  THIS SUBROUTINE INSERTS RECORDS INTO THE ROWS FILE,  */
/*      THIS IS FOR PURPOSES OF BUILDING THE ROWS SECTION OF THE    */
/*      MPS DATA INPUT FILE,                                        */
/*                                                                 */
/*******************************************************************/
                                                                  /**/
                                                                  /**/
ROWS:  PROC;
ROW_REC.ROW_TYPE = SUBSTR(CFIELD(2),1,1);
ROW_REC.ROW_NAME = VARNAME(CFIELD(3),CLENGTH(3));
WRITE FILE (ROWS1) FROM (ROW_REC);
#ROWS = #ROWS + 1;
IF DEBUG THEN PUT FILE (REPORT) EDIT (#ROWS,ROW_REC.ROW_TYPE,
                 ROW_REC.ROW_NAME) (COL(1),F(8),COL(10),A,COL(20),A);
RETURN;
END ROWS;
                                                                  /**/
                                                                  /**/
/*******************************************************************/
/*                                                                 */
/*      RHS:  THIS SUBROUTINE INSERTS RHS RECORDS INTO THE RHS FILE.  */
/*      THIS RESULTS IN THE CREATION OF THE RHS SECTION OF THE DATA  */
/*      INPUT TO MPS,                                               */
/*                                                                 */
/*******************************************************************/
                                                                  /**/
                                                                  /**/
RHS:  PROC;
RHS_REC.RHS_NAME = VARNAME(CFIELD(2),CLENGTH(2));
RHS_REC.ROW_NAME = VARNAME(CFIELD(3),CLENGTH(3));
RHS_REC.VALUE = FCOEFF(FSTACK(1));
IF NON_ZERO THEN DO;
```

```
   WRITE FILE (RHS1) FROM (RHS_REC);
   #RHS = #RHS + 1;
   IF DEBUG THEN PUT FILE (REPORT) EDIT (#RHS,RHS_REC.RHS_NAME,
                 RHS_REC.ROW_NAME,RHS_REC.VALUE) (COL(1),F(8),
                 COL(10),A,COL(20),A,COL(30),A);
END;
RETURN;
END RHS;
                                                                 /**/
                                                                 /**/
/********************************************************************/
/*                                                                  */
/*      BOUNDS:  THIS SUBROUTINE PLACES RECORDS INTO THE BOUNDS FILE. */
/*      THIS CREATES THE BOUNDS SECTION OF THE MPS DATA INPUT.      */
/*                                                                  */
/********************************************************************/
                                                                 /**/
                                                                 /**/
BOUNDS:  PROC;
BOUND_REC.BOUND_TYPE = SUBSTR(CFIELD(3),1,2);
BOUND_REC.BOUND_NAME = VARNAME(CFIELD(2),CLENGTH(2));
BOUND_REC.COL_NAME = VARNAME(CFIELD(4),CLENGTH(4));
IF BOUND_REC.BOUND_TYPE = 'FR' THEN BOUND_REC.VALUE = '          ';
ELSE BOUND_REC.VALUE = FCOEFF(FSTACK(1));
WRITE FILE (BOUNDS1) FROM (BOUND_REC);
#BNDS = #BNDS + 1;
IF DEBUG THEN PUT FILE (REPORT) EDIT (#BNDS,BOUND_REC.BOUND_TYPE,
                 BOUND_REC.BOUND_NAME,BOUND_REC.COL_NAME,
                 BOUND_REC.VALUE) (COL(1),F(8),COL(10),A,COL(20),A,
                 COL(30),A,COL(40),A);
RETURN;
END BOUNDS;
                                                                 /**/
                                                                 /**/
/********************************************************************/
/*                                                                  */
/*      COLUMNS:  THIS SUBROUTINE INSERTS RECORDS INTO THE COLUMNS  */
/*      FILE, WHICH RESULTS IN THE CONSTRUCTION OF THE COLUMNS      */
/*      SECTION OF THE DATA INPUT.  NOTE, THIS SUBROUTINE           */
/*      DISTINGUISHES BETWEEN CONTINUOUS, INTEGER, AND BINARY       */
/*      VARIABLES.                                                  */
/*                                                                  */
/********************************************************************/
                                                                 /**/
                                                                 /**/
COLUMNS:  PROC;
COL_REC.COL_NAME = VARNAME(CFIELD(3),CLENGTH(3));
COL_REC.ROW_NAME = VARNAME(CFIELD(2),CLENGTH(2));
COL_REC.COEFF = FCOEFF(FSTACK(1));
IF NON_ZERO THEN DO;
   IF CLENGTH(4) = 0 THEN DO;
      WRITE FILE (COLUMNS1) FROM (COL_REC);
      #COLS = #COLS + 1;
      IF DEBUG THEN PUT FILE (REPORT) EDIT (#COLS,COL_REC.COL_NAME,
                 COL_REC.ROW_NAME,COL_REC.COEFF) (COL(1),F(8),
                 COL(10),A,COL(20),A,COL(30),A);
   END;
   ELSE IF SUBSTR(CFIELD(4),1,1) = 'I' THEN DO;
      WRITE FILE (INT1) FROM (COL_REC);
      #ICOLS = #ICOLS + 1;
      IF DEBUG THEN PUT FILE (REPORT) EDIT (#ICOLS,COL_REC.COL_NAME,
                 COL_REC.ROW_NAME,COL_REC.COEFF) (COL(1),F(8),
                 COL(10),A,COL(20),A,COL(30),A);
   END;
   ELSE IF SUBSTR(CFIELD(4),1,1) = 'B' THEN DO;
      WRITE FILE (BIV1) FROM (COL_REC);
      #BCOLS = #BCOLS + 1;
      IF DEBUG THEN PUT FILE (REPORT) EDIT (#BCOLS,COL_REC.COL_NAME,
                 COL_REC.ROW_NAME,COL_REC.COEFF) (COL(1),F(8),
                 COL(10),A,COL(20),A,COL(30),A);
   END;
   ELSE DO;
      #SEP = #SEP + 1;
      SEP_REC.COL_NAME = COL_REC.COL_NAME;
      SEP_REC.ROW_NAME = COL_REC.ROW_NAME;
      SEP_REC.COEFF = COL_REC.COEFF;
      SEP_REC.SEP_SET = VARNAME(CFIELD(5),CLENGTH(5));
      WRITE FILE (SEP1) FROM (SEP_REC);
      IF DEBUG THEN PUT FILE (REPORT) EDIT (#SEP,SEP_REC.COL_NAME,
                 SEP_REC.ROW_NAME,SEP_REC.COEFF,SEP_REC.SEP_SET)
                 (COL(1),F(8),COL(10),A,COL(20),A,COL(30),A,COL(45),
                 A);
   END;
END;
RETURN;
END COLUMNS;
                                                                 /**/
                                                                 /**/
```

```
/*********************************************************************/
/*                                                                   */
/*      VARNAME:  THIS SUBROUTINE READS THE INDICATED FIELDS OF THE  */
/*      COMMAND LINE AND CREATES THE APPROPRIATE ROW, COLUMN, RHS,   */
/*      ETC. NAMES FROM THEM.                                        */
/*                                                                   */
/*********************************************************************/
                                                                  /**/
                                                                  /**/
VARNAME:  PROC (AFIELD,CL) RETURNS (CHAR(8));
DCL AFIELD CHAR (12);
DCL ANAME CHAR (8) INIT ('        ');
DCL (INNDEX,I,J,CL,ANO) FIXED;
DCL ACHAR CHAR (1);
INNDEX = INDEX(AFIELD,',');
IF INNDEX = 0 THEN SUBSTR(ANAME,1,CL) = SUBSTR(AFIELD,1,CL);
ELSE DO;
   INNDEX = 0;
   LOOP:  INNDEX = INNDEX + 1;
      ACHAR = SUBSTR(AFIELD,INNDEX,1);
      IF ACHAR = ',' THEN DO;
         INNDEX = INNDEX + 1;
         ACHAR = SUBSTR(AFIELD,INNDEX,1);
         IF ACHAR = 'I' THEN ANO = ISTACK(1);
         ELSE DO;
            GET STRING (ACHAR) EDIT (I) (F(1));
            ANO = IDO(I);
         END;
         IF ANO < 10 THEN PUT STRING (SUBSTR(ANAME,INNDEX - 1,2))
                  EDIT (0,ANO) (2 F(1));
         ELSE PUT STRING (SUBSTR(ANAME,INNDEX - 1,2)) EDIT (ANO)
                  (F(2));
      END;
      ELSE SUBSTR(ANAME,INNDEX,1) = ACHAR;
   IF INNDEX < CL THEN GO TO LOOP;
END;
RETURN (ANAME);
END VARNAME;
                                                                  /**/
                                                                  /**/
/*********************************************************************/
/*                                                                   */
/*      FCOEFF:  THIS SUBROUTINE PLACES THE VALUE OF THE FIRST ENTRY */
/*      OF THE STACK INTO THE INDICATED CHARACTER STRING.            */
/*                                                                   */
/*********************************************************************/
                                                                  /**/
                                                                  /**/
FCOEFF:  PROC (Y) RETURNS (CHAR(12));
DCL COEFF CHAR (12) INIT ('            ');
DCL DUMMY CHAR (15);
DCL PTR FIXED;
DCL (X,Y) FLOAT;
IF Y = 0 THEN DO;
   COEFF = '    0.000000';
   NON_ZERO = '0'B;
   RETURN (COEFF);
END;
ELSE NON_ZERO = '1'B;
X = ABS(Y);
IF X < 0.00001 THEN PTR = 1;
ELSE IF X < 1 THEN PTR = 2;
ELSE IF X < 1000 THEN PTR = 3;
ELSE IF X < 1000000 THEN PTR = 4;
ELSE PTR = 1;
GO TO Q(PTR);
Q(1):  PUT STRING (DUMMY) EDIT (Y) (E(15,5));
   SUBSTR(COEFF,1,10) = SUBSTR(DUMMY,1,10);
   SUBSTR(COEFF,11,2) = SUBSTR(DUMMY,14,2);
   GO TO NEXT;
Q(2):  PUT STRING (COEFF) EDIT (Y) (F(12,9));
   GO TO NEXT;
Q(3):  PUT STRING (COEFF) EDIT (Y) (F(12,6));
   GO TO NEXT;
Q(4):  PUT STRING (COEFF) EDIT (Y) (F(12,4));
NEXT:  RETURN (COEFF);
END FCOEFF;
                                                                  /**/
                                                                  /**/
/*********************************************************************/
/*                                                                   */
/*      IFTHEN:  THIS SUBROUTINE PERFORMS "IF-THEN" LOGICAL PROGRAM  */
/*      BLOCKS AS SPECIFIED IN THE INPUT INSTRUCTIONS.               */
/*                                                                   */
/*********************************************************************/
```

```
                                                                      /**/
                                                                      /**/
IFTHEN:  PROC;
DCL (N0,N1,N2,J1,J2) FIXED;
DCL TEST BIT (1);
DCL INT BIT (1) INIT ('0'B);
IF INDEX(CFIELD(2),'I') > 0 THEN INT = '1'B;
IF INDEX(CFIELD(2),'X>Y') > 0 THEN TEST = XGTY(INT);
ELSE IF INDEX(CFIELD(2),'X<Y') > 0 THEN TEST = XLTY(INT);
ELSE IF INDEX(CFIELD(2),'X=Y') > 0 THEN TEST = XEQY(INT);
ELSE IF INDEX(CFIELD(2),'X>=Y') > 0 THEN TEST = XGEY(INT);
ELSE IF INDEX(CFIELD(2),'X<=Y') > 0 THEN TEST = XLEY(INT);
ELSE IF INDEX(CFIELD(2),'X¬=Y') > 0 THEN TEST = XNEY(INT);
ELSE IF INDEX(CFIELD(2),'X>0') > 0 THEN TEST = XGT0(INT);
ELSE IF INDEX(CFIELD(2),'X=0') > 0 THEN TEST = XEQ0(INT);
ELSE IF INDEX(CFIELD(2),'X<0') > 0 THEN TEST = XLT0(INT);
ELSE IF INDEX(CFIELD(2),'X>=0') > 0 THEN TEST = XGE0(INT);
ELSE IF INDEX(CFIELD(2),'X¬=0') > 0 THEN TEST = XNE0(INT);
ELSE IF INDEX(CFIELD(2),'X<=0') > 0 THEN TEST = XLE0(INT);
GET STRING(CFIELD(3)) LIST (N1);
IF CLENGTH(4) > 0 THEN GET STRING (CFIELD(4)) LIST (N2);
ELSE N2 = 0;
N0 = NDEX;
IF TEST THEN DO;
   J1 = NDEX + 1;
   J2 = NDEX + N1;
   DO NDEX = J1 TO J2;
      CALL INTERP;
   END;
END;
ELSE IF CLENGTH(4) > 0 THEN DO;
   J1 = NDEX + N1 + 1;
   J2 = NDEX + N1 + N2;
   DO NDEX = J1 TO J2;
      CALL INTERP;
   END;
END;
NDEX = N0 + N1 + N2;
RETURN;
END IFTHEN;
                                                                      /**/
                                                                      /**/
/********************************************************************/
/*                                                                  */
/*      THE FOLLOWING 12 ROUTINES PERFORM THE REQUESTED LOGICAL     */
/*      COMPARISONS ON MEMBERS OF THE STACKS AND RETURN A TRUE OR   */
/*      FALSE BIT IF THE COMPARISON IS TRUE OR FALSE.               */
/*                                                                  */
/********************************************************************/
                                                                      /**/
                                                                      /**/
XGTY:  PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) > ISTACK(2) THEN TST = '1'B;
END;
ELSE IF FSTACK(1) > FSTACK(2) THEN TST = '1'B;
RETURN (TST);
END XGTY;
                                                                      /**/
                                                                      /**/
XLTY:  PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) < ISTACK(2) THEN TST = '1'B;
END;
ELSE IF FSTACK(1) < FSTACK(2) THEN TST = '1'B;
RETURN (TST);
END XLTY;
                                                                      /**/
                                                                      /**/
XEQY:  PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) = ISTACK(2) THEN TST = '1'B;
END;
ELSE IF FSTACK(1) = FSTACK(2) THEN TST = '1'B;
RETURN (TST);
END XEQY;
                                                                      /**/
                                                                      /**/
XGEY:  PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
```

```
   IF ISTACK(1) >= ISTACK(2) THEN TST = '1'B;
END;
ELSE I  FSTACK(1) >= FSTACK(2) THEN TST = '1'B;
RETURN (TST);
END XGEY;
                                                          /**/
                                                          /**/
XLEY: PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) <= ISTACK(2) THEN TST = '1'B;
END;
ELSE IF FSTACK(1) <= FSTACK(2) THEN TST = '1'B;
RETURN (TST);
END XLEY;
                                                          /**/
                                                          /**/
XNEY: PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) ¬= ISTACK(2) THEN TST = '1'B;
END;
ELSE IF FSTACK(1) ¬= FSTACK(2) THEN TST = '1'B;
RETURN (TST);
END XNEY;
                                                          /**/
                                                          /**/
XGT0: PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) > 0 THEN TST = '1'B;
END;
ELSE IF FSTACK(1) > 0 THEN TST = '1'B;
RETURN (TST);
END XGT0;
                                                          /**/
                                                          /**/
XEQ0: PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) = 0 THEN TST = '1'B;
END;
ELSE IF FSTACK(1) = 0 THEN TST = '1'B;
RETURN (TST);
END XEQ0;
                                                          /**/
                                                          /**/
XLT0: PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) < 0 THEN TST = '1'B;
END;
ELSE IF FSTACK(1) < 0 THEN TST = '1'B;
RETURN (TST);
END XLT0;
                                                          /**/
                                                          /**/
XGE0: PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) >= 0 THEN TST = '1'B;
END;
ELSE IF FSTACK(1) >= 0 THEN TST = '1'B;
RETURN (TST);
END XGE0;
                                                          /**/
                                                          /**/
XNE0: PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) ¬= 0 THEN TST = '1'B;
END;
ELSE IF FSTACK(1) ¬= 0 THEN TST = '1'B;
RETURN (TST);
END XNE0;
                                                          /**/
                                                          /**/
XLE0: PROC (INT) RETURNS (BIT(1));
DCL INT BIT (1);
DCL TST BIT (1) INIT ('0'B);
IF INT THEN DO;
   IF ISTACK(1) <= 0 THEN TST = '1'B;
```

```
END;
ELSE IF FSTACK(1) <= 0 THEN TST = '1'B;
RETURN (TST);
END XLEQ;
                                                                     /**/
                                                                     /**/
/*********************************************************************/
/*                                                                   */
/*      COMMENT:  THIS SUBROUTINE SENDS COMMENT LINES TO THE REMOVE  */
/*      OUTPUT FILE.                                                 */
/*                                                                   */
/*********************************************************************/
                                                                     /**/
                                                                     /**/
COMMENT:  PROC;
PUT FILE (OTF) EDIT (COMMAND_LINE,' ') (COL(1),A);
RETURN;
END COMMENT;
                                                                     /**/
                                                                     /**/
/*********************************************************************/
/*                                                                   */
/*      SORTIT:  THIS SUBROUTINE SORTS ALL PREVIOUSLY CREATED FILES  */
/*      AND MAKES FROM THE SORTED FILES AN MPS-COMPATABLE INPUT FILE, */
/*                                                                   */
/*********************************************************************/
                                                                     /**/
                                                                     /**/
SORTIT:  PROC;
DCL LINE_NO FIXED DEC INIT (200);
DCL OLD_SEP CHAR (8) INIT ('99999999');
IF LISTING THEN PUT FILE (REPORT) PAGE;
PUT FILE (OTF) EDIT ('NOW SORTING LP SUBFILES,','SORT STATISTICS:',
                    'NO. OF ROWS:',#ROWS,'NO. OF REAL COLUMNS:',#COLS,
                    'NO. OF INTEGER COLUMNS:',#ICOLS,
                    'NO. OF BINARY COLUMNS:',#BCOLS,
                    'NO. OF SEPARABLE COLUMNS:',#SEP,
                    'NO. OF RHS:',#RHS,'NO. OF BOUNDS:',#BNDS,' ')
                    (2(COL(1),A),7(COL(5),A,COL(35),F(5)));
IF #ROWS > 0 THEN DO;
   PUT FILE (OTF) EDIT ('NOW SORTING ROWS',' ') (COL(1),A);
   CLOSE FILE (ROWS1) OPTIONS (LOCK);
   TITLE(ROWS2) = 'ROWS1';
   SORT ROW_REC ON ASCENDING KEY (ROW_REC.ROW_NAME) USING FILE (ROWS2)
                    GIVING FILE (ROWS3);
   OPEN FILE (ROWS4) OPTIONS (KIND='DISK',TITLE='ROWS3');
   ON ENDFILE (ROWS4) GO TO NEXT1;
   PUT FILE (GREEN) EDIT ('NAME','GREEN','ROWS') (COL(1),A,COL(15),A);
   IF LISTING THEN PUT FILE (REPORT) EDIT (100,'NAME','GREEN',200,
                    'ROWS') (COL(1),F(8),COL(11),A,COL(25),A);
   LOOP1:  READ FILE (ROWS4) INTO (ROW_REC);
      PUT FILE (GREEN) EDIT (ROW_REC.ROW_TYPE,ROW_REC.ROW_NAME)
                    (COL(2),A,COL(5),A);
      IF LISTING THEN DO;
         LINE_NO = LINE_NO + 100;
         PUT FILE (REPORT) EDIT (LINE_NO,ROW_REC.ROW_TYPE,
                    ROW_REC.ROW_NAME) (COL(1),F(8),COL(12),A,COL(15),A);
      END;
   GO TO LOOP1;
END;
NEXT1:  IF (#COLS > 0) | (#ICOLS > 0) | (#BCOLS > 0) | (#SEP > 0) THEN
                    PUT FILE (GREEN) EDIT ('COLUMNS') (COL(1),A);
IF LISTING THEN DO;
   LINE_NO = LINE_NO + 100;
   PUT FILE (REPORT) EDIT (LINE_NO,'COLUMNS') (COL(1),F(8),COL(11),A);
END;
IF #COLS > 0 THEN DO;
   PUT FILE (OTF) EDIT ('NOW SORTING REAL COLUMNS',' ') (COL(1),A);
   CLOSE FILE (COLUMNS1) OPTIONS (LOCK);
   TITLE (COLUMNS2) = 'COLUMNS1';
   SORT COL_REC ON ASCENDING KEY (COL_REC.COL_NAME,COL_REC.ROW_NAME)
                    USING FILE (COLUMNS2) GIVING FILE (COLUMNS3);
   OPEN FILE (COLUMNS4) OPTIONS (KIND='DISK',TITLE='COLUMNS3');
   ON ENDFILE (COLUMNS4) GO TO NEXT2;
   LOOP2:  READ FILE (COLUMNS4) INTO (COL_REC);
      PUT FILE (GREEN) EDIT (COL_REC.COL_NAME,COL_REC.ROW_NAME,
                    COL_REC.COEFF) (COL(5),A,COL(15),A,COL(25),A);
      IF LISTING THEN DO;
         LINE_NO = LINE_NO + 100;
         PUT FILE (REPORT) EDIT (LINE_NO,COL_REC.COL_NAME,
                    COL_REC.ROW_NAME,COL_REC.COEFF) (COL(1),F(8),
                    COL(15),A,COL(25),A,COL(35),A);
      END;
   GO TO LOOP2;
END;
NEXT2:  IF #ICOLS > 0 THEN DO;
   PUT FILE (OTF) EDIT ('NOW SORTING INTEGER COLUMNS',' ') (COL(1),A);
   IF LISTING THEN DO;
```

```
            LINE_NO = LINE_NO + 100;
            PUT FILE (REPORT) EDIT (LINE_NO,'INT1','''MARKER''','''INTORG''')
                         (COL(1),F(8),COL(15),A,COL(25),A,COL(50),A);
         END;
         PUT FILE (GREEN) EDIT ('INT1','''MARKER''','''INTORG''') (COL(5),A,
                         COL(15),A,COL(40),A);
         CLOSE FILE (INT1) OPTIONS (LOCK);
         TITLE (INT2) = 'INT1';
         SORT COL_REC ON ASCENDING KEY (COL_REC.COL_NAME,COL_REC.ROW_NAME)
                         USING FILE (INT2) GIVING FILE (INT3);
         OPEN FILE (INT4) OPTIONS (KIND='DISK',TITLE='INT3');
         ON ENDFILE (INT4) GO TO NEXT3;
         LOOP3:  READ FILE (INT4) INTO (COL_REC);
            PUT FILE (GREEN) EDIT (COL_REC.COL_NAME,COL_REC.ROW_NAME,
                         COL_REC.COEFF) (COL(5),A,COL(15),A,COL(25),A);
            IF LISTING THEN DO;
               LINE_NO = LINE_NO + 100;
               PUT FILE (REPORT) EDIT (LINE_NO,COL_REC.COL_NAME,
                         COL_REC.ROW_NAME,COL_REC.COEFF) (COL(1),F(8),
                         COL(15),A,COL(25),A,COL(35),A);
            END;
         GO TO LOOP3;
         NEXT3:  PUT FILE (GREEN) EDIT ('INT10','''MARKER''','''INTEND''')
                         (COL(5),A,COL(15),A,COL(40),A);
            IF LISTING THEN DO;
               LINE_NO = LINE_NO + 100;
               PUT FILE (REPORT) EDIT (LINE_NO,'INT10','''MARKER''',
                         '''INTEND''') (COL(1),F(8),COL(15),A,COL(25),A,
                         COL(50),A);
            END;
      END;
      IF #BCOLS > 0 THEN DO;
         PUT FILE (OTF) EDIT ('NOW SORTING BINARY COLUMNS',' ') (COL(1),A);
         PUT FILE (GREEN) EDIT ('INT2','''MARKER''','''BIVORG''') (COL(5),A,
                         COL(15),A,COL(40),A);
         IF LISTING THEN DO;
            LINE_NO = LINE_NO + 100;
            PUT FILE (REPORT) EDIT (LINE_NO,'BIV1','''MARKER''','''BIVORG''')
                         (COL(1),F(8),COL(15),A,COL(25),A,COL(50),A);
         END;
         CLOSE FILE (BIV1) OPTIONS (LOCK);
         TITLE (BIV2) = 'BIV1';
         SORT COL_REC ON ASCENDING KEY (COL_REC.COL_NAME,COL_REC.ROW_NAME)
                         USING FILE (BIV2) GIVING FILE (BIV3);
         OPEN FILE (BIV4) OPTIONS (KIND='DISK',TITLE='BIV3');
         ON ENDFILE (BIV4) GO TO NEXT4;
         LOOP4:  READ FILE (BIV4) INTO (COL_REC);
            PUT FILE (GREEN) EDIT (COL_REC.COL_NAME,COL_REC.ROW_NAME,
                         COL_REC.COEFF) (COL(5),A,COL(15),A,COL(25),A);
            IF LISTING THEN DO;
               LINE_NO = LINE_NO + 100;
               PUT FILE (REPORT) EDIT (LINE_NO,COL_REC.COL_NAME,
                         COL_REC.ROW_NAME,COL_REC.COEFF) (COL(1),F(8),
                         COL(15),A,COL(25),A,COL(35),A);
            END;
         GO TO LOOP4;
         NEXT4:  PUT FILE (GREEN) EDIT ('INT20','''MARKER''','''BIVEND''')
                         (COL(5),A,COL(15),A,COL(40),A);
            IF LISTING THEN DO;
               LINE_NO = LINE_NO + 100;
               PUT FILE (REPORT) EDIT (LINE_NO,'BIV10','''MARKER''',
                         '''BIVEND''') (COL(1),F(8),COL(15),A,COL(25),A,
                         COL(50),A);
            END;
      END;
      IF #SEP > 0 THEN DO;
         PUT FILE (OTF) EDIT ('NOW SORTING SEPARABLE COLUMNS',' ')
                         (COL(1),A);
         CLOSE FILE (SEP1) OPTIONS (LOCK);
         TITLE(SEP2) = 'SEP1';
         SORT SEP_REC ON ASCENDING KEY (SEP_REC.SEP_SET,SEP_REC.COL_NAME,
                         SEP_REC.ROW_NAME) USING FILE (SEP2) GIVING FILE
                         (SEP3);
         OPEN FILE (SEP4) OPTIONS (KIND='DISK',TITLE='SEP3');
         ON ENDFILE (SEP4) GO TO NEXT8;
         LOOP8:  READ FILE (SEP4) INTO (SEP_REC);
            IF OLD_SEP ¬= SEP_REC.SEP_SET THEN DO;
               OLD_SEP = SEP_REC.SEP_SET;
               PUT FILE (GREEN) EDIT (SEP_REC.SEP_SET,'''MARKER''',
                         '''SEPORG''') (COL(5),A,COL(15),A,COL(40),A);
               IF LISTING THEN DO;
                  LINE_NO = LINE_NO + 100;
                  PUT FILE (REPORT) EDIT (LINE_NO,SEP_REC.SEP_SET,
                         '''MARKER''','''SEPORG''') (COL(1),F(8),COL(15),
                         A,COL(25),A,COL(50),A);
               END;
            END;
            PUT FILE (GREEN) EDIT (SEP_REC.COL_NAME,SEP_REC.ROW_NAME,
                         SEP_REC.COEFF) (COL(5),A,COL(15),A,COL(25),A);
```

```
            IF LISTING THEN DO;
               LINE_NO = LINE_NO + 100;
               PUT FILE (REPORT) EDIT (LINE_NO,SEP_REC.COL_NAME,
                          SEP_REC.ROW_NAME,SEP_REC.COEFF) (COL(1),F(8),
                          COL(15),A,COL(25),A,COL(35),A);
            END;
         GO TO LOOP8;
         NEXT8:  PUT FILE (GREEN) EDIT ('ENDSEP','''MARKER''','''SEPEND''')
                          (COL(5),A,COL(15),A,COL(40),A);
            IF LISTING THEN DO;
               LINE_NO = LINE_NO + 100;
               PUT FILE (REPORT) EDIT (LINE_NO,'ENDSEP','''MARKER''',
                          '''SEPEND''') (COL(1),F(8),COL(15),A,COL(25),A,
                          COL(50),A);
            END;
      END;
      IF #RHS > 0 THEN DO;
         PUT FILE (OTF) EDIT ('NOW SORTING RHS',' ') (COL(1),A);
         PUT FILE (GREEN) EDIT ('RHS      ') (COL(1),A);
         IF LISTING THEN DO;
            LINE_NO = LINE_NO + 100;
            PUT FILE (REPORT) EDIT (LINE_NO,'RHS') (COL(1),F(8),COL(11),A);
         END;
         CLOSE FILE (RHS1) OPTIONS (LOCK);
         TITLE (RHS2) = 'RHS1';
         SORT RHS_REC ON ASCENDING KEY (RHS_REC.RHS_NAME,RHS_REC.ROW_NAME)
                          USING FILE (RHS2) GIVING FILE (RHS3);
         OPEN FILE (RHS4) OPTIONS (KIND='DISK',TITLE='RHS3');
         ON ENDFILE (RHS4) GO TO NEXT5;
         LOOP5;  READ FILE (RHS4) INTO (RHS_REC);
            PUT FILE (GREEN) EDIT (RHS_REC.RHS_NAME,RHS_REC.ROW_NAME,
                          RHS_REC.VALUE) (COL(5),A,COL(15),A,COL(25),A);
            IF LISTING THEN DO;
               LINE_NO = LINE_NO + 100;
               PUT FILE (REPORT) EDIT (LINE_NO,RHS_REC.RHS_NAME,
                          RHS_REC.ROW_NAME,RHS_REC.VALUE) (COL(1),F(8),
                          COL(15),A,COL(25),A,COL(35),A);
            END;
         GO TO LOOP5;
      END;
      NEXT5:  IF #BNDS > 0 THEN DO;
         PUT FILE (OTF) EDIT ('NOW SORTING BOUNDS',' ') (COL(1),A);
         PUT FILE (GREEN) EDIT ('BOUNDS') (COL(1),A);
         IF LISTING THEN DO;
            LINE_NO = LINE_NO + 100;
            PUT FILE (REPORT) EDIT (LINE_NO,'BOUNDS') (COL(1),F(8),COL(11),
                          A);
         END;
         CLOSE FILE (BOUNDS1) OPTIONS (LOCK);
         TITLE(BOUNDS2) = 'BOUNDS1';
         SORT BOUND_REC ON ASCENDING KEY (BOUND_REC.BOUND_NAME,
                          BOUND_REC.COL_NAME) USING FILE (BOUNDS2) GIVING
                          FILE (BOUNDS3);
         OPEN FILE (BOUNDS4) OPTIONS (KIND='DISK',TITLE='BOUNDS3');
         ON ENDFILE (BOUNDS4) GO TO NEXT6;
         LOOP6;  READ FILE (BOUNDS4) INTO (BOUND_REC);
            PUT FILE (GREEN) EDIT (BOUND_REC.BOUND_TYPE,BOUND_REC.BOUND_NAME,
                          BOUND_REC.COL_NAME,BOUND_REC.VALUE) (COL(2),A,
                          COL(5),A,COL(15),A,COL(25),A);
            IF LISTING THEN DO;
               LINE_NO = LINE_NO + 100;
               PUT FILE (REPORT) EDIT (LINE_NO,BOUND_REC.BOUND_TYPE,
                         BOUND_REC.BOUND_NAME,BOUND_REC.COL_NAME,
                         BOUND_REC.VALUE) (COL(1),F(8),COL(12),A,COL(15),A,
                         COL(25),A,COL(35),A);
            END;
         GO TO LOOP6;
      END;
      NEXT6:  PUT FILE (GREEN) EDIT ('ENDATA') (COL(1),A);
         PUT FILE (OTF) EDIT ('SORT COMPLETE',' ') (COL(1),A);
         IF LISTING THEN DO;
            LINE_NO = LINE_NO + 100;
            PUT FILE (REPORT) EDIT (LINE_NO,'ENDATA') (COL(1),F(8),COL(11),
                          A);
         END;
         CLOSE FILE (GREEN) OPTIONS (LOCK);
         RETURN;
      END SORTIT;
                                                                          /**/
                                                                          /**/
     /************************************************************************/
     /*                                                                      */
     /*      END OF MAIN PROGRAM.                                            */
     /*                                                                      */
     /************************************************************************/
```

```
                                                                /**/
                                                                /**/
FINI:  CLOSE FILE (COMMANDS) OPTIONS (LOCK);
   CLOSE FILE (MASTER) OPTIONS (LOCK);
   CLOSE FILE (GFILE) OPTIONS (LOCK);
END MGENERATOR;
```