THE RELATIONSHIP BETWEEN HUMAN ACTIVITIES
AND THE TROPHIC STATUS OF IDAHO LAKES

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TIM HOLMES

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ABSTRACT

THE RELATIONSHIP BETWEEN HUMAN ACTIVITIES AND THE TROPHIC STATUS OF IDAHO LAKES

A human ecological approach is utilized to develop, measure and analyze human influences on eutrophication in Idaho lakes. Eighty-five lakes were selected for study from the over 2,500 lakes in the state. The lakes were chosen primarily for their recreational value or for the their trophic status problems. This study is part of a larger, interdisciplinary study, the Idaho Clean Lakes Project, and utilizes the same extensive data base. Many of the lakes, especially the high mountain lakes, were previously unsampled. The variables studied represent the influences of landuse, land ownership, population growth, and recreational use. The orientation of the research is the ecosystem-watershed concept, emphasizing the watershed as the major boundry of study for each lake. The watershed population and watershed population growth between 1970 and 1980 are major demographic variables, relatively unique in eutrophication studies. Aerial photography was extensively utilized in data collection on these and other variables. The analysis explores the relationship between seven measures of trophic status and nineteen human activity measures via correlation coefficients, factor analysis, and canonical correlation. The findings confirm the thrust of current lake management in Idaho and offer insights into the previously unexplored relationship between trophic status and the social indicators of population and recreation. The relationship between population and tropic status is ambiguous. Watershed population growth appears to have an adverse impact on tropic status, while population growth within fifty miles shows the opposite relationship. Recreational development is greatest near the least eutrophic lakes. The clean, clear lakes of Idaho appear to be very strong attracters of people. Examples and implications are discussed in the conclusion. The complete Clean Lakes Project data set and an annotated bibliography of local and national research related to this study are provided in the appendices.

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CHAPTER I

INTRODUCTION

This study is designed to explore the relationship between the trophic status of Idaho's lakes and human activities around those waterbodies. The purpose is to determine which human activities are adversely affecting trophic status in Idaho. The research was conducted in conjunction with the Idaho Clean Lakes Project, an interdisciplinary study of Idaho's lakes and reservoirs. The Idaho Clean Lakes Project is funded by the Environmental Protection Agency's (EPA) Clean Lakes Program, as directed by Section 314 of the Clean Water Act (1977).

The goal of the program is to control pollution of the nation's freshwater lakes and to restore lakes that are currently polluted. A more specific goal is to protect or restore at least one recreational lake within 25 miles of every major population center by 1985. This goal is to be applied with discretion to take account of the differing needs and resources of different areas of the country. Major objectives are to emphasize watershed management and to select projects with the greatest public benefits.

In line with these objectives, this study uses a human ecological approach to explore the relationship between the trophic status of Idaho's lakes, human use of those lakes, and population growth in Idaho. The goals of this research are:

1. To determine areas of high population growth in Idaho and near its borders;

2. to gather available information on recreational use of Idaho's lakes;

3. to develop indicators which represent population growth and recreation, and other human use activities near lakes;

4. to relate the indicators to the eutrophication data acquired in the Idaho Clean Lakes Project; and

5. to discuss the effects of population growth, recreation, and other human use activities on eutrophication problems of Idaho's lakes in terms of monitoring and management needs.

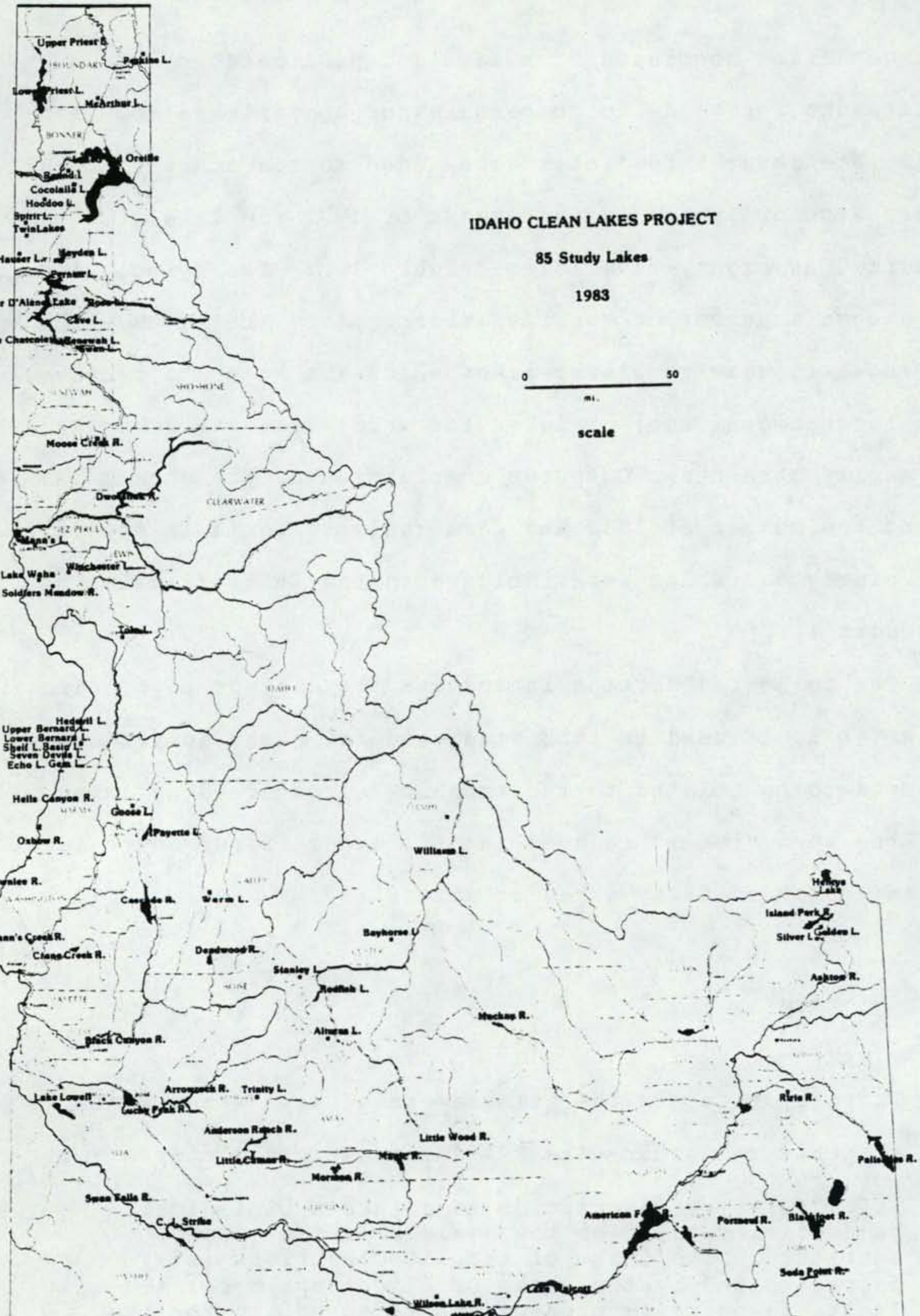
The Idaho Clean Lakes Project team was formed in August of 1980. Team members represent eight disciplines: agricultural economics, biology, civil engineering, economics, geography, limnology, sociology, and wildland recreation. By Spring, 1981, all of the team members were well into the data gathering process. During the summer of 1981, team members and assistants visited approximately one hundred lakes to gather physical and chemical data. The author participated in 35 of those lake visits. No systematic social science data was collected during those visits, but observations and discussions with lake managers and users provided insights and new data sources. During the winter of 1981 and the spring of 1982, data gathering continued from maps and publications; adjustments were made to compensate for unavailable or incomplete data; a few lakes were added to the study list while others were dropped. By the summer of 1982 the lake list was finalized at eighty-five lakes (Figure 1.). Their inclusion is based upon a number of considerations: they are lakes which are known to have problems; lakes which are known to receive much recreational use; or lakes for which data was gathered or was easily obtained. Computer compilation of the data began during the summer of 1982 and data analysis began in the fall. Over ninety variables were included in the initial analysis (Appendix A.).

The following section introduces the concept of trophic status as it is used in this study and the human activities believed to be related to the trophic status of Idaho lakes. When the word "lakes" is used in this study it refers to lakes or reservoirs of fifty acres or larger.

EUTROPHICATION

Trophic status is the measurement of lake water quality used for this research. The EPA defined trophic status as:

> ...a relative description of a lake's biological productivity based on the availability of plant nutrients. The range of trophic conditions is characterized by the terms of oligotrophic for the least biologically productive, to eutrophic for the most biologically productive (Environmental Protection Agency, 1980b:7793).


IDAHO CLEAN LAKES PROJECT
85 Study Lakes
1983
0
50
mi.
scale
Upper Priest L.
Lower Priest L.
McArthur L.
Cocolalla L.
Hoodoo L.
Twin Lakes
Hauser L.
Hayden L.
Coeur D'Alene Lake
Cave L.
Moose Creek R.
Mann's L.
Winchester L.
Soldiers Meadow R.
Hells Canyon R.
Goose L.
Payette L.
Oxbow R.
Williams L.
Brownlee R.
Cascade R.
Warm L.
Island Park R.
Silver L.
Mann's Creek R.
Crane Creek R.
Deadwood R.
Bayhorse L.
Stanley L.
Redfish L.
Ashton R.
Mackay R.
Alturas L.
Black Canyon R.
Arrowrock R.
Trinity L.
Lake Lowell
Anderson Ranch R.
Little Wood R.
Mormon R.
Palisades R.
Swan Falls R.
C. J. Strike
American Falls R.
Portneuf R.
Blackfoot R.
Soda Point R.
Lake Walcott
Wilson Lake R.
Murtagh Lake R.
Cedar Creek R.
Salmon Falls
Twin Lakes R.
Lamont R.
CLEARWATER

There are many water quality parameters which are often used to determine trophic status (such as PH, water clarity, nitrogen content, turbidity, etc.), and there is disagreement in the literature over which measures are the best indicators. The only concensus is that a variety of measures should be used to allow for the most accurate determination of trophic status.

Moss stressed that the words oligotrophic (infertile) and eutrophic (fertile) are ambiguous and used "in a confusing variety of ways" (1980:37). He suggestd that whatever measure is used to determine trophic status, the emphasis should be "on a continuum of productivity from very low to the maximum potential for a given latitude" (1980:36). The EPA (1980a) also pointed out that there is a continuum in lake types and "that within a classification such as eutrophic, there is a broad range in water quality from those lakes with the highest levels of productivity to those with the lowest" (Environmental Protection Agency, 1980a:9).

Eutrophication can not always be considered as "bad". An eutrophic lake is not always a "polluted" lake, and it may be excellent duck habitat, support desirable fish, or support unique bird, animal, or amphibian populations.

The widely used term, "eutrophication", represents a process or change in a water body's trophic condition, a change away from an oligotrophic infertile condition towards a eutrophic or fertile condition. In addition, eutrophication is not always a oneway change (such as ecological succession in terrestrial environments) but rather it is a variable process. A lake can go from one trophic condition to another and back again, and in varying time periods. A particular trophic status, at a particular time, for a particular lake "is determined by a large number of factors including latitude, altitude, climate, watershed characteristics, soil types, human activities, and lake morphometry" (Environmental Protection Agency 1980a:10).

The process of eutrophication is also synonymous with the natural process of lake aging. From the day a lake is created, naturally or man-made, it begins to fill in with sediments and nutrients. "The whole process happens naturally...but man can significantly accelerate the process by adding nutrients and other substances to lake water -- a process referred to as <u>cultural eutrophication</u> (Environmental Protection Agency, 1979:17). Urbanization, housing developments, agricultural, logging and mining practices, and recreational development and use, are a few human use activities that can result in erosion and contribute sediments and nutrients to streams and lakes.

Many of these activities take place in the watershed of a lake rather than right on the lakeshore, thus the watershed is recognized as a major unit of study. The watershed is in essence, the lake. As Moss related:

> ...a lake cannot be understood in isolation, nor even the lake and its inflowing streams. The real unit of study is the catchment area, or drainage basin from which, via its feeder streams, the lake takes its water - water which owes much of its chemical composition to the geology, geography and cultural development of the catchment (Moss, 1980:1).

Moss has also stated that even the catchment area, for which the lake acts as a sink or "rubbish bin", does not have firm boundries. The atmosphere plays a role when gases and particles in the air drift in or dissolve in the rainwater that falls in the drainage basin. Or, as is the case of many of Idaho's lakes, roosting waterfowl deposit substances in the water in the form of excreta, which were possibly obtained outside the basin. Although these outside influences are recognized and must be considered, the major unit of study in lake research is the watershed. It forms a boundary of study for the physical scientists. It is a physical boundary that the social scientists have also utilized so that our data might better "fit" with that of the physical scientists on the project.

CULTURAL EUTROPHICATION

Lakes of Idaho and the rest of the Northwest are exposed to a variety of influences on cultural eutrophication. Logging, mining, farming, urban areas, second home development, recreation, waterfowl, housing developments, and nuclear research facilities are all possible contributers. The human activities that may affect water quality can be classed as point and non-point source pollution. A point source is pollution that can be identified clearly as originating at one particular spot. Outlet pipes from a factory, storm sewer or sewage treatment plant are point source pollutants. Non-point sources have no single, recognized source of the pollutants. Agricultural, logging, and mining areas may be considered non-point sources of pollution if run-off from those areas contains large amounts of sediments or chemicals that do not enter the water drainage system at one particular spot. Irrigation return-flow has characteristics of both a point and non-point source. The inlet to a river or reservoir can be pinpointed, but the source of its pollutants may range over many miles of farmland. Recreation can be considered as a non-point source of pollution, although that label is rarely applied to it. Some types of recreation, such as motor boating or camping, could also be considered as point sources of pollution and there is some research supporting that notion (Aukerman & Springer, 1976; Funk, 1977). Both point and non-point source pollution are discussed in this report, although non-point sources are given the major emphasis.

The influences on cultural eutrophication considered to be important for obtaining the goals of the Idaho Clean Lakes project are human activities grouped under three main headings: population, recreation, and landuse/land ownership.

Population Growth in Idaho

The 1980 census indicates that Idaho is one of the ten fastest growing states in the United States. The growth rate from 1970 to 1980 was over thirty-two percent, higher than any of the other states in the Northwest: Oregon (25.9%), Washington (21%) and Montana (13.3%). While the population of Idaho increased by only 231,000 people, that increase is six times the population increase between 1960 and 1970.

The 1980 census also indicates that the counties containing Idaho's largest natural lakes are among the fastest growing counties. Kootenai County (Lake Couer d'Alene), Valley County (Payette Lake) and Bonner County (Priest and Pend Oreille Lakes) are, respectively, the 3rd., 4th., and 5th. fastest growing counties in the state. While the combined growth ot Idaho's northern lake counties was only 35,000 people, the growth rates were very high, 69.2% for Kootenai and 55.2% for Bonner (Bureau of Census: 1981). Growth along Idaho's borders is also very high. Spokane County, Washington, in close proximity to Idaho's northern lakes, grew by 64,000 people between 1970 and 1980. Out-of-state population within 100 miles of Idaho's southeastern lakes and reservoirs, Bear Lake for example, is over one million people, a number greater than the total population of Idaho.

Human population and population growth are major variables in a eutrophication study because they indicate potential sources of non-point pollution and other influences on cultural eutrophication. High population growth indicates a greater presence of septic tanks, roads, other cleared and paved surfaces, and fertilizers. These activities and substances influence trophic status via increased nitrogen, phosphorus, and sediments. While the presence of 500 people in a watershed may be insignificant, the influence may be adverse if the watershed-ecosystem is incapable of absorbing the impacts.

Recreation

The Pacific Northwest River Basins Commission (1971) reported that "outdoor recreation is an important and expanding aspect of life for residents of the Pacific Northwest" and that "tourism is the fourth largest and probably fastest growing industry in the region" (1971:5). The Commission (1971) estimated that "nearly thirty-eight percent of the total recreation demand is for water related recreation" (1971:56). A more current survey stated that in Idaho, swimming, boating and water skiing are "rapid" growth recreational activites and that "participation in outdoor recreation is increasing at an even faster rate than population" (Idaho Department of Parks and Recreation, 1977:4.35, 4.30). The travel industry is now Idaho's third largest industry: tourism and travel account for twelve percent of the state's income (Idaho Travel Committee, 1980).

One aspect of recreation and tourism that is thought to have a direct effect on eutrophication is recreational homes or summer cottages. A comprehensive inventory of summer home development in Idaho (Payne, 1976) and an indepth study of five of the state's major recreation areas (Payne, 1977), provide good base figures for the volume of summer home activity in Idaho. The conclusion from both studies was that greater care needs to be taken in maintaining public access to lakes, and while public access has not been unduly impeded by second home development, "the potential for dramatic change is available at some point in the future" (Payne, 1977:400).

The impact of recreation on eutrophication is an area of study where there are few conclusive findings. Few studies have been done in Idaho to explore the relationship between eutrophication and recreation, although some very good studies make a start (Corbett, 1973; Idaho Department of Water Resources, 1975; Payne, 1976, 1977; Thorsen, 1979). There are several reasons for the lack of recreation data and recreation studies on Idaho. Recreation is often rated as a low priority water use (Pierce et al., 1981; Pierce and Doerksen, 1975). Also, there are a variety of recreation participation data collection procedures, so that data is not often comparable between lakes and between the agencies which manage them. Finally, the absence of a statewide, easily accessed and easily updated data base prevents the analysis of longterm data, a necessity in determining impacts of recreatonal use and development on eutrophication.

Since little recreation participation data was available, additional variables were investigated to allow for an indirect analysis of recreational use near lakes. Indicators for shoreline development, road access, lake remoteness, land use in the watershed, and shoreline and watershed ownership were all included. Since recreational use of Idaho's lakes involves local, nonlocal instate, and out-of-state users, the population growth within fifty and one hundred miles of lakes, including growth in counties in neighboring states and in Canada, were used in conjunction with the recreation indicators.

Landuse and Ownership

Landuse is very often associated with trophic status. While its inclusion in the data set would appear logical, inclusion of data for land ownership in the watershed and along the lakeshore may not. The purpose for including ownership in the analysis is twofold: (1) to explore whether there is a relationship between ownership and eutrophication and, (2) to supplement the basis for the development of the priority list of lakes and the recommendations for improving eutrophication. As mandated by the Clean Waters Act, lakes with the highest "public" value should receive higher priority than more private lakes. Also, a diversity of ownership would require somewhat different management techniques than "single owner" lakes.

EUTROPHICATION AND WATER QUALITY IN IDAHO

The Environmental Protection Agency (1979) rates the water quality of Idaho lakes as "generally good", but stated that "many of the major recreational lakes in the state have significant water quality problems which impair their recreational use" (Environmental Protection Agency, 1979:17). The water quality problems are primarily related to algal blooms. Algal blooms indicate that a lake may be becoming more "eutrophic" and the effects are poor fishing, impaired swimming and boating, unpleasant tastes and odors, and possibly health related problems (Billings, 1981). The EPA evaluated the trophic status of 47 Idaho lakes, then rated their water quality based on the findings: eighteen are problem lakes, five are good and twenty-four have unknown water quality (Environmental Protection Agency, 1979). Thus the trophic status of Idaho's lakes is relatively unknown. The results of this research will contribute information on most of the lakes included in the EPA's evaluation.

CHAPTER II

REVIEW OF LITERATURE

VIEWING ENVIRONMENTAL PROBLEMS AS SOCIAL PROBLEMS

Natural resources are defined by people who use them. They don't exist as "resources" until someone defines them as such, and that definition is often based upon the use of that resource (Klausner, 1970). The importance of a lake to a group of people lies not in the fact that it is a body of water, at a specific location, with a certain depth and size, but that is a pleasant place to live, a good fishing lake, a source of irrigation water, the local source of drinking water, a nice place to sit or walk beside, or a place of historical or religious significance. The definition of the resource and its appropriate use help to comprise its "social value". When a perceived inappropriate use of a resource starts to infringe upon its social value, then an environmental problem is recognized.

Regardless of why, or even if, a society recognizes a situation as an environmental problem, the resource, the particular problem, and the solution are all social entities: socially defined and socially managed. This idea is perhaps most concisely related by Klausner (1970):

> The relation of society to its physical environment is governed by the society's definitions of its resources and the rules evolved for regulating social relations with respect to the environment. Fundamental solutions to environmental problems must, therefore, include social solutions (Klausner 1970:1).

From another part of the world, Klausner's words were echoed ten years later:

> Studies by all leading scientists say the same thing: large scale ecological problems cannot be resolved solely within the framework of ecology, solely within the framework of technology, or even within the framework of pure economics. They require simultaneous changes both in the economy and in the social and moral foundations of society (Komarov, 1980:133).

Firey (1960) further illuminated the underlying concept of social and environmental interrelatedness inherent in the above statements:

> Once we have recognized that resources have a "social" as well as a "natural" aspect, it becomes evident that any change in one will be a change in the other (Firey 1960:207).

APPROACHES TO THE STUDY OF LAKES

The resource under study in this project is lakes. The environmental problem that is of concern is premature aging or cultural eutrophication of lakes. The specific research question is tied to the social aspects of natural resources, in this case: what are the social influences on eutrophication of lakes in Idaho and which social variables are important enough to be considered as trophic status indicators? In this section, various models are discussed which will aid in determining important social variables and in analyzing their interrelationships with other variables (physical, chemical, etc.).

<u>Systems Approach</u>

General Systems Theory (GST), the theoretical formulation of the system approach, originated in the early 1950's and is the predecessor of many similar types of analysis such as game theory, decision theory, systems analysis, and operations research. The variations on GST are more specific, application-oriented approaches as opposed to the more general, "understanding" orientation of the theory. GST is "a problem solving strategy aimed at understanding rather than explanation" (Walmsley, 1972:25). Some of the characteristics of GST which accent this stress on understanding are:

1. It is an empirico-intuitive approach, value-judgements forming an important part of the analysis while it aims to introduce exact formulations into the nonphysical fields of inquiry;

2. it attempts to integrate the natural and social sciences;

3. it is synoptic, it looks outwards from a problem to its contexts rather than studying parts one at a time;

4. it is concerned with open systems that can be characterized by a input, throughput, and output of energy or matter; and

5. it uses terminology that reflects the interdisciplinary and abstract nature of the theory: steadystate, entropy, feedback, equifinality, and the concept of environment (Walmsley, 1972).

Although these characteristics seem to make GST especially useful in the study of environmental problems, its critics say that: 1) it is too general and therefore lacks predictive power; 2) it is only an analogy because it tries to synthesize exsisting disciplines; and, 3) that a large degree of subjectivity is introduced into the analysis because there are often a large number of variables to be considered and the relationship under study is often "only between certain variables in one system and certain variables in another" (Walmsley, 1972:37). At this point, the stress on understanding through exploration of the human/environment interaction via an interdisciplinary approach is enough to make a general systems approach at least a heuristic devise for this study of people/lake relationships.

Human Ecological Theories

One approach to studying cultural eutrophication are the analytic frameworks that form the core of environmental sociology (Dunlap and Catton, 1979). These human ecological frameworks have been developed as a means for social scientists to include the environment as a major variable in their study of society. The frameworks are a form of systems analysis, an applied approach of general systems theory as discussed above. A variety of frameworks have been developed which illustrate the important variables and their interrelationships. The major categories recommended for consideration are population, technology, cultural system, social system, and personality system. Changes within and between the categories may cause environmental change, which in turn has its influence on each of the categories.

The frameworks contribute to one of the fundamental tasks of human ecologists, "understanding how a population organizes itself in adapting to a constantly changing yet restricting environment" (Dunlap and Catton 1979:251). As with systems analysis in general, human ecological frameworks offer "a useful conceptual device for viewing the interactions of human societies with their environments" (Dunlap and Catton, 1979:251). This opinion is also held by Murdock (1979), who elaborated on the important contribution that can be made by human ecological models in organizing social impact assessments.

Hardy (1977) developed a human ecological model for the study of New England lakes. He studied the changing trophic status of six New England lakes, and how those changes were related to social and environmental factors. His model illustrated the general interactions between three major dynamic systems. One is the social system, primarily represented by urbanization, another is the ecological/physical system, represented by the lake and its watershed. The product of this interaction is included as a third dynamic system, "a system of attitudes and political and personal decisions by affected social groups leading to conflicts, accommodations, and ultimately to laws, institutions, regulations, and management practices" (Hardy, 1977:24).

The researchers developed a list of research elements for each of the dynamic systems (Fig. 2.). An interdisciplinary approach was then utilized to study and gather data on those research elements. The result was a general discussion of the changing uses and conditions of six New England lakes. The researchers found their approach to be extremely useful in exploring the complex processes that relate to water use and which need to be understood when planning solutions to water quality problems. The researchers admitted that their findings were very general and that a major contribution of their project was generating a list of research needs, including:

1. Establishing key socio-economic variables for inclusion in lake classification systems;

2. analyzing the impact of population distribution, growth, trends, and changes in lifestyle and attitudes on lakesheds of the region;

Social System

General Description of Urbanization
Demand for Lakes
Impact of Urbanization on Lakes
Population and Economic Characteristics
Land Value Assessment
Land Use and its History
Lakeshed Population Survey
Local Government Decision Making Process

Natural System

Supply of lakes
Impact of Urbanization
Federal and State Laws
Paleo-Analysis
Phosphorus Budget
Physical Profile
Pesticides and Heavy Metals

INSTITUTIONAL SYSTEM

Federal and State Laws and Regulations
Lake Quality Management Tools
Local Government Decision Making Process

Figure 2.
Three Dynamic Systems for Lake Studies. Hardy, et al. (1977)

3. analyzing the relationship between land values and lake quality characteristics;

4. identifying quantitative and qualitative components for determining socio-economic values for different types of lakes; and

5. analyzing the feasibility of local interjurisdictional agreements for lake management (Hardy, 1977).

Only the first research need is directly addressed in this research. Of greater concern is determining how human activity is related to trophic status. The research below more specifically addresses this relationship.

The Ecosystem-Watershed Concept

O'Sullivan (1979) discussed a model for studying lakes, the ecosystem-watershed concept, which provides a conceptual framework for integrating the approaches and findings of ecology, hydrology, limnology, meteorology, and the social sciences. The concept requires an interdisciplinary approach to the study of lakes that is based on the interrelationships taking place within the lake's watershed and ecosystem. O'Sullivan's model (1979:278) illustrates the relationship between major factors in the ecosystem-watershed (Fig. 3.). With each factor he included a description of the type of variables that could be studied. The feedback loops are illustrated to stress the interrelationships that are constantly taking place within the system.

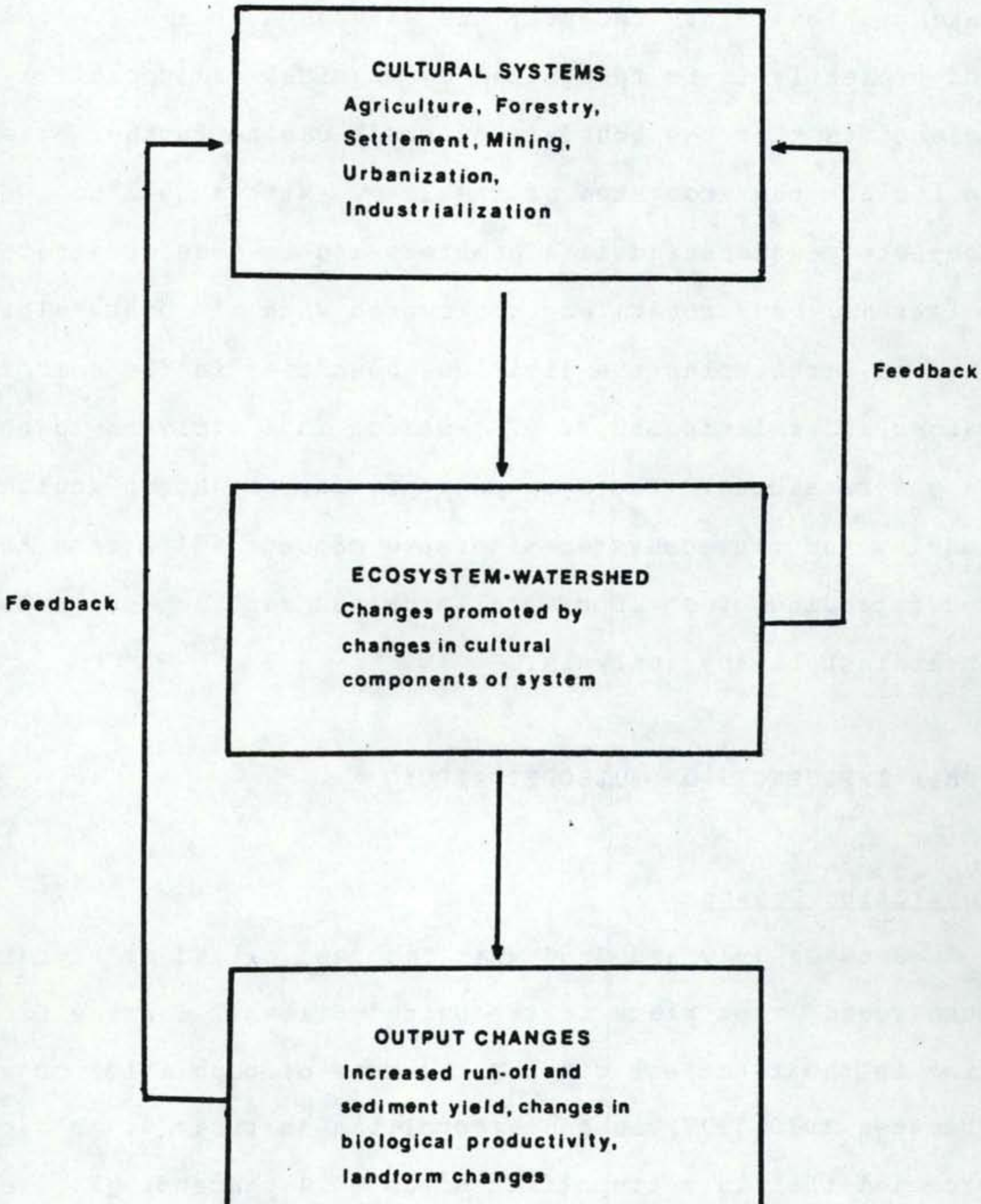


Figure 3. Ecosystem/Watershed Concept

Formerly, the water's edge was the boundary of study for lake problems; more recently the watershed became the boundary; and presently it is recognized by physical and social scientists that the boundary of study can be further extended to include the ecosystem of the lake. With a goal to completely understand lake problems and to develop effective solutions, researchers are confronted with the overwhelming task of structuring the limitless boundries in the search for causes and relationships. The search is a striving to obtain an understanding. The systems approach, the human ecological models, and the ecosystem-watershed concept all stress that an understanding of environmental problems must depend on an interdisciplinary analysis.

HUMAN INFLUENCES ON EUTROPHICATION

Population Growth

Between 1970 and 1980 what has been called a "migration turnaround" took place in the United States. For the first time in the twentieth century the rate of population growth (between 1970-1977) in nonmetropolitan America (9.1 per cent) exceeded that in metropolitan areas (5.4 percent) (Wardwell and Brown, 1980). Rural areas are growing faster than they have since about 1900, when the rate of growth in rural America was about twelve percent (Beale, 1978). America is not becoming more rural, nor are the cities being emptied. The number of people in urban areas still remains very high, about seventy-five percent of the population. The "turn-around" is not unique to the United States. At least eleven other countries are experiencing the same phenonmenon: Japan, Sweden, Norway, Italy, Denmark, New Zealand, Belgium, France, West Germany, East Germany, and the Netherlands (Wardwell, 1980).

Important determinants of population growth in rural areas are: modernization of rural areas, presence of colleges, decentralization of manufacturing, growth of affluence, early retirement, recreation and preference for small towns (Wardwell and Brown, 1980). Also, advanced communication systems allow service- type industries to locate anywhere that a telephone and a computer terminal can be plugged in. Long and Hansen (1979) found that jobs are a main impetus for interstate migration. They utilized census data to develop a sample of 16,332,000 people who had recently migrated and found that 23.8 percent moved because of job transfer, 23.6 percent moved in search of work, 7.9 percent moved to be closer to family, 5.1 percent moved for a change of climate and 3.4 percent moved because of retirement (Long and Hansen, 1979).

New growth in rural areas is especially important since some of the impacts may be long term and others may not be obvious for a few years. So the <u>duration</u> of the impacts is an important consideration. The situation in rural areas is comparable to the baby boom of the 1940's and 1950's. There has been rural growth for ten to fifteen years. If the new migrants stay and raise their families in rural areas, the impacts may last for several decades. Social change such as this (changes in social organization reflected in population migration) is "cumulative and evolutionary" (Wardwell, 1980:109).

A general view of historical population growth in the Western United States shows that Idaho has only recently become one of the fastest growing states. The large increase in its growth rate indicates that it is the most recently "discovered" of the Northwest states, whether it be for jobs, recreation, retirement, etc. Only one county in Idaho lost population between 1970 and 1980 (Shoshone), in contrast to twenty one which lost population between 1960 and 1970.

The study of the effects of this growth and change on the lakes of Idaho is something of a reverse social impact assessment. There is no specific project or governmental program that has caused the new trend, however, it is obviously a very real trend, as are its consequences. The environmental impact of this population growth is a planning issue on a local, regional and state level.

In Northern Idaho, the possible impact on lakes has been recognized and regional planning has been undertaken. Kootenai County, containing some of the lakes in this study (Coeur d'Alene, Fernan, Hauser, Spirit and Twin lakes) has developed the Kootenai County Lakes Master Plan (forthcoming). The purpose of this "lake use" plan is to encourage orderly growth near lakes and to control some activities that may be harmful to water quality. The Idaho State Department of Health and Welfare (IDHW), Water Quality Division, has developed a Pend Orielle Lakes Master Plan (Stravens, 1982) and its purpose is similar to the Kootenai County plan. Both plans are ambitious, far-sighted attempts to control what is recognized as a current and potentially worsening problem: population growth near lakes.

To incorporate population growth into a model of lake eutrophication, two main indicators of population pressure on lakes are utilized in this study.

(1) Population growth within 50 and 100 mile radii

The distance to a lake is recognized as an important consideration when studying human influences on the waterbody, primarily in terms of recreational use (Merewitz, 1966; Stevens, 1966; Tussey, 1967; Idaho Department of Parks and Recreation, 1967, 1977; Storey and Ditton, 1970). Tussey (1967) found that distance is one of the most important variables for determining reservoir use and in an evaluation of alternative distance measures, found that distance in air miles is a more significant measure than distance in road miles or in time spent traveling. The Pacific Northwest River Basins Commission (1973) estimated that seventy-five percent of the recreational use in this region is by local residents. The Commission (1971) also estimated that ninty percent of the total recreational demand generated from a population center is for sites within a 125 mile radius. The Idaho Department of Parks and Recreation (1977) has determined that in Idaho, fifty miles is the average distance for day use of recreation areas and 125 to 150 miles is the average distance for weekend trips. Corbett (1973) estimated that two-thirds of the visitors to Priest Lake live within 150 miles of the lake. Based on the findings of these researchers, population growth within 50 and 100 air miles was estimated for each of the study lakes.

(2) Population Growth Within the Lake Watershed

The measurement of watershed population is based on the discussion of Moss (1980) and O'Sullivan (1979). The watershed of a lake is as an important unit of analysis as the lake itself.

Population data organized by county was not appropriate for this study. County growth, as a measure of population dynamics, is a questionable basis for an investigation into the relationship between population change and trophic status in Idaho. Many lakes stradle county borders, many lakes lie close to state borders, and county lines don't appear to influence people's movement to a large degree. Also, the emphasis here is on developing an ecologically-sound model of influences on lake trophic status.

Recreation

Recreation is growing in Idaho and is projected to increase due to recent population growth in the region. Although recreation is often mentioned by Idaho lake managers as causing impaired water quality, there is insufficient data available to substantiate that claim. The literature reveals that researchers have been more concerned with the influence of water quality on recreational use than they have been with the influence of recreation on water quality. In an annotated bibliography entitled, Lake and River Pollution, there is no mention of recreation as a source of pollution (Sinha, 1971). In David Jordening's (1974) fairly comprehensive discussion and literature review of causes of water quality impairment and the benefits of water quality improvement, there is no mention of recreation as a source of pollution, although many pollutants are discussed that could be introduced or influenced by recreational activity.

The studies that deal with recreational influences on water quality are inconclusive; some are contradictory. Stuart (1971) found that after a watershed was opened to recreation, the stream became less polluted, while in similar studies Skinner et al. (1974) and Johnson (1975) found the opposite to be true. Funk (1977) believes that there is a positive relationship between motorboating and eutrophication in shallow lakes. This is very likely, since depth is one of the major variables in determining eutrophication potential (Moss, 1980).

Motor boating has been mentioned by Idaho lake users in relation to water quality problems in the Thorofare between Upper and Lower Priest Lakes and in some of the littoral lakes along the Couer d'Alene River (Rose Lake for instance).

A few of the articles deal specifically with soil erosion (Manning, 1979; Kuss and Morgan, 1980) and lead to the conclusion that managers need to evaluate their present and proposed recreation sites on their soil characteristics, vegetation and recreational type and intensity. In Idaho, on a county by county basis, the Soil Conservation Service is currently compiling soil type classification surveys which comprehensively examine soil types and appropriate uses for each type (including recreation).

Synder (1980) did a methodologically sound study of recreatonal influences on wilderness lakes. He concluded that increasing recreational use of wilderness areas will result in large scale impacts on wilderness resources, primarily from livestock and man via erosion and bacterial contamination.

The effects of recreation on trophic status is a relatively young area of study. Lake characteristics, and intensity and type of recreational use, need to be carefully evaluated. The prevalent interest in the influence of water quality (including trophic status) on recreation needs to be maintained, while the influence of recreation on trophic status is a research area that needs further study.

In summary, the theoretical basis of this study is a systems approach, emphasizing the human ecological models and specifically utilizing the ecosystem-watershed concept for relating human activities to lake eutrophication. A systems approach allows for the most general overview of environmental problems; the human ecological approach is conducive to interdisciplinary study and in interrelating social and environmental variables; and the ecosystem-watershed concept appears to be the most accurate, graphic representation of interrelated influences on cultural eutrophication.

CHAPTER III

METHODOLOGY

SOURCES OF DATA

Questionnaires

As a first step in determining which factors are influencing the trophic status of Idaho lakes, a brief questionnaire was sent to forty lake managers asking them to indicate the factors affecting the trophic status of the study lakes with which they were familiar. They were also asked to supply information or data available on lake conditions.

The questionnaires revealed that there was limited information available on the cultural eutrophication of Idaho lakes. To obtain the information requested, a network was initiated that involved approximately fifty individuals representing a variety of agencies in Idaho, Oregon, Washington, Utah, British Columbia and Alberta. Letters, the primary form of communication, were very affective in most cases except when much general information was required. Sometimes a conversation was the only way to gain a full understanding of what information was available at a particular agency. Also, a phone call was resorted to when a letter did not elicit a response.

The contacts resulted in data and information that was not available in the literature. Recreational use data is especially uncentralized, hard to find, and simply unavailable for many Idaho lakes. The Idaho Department of Parks and Recreation, Army Corp, and the BLM provided data for the lakes under their jurisdiction. For the other lakes, recreation data had to be requested on a lake by lake basis.

Lake Visits

During the summer and fall of 1981, an attempt was made to visit every study lake in order to gather the limniological data necessary for a determination of trophic status.

This researcher participated in about thirty-five lake visits. Major duties during each lake visit included: charting the depth profile using a sonic depth finder; measuring water clarity with a secchi disc; collecting water, sediment, and plankton samples; and charting the oxygen/temperature profile. The visits also contributed to a better understanding of lake use in Idaho through observations and discussions with lake users and aided in later interpretation of maps and aerial photos. An example is that useage patterns at some of the southern reservoirs differ greatly from those at northern lakes. Fishermen and boaters will approach the desert reservoirs (Salmon Falls Creek, for example) by any number of dirt roads, and, water level permitting, will drive along the shoreline, fishing and launching their boats. On Salmon Falls this increases the number of recreational accesses from the one provided at the dam, to five, located at various points around the reservoir.

Maps

A large amount of map work was necessary to obtain some of the data. Since lake watersheds were to be studied as ecological units, accurate watershed maps were a necessity. The base map for the watersheds is the Hydrological Unit Map-1974: State of Idaho (U.S. Geological Survey). The watersheds were transferred to this map from topographic maps and watershed maps available at the University of Idaho Water and Energy Resouces Research Institute. An identical watershed base map was used by the economists and this researcher to determine watershed size (in sq. miles) and watershed landuse (by seven major categories). A map-o-graph was used to enlarge census subdistrict maps (Bureau of the Census, 1981) to the same scale as the watershed base map so that subdivision boundries could be traced onto the base map. This map became the basis for determining watershed populations.

The Institute's maps were extensively used, as was the electronic graphics calculator, which is a device for electronically measuring distances and areas on maps. The maps utilized were:

General Highway Maps of Counties (Idaho Transportation Department, 1976-1978)

Surface Management Status Maps (Bureau of Land Management, 1979)

7.5 minute topographic maps (U.S. Geological Survey, usually early 1960's)

Forest Service Maps:
Clearwater National Forest (1980)
Coeur d'Alene National Forest (1972)
Sawtooth Natonal Forest (1972)
Selway Bitterroot Wilderness (1980).

These maps were also used for collection of much of the recreation, development and road data, and aided in determining areas of sparse population within watersheds. This information, supplemented by aerial photos and lake visits, allowed for collection of data of a high degree of reliability. Every project team member participated in at least one lake visit. They recorded recent population and landuse changes near the lakes and acted as final checks on data validity.

Aerial Photography

Aerial photography proved to be extremely useful as a data source and supplement in the gathering of social science data for this project. Prior to viewing any aerial photos, the researcher completed a week-long workshop at the University of Idaho on aerial photography and aerial photo interpretation.

There are many reports in the literature on the use of aerial photos in social science research. A few writers dealt primarily with archaeological applications of aerial photos (Lyons et al., 1980; Lyons and Avery, 1977; Vogt, 1974). These were useful for their introduction to aerial photo interpretation and offered clues for interpreting very subtle differences in landscape features.

Stokes (1950) was the earliest to write about sociological applications of aerial photography. He concluded that the cultural landscape may be studied with greatly reduced time and money. He believed that familiarity of the landscape is highly desirable but not essential, and if field investigation is required, "the time needed to satisfactorily complete such investigation will be materially reduced by a careful photographic study made prior to going into the field" (Stokes, 1950:40).

Green (1957), Green and Monier (1959) is somewhat of a pioneer in aerial photo interpretation by social scientists. In 1957 he used aerial photos in an attempt to differientiate between residential sub-areas within six different cities. In 1959, he further examined his earlier study and discovered that discrepancies in the photographic observations were distributed non-randomly. Systematic correlation factors could then be constructed through knowledge of the nature, amount, and direction of photodata errors (Green and Monier, 1959).

Silberman (1959) did a short ground survey in Kenya to determine the average number of people in a certain type of complex, then counted the complexes by air. He believed that the aerial survey resulted in more exact classification and description of social structures and housing types. Mumbower and Donoghue (1967) used repetitive photo coverage to study changes in poverty areas of cities.

Harrington and Tocher's (1967) aerial recreation inventory of mountain lakes and streams concluded that some field checking is necessary. Nettles (1974) studied landuse changes in watersheds and stated that "periodic aerial photos...are an excellent method for determining progressive landuse changes in watersheds" (Nettles, 1974:51).

In an extensive analysis dealing with the accuracy of estimating the population of four U. S. cities with aerial photos, Kraus, et al. (1974) found a maximum error factor of nine percent and a composite underestimate error of about five percent (4.5%). The error factor represents the difference between their estimates and the actual population as reported in the 1970 census. They offer three recomendations: use the largest scale photo that is available, expand residential landuse classification systems to account for a wide range of residential lot sizes, and attempt to account for "hidden" residential uses within commercial districts.

Two experts in aerial photo interpretation offer suggestions and advice which are worth consideration.

O'Mallery (1978) cautioned that scale and sensor type must always be taken into account. Incorrect scale selection usually leads to attempts to extract more data from an image than is available on the image. Correct sensor selection (color, color-infrared, black and white, etc.) is equally important in that some components of the the rural landscape are well enhanced on an image of one sensor type and not so well on another. O'Mallery (1978) noted that remote sensing, while not the total answer for investigating the rural cultural landscape, provides an additional tool for the investigator. Peplies (1976) suggested that three approaches can be used for cultural and landscape interpretation of aerial photography: consider the image as a direct representation of the object, consider the image as a surrogate or proxy of the object, or consider the image as a direct representation of an object which is normally not detectable with the human eye. For example, in attempting to determine population of a watershed, houses might be counted and the total would represent the total number of households in the watershed. Or, each house might be interpreted as representing a family and the population of a watershed could be estimated from the number of houses, as was done above. Finally, an increase in the number of houses in a rural watershed, observed in aerial photos taken over time, might be interpreted as an indicator of social change, such as an increase in in-migration, an increase in affluence of the local population, or an increase in the desire for a rural lifestyle.

For this study, aerial photography was used in the later stages of the project. The photos were used to check the data and to fill in some of the missing data. The data that especially needed to be checked and updated was percentage of shoreline with a road and road-type; number of recreational accesses on the lake; and percentage of shoreline that is in hard recreational development.

Reviewed first were the photos taken especially for this project. These are low altitude photos that have excellent detail. They were shot at about 3,000 feet above the lake surface and are at a scale of about 1:3000. They are not stereo pairs as an attempt was make to cover each lake with the least amount of photography possible. They are color positives, best viewed on a light table with the aid of a magnifing glass.

Their utility in social analysis is somewhat limited by two factors. One is that there is only partial coverage of the large lakes because only random shots of the shoreline were taken. The other limiting factor is that due to budget limitations, not all of the study lakes could be photographed. But for the lakes that are completely photographed, the photos are very revealing because they are very current and shot at low altitude.

The other aerial photos that are extensively utilized are the U-2, NASA photos available at the University of Idaho, College of Forestry, Remote Sensing Center (RMC). These are high altitude flights, flown at approximately 60,000 feet and are at a scale of 1:125,000. The photos used for this project were primarily color infra-red transparencies and are viewed on a light table as stereo pairs. The ease of viewing and the photos' utility are much improved by the use of an "Old Delft" scanning stereoscope. The Old Delft sits on a light table and two photos are placed under it. Focus and stereo image dials are turned until the correct image comes into view. The photos can then be scanned by simply turning the dials. This scanning feature allows for easy viewing of lakeshore areas. The Old Delft also has magnification capabilities of up to 4.5X.

Fortunantly, some form of aerial coverage is available at the University of Idaho for every study lake except Henry's Lake and Pallisades Reservoir. The Clean Lakes project photos have good coverage of the northern half of Idaho, but not of the south; while the U-2 coverage available at the RMC is primarily of the southern half of the state.

The lakes project photos were used to confirm the number and location of recreational accesses. These are very visible in the form of parking lots, beaches, and campgrounds (referred to here as "hard" recreational development). Percentage of lakeshore in urban, housing, resort, and hard recreational development can easily be estimated on the U-2 photos. A measure of "soft" development was attempted early in the data gathering but was subsequently dropped from the analysis. Soft recreational development represents the percentage of the shoreline that is in trails, or else is public land potentially used for low impact recreational activities such as hunting, hiking, or picnicing. Measurement of trails, with even the large scale photos proved to be very difficult. In many cases, trails and even small roads that were known to exist, were not visible in the aerial photos due to a dense tree canopy. If necessary, this problem could be overcome by estimating trail location from the partial sections of trail which are visible through sporadic openings in the tree canopy. Camping areas are usually visible because the surrounding tree canopy is often open and is often accompanied by a lack of vegetation.

The U-2 photography most extensively utilized, identified by their date, flightline number, and lake names included:

1. 1972 72-186 Anderson Ranch, Mt. Home, American Falls, Little Camus

2. 1973 73-172 Bear, Blackfoot, Mackay, Soda Pt., Twin Lakes Res., Portneuf, Lamont

3. 1973 73-151 Manns, Crane Ck.

4. 1975 75-169 Payette, Cascade, Upper Payette, Deadwood, Warm Lake

These photos proved to be excellent data supplements in some cases, especially for those lakes which this researcher did not visit personnally. Some roads that appear on a map to be right on the shoreline, were revealed on aerial photos to actually be on the other side of a ridge or hill. Road type is also easily checked on U-2 photography, as are most of the recreation variables in this study. As mentioned above, human development is sometimes not visible due to a tree canopy. This is when experience in interpretation, knowledge of the area, and imagination are useful. Small roads - driveways - leading into clumps of trees on the shore give clues of homes on the lakeshore. Another clue, provided the time of the photography is between May and September, is the presence of docks on the lakeshore. They are very visible when homes often may not be. The U-2 photos are also used for a few lakes to supplement the watershed population data. Watershed boundries are easily found under a stereoscope and a complete watershed for a small lake can often be viewed in one pair of photos.

As a check on population estimation from U-2 photography, the researcher chose a census subdistrict which has available census data; has borders easily recognized on aerial photos; and which is entirely included in two to four aerial photos. The Hagerman subdivision in Gooding County was chosen as a test case. The photography available for the Hagerman division was taken in 1972, so the interpreted population estimate was checked against the 1970 census figure.

The researcher counted 170 rural dwellings on the photos. This figure is an estimate since a few dwellings are hidden by tree canopy, a few barns and shops are counted as dwellings, and the exact boundries of the the town of Hagerman were undetermined. The next step of the process was to multiply 170 times the number of persons in each dwelling. In Idaho, in 1970, the average was 3.17 and in Gooding County it was 3.00. Multiplying 170 times 3 equals 510 people. The actual rural population in 1970 was 683; thus it is underestimated by twenty-six percent, which is much higher than Kraus's (1974) reported error of five percent. However, assuming that the average number of people per household is greater in rural areas than in cities or towns, and is estimated at four people per household rather than three; the revised estimate of total rural population becomes 680 people, which is almost identical to the census figure.

In conclusion, the findings are very positive for aerial photo interpretion for social science investigation. This has been reported in the literature beginning with Stokes (1950). More recently, social science researchers have rigorously tested aerial photos against other data sources and they also have favorable reports (Kraus, 1974; Nettles, 1974; Mumbower and Donoghue, 1967).

The next section describes in detail the data collection procedures for the demographic and recreation data. Data for some variables were collected, but weren't utilized in the final analysis. The complete data sets are provided in tables where appropriate. The data used in the analysis are provided with the complete Clean Lakes Project data set (Appendix A).

POPULATION DATA

Watershed Population

To obtain an indicator of population pressure on a lake, an attempt was made to determine population growth within watersheds (Table 1.). The first stage of data collection involves overlaying census subdistrict maps on watershed maps.

The Lake Coeur d'Alene watershed is a good example of a fairly close match-up between census subdistrict lines and the watershed boundry. Coeur d'Alene also illustrates the type of assumptions that have to be made with most watersheds. First of all, the watershed boundry runs through the middle of the Coeur d'Alene census subdistrict. After the population of the towns within the subdistrict are separated, such as the town of Coeur d'Alene which falls within the watershed and the town of Hayden which falls without, then the population of the rural area has to be apportioned. With no census data available on a watershed basis, an assumption has to made on what percentage of the subdivision's total rural population lies within a particular watershed. This is where the other information sources are very useful. Forest Service maps are extremely useful for some areas. They illustrate cultural features such as houses, farms, and businesses, and differentiate between private and public land. Aerial photos also contribute to an

Table 1. Population Data.

	WATERSHED POPULATION			POPULATION WITHIN FIFTY MILES			POPULATION WITHIN 100 MILES		
	1960	1970	1980	1960	1970	1980	1960	1970	1980
ALTURAS L	0	0	0	1830	2465	3602	228058	249909	355676
AMERICAN FALLS R	80877	85480	107509	10241	108405	134082	283529	327948	412501
ANDERSON RANCH R	110	84	87	106004	126634	180969	270749	292899	411570
ARROWROCK R	155	172	374	179950	203875	295646	258234	281087	394100
ASHTON R	1242	1187	1219	999	8911	12002	138480	156823	199615
BASIN L	0	0	0	13985	13087	15287	230915	246493	282224
BAYHORSE L	0	0	0	1830	2465	3602	228058	249909	355676
BEAR L	1205	1105	1366	74419	76599	97365	647710	772828	1048465
BENEWAH L	.	130	215	363179	382564	454027	488819	512057	597492
BLACK CANYON R	3094	2988	4054	179950	203875	295646	258234	281087	394100
BLACKFOOT R	.	300	800	12161	129279	165400	267000	278286	356350
BROWNLEE R	23714	20884	23225	105753	110032	143649	275948	297420	407354
C J STRIKE R	17180	17882	22072	112339	131848	197398	274591	298411	417772
CASCADE R	1592	1378	2073	9188	8687	11190	190441	267280	365197
CAVE L	.	150	190	363179	382564	454027	488819	512057	597492
CEDAR CREEK R	11	13	32	6311	61361	80304	125797	132764	163720
COCOLALLA L	548	603	1366	81117	88690	126291	469424	498799	617913
CRANE CREEK R	334	295	270	105753	110032	143649	275948	297420	407354
DEADWOOD R	.	.	40	11336	11526	15464	190441	267280	365197
DEEP CREEK R	.	.	40	74419	76599	97365	647710	772828	1048465
DWORSHAK R	2372	3232	2769	91185	108634	119009	503622	532772	630397
ECHO L	0	0	0	13985	13087	15287	230915	246493	282224
FERNAN L	.	637	1244	344837	358092	443303	495047	532634	638230
GEM L	0	0	0	13985	13087	15287	230915	246493	282224
GOLDEN L	0	0	0	1778	20873	27071	138480	156823	199615
GOOSE L	0	0	0	9188	8687	11190	190441	267280	365197
HAUSER L	582	760	1520	338618	348372	440754	440455	474027	590742
HAYDEN L	.	2692	5525	344837	358092	443303	495047	532634	638230
HEDEVIL L	0	0	0	13985	13087	15287	230915	246493	282224
HELLS CANYON R	.	.	80	13985	13087	15287	230915	246493	282224
HENRYS L	50	48	122	999	8911	12002	138480	156823	199615
HOODOO L	274	302	683	81117	88690	126291	469424	498799	617913
ISLAND PARK R	173	206	454	1778	20873	27071	138480	156823	199615
LAKE PEND OREILLE	10771	10904	16582	81117	88690	126291	469424	498799	617913
LAKE CHATCOLET	.	584	1562	363179	382564	454027	488819	512057	597492
LAKE COEUR D'ALENE	.	45793	54934	344837	358092	443303	495047	532634	638230
LAKE WAHA	.	10	15	93616	110924	123452	238444	265450	309199
LAKE LOWELL	20397	22448	27183	191401	215828	309962	243614	266282	368529
LAKE WALCOTT	2599	2455	3154	58740	62007	75084	185811	176209	216671
LAMONT R	136	113	147	74419	76599	97365	647710	772828	1048465
LITTLE CAMUS R	55	42	44	10604	126634	180969	270749	292899	411570
LITTLE WOOD R	.	.	10	53819	53779	71583	255610	286759	390475

Table 1. (cont.) Population Data.

	WATERSHED POPULATION			POPULATION WITHIN FIFTY MILES			POPULATION WITHIN 100 MILES		
	1960	1970	1980	1960	1970	1980	1960	1970	1980
LOWER PRIEST L	781	813	1324	55653	54853	69216	463985	496510	612144
LOWER BERNARD L	0	0	0	13985	13087	15287	230915	246493	282224
LUCKY PEAK R	288	294	660	17950	203875	295646	258234	281087	394100
MACARTHUR L	177	186	302	30495	30310	41402	435516	454398	571468
MACKAY R	255	320	350	12421	10125	12824	223372	249829	309075
MAGIC R	4169	5076	9653	53819	53779	71583	255610	286759	390475
MANN'S L	.	10	15	93616	110924	123452	238444	265450	309199
MANN'S CREEK R	144	123	143	10553	110032	143649	275948	297420	407354
MILNER R	28542	30840	36675	58740	62007	75084	185811	176209	216671
MOOSE CREEK R	.	.	.	91185	108634	119009	503622	532772	630397
MORMON R	50	40	48	53819	53779	71583	255610	286759	390475
MOUNTAIN HOME R	45	51	93	10604	126634	180969	270749	292899	411570
MURTAUGH LAKE R	1379	1086	1097	58740	62007	75084	185811	176209	216671
MYRTLE L	0	0	0	55653	54853	69216	463985	496510	612144
OXBOW R	.	.	64	105753	110032	143649	275948	297420	407354
PALISADES R	4570	4590	6905	67136	78083	105491	188382	277566	260779
PAYETTE L	1877	2131	3038	988	8687	11190	190441	267280	365197
PERKINS L	.	20	30	23330	25842	31826	310308	343049	437008
PETIT L	.	.	80	1830	2465	3602	228058	249909	355676
PORTNEUF R	1	0	0	121561	129279	165400	267000	278286	356350
REDFISH L	.	.	40	1830	2465	3602	228058	249909	355676
RIRIE R	.	345	925	93462	105336	136009	202661	214639	276688
ROSE L	.	150	190	363179	382564	454027	488819	512057	597492
ROUND L	82	91	205	81117	88690	126291	469424	498799	617913
SALMON FALLS R	39	41	69	63711	61361	80304	125797	132764	163720
SEVEN DEVILS L	0	0	0	13985	13087	15287	230915	246493	282224
SHELF L	0	0	0	13985	13087	15287	230915	246493	282224
SILVER L	13	12	30	17278	20873	27071	138480	156823	199615
SODA POINT R	7170	6958	8908	121561	129279	165400	267000	278286	356350
SOLDIERS MEADOW R	.	.	.	93616	110924	123452	238444	265450	309199
SPIRIT L	953	1024	1980	338618	348372	440754	463979	498831	616286
STANLEY L	0	0	0	1830	2465	3602	228058	249909	355676
STEVENS L	0	0	0	48562	50514	57867	552844	603857	729269
SWAN L	0	0	0	363179	382564	454027	488819	512057	597492
SWAN FALLS R	371	413	573	11239	131848	197398	274591	298411	417772
TOLO L	0	12	48	9188	8687	11190	190441	267280	365197
TRINITY L	.	.	36	10604	126634	180969	270749	292899	411570
TWIN LAKES UPPER L	174	270	764	338618	348372	440754	463979	498831	616286
TWIN LAKES LOWER L	174	270	764	338618	348372	440754	463979	498831	616286
TWIN LAKES NORTH R	46	38	36	74419	76599	97365	647710	772828	1048465
TWIN LAKES SOUTH R	46	38	36	74419	76599	97365	647710	772828	1048465
UPPER PRIEST L	0	0	0	55653	54853	69216	463985	496510	612144
UPPER BERNARD L	0	0	0	13985	13087	15287	230915	246493	282224
WARM L	.	160	210	9188	8687	11190	190441	267280	365197
WILLIAMS L	.	.	144	8812	8533	10845	110083	105198	115745
WILSON LAKE R	433	396	496	58740	62007	75084	185811	176209	216671
WINCHESTER L	454	318	397	93616	110924	123452	238444	265450	309199

understanding of population distribution near some of the lakes.

The estimate of rural population is made in one of two ways. Either the entire census subdivision is analyzed and the rural population apportioned on a percentage basis, a certain percentage of the subdistrict's rural population falling within the watershed; or else the houses visible on the maps and the aerial photos are counted and multiplied by the average number of persons per house. As discussed above, four is the average number of people per rural household used for this study.

Utilization of population figures derived in this manner, either to discuss population growth within a watershed or to compare 1980 population within different watersheds, involves a few assumptions. To apply a percentage population figure derived for one year (usually 1970) to the census population for two other years (1960 and 1980) assumes that the growth rate of the watershed is identical to the growth rate of the census subdivision. The numerous factors influencing human migration and settlement patterns make this a questionable assumption. In order to improve the validity of the figures, they are evaluated and adjusted to other sources of information: personal knowledge, aerial photos, and Idaho publications, ie. Payne (1976,1977) and Idaho Department of Water Resources (1975)

Population Within 50 and 100 Miles

The other reason to study population growth is to better understand recreational lake use. Including potential user population figures into an analysis of trophic status problems helps to define the extent of the potential user population. These are sociological extensions of the lake ecosystem which include the people within fifty and one hundred miles of a lake. These extensions are lakeuse areas, fifty miles representing day use and one hundred miles representing weekend use (Table 1.).

The method for determining population growth within the two selected distances of each lake is fairly simple. On standard state highway maps, circles are drawn around each lake which represent the area within fifty and one hundred miles of each lake. The center of the circle is usually the center of the lake for the smaller lakes, and is a major recreational use area for the larger lakes. The procedure for determining the population within the use areas follows these steps:

1. A circle is drawn on an Idaho road map as well as on maps of neighboring states and Canada that represents the area within fifty miles of the lake.

2. All counties falling completely with the circle are listed.

3. All the census subdistricts which are outside the counties listed in (2), but which fall completely within the circles, are listed.

4. All the cities and towns within the circle, but not included in (2) or (3), are listed.

5. The populations of the counties, subdistricts, cities and towns are gathered from the census data and listed for the years 1960, 1970 and 1980.

6. The total population within fifty miles for 1960, 1970 and 1980 is then computed by adding the population figures.

7. The procedure is repeated for the one hundred mile radius.

There are two modifications of this data procedure. One is that the population of an entire county is included if the portion of it falling outside the circles lies completely within a national forest or else is known to be a very sparsely populated section of the county. The other modification is that when two or more lakes lie within twenty-five miles of each other, they are given the same lake use areas.

Pend Orielle, Cocolalla, Hoodoo and Round lakes have the same use areas, as do Coeur d'Alene, Hayden, and Fernan lakes. There are many other groups of neighboring lakes, as is apparent from the data, and these lakeuse areas are fairly evenly distributed throughout the state. Almost any lake in Idaho will fall within one of them so that the population of any lake's lake use area can be easily estimated.

RECREATION DATA

An attempt was make to gather as much actual recreational use data as is available for the eighty five study lakes.

Data was compiled for only twenty eight of those lakes. As a result of such a small sampling, the data will not be used in the analysis, but is displayed and discussed in the final chapter.

Data was collected to serve as indicators of lake accessibility, human development on the lakeshore, and recreational access (Table 2.). They are substitutes for recreational use data which is unavailable for most lakes. The following description of the variables elaborates on the particular data sources for each variable. In most cases the most recently published source is considered most accurate, but not always. The aerial photos usually predate the maps, yet the information they convey is often much more revealing. Roadtype or presence of a camping area will often be revealed in a photo and not be present on a map.

The variables fall under three main headings:

Accessibility

Number of Recreation Accesses - This figure is primarily derived from the Outdoor Recreation Facilities Inventory (Idaho Department of Parks and Recreation, 1980), supplemented by: forest service maps and publications, other agencies' publications, aerial photos, state and county pamphlets, and personal observation. This figure varies from "1" for the mountain lakes to "12" for lake Coeur d'Alene.

Number of Road Accesses - The number of directions by which a lake can be approached by road. This value ranges from "0" for lakes that have only trail access to "4" for those lakes which can be approached from any direction. This measure has been subsequently dropped from the analysis.

Table 2. Recreation Data

	ROAD ACCESS	REC ACCESS	MILES TO MAJOR HIWAY	DISTANCE TO MAJOR HIGHWAY BY ROADTYPE				DEVELOPMENT ON THE SHORELINE (%)				SHORELINE ROAD BY ROADTYPE (%)	
				SECONDARY	GRAVEL	DIRT	TRAIL	URBAN	HOUSES	HARD	SOFT	PAVED	UNPAVED
ALTURAS L	2	3	6.00	6.00	0.0	0.0	0.0	0.00	0.02	0.02	0.02	0.40	0.20
AMERICAN FALLS R	4	1	0.10	0.10	0.0	0.0	0.0	0.02	0.05	0.01	.	0.10	0.25
ANDERSON RANCH R	2	5	5.00	3.00	2.0	0.0	0.0	0.00	0.02	0.02	0.50	0.10	0.50
ARROWROCK R	2	2	1.00	1.00	0.0	0.0	0.0	0.00	0.00	0.01	0.99	0.02	0.40
ASHTON R	3	2	0.10	0.10	0.0	0.0	0.0	0.00	0.01	0.01	0.04	0.02	0.05
BASIN L	1	1	19.00	0.00	7.0	7.0	5.0	0.00	0.00	0.00	1.00	0.00	0.00
BAYHORSE L	1	1	16.00	8.00	3.0	5.0	0.0	0.00	0.00	0.00	1.00	0.00	0.00
BEAR L	4	2	0.10	0.10	0.0	0.0	0.0	0.02	0.40	0.05	.	0.40	0.50
BENEWAH L	2	1	1.00	1.00	0.0	0.0	0.0	0.00	0.20	0.10	0.65	0.80	0.00
BLACK CANYON R	3	2	0.10	0.10	0.0	0.0	0.0	0.00	0.02	0.02	0.73	0.50	0.10
BLACKFOOT R	3	4	15.00	12.00	3.0	0.0	0.0	0.01	0.01	0.02	.	0.02	0.10
BROWNLEE R	4	2	0.10	0.10	0.0	0.0	0.0	0.10	0.05	0.01	.	0.05	0.50
C J STRIKE R	4	6	0.10	0.10	0.0	0.0	0.0	0.10	0.10	0.01	0.59	0.10	0.20
CASCADE R	2	9	0.10	0.10	0.0	0.0	0.0	0.05	0.04	0.05	.	0.05	0.50
CAVE L	2	2	1.20	1.20	0.0	0.0	0.0	0.00	0.30	0.05	0.55	0.30	0.20
CEDAR CREEK R	1	1	1.50	0.00	0.0	1.5	0.0	0.00	0.00	0.00	0.50	0.00	0.20
COCOLALLA L	2	1	0.40	0.40	0.0	0.0	0.0	0.00	0.50	0.10	0.00	0.60	0.20
CRANE CREEK R	2	2	11.00	8.00	3.0	0.0	0.0	0.00	0.00	0.02	0.23	0.10	0.10
DEADWOOD R	2	3	44.00	17.00	27.0	0.0	0.0	0.00	0.05	0.02	.	0.00	0.40
DEEP CREEK R	.	2	10.00	9.00	1.0	0.0	0.0	0.00	0.02	0.02	.	0.30	0.40
DWORSHAK R	4	12	5.00	5.00	0.0	0.0	0.0	0.00	0.00	0.10	0.90	0.00	0.10
ECHO L	1	2	22.00	0.00	7.0	7.0	8.0	0.00	0.00	0.00	1.00	0.00	0.00
FERNAN L	2	2	0.10	0.10	0.0	0.0	0.0	0.10	0.20	0.05	0.60	0.40	0.00
GEM L	1	1	21.00	0.00	7.0	7.0	7.0	0.00	0.00	0.00	1.00	0.00	0.00
GOLDEN L	2	2	8.00	8.00	0.0	0.0	0.0	0.00	0.00	0.10	.	0.30	0.00
GOOSE L	1	1	9.40	3.00	6.4	0.0	0.0	0.00	0.00	0.02	.	0.00	0.40
HAUSER L	1	2	1.40	1.20	0.2	0.0	0.0	0.10	0.25	0.02	0.03	0.90	0.10
HAYDEN L	1	3	1.40	1.40	0.0	0.0	0.0	0.10	0.65	0.10	0.00	0.20	0.80
HEDEVIL L	1	1	23.00	0.00	7.0	7.0	9.0	0.00	0.00	0.00	1.00	0.00	0.00
HELLS CANYON R	1	1	22.00	22.00	0.0	0.0	0.0	0.00	0.01	0.01	.	0.50	0.00
HENRYS L	3	2	2.00	2.00	0.0	0.0	0.0	0.00	0.10	0.02	.	0.02	0.20
HOODOO L	2	1	7.40	5.40	1.6	0.4	0.0	0.00	0.00	0.10	0.90	0.00	0.20
ISLAND PARK R	2	3	1.50	0.00	1.5	0.0	0.0	0.00	0.10	0.02	.	0.00	0.10
LAKE CHATCOLET	3	2	1.50	1.50	0.0	0.0	0.0	0.00	0.20	0.15	0.65	0.50	0.00
LAKE COEUR D'ALENE	4	12	0.10	0.10	0.0	0.0	0.0	0.05	0.65	0.10	0.05	0.50	0.30
LAKE LOWELL	4	2	1.00	1.00	0.0	0.0	0.0	0.00	0.00	0.10	0.90	0.50	0.40
LAKE PEND OREILLE	4	9	0.10	0.10	0.0	0.0	0.0	0.01	0.50	0.05	0.25	0.40	0.10
LAKE WAHA	2	2	14.00	14.00	0.0	0.0	0.0	0.00	0.05	0.02	.	0.00	0.10
LAKE WALCOTT	4	4	15.00	15.00	0.0	0.0	0.0	0.00	0.00	0.05	0.95	0.00	0.40
LAMONT R	4	1	0.10	0.10	0.0	0.0	0.0	0.02	0.02	0.02	.	0.30	0.45
LITTLE CAMAS R	2	4	0.50	0.00	0.5	0.0	0.0	0.00	0.00	0.03	.	0.05	0.60
LITTLE WOOD R	1	1	10.00	5.00	5.0	0.0	0.0	0.00	0.00	0.05	0.86	0.00	0.05

Table 2. (cont.) Recreation Data

	ROAD ACCESS	REC ACCESS	MILES TO MAJOR HIWAY	DISTANCE TO MAJOR HIGHWAY BY ROADTYPE				DEVELOPMENT ON THE SHORELINE (%)				SHORELINE ROAD BY ROADTYPE (%)	
				SECONDARY	GRAVEL	DIRT	TRAIL	URBAN	HOUSES	HARD	SOFT	PAVED	UNPAVED
LOWER BERNARD L	1	1	20.00	0.00	7.0	7.0	6.0	0.00	0.00	0.00	1.00	0.00	0.00
LOWER PRIEST L	2	9	26.00	26.00	0.0	0.0	0.0	0.01	0.50	0.05	0.05	0.20	0.50
LUCKY PEAK R	2	4	0.10	0.10	0.0	0.0	0.0	0.00	0.00	0.02	0.47	0.15	0.05
MACARTHUR L	2	2	1.00	1.00	0.0	0.0	0.0	0.00	0.10	0.10	0.80	0.15	0.00
MACKAY R	2	3	0.10	0.10	0.0	0.0	0.0	0.00	0.00	0.01	.	0.10	0.20
MAGIC R	4	6	8.00	8.00	0.0	0.0	0.0	0.02	0.10	0.05	0.48	0.05	0.20
MANN'S L	2	2	9.00	8.50	0.5	0.0	0.0	0.00	0.01	0.01	.	0.00	0.30
MANN'S CREEK R	2	1	1.00	1.00	0.0	0.0	0.0	0.00	0.00	0.02	.	0.40	0.20
MILNER R	2	4	0.10	0.10	0.0	0.0	0.0	0.10	0.10	0.02	0.08	0.05	0.10
MOOSE CREEK R	1	1	1.80	0.00	1.8	0.0	0.0	0.00	0.00	0.05	0.95	0.00	0.50
MORMON R	3	2	5.00	0.00	5.0	0.0	0.0	0.00	0.00	0.02	0.74	0.00	0.05
MOUNTAIN HOME R	4	2	0.10	0.10	0.0	0.0	0.0	0.00	0.00	0.01	0.93	0.30	0.30
MURTAUGH LAKE R	2	1	1.00	1.00	0.0	0.0	0.0	0.00	0.10	0.05	0.00	0.00	0.05
MYRTLE L	1	1	23.60	6.00	10.8	2.8	4.0	0.00	0.00	0.05	0.95	0.00	0.00
OXBOW R	2	2	35.00	35.00	0.0	0.0	0.0	0.00	0.01	0.01	.	0.50	0.10
PALISADES R	3	6	0.10	0.10	0.0	0.0	0.0	0.02	0.02	0.02	.	0.40	0.15
PAYETTE L	2	4	0.10	0.10	0.0	0.0	0.0	0.07	0.55	0.10	0.25	0.55	0.20
PERKINS L	1	2	5.60	2.80	2.8	0.0	0.0	0.00	0.00	0.00	1.00	0.00	0.05
PETIT L	2	1	1.50	0.00	1.5	0.0	0.0	0.00	0.20	0.05	0.02	0.00	0.50
PORTNEUF R	2	4	19.00	15.00	4.0	0.0	0.0	0.00	0.00	0.01	.	0.00	0.60
REDFISH L	3	5	2.00	2.00	0.0	0.0	0.0	0.00	0.02	0.02	0.02	0.20	0.00
RIRIE R	2	2	2.50	2.50	0.0	0.0	0.0	0.00	0.00	0.00	0.90	0.00	0.05
ROSE L	1	1	0.50	0.50	0.0	0.0	0.0	0.00	0.60	0.10	0.30	0.00	0.40
ROUND L	2	1	0.20	0.20	0.0	0.0	0.0	0.00	0.00	0.10	0.90	0.00	0.05
SALMON FALLS R	2	5	10.00	9.00	1.0	0.0	0.0	0.00	0.00	0.01	0.80	0.00	0.05
SEVEN DEVILS L	1	1	15.50	0.00	7.0	8.0	0.3	0.00	0.00	0.00	1.00	0.00	0.00
SHELF L	1	1	20.00	0.00	7.0	7.0	6.0	0.00	0.00	0.00	1.00	0.00	0.00
SILVER L	2	3	2.00	2.00	0.0	0.0	0.0	0.00	0.00	0.00	0.20	0.00	0.02
SODA POINT R	2	1	5.00	3.00	0.0	2.0	0.0	0.00	0.01	0.02	.	0.00	0.40
SOLDIERS MEADOW R	2	2	21.50	14.00	1.5	6.0	0.0	0.00	0.00	0.02	.	0.00	0.20
SPIRIT L	4	2	2.00	2.00	0.0	0.0	0.0	0.02	0.50	0.05	0.00	0.43	0.15
STANLEY L	2	3	4.00	0.00	4.0	0.0	0.0	0.00	0.00	0.20	0.80	0.00	0.40
STEVENS L	0	1	4.00	0.00	0.0	2.0	2.0	0.00	0.00	0.00	1.00	0.00	0.00
SWAN FALLS R	4	1	0.10	0.10	0.0	0.0	0.0	0.05	0.05	0.01	0.20	0.00	0.30
SWAN L	1	1	1.50	0.50	0.6	0.3	0.1	0.00	0.00	0.00	0.00	.	0.00
TOLC L	2	3	24.00	22.00	2.0	0.0	0.0	0.00	0.00	0.01	.	0.00	0.50
TRINITY L	1	2	33.00	3.00	11.0	16.0	0.0	0.00	0.00	0.10	0.90	0.00	0.30
TWIN LAKES UPPER L	.	2	3.00	3.00	0.0	0.0	0.0	0.00	0.45	0.01	.	0.30	0.05
TWIN LAKES LOWER L	4	3	0.10	0.10	0.0	0.0	0.0	0.00	0.60	0.02	0.00	0.10	0.30
TWIN LAKES NORTH R	2	2	3.00	1.00	0.0	2.0	0.0	0.00	0.00	0.02	.	0.00	0.80
TWIN LAKES SOUTH R	2	1	2.00	1.00	1.0	0.0	0.0	0.00	0.00	0.02	.	0.00	0.75
UPPER BERNARD L	1	1	20.50	0.00	7.0	7.0	6.5	0.00	0.00	0.00	1.00	0.00	0.00
UPPER PRIEST L	2	4	50.00	47.00	0.0	0.0	3.0	0.00	0.00	0.10	0.80	0.00	0.00
WARM L	2	3	24.00	22.00	2.0	0.0	0.0	0.00	0.45	0.05	.	0.00	0.50
WILLIAMS L	2	2	10.00	6.00	4.0	0.0	0.0	0.00	0.30	0.02	.	0.00	0.60
WILSON LAKE R	2	1	6.00	5.00	1.0	0.0	0.0	0.00	0.00	0.05	0.85	0.00	0.05
WINCHESTER L	2	4	0.10	0.10	0.0	0.0	0.0	0.00	0.00	0.10	0.90	0.20	0.50

Percentage of Shoreline with a Road - This is an estimate of the percentage shoreline where a road is present, either paved or unpaved, from which there could be lake access and from which the lake can at least be viewed. Sources are Idaho Department of Transportation (1976) and Bureau of Land Management (1979) maps, forest service maps, and aerial photos.

Remoteness

Distance to Primary Highway and Road Type - These measures are taken exclusively from the Idaho Department of Transportation (1978) county highway maps. The distance from the lake to the closest primary highway is measured by use of an electronic graphics calculator. This device electronically measures road length in miles when a pointer is manually moved along the road section to be measured. The length is displayed on a screen, is converted to miles, and the distance recorded. The distance for each road type is summed to yield distance from the primary highway. The road types are secondary road (any two-lane blacktop), gravel road, dirt road, and trail. This measure is scaled to a single remoteness scale. The scaling procedure is to multiply the miles of hard-surface road by one, then double the multiplier progressively for the next three road types. Miles of trail is multiplied by eight, giving it the largest weighting on remoteness. The formula is:

miles of secondary road X 1
+ miles of gravel road X 2
+ miles of dirt road X 4
+ miles of trail X 8.

This figure varies from .10 for lakes that are right along a highway to 114 for Hedevil lake in the Seven Devils area, the most remote lake surveyed.

Development

Urban Development - This is the percentage of the shoreline that is bordered by a town of any size.

Houses and Resorts - This is the percentage of shoreline that has resorts, houses, or cottages. The source of this data is primarily aerial photos and personal observation.

Hard Recreational Development - This is an estimate of the percentage of shoreline that has recreational development in the form of boat ramps, campgrounds, and beaches. All of the data sources contributed to the collection of this data.

Soft Recreational Development - This an estimate of the percentage of shoreline that is public and is not included in the measure of Hard Recreational Development. This measure has been dropped from the analysis. The first three development variables are added together to represent the total percentage of the lakeshore that has human development (Appendix A.).

LANDUSE/OWNERSHIP DATA

Landuse maps (dated 1976) available at the Idaho Water and Energy Resources Research Institute were overlaid on watershed maps. The area of the watershed and the area of the landuse types were computed by use of the electronic graphics calculator. The landuse areas were then converted to a percentage figure, representing the percentage of the watershed in Idaho with that type of use. The landuse categories used in the analysis are: Urban, Range, Agriculture, and Forest (Appendix A.).

By using primarily the Surface Management Status Maps (BLM, 1979), land ownership is converted to a percentage figure for each of the shoreline and watersheds. The categories are percentage Federal, State, Private, and Other (usually Indian Reservation) (Appendix A.). Percentage of the watershed in private ownership was the variable used for the analysis.

TROPHIC STATUS DATA

Data for approximately thirty trophic status variables were gathered for the Clean Lakes Project (Appendix A). Eight variables were chosen to be included in the analysis (Table 3.). The basis for their inclusion is that they are commonly used in eutrophication studies, that they measure different aspects of trophic status, and that they are all reliable measures.

RESEARCH DESIGN

A total of ninty different variables were measured for the Idaho Clean Lakes Project (Appendix A). The variables chosen for analysis, discussed above, include nineteen human activity variables (the independent variables) and eight trophic status variables (the dependent variables) (Table 3.). The following chapter discusses the findings from statistical analysis of the twenty seven variables. There are two major purposes of the analysis: to determine which human activity variables are significantly correlated to each of the trophic status variables and to develop two parsimonious sets of variables

Table 3.

DEPENDENT VARIABLES

VARIABLE	SYMBOL	DEFINITION	RANGE
Secchi	SECCHI	Measure of water clarity.	.10 to 14.0
Chlorophyll-a	CHLA	Chlorophyll content.	0 to 138.5
PH	PH	Measure of acidity.	6.1 to 10.0
Conductivity	CONDUCT	Measure of alkalinity.	12.0 to 650.0
Turbidity	TURB	Light reflectence.	.30 to 90.0
Total Phosphorus	PTOTAL	Phosphorus concentration.	.004 to 2.66
Total Nitrogen	NTOTAL	Nitrogen concentration.	.05 to 3.36
N/P	N/P	NTOTAL divided by PTOTAL.	.10 to 52.50

INDEPENDENT VARIABLES

VARIABLE	SYMBOL	DEFINITION	RANGE
Recreation Access	RECA	Number of public accesses on the shoreline.	1 to 12
Remoteness	REMOTE	Distance to major highway, weighted by roadtype.	.10 to 114
Development	DEV	Percentage of shoreline with permanent development.	0 to .85
Road Access	ROADA	Percentage of shoreline with a road adjacent.	0 to 1.00
Population	WSPOP 80	Population of the watershed in 1980.	0 to 107509
	FIPOP 80	Population within a 50 mile radius (air miles) in 1980.	3602 to 454027
	HUNPOP 80	Population within a 100 mile radius in 1980.	115745 to 1048000
Population Density	WSPOP DENS	WSPOP 80 divided by the size of the watershed (sq. miles).	0 to 183.75
Population Growth	WSG 70-80	Population growth rate within the watershed 1970-1980.	-0.14 to 3.00
	FIG 60-70	Population growth rate within 50 miles 1960-1970.	-0.18 to .35
	FIG 70-80	Population growth rate within 50 miles 1970-1980.	.10 to .50
	HUG 60-70	Population growth rate within 100 miles 1960-1970.	-0.05 to .47
	HUG 70-80	Population growth rate within 100 miles 1970-1980.	-0.06 to .42
Landuse	WS URBAN	Percentage of the watershed in urban land.	0 to .08
	WS AGR	Percentage of the watershed in agricultural land.	0 to 1.0
	WS RANGE	Percentage of the watershed in range land.	0 to 1.0
	WSFOREST	Percentage of the watershed in forest land.	0 to 1.0
Land Ownership	LS PRIV	Percentage of the lakeshore in private ownership.	0 to 1.0
	WS PRIV	Percentage of the watershed in private ownership.	0 to 1.0

which include the most important variables from both groups. The development of a parsimonious set of variables (trophic status indicators) is based on statistical analysis beginning with correlation analysis, followed by factor analysis, and completed by canonical correlation analysis. All analysis was done using SPSS, Statistical Package for the Social Sciences (Nie et al., 1975).

Since the data are all interval-level measures, Pearson product-moment correlation coefficients were utilized for summerizing the relationships between pairs of variables. The correlation coefficients indicate the degree to which a change in one variable is related to a change in another. The correlation coefficients are the "r" values and indicate the strengh and the direction of the relationships. If "r" is close to zero, we can assume little or no linear relationship, if "r" approaches +1.0 or -1.0, we can assume a strong linear relationship. One purpose of this type of analysis is data reduction by examining the correlations among the dependent and independent variables. If two variables have correlations of .70 or greater then they may be measuring the same thing. If there are high correlations among the data, the researcher may be able to remove or combine variables in later analysis.

The significance value of "r" is often used to reject or accept the null hypothesis that there is no relationship between a pair of variables in the population from which a random sample is drawn. The group of study lakes is not a random sample, but a significance value of .05 or .001 indicates that the null hypothesis should be rejected and that the correlation is worthy of discussion. The discussion centers around the question of whether or not the human activity variables are major influences on the trophic status variables.

Trophic Status Indicators

Each of the eight trophic status variables is a scientifically accepted indicator of trophic status, but as individual indicators, they are not always reliable for every lake at every time of the year. A set of indicators may more accurately reflect trophic status. Factor analysis and canonical correlation are used to determine which combinations of trophic status variables and human activity variables have the highest correlation.

Factor anlaysis is a technique that is used primariy for its data reduction capabilities. A large number of variables can often be reduced to a more manageable number of "factors". The factors are imaginary variables which may account for much of the variation in the data. The factor which would be hypothesized as emerging from the trophic status variables is a trophic status factor. The set of trophic status variables would factor together and be interpreted as indicating trophic status. For the human activity variables, such an interpretation can not be assumed. The purpose is to determine which variables have very little influence on the data, so that they can be removed from the analysis. For the remaining variables, those that factor together can be used in canonical correlation to determine their relationship, as a set, with the trophic status variables.

Canonical correlation is a multivariate statistical technique that is especially suited to this research problem, because of its simultanious treatment of all variables. It produces linear combinations of the original variables, with the aim of accounting for a maximun amount of the relationship between two sets of variables. The two important statistics that are produced are the canonical variates and the canonical correlations. The canonical variates are coefficients which reflect each variable's importance in the relationship. They also indicate if the variable has a direct or inverse relationship with the other variables. The canonical correlation is the total amount of correlation between the two sets of variables. Its square, which is equivelant to the eigenvalue represents the total amount of variance in the dependent variables accounted for by the independent variables.

In summary, the statistical analysis progresses from determining which variables individually correlated most highly within both sets, to determining which human activity variables are significantly correlated to each of the trophic status variables, to an anlaysis of the correlation between the two sets of variables. The logic of this progression is that a concise set of trophic status variables and human activity variables will emerge that can be interpreted as entitled to classification as trophic status indicators for Idaho lakes.

CHAPTER IV

FINDINGS AND INTERPRETATIONS

CORRELATIONS

A main purpose in examining the correlations is to see if there any variables which are very highly correlated, thus measuring the same thing. Using highly correlated independent variables in multiple regression analysises could result in poor results and interpretations.

Among Trophic Status Variables

There is much interelationship among the trophic status variables. Secchi, conductivity, N/P and turbidity each correlate with at least five other variables (Table 4.). The most significant correlations are between secchi and the other variables. CHLA and NTotal correlate with the least number of variables. The only correlation above .50 is between PTotal and NTotal (.73), so it could be that these two variables are measuring the same aspect of trophic status. All the variables will be retained for the initial analysis.

TABLE 4.
CORRELATIONS AMONG TROPHIC STATUS VARIABLES.

	SECCHI	CHLA	PH	CONDUCT	TURB	PTOTAL	NTOTAL	NP
SECCHI	1.00	-0.36**	-0.49**	-0.39**	-0.39**	-0.16	-0.19	0.44**
CHLA	-0.36**	1.00	0.14	0.05	0.21*	-0.04	0.024	-0.18
PH	-0.49**	0.14	1.00	0.44**	0.27*	0.10	0.13	-0.33**
CONDUCT	-0.39**	0.05	0.44**	1.00	0.14	0.24*	0.22*	-0.30*
TURB	-0.39**	0.21*	0.27*	0.14	1.00	0.42**	0.28*	-0.27*
PTOTAL	-0.16	-0.04	0.10	0.24*	0.42**	1.00	0.73**	-0.24*
NTOTAL	-0.19	0.02	0.13	0.22*	0.28*	0.73**	1.00	-0.06
NP	0.44**	-0.18	-0.34**	-0.31*	-0.27*	-0.24*	-0.07	1.00

* $P < .05$ ** $P < .001$

Among Human Activity Variables

The highest correlations in this set are between the fifty and one hundred mile population growths (1970-80) (.70), and the inverse correlation between percentage of watershed that is forest and that which is rangeland (-.65) (Table 5.). Many of the other variables have a large number of significant correlations, such as remoteness, development, road accesses, population density in the watershed and fifty mile population (1980). Three have very few significant correlations, recreation accesses, watershed population (1980), and watershed in forest land. Initially, all the variables will be included in the analysis, the first step being to examine the correlations between the trophic status variables and the human activity variables.

Between Trophic Status and Human Activity Variables

The correlations are examined to find correlations significant at the .05 level or greater. To shorten the discussion, the correlations are discussed in terms of the trophic status variable with which they are significant (Table 6.).

Secchi basically represents water clarity, which is usually poor when eutrophication is present. Secchi and N/P are inversely correlated with the other six trophic status

TABLE 5.
CORRELATIONS AMONG HUMAN ACTIVITY VARIABLES.

	RECA	REMOTE	DEV	ROADA	WSPOP80	POP DENS	FIPOP80	HUNPOP80	WSG70-80
RECA	1.00	-0.19	0.30*	0.18	0.21*	-0.07	0.03	0.04	0.00
REMOTE	-0.19	1.00	-0.29*	-0.42**	-0.16	-0.22*	-0.35**	-0.24*	-0.30*
DEV	0.30*	-0.29*	1.00	0.50**	0.16	0.35**	0.51**	0.35**	0.23*
ROADA	0.18	-0.42**	0.50**	1.00	0.12	0.44**	0.38**	0.51**	0.04
WSPOP 80	0.21*	-0.16	0.16	0.12	1.00	0.02	0.12	0.00	-0.09
POP DENS	-0.07	-0.22	0.35**	0.43**	0.02	1.00	0.35**	0.41**	0.12
FIPOP 80	0.03	-0.35**	0.51**	0.38**	0.12	0.35**	1.00	0.39**	0.28*
HUNPOP80	0.04	-0.24*	0.35**	0.51**	0.00	0.41**	0.39**	1.00	0.02
WSG70-80	0.00	-0.30*	0.23*	0.04	-0.09	0.12	0.28*	0.02	1.00
FIG60-70	0.10	-0.30*	-0.10	0.05	0.01	-0.05	0.07	-0.00	-0.03
FIG70-80	0.07	-0.29*	-0.01	0.14	0.01	-0.09	-0.02	0.00	0.15
HUG60-70	0.14	-0.02	0.02	0.24*	-0.01	0.02	-0.25*	0.09	0.07
HUG70-80	0.01	-0.27*	-0.10	0.22*	0.00	-0.01	-0.09	0.17	0.00
WS URBAN	-0.03	-0.16	0.52**	0.27*	0.03	0.42**	0.47**	0.15	0.04
WS AGR	-0.15	-0.22*	-0.19	0.10	0.05	0.30*	0.06	0.26*	-0.07
WS RANGE	-0.01	-0.16	-0.30*	-0.00	0.07	-0.26*	-0.14	-0.26*	0.01
WSFOREST	0.15	-0.03	0.38**	0.06	-0.08	0.05	0.19	0.03	0.19
LS PRIV	-0.01	-0.41**	0.28*	0.27*	0.08	0.26*	0.36**	0.34**	0.23*
WS PRIV	-0.12	-0.40**	0.16	0.17	0.04	0.25*	0.39**	0.44**	0.37**

* P< .05 ** P< .001

TABLE 5. (cont.)
Correlations Among Human Activity Variables.

	FIG60-70	FIG70-80	HUG60-70	HUG70-80	WS URBAN	WS AGR	WS RANGE	WSFOREST	LS PRIV	WS PRIV
RECA	.01	.07	.14	.01	-0.03	-0.15	-0.01	0.15	-0.01	-0.12
REMOTE	-.30*	-.29*	-.02	-.27*	-0.16	-0.22*	-0.16	-0.03	-0.41**	-0.40**
DEV	-.10	-.01	.02	-.10	0.52**	-0.19	-0.30*	0.39**	0.29*	0.16
ROADA	.05	.14	.24*	.22*	0.28*	0.10	-0.01	0.06	0.28*	0.17
WSPOP 80	.01	.01	-.01	.00	0.03	0.05	0.07	-0.08	0.08	0.04
WSPOPDENS	-.05	-.09	.02	-.01	0.43**	0.30*	-0.26*	0.05	0.26*	0.25*
FIPOP 80	.07	-.02	-.25*	-.00	0.48**	0.06	-0.14	0.19	0.36**	0.39**
HUNPOP 80	-.00	.00	.09	.17	0.15	0.26*	-0.26*	0.03	0.35**	0.45**
WSG 70-80	-.03	.15	.07	.00	0.044	-0.07	0.01	0.19	0.23*	0.38**
FIG 60-70	1.00	.37**	-.12	.30*	-0.04	0.01	-0.04	0.19	-0.09	-0.01
FIG 70-80	.37**	1.00	.12	.70*	-0.12	-0.15	0.32*	-0.04	-0.05	-0.16
HUG 60-70	-.12	.12	1.00	.23*	-0.13	-0.03	-0.09	0.15	0.08	-0.09
HUG 70-80	.30*	.70**	.23*	1.00	-0.15	0.03	0.36**	-0.18	0.03	-0.04
WS URBAN	-.04	-.12	-.13	-.15	1.00	-0.01	-0.18	0.13	0.23*	0.16
WS AGR	.01	-.15	-.03	.03	-0.01	1.00	-0.03	-0.51**	0.17	0.41**
WS RANGE	-.04	.31*	-.09	.35**	-0.18	-0.03	1.00	-0.65**	0.04	-0.11
WSFOREST	.19	-.04	.15	-.18	0.13	-0.51**	-0.65**	1.00	-0.02	-0.01
LS PRIV	-.09	-.05	.08	.03	0.23*	0.17	0.04	-0.02	1.00	0.52**
WS PRIV	-.01	-.16	-.09	-.04	0.16	0.41**	-0.11	-0.01	0.52**	1.00

* P< .05 ** P< .001

variables. When secchi is low, indicating low water clarity, CHLA, PH, and the others (besides N/P) are high. Secchi correlates with five of the other seven trophic status variables (all at the .001 level).

A low secchi has direct correlation with remoteness and percentage of forest in the watershed. It correlates inversely with percentage of agriculture, range and private land in the watershed and on the lakeshore (Table 6.). All of these relationships are strongly influenced by the high water clarity of the twenty mountain lakes in the study. The deep mountain lakes in the Seven Devils and Sawtooth National Recreation Areas, having secchi readings of over forty feet, are also those lakes which are at high elevations, have no private or agricultural land in their watersheds and have very little rangeland. The correlations are also influenced at the other end of the scale by many of the southern reservoirs which have low water clarity and high percentages of agriculture, range and private land in their watersheds. One exception is Hayden, which has high water clarity (40 ft.), but is not at all remote and has much of its lakeshore in private ownership. The landuse/ownership variables are exhibiting the strongest influence on secchi.

Chla is the amount of chlorophyll-a in the lake water and indicates an imbalance between production and consumption in the ecosystem. It is often related to a high imput of organic

TABLE 6.
CORRELATIONS BETWEEN THE TROPHIC STATUS AND THE
HUMAN ACTIVITY VARIABLES.

	SECCHI	CHLA	PH	CONDUCT	TURB	PTOTAL	NTOTAL	NP
RECA	0.17	-0.11	0.13	-0.09	-0.09	-0.08	-0.05	0.35**
REMOTE	0.33*	-0.18	-0.40**	-0.28*	-0.12	-0.04	-0.12	0.12
DEV	0.14	-0.01	-0.32*	-0.19	-0.16	-0.19	-0.11	0.34*
ROADA	-0.00	-0.04	0.14	0.03	-0.10	-0.11	-0.06	0.12
WSPOP 80	-0.07	0.07	0.13	0.21*	-0.01	-0.05	-0.01	-0.01
POP DENS	-0.04	0.02	-0.10	-0.08	-0.09	-0.10	-0.09	-0.05
FIPOP 80	-0.20	0.31*	-0.07	-0.16	0.01	-0.15	-0.06	-0.10
HUNPOP80	0.02	0.06	-0.10	0.03	-0.07	-0.12	-0.19	0.08
WSG 70-80	-0.19	-0.07	-0.04	0.10	0.14	0.08	-0.10	-0.08
FIG 60-70	0.10	0.03	0.16	-0.05	-0.05	-0.12	-0.12	0.11
FIG 70-80	0.04	-0.045	0.32*	0.08	0.10	0.06	-0.14	0.08
HUG 60-70	0.10	-0.15	0.04	-0.07	0.00	0.10	-0.07	0.05
HUG 70-80	0.02	-0.10	0.40**	0.14	0.15	0.14	-0.06	0.02
WS URBAN	0.10	0.06	-0.17	-0.08	-0.06	-0.05	-0.00	0.03
WS AGR	-0.37**	0.46**	0.25*	0.32*	0.18	0.07	0.18	-0.21*
WS RANGE	-0.31*	-0.02	0.51**	0.47**	0.31*	0.23*	0.23*	-0.29*
WS FOREST	0.20	-0.18	-0.37**	-0.52**	-0.24*	-0.15	-0.22	0.21*
LS PRIV	-0.30*	0.20	0.10	0.25*	0.16	0.07	0.08	-0.23*
WS PRIV	-0.44**	0.29*	0.03	0.31*	0.23*	0.10	0.12	-0.21

* P< .05 ** P< .001

matter, such as duck excreta, run-off from feedlots, and sewage input, which results in an overproduction of algae at a level too high to be completely consumed by the microcrustacea and other zooplankton consumers. There are significant direct correlations between CHLA and fifty mile population (1980), and percentage of agriculture and private ownership in the watershed. The correlation with fifty mile population is partially due to the high CHLA of many of the southern reservoirs which are within fifty miles of the large population centers of Pocatello, Burley, and Boise. It also is due in part to the northern lakes with high CHLA which are within fifty miles of Spokane (Cocollala, Swan, Round, McArthur, Benewah, and Cave). Notable exceptions are Hayden Lake, with a low CHLA and a large population in close proximity, and Cascade, with high CHLA and a very low population in close proximity. CHLA is the only trophic status indicator that correlates significantly with fifty mile population.

pH indicates an alkaline aquatic environment if it is above 7.0 and an acidic environment if it is below 7.0. Mountain lakes are more acidic than others, usually in the range of 6.1 to 7.1. A high pH indicates a possible eutrophication problem.

pH correlates directly with population growth within 50 and 100 miles (1970-80) and with agriculture and rangeland in the watershed. It correlates inversely with remoteness, development on the lakeshore, and forest in the watershed. Agricultural landuse is again significant, indicating that landuse is affecting trophic status. An important aspect of its influence is that many of the reservoirs where direct correlation between landuse and the trophic status variables is present, also receive inflow from irrigation canals or are on-stream reservoirs (Wilson, Murtaugh, Walcott, Milner, and American Falls, for example). So there is not only the impact from surrouding landuses, but there is a compounding effect via the eutrophic inputs from streams and canals.

High population growth correlates with a high pH, indicating that population growth is greater on the average near the eutrophic lakes. Exceptions are the low-PH Sawtooth NRA lakes (Redfish, Alturas, and Stanley). The population within fifty miles of these lakes is only 3,602, and is average for the one hundred mile radius (355,676), but the population growth rates within fifty and 100 miles are among the highest in the state (46% and 42% respectively).

High development correlates with low pH, indicating that development is not adversely affecting trophic status. Many of the northern lakes which have high lakeshore development have a low pH (Twin Lakes, Cocolalla, Spirit Lake, Fernan, Hauser, Coeur d'Alene, Lower Priest, and Hayden).

An important aspect of pH is that the more alkaline lakes, those with a high pH, have a higher buffer capacity than the more acidic lakes. Their alkalinity raises their capacity to absorb adverse influences on their pH and thus their trophic status. Lakes in granite, which are usually more acidic, are more susceptible to eutrophication problems. So more than being just an indicator of trophic status, pH indicates those lakes which are most susceptible to eutrophication, should adverse influences be introduced into their ecosystems. With this in mind, the low PH lakes with high population growth and high development may have a threatened, unstable trophic status.

Conductivity is representative of the amount of ionized particles in the water. It is significantly related to five of the other trophic status variables (Table 6.). Even more than PH, conductivity is an indicator of alkalinity. Lakes with low conductivity are then more susceptible to eutrophication problems, although they are presently less eutrophic than those with high conductivity.

Human activity variables that correlate directly with high conductivity are watershed population (1980); agricultural land and rangeland; and percentage of private ownership on the lakeshore and in the watershed. Inverse correlations are with remoteness and forest land. These correlations are consistent with earlier findings, except that a unique population variable is related to conductivity, watershed population (1980). As with CHLA, the relationship between a population variable and a trophic status variable is a direct one, the more the indicator points toward a eutrophication problem, the higher the population value. Also consistent with CHLA, the lakes with a high conductivity value and a high population value are primarily the southern reservoirs. Soda Point, Milner, American Falls, Brownlee, C J Strike, and Palisades are most representative of this relationship. Major exceptions are Coeur d'Alene, Pend Oreille, Lower Priest, Payette, and Spirit Lake, having low conductivity and high population growth. Coeur d'Alene is second only to American Falls in the size of its watershed population (54,934 and 107,509, respectively). These low conductivity lakes, as with the low pH lakes, are more susceptible to eutrophication problems.

Turbidity is a measure of the light reflectance of the water, a general measure of the level of particles present. It is related to six of the other trophic status variables and is directly correlated with rangeland and private ownership in the watershed. Percentage of forest land is inversely correlated, the lower the turbidity, the greater amount of forest in the watershed. Exceptions to the rangeland correlation are Hells Canyon, Brownlee, Oxbow, and Ririe, all with an above average percentage of rangeland in their watersheds and low turbidity. Exceptions to the forest relationship at the other end of the turbidity scale are McArthur, Lake Waha, Soldiers Meadow, Cocolalla, and Rose, all of which have a high percentage of forest in their watersheds. These lakes do have a high percentage of their watersheds in private ownership, so there may be other influnces, related to private ownership, which are influencing the turbidity of their waters.

PTotal is the total phosphorous concentration. PTotal correlates with rangeland, a direct relationship. NTotal correlates very high with PTotal (.73), indicating that they are measuring a similar condition. NTotal appears to be more consistent than PTotal, so PTotal is dropped from further analysis.

NTotal is the total nitrogen concentration. NTotal correlates directly with rangeland and inversely with forest land.

N/P is NTotal divided by PTotal. It correlates with five of the other trophic status indicators. N/P, like secchi, is interrpreted inversely from the other trophic status variables. The higher the N/P, the less the eutrophication problem. N/P correlates directly with recreation accesses, development and forest land. It correlates inversely with agriculture, and the two ownership measures. The relationship with recreation accesses is unique among the trophic status variables. It indicates that the lakes with the most accesses have the highest N/P, they are the least eutrophic lakes in terms of the N/P variable. Lakes indicative of this relationship include

Lower Priest, Pend Oreille, Payette, Coeur d'Alene, and Dworshak.

The landuse/ownership relationships remain consistent, pointing towards eutrophication. N/P is similar to PH in its relationship with development. Lower Priest, Pend Oreille, Twin Lakes, and Hauser are high development lakes at the high end of the N/P scale. They share their position with the undeveloped lakes such as Echo, Upper Priest, Redfish, Alturas, Goose, and Stanley. Exceptions are Bayhorse, a mountain lake with low N/P, and Spirit and Hayden lakes, developed lakes located near the lower end of the N/P scale.

In summary, there are a few human activity variables that are consistently related to the trophic status variables. They are mainly the landuse/ownership indicators. Others that relate to two or three trophic status variable are remoteness and development. Variables that relate to only one trophic status variable are recreation accesses, watershed population (1980), fifty-mile population (1980), and the population growth rates 1980 within fifty and one hundred miles (1970-80). The landuse/ownership variables (except forest) and the population variables are consistently indicating the presence of a eutrophication problem, as is remoteness. The recreation access and development indicate the lack of a eutrophication problem in their relationship with PH and N/P.

There are some of the variables which are not significantly related with any of the trophic status variables: number of road accesses, population density in the watershed, watershed population growth rate (1970-80), population within one hundred miles (1980), fifty and one hundred mile population growths (1960-70), and watershed in urban land. These variables are dropped from further analysis.

The following analysis is an attempt to develop sets of human activity variables and trophic status variables which represent indicators that contribute to an ecological model of eutrophication problems of Idaho lakes. Emphasis is given those variables which are shown above to be interrelated, but which do not exhibit colinearity.

SOCIAL INDICATORS OF TROPHIC STATUS

Factor analysis and canonical correlation have been utilized to further understand the relationship between human activities and the trophic status variables. The purpose is to explore influences on different aspects of eutrophication with the goal of developing a parsimonious set of social indicators which qualify for inclusion in further studies of eutrophication problems of Idaho lakes.

Landuse/Ownership Indicator

The first factor (Table 7.) illustrates the importance of agriculture and private ownership in the watershed.

TABLE 7.

FACTOR ANALYSIS

	LANDUSE/ OWNERSHIP FACTOR	POPULATION FACTOR	DEVELOPMENT FACTOR	RECREATION FACTOR
RECA	-0.14	0.03	0.15	0.55
REMOTE	-0.55	-0.37	-0.19	-0.38
DEV	0.06	-0.09	0.93	0.32
WSPOP 80	0.09	0.01	0.03	0.38
FIPOP 80	0.40	-0.04	0.49	0.11
FIG 70-80	-0.13	0.90	0.09	0.01
HUG 70-80	0.04	0.79	-0.08	-0.01
WS AGR	0.50	-0.05	-0.22	-0.06
WS RANGE	0.01	0.42	-0.29	0.11
LS PRIV	0.57	0.04	0.23	0.10
WS PRIV	0.83	-0.10	0.15	-0.09

Other components of this factor are fifty mile population in 1980, remoteness, and private ownership on the lakeshore. An interpretation of this factor is that it represents less remote lakes which have a majority of the watershed in private ownership, have a large percentage of private ownership on their lakeshore, have a large percentage of agricultural land in their watershed, and which have a medium to large population center within fifty miles. Together, these characteristics account for almost forty percent (39.2%) of the varience in the data.

There is a discrepancy within this indicator. Since this is the landuse factor, rangeland should factor highly. Instead, rangeland is a major variable in the population growth indicator. One explanation is that rangeland is usually associated with public lands, while agricultural land is associated with private land. This indicator gives major emphasis to private ownership and thus to agricultural landuse.

Population Growth Indicator

Factor two (Table 7.) factors highly on both fifty and one hundred mile population growth between 1970 and 1980. Other components of this factor are rangeland and remoteness. It represents those lakes with a high population growth near-by and most likely a large, rapid-growth population center within one hundred miles. This type of lake also has a significant amount of open rangeland in its watershed. This factor accounts for almost one third (31.6) of the variance in the data.

Development Indicator

The third factor factors highly on the development variable and moderately high on fifty mile population in 1980. It represents lakes with a high percentage of development on their shore and which either have a large population center within fifty miles or which have a large relatively population in surrounding areas. This factor accounts for approximately twenty percent (21.8%) of the variation in the data.

Recreation Indicator

Factor four factors highly on the variables which are intended to represent recreational use of Idaho lakes. The variables are: recreational accesses, development on the lakeshore, and watershed population in 1980. Lakes represented by this factor are those with a large number of recreational accesses, are not too remote, have a large percent of their shoreline in development, and have a large watershed population. This factor accounts for less than ten percent (7.4%) of the variation in the data.

In summary, the factor analysis reveals four factors that together account for one hundred percent of the variation in the independent variables. They correspond with the major categories of variables around which this study has been organized. Since this is the case, the variables within each factor will together be referred to as indicators, social indicators of trophic status.

The next step in the analysis is to include these four factors into a canonical correlation analysis with the seven trophic status variables. Five canonical correlations were produced, one which includes all of the variables and one for each of the four indicators. When interpreting the canonical variates, a value of .20 or greater is usually considered a significant correlation.

The first canonical correlation (Table 8.) includes all the variables. The variates indicate trends which are found in the later correlations. Rangeland, agricultural land, and private ownership in the watershed are exerting the most influence on the relationship. They appear as adverse influences, as does watershed population in 1980 and lakeshore in private ownership. Remoteness, development, and one hundred mile population growth are indicative of less eutrophic water.

The trophic status variables which are primarily involved in the relationship are conductivity, secchi, and CHLA. N-Total is the variable least involved in the relationship between all the variables. In terms of eutrophication, the dependent variables relate in the expected directions, secchi and N/P relating in the opposite direction of the other trophic status variables.

TABLE 8.

CANONICAL CORRELATIONS ON FACTORS

		CANONICAL COEFFICIENTS			
INDEPENDENT VARIABLES	ALL VARS.	LANDUSE/ OWNERSHIP INDICATOR	POPULATION INDICATOR	DEVELOPMENT INDICATOR	RECREATION INDICATOR
RECA	0.12				0.00
REMOTE	0.22	-0.21	-0.43		-0.81
DEV	0.22			-1.03	-0.82
WSPOP 80	-0.15				0.22
FIPOP 80	0.10	-0.09		.99	
FIG 70-80	-0.08		-0.17		
HUG70-80	0.20		0.23		
WS AGR	-0.35	0.61			
WS RANGE	-0.59		0.78		
LS PRIV	-0.15	0.19			
WS PRIV	-0.32	0.37			
DEPENDENT VARIABLES					
SECCHI	0.25	-0.42	-0.04	-0.19	0.01
CHLA	-0.19	0.50	-0.09	0.38	0.10
PH	-0.15	-0.08	0.63	0.28	0.72
CONDUCT	-0.56	0.51	0.41	-0.35	0.23
TURB	-0.15	0.05	0.20	-0.04	0.00
NTOTAL	-0.09	0.06	0.09	0.02	0.13
N/P	0.16	0.02	-0.02	-0.69	-0.23
CHI-SQUARE	161.55	78.21	63.60	35.43	65.27
SIGNIFICANCE	.000	.000	.000	.000	.000
EIGENVALUE	.67	.42	.47	.30	.45

Agricultural land and private ownership in the watershed are contributing most to the canonical correlation on the landuse/ownership indicator. Their influence is most related to secchi, CHLA, and conductivity. The direction of the relationships, inverse in terms of secchi and direct in terms of CHLA and conductivity, is indicating the adverse influence of the indicator on trophic status.

The canonical correlation on the population growth indicator gives most emphasis to rangeland. A high percentage of rangeland in the watershed, and less remoteness are most influential on trophic status in terms of pH, conductivity, and turbidity. Population growth is ambiguous in this relationship. Fifty mile population growth indicates a less eutrophic state, while one hundred mile population growth indicates the opposite. This finding illustrates the basic differences in population dynamics between northern and southern Idaho. In southern Idaho the population growth is greater in the larger urban areas which are commonly within one hundred miles of the more eutrophic reservoirs. In norhtern Idaho the population growth is greater in close proximity to the relatively less eutrophic lakes, either concentrated in the Spokane, Washington area, or dispersed in rural areas and small towns.

At this point it is interesting to note that the two landuse variables have emerged as important influences on trophic status, but on different aspects of the process.

Agricultural land is related to water clarity (secchi), algae (CHLA), and alkaline particles (conductivity), while rangeland is most related to pH and conductivity. Agriculture is then more indicative of the conditions by which we usually judge trophic condition or water quality - cloudy water and algae growth. Rangeland is indicative of conditions which are conducive to the eutrophication process, but which may not yet be present in the forms commonly recognized.

In the canonical correlation on the development indicator, population within fifty miles and development on the shoreline are given almost equal weight, but in opposite directions. In terms of four trophic status variables, secchi, CHLS, pH, and N/P, development on the shoreline indicates a less eutrophic condition, while population within fifty miles indicates a more eutrophic condition. The value of their variates are unusually high and the conductivity variable is operating opposite from the expected direction. Given these anomolies and the low eigenvalue of the relationship, no further interpretation is attempted.

Remoteness and development are exerting the most influence in the canonical correlation on the recreation indicator. Remoteness and development are both indicative of a less eutrophic condition in this relationship. A large population in the watershed is related to a more eurtophic condition. Trophic status in this relationship is represented by pH, conductivity, and N/P.

The statistical inclusion of N/P with this indicator is an interesting finding. Development, which is thought to be a major influence on N/P, appears to be preventing its occurance rather than encouraging it. Watershed population in 1980 is acting more in the hypothesized direction, higher populations indicating a more eutrophic condition. An interpretation of this apparent contradiction is that shoreline development, while changing aesthetic conditions on the lake, is not having a major impact on eutrophication. Watershed development, reflected in watershed population, while more disperse, appears to be having more of a negative impact on trophic status. This finding lends further support to the importance of the watershed as the boundary for social and physical research on lake eutrophication.

SUMMARY

An ideal of ecological studies is to determine which inputs are causing a change in the ecology of the system. It is an ideal because it purports to determine <u>why</u> an ecological change takes place. The answer to the question of why conditions are as they are is left to those who are better able to interpret the myriad of influences on people and natural resources (see for example Catton, 1980). This study has been aimed more at gaining an understanding of <u>how</u> Idaho lakes are becoming more eutrophic, to determine major human activities which can be used as social indicators of cultural eutrophication.

As determined from the statistical analysis, indicators of eutrophication, in order of importance are: agricultural land and private land in the watershed, related primarily to secchi, CHLA, and conductivity; rangeland in the watershed, related primarily to pH, conductivity, and turbidity; watershed population in 1980, related primarily to pH, conductivity and N/P; and fifty mile populaion in 1980, related primarily to N/P, CHLA, pH, and secchi. Remoteness is related to all the trophic status variables, the accessibility of a lake appears to go hand-in-hand with its eutrophication.

Development on the shoreline is higher near the least eutrophic lakes. The conclusion is that the clear, clean lakes are attracting development which has not yet adversely influenced their conditions. Examples are Coeur d'Alene, Pend Orielle, Priest, and Payette lakes, lakes which appear to have the resilience to withstand the impacts of shoreline development, although they are experiencing localized problems along some of their shoreline areas.

Recreational accesses on the shoreline have no relationship with the set of trophic status variables. Population growth within fifty and one hundred miles between 1970 and 1980 are in opposition in their relationship with the trophic status variables. The utility of these three surrogate recreational use measures is questionable at this time, but they may prove more useful if included in more specific studies of individual lakes, especially studies which have the advantage of including time-series data in the analysis.

Canonical correlation has been useful for narrowing the list of variables to two sets of variables which have the maximum amount of correlation among the variables and between the sets:

SECCHI	REMOTENESS
CHLA	DEVELOPMENT on the LAKESHORE
N/P	100 MILE POPULATION GROWTH (1970-80)
CONDUCTIVITY	WATERSHED POPULATION (1980)
TURBIDITY	WATERSHED in AGRICULTURE
PH	WATERSHED in RANGELAND
	LAKESHORE in PRIVATE OWNERSHIP
	WATERSHED in PRIVATE OWNERSHIP

These two sets form the list of trophic status indicators for the eighty five lakes in the Clean Lakes Project.

CHAPTER V

CONCLUSIONS AND DISCUSSION

SOCIAL ASPECTS OF EUTROPHICATION

Landuse/Ownership

These indicators have by far the greatest influence on trophic status. Any lake with a significant amount of range and agriculture in its watershed will have worsening problems without management plans and practices designed to limit the effects. Specific adverse practices will have to be determined and programs instigated to lessen the adverse impacts. Any new range or agricultural activities proposed in a watershed should be approved only if best management practices are adopted. Since the adversely affected lakes are mostly the southern reservoirs which are extensively interrconnected, and whose combined watersheds cover hundreds of miles, the effects of even a vigorous lake management program will probably maintain the current trophic status at best. Eutrophication is a natural process, so can never be completely halted, especially in shallow, man-made reservoirs. The goal of management for many of the reservoirs is to maintain their condition at a level that is adequate for swimming, fishing, and boating, a level that is far from pristine, but which serves the purpose of improving the quality of life of the local residents and the weekend user.

The relationship between trophic status and landuse/ownership indicators is recognized by most lake managers around the state, and many programs and activities have been implemented in an attempt to lessen their impact. Specific causes for the relationship need to be addressed on a lake by lake basis. One approach would be to develop a more comprehensive land use inventory that would break the major catagories into specific crop, grazing, and irrigation uses and that would also include data on slope, soil type, and vegetation. This type of survey is currently being done in cooperation by the Idaho Division of Environment and the Soil Conseravation Service. The program also includes information/education activities aimed at farmers and residents in critical areas. There are currently at least fifeteen priority areas recognized by the Idaho Division of Environment, where studies are on going and water pollution abatement programs for private farm lands are being implemented. Reservoirs included are American Falls, Milner, Ririe, and the reservoirs of the Lewiston Orchards Irrigation District: Mann's Lake, Soldier's Meadow, and Lake Waha.

Population Growth

The major population variables, as determined by this research, are the watershed population in 1980 and the population growth within fifty and one hundred miles between 1970 and 1980. The watershed population and the one hundred mile population growth appear to have a negative influence on trophic status, and the fifty mile population growth, a positive influence. The later relationship is interrpreted as indicating that the less eutrophic lakes are an influence on peoples' migration decisions.

One of the major goals of this research is to determine which lake areas are experiencing the highest population pressures. Population pressure is defined as either large numbers of people or high rates of population growth near lakes. The definition of what is "high" population growth is very subjective and is relative to a variety of factors. Services available, jobs, environmental resilience, population density, and many other characteristics of an area and of a population of people will contribute to a classification of high or low population growth.

Lakes appear to be a very strong influence on people's migration decisions. The five fastest growing counties: Boise, Blaine, Kootenai, Valley, and Bonner, are all relatively rural counties with high scenic value and recreational opportunity. The growth in Boise and Kootenai counties is undoubtedly also influence by the close proximity of large cities, Boise and

Spokane respectively. Potential job opportunities cannot be ignored, but it does appear that the environment may be a stronger influence on migration to and in Idaho, than it is nationally, as discussed by Long and Kristen (1979).

There are six major areas of the state currently experiencing the greatest population growth. From North to South they are: Couer d'Alene area, McCall area, Sun Valley-Ketchum area, Boise-Nampa area, Twin Falls-Burley area, and the Bear Lake area. These areas correspond with the location of some of the state's least eutrophic lakes. But they also contain lakes which are exhibiting tendencies towards eutrophication, and given the recent surge in population growth, they are the areas in which lake conditions could be most precarious.

The larger northern lakes are a case in point. Their high population growth has not yet caused many of the northern lakes to become eutrophic, but there are a few examples of where this might be the case. Cocolalla is a popular lake with documented problems, while Spirit, Twin, Hauser, Hayden, and Coeur d'Alene lakes are known to suffer from algae blooms and poor water clarity at times. These same lakes are experiencing high population growth and are given a high priority classification in the Idaho Clean Lakes Project draft report (Milligan et al., 1983). Cultural eutrophication is occuring at these lakes and their social value, including economic and quality of life considerations, is deteriorating. These priority lakes will most likely have continually worsening conditions without implementation of plans and activities to ameliorate the impacts, although the trends in trophic status for any of these lakes have not been established. The only evidence we really have are the observations of longtime lake residents and the chemical/physical evidence of the lakes' present conditions. Monitoring has been done on a few of the lakes over the years, but the approach hasn't been organized enough to make a firm statement on trends in trophic status.

Three of the least eutrophic lakes in Idaho, Alturas, Redfish, and Stanley, are among those lakes on the study list with the fastest growing populations within fifty and one hundred miles. This reflects the high quality of the lake water and the surrounding area. The high growth is primarily in the adjacent Ketchum-Stanley area, both located in Blaine county, the second fastest growing county in the state between 1970-1980. This further indicates the distinction between population growth in lakeuse areas versus that of counties, as the above mentioned lakes lie in Camas and Custer county, the slowest growing counties in the state.

While population growth does not always consistently correlate with trophic status, high growth rates could mean that managers may need to alter their recreation planning to account for changes and increase in recreational use. This involves developing new management techniques in order to protect the resource and to keep users informed of the condition of the lake and the effects of their actions upon it.

Recreational Use of Lakes

Actual recreational use figures were obtained for only twenty eight of the lakes (Table 9.). The sources for this data are six different agencies, each using a different data measure and a different data collection technique. Due to the small sample size and the variations in measurement, this data was not used in the statistical analysis.

One way to discuss this data is to compare lakes within each agency's jurisdiction. Under the Bureau of Reclamation, Palisades receives an extremely high amount of use. Lake Lowell and Cascade Reservoir are the second and third most highly used lakes under the Bureau. For those reservoirs under the Army Corp, of which there are only three, Lucky Peak is by far the most utilized for recreation, with Dworshak and Pend Orielle both receiving high use. Under State Park's jurisdiction, Lucky Peak again, far exceeds the use at other lakes. Winchester Lake shows relatively high attendance figures for a lake of its size. The only lake under the Forest Service is Lower Priest. The figures show that use is down form a peak in 1977. The Forest Service keeps very detailed records on percentage of users participating in a variety of recreational activities. Use is very diverse at Priest, with recrational homes and resorts being very high use activities.

Table 9
Recreational Use Data, 1976-1980

Lake	1980	1979	1978	1977	1976
LOWER PRIEST L (Forest Service) (Camping, Recreation Cabins, Sightseeing)	234900	230900	253500	308300	279300
LOWER PRIEST L (State Park) (Swimming, boating, camping)	31471	31670	28223	27386	24374
LAKE PEND OREILLE (Army Corp) (Swimming, Sightseeing)	201000	247400	283100	211000	191200
LAKE PEND OREILLE (State Park) (Fishing, Boating, Swimming, Camping)	98551	119221	91102	105167	123193
ROUND LAKE (State Park) (Camping, Fishing, Swimming)	42209	51624	50702	51651	37311
LAKE CHATCOLET (State Park) (Fishing, Picnicing, Swimming)	112925	255134	292558	226707	151987
MANN'S L (Bureau of Reclamation) (Fishing)	3700	7400	7400	7400	7400
LAKE WAHA (Bureau of Reclamation) (Fishing)	11880	11880	11800	11800	11800
SOLDIERS MEADOW R (Bureau of R.) (Fishing, Picnicing)	6700	5700	5700	5100	5100
WINCHESTER L (State Park)	44267	37836	31973	40401	58112
DWORSHAK R (Army Corp) (Sightseeing, Boating)	274500	263900	235300	163000	171352
ALTURAS L (SNRA)	11800	11900	13900	13500	12100
PETIT L (SNRA)	11800	11900	13900	13500	12100
REDFISH L (SNRA)	39100	37800	40000	40100	34300
STANLEY L (SNRA)	39100	37800	40000	40100	34300
ANDERSON RANCH R (Bureau of R.) (Fishing, Sightseeing)	68950	69956	149623	33471	56517
ARROWROCK R (Bureau of Reclamation) (Fishing, Sightseeing)	22200	21000	61037	33350	49024

Table 9 (cont.)
Recreational Use Data, 1976-1980

Lake	1980	1979	1978	1977	1976
BLACK CANYON R (Bureau of R.) (Boating, Picnicing)	63611	105780	53850	100859	42500
BLACK CANYON R (State Park)	•	•	74398	100859	69960
CASCADE R (Bureau of Reclamation) (Camping, Fishing)	151300	139000	137100	132900	131600
DEADWOOD R (Bureau of Reclamation) (Camping, Sightseeing)	17480	17871	14250	14235	14200
LAKE LOWELL (Bureau of Reclamation) (Sightseeing, Boating, Fishing)	156590	139000	132592	220700	111300
MANN'S CREEK R (Bureau of R.) (Fishing, Camping)	20257	8655	8635	9055	15040
LUCKY PEAK R (State Park) (Day Use Only)	622959	558715	436280	748988	640752
PAYETTE L (State Park)	72921	43934	117466	67445	79763
AMERICAN FALLS R (Bureau of R.) (Swimming, Boating)	73459	51250	53150	46000	49490
ISLAND PARK R (Bureau of R.) (Fishing, Sightseeing, Camping)	175400	170500	203800	222000	221327
LAKE WALCOTT (Bureau of R.) (Picnicing, Fishing, Sightseeing)	56866	92705	60044	42719	21005
LAKE WALCOTT (MNWR)	4095	5284	4955	4373	•
LITTLE WOOD R (Bureau of R.) (Camping, Fishing)	21853	8289	26608	16275	14900
RIRIE R (Bureau of Reclamation)	69750	52591	48299	•	•
HENRYS L (State Park)	20502	46257	52299	29254	28673
PALISADES R (Bureau of Reclamation) (Sightseeing, Boating)	698633	542355	573800	530167	681042
BEAR L (State Park) (Day Use Only)	71131	51791	51719	52602	57351

In parentheses are the agency and the major recreational uses. Each of the of the agencies has a different form of measurement for their recreation data:

Forest Service - Visitor Days; Army Corp of Engineers - Recreation Days; Bureau of Reclamation - Visitor Days; Idaho Department of Parks and Recreation - Attendence Figures; Sawtooth National Rec. Area (SNRA) - Recreation Visitor Days; Minidoka National Wildlife Refuge (MNWR) - Number of Visitors.

The data from the Sawtooth National Recreation Area also shows a downturn in recreational use, with Redfish and Stanley receiving more visitors than Petit and Alturas.

In summary, recreation use data is one of the least available and least usable for statistical analysis of any of the social science data collected for this research. For some lakes, and within a single agency, it may be somewhat useful as a guage of lake use and as a supplement to agency planning for policies and facilities related to recreation.

Recreation

Due to the lack of recreational use data, variables were measured that indirectly represent recreational use. The major influences of these variables on eutrophication among the study lakes are development on the lakeshore, statistically related to two of the trophic status variables (pH and N/P), and recreation accesses (correlated with N/P). Development was determined to be inversely related to trophic status in the later analysis and the number of recreation accesses had no relationship.

Development on lakeshores, in the form of houses, resorts and campgrounds, is more prevelent on the northern lakes. Very few of these lakes are classified as eutrophic, but many of these lakes are targeted as priority lakes by the Clean Lakes report (Cocolalla, Rose, Lake Chatcolet, Hauser, Twin Lakes and Spirit Lake) (Milligan et al., 1983). Also included in this group of lakes are some areas of Lake Coeur d'Alene and Priest Lake. They are given priority ranking because some of their bays are experiencing eutrophication problems.

The managers of these lakes are aware of their local problems. Septic tanks are a major impact. Poorly constructed septic tanks, especially in soils that are prone to easy leaching of nutrients into the water, are directly related to algae growth and thus accelerate the eutrophication process. The Idaho Division of Environment has attempted ambitious programs in northern Idaho to determine the number and condition of septic tanks on lake shores. They've included educational programs to inform cottage and home owners of the impact of septic tanks on water quality. Alternatives and actions are proposed which might lesson the impacts.

Also, the counties of Kootenai and Bonner have begun developing Lake Master Plans. Bonner's plan (Stravens, 1982) deals specifically with Lake Pend Orielle and is mainly a landuse plan for lake-side lands. One main purpose is to identify potential development areas and to carefully evaluate each site on its access, utility services, compatible uses, ownership, soils, and lake pollution potential (based on a variety of development options) (Stravens, 1982). Kootenai's plan (forthcoming) is somewhat broader and includes consideration of the south end of Lake Pend Orielle and six other lakes, all of which received priority status in the Clean Lakes Project Report (Milligan et al., 1983). The Kootenai

County plan attempts to deal with surface use problems as well as adjoining landuse problems. Both plans place high priority on public participation throughout the plan development process. Both plans will have to survive the scrunity of a public with diverse and often conflicting interests. Undoubtedly the plans will undergo many changes before they are approved and implemented by city and county zoning boards.

Are the lakes with high population growth and a high percentage of development on their shores, and which may have a threatened trophic status as indicated by recently observed trends, tommorrow's eutrophic lakes? Since they are among the states most pristine lakes, it is an important question, but one which remains unanswered by this research. They would benefit from some lake-extension work by area managers. The major emphasis of managers should be to inform local land owners, residents, and users on protecting water quality. These lakes are the ones where any available funds should be channeled for monitoring, research, education, and prevention of eutrophication. The clean-up of an eutrophic lake is an expensive process and is not always effective. The recognition of sources, education of the users, and activities for the prevention of further adverse influence on a lake are more effective and less expensive in the long-run.

LIMITATIONS OF THE RESEARCH

This project was proposed to be a multidisciplinary study of the trophic condition of Idaho lakes. Multidisciplinary research places different time constraints on project members than do other types of research. More time has to be devoted to developing a framework for incorporating each contributor's interests and data, and to communicating progress and alterations. Timing is especially important if team members' analysis depends on the data or findings from other members. The researchers on this project, myself included, did not develop the coordination and flexibility necessary for the project to become the multidisciplinary approach that was originally proposed. The project basically evolved into each discipline approaching a common problem independently. As a result, a final analysis that involves input from each discipline, as was attempted here, falls short of scientifically incorporating the wide variety of influences on the trophic status of Idaho lakes. The advantage of multidisciplinary research is that scientists from each discipline can contribute their expertise to the best of their ability, while working within a framework that includes a variety of inputs. Without well defined goals and responsibilities there is a waste of energy when team members stray outside their disciplines to gather data or find information that is more easily and accur tely gathered by another team member.

Coordination and communication is also vital to an evolving research framework that is responsive to new understandings of the problem that can occur in any type of project, but which especially do when a variety of disciplines work together for the first time and begin to develop a more ecological understanding of an environmental problem.

The scope of this project prevented the findings from being as specific and revealing as was initially hypothesized. A more carefully developed list of study lakes would have included a smaller number of lakes, representative of basic lake types, and would have required less data collection and travel, while allowing for inclusion of more specific variables. A smaller group of study lakes would have allowed for multiple water samples from each lake, at different time periods and in different locations on the lakes.

Time is an important variable, or an important aspect of every variable, which is not adequately accounted for in this project. Time is especially important when studying eutrophication since it is a process that changes from year to year and from one time of year to another. The timing of the water sampling varied from early June to early October. Comparisons between lakes is thus confounded by trophic status data that is influenced by varied climatic conditions. This problem was accounted for somewhat by timing the lake visits based on each lake's altitude.

Another limitation is alluded to in the above discussion. It centers around the debate over the breadth of a study, whether it should be broad and general or narrow and specific. Due to the choice of the broad and general approach the results are also general and fairly predictable (Pierce and Doerksen, 1975). If they are predictable, then their usefulness is that they act as a confirmation of beliefs and general understanding. By choosing a more specific approach, also not without problems that can result from over-specificity, the state-of-the-art in multidisciplinary research and the understanding of eutrophication problems in Idaho, might have been better served.

Perhaps the major shortcoming of this study is that in the final analysis, it did not take the ecological approach that was discussed and encouraged throughout the earlier chapters. The major boundary of this study - Idaho - is a political rather than an ecological entity. As a result, the discussion was repeatedly amended with references to southern reservoirs vs. northern lakes and highland lakes vs. lowland lakes. Further studies would benefit from grouping lakes more ecologically, for example by drainage, altitude, and latitude.

SUGGESTIONS FOR FURTHER RESEARCH

The multidisciplinary approach is strongly recommended for further study of eutrophication in Idaho. The approach is necessary for differentiating between natural and cultural eutrophication processes taking place in each lake and in each lake's watershed. Not only does the approach aid in a better evaluation of lake trophic status condition, but it is necessary in developing effective solutions to eutrophication problems. Burdge and Opryszek summerize the opinions of many supporters of the multidisciplinary approach, "one of the reasons for the present 'environmental fix' is the single discipline approach to environmental problems" (Burdge and Opryszek, 1981:349).

This study only begins to illuminate the relationships that result in cultural eutrophication. That landuse and ownership are major influences is apparent, but the broadness of the categories prevents the findings from being directly incorporated into lake management plans. Data on specific activities and owners need to be included. The population and recreation data is likewise general, and although correlations with trophic status are demonstrated, there are some "grey" areas that need to be more fully explored. It was hypothesized that population growth and development are adversely affecting trophic status. This type of relationship was not substantiated by the analysis, yet a correlation is evident.

To more fully explore the issue, a more specific, integrative and interactive research approach should be followed. The majority of variables in this study were static variables. Later studies should incorporate variables that reflect change over time. One approach would be to compare the trophic status lakes of similar physical characteristics (altitude, climate, depth) based on a study of changing landuse, development, and population. A companion to this approach, which has been recommended elsewhere (Panhandle Area Council, 1978), is to initiate regular testing on many of Idaho's lakes. The water sampling should be consistent for each lake, at a variety of locations in the lake, and at different times of the year. This data can then be correlated with other time series data, such as changes in: landuse, housing, roads, recreationists, recreational uses, population, ownership, etc. Social/environmental monitoring is an added expense to already strained federal and state budgets. A cooperative agreement between agencies, counties, and universities could result in lowering the initial expense of developing the data gathering collection framework. With a centralized data base, accessible to all concerned agencies, the cost and efficiency of lake monitoring would be enhanced.

This proposal for a centralized, easily available, easily updated data base applies especially to recreation data. Idaho needs a standardized recreation data collection scheme that can be accessed and updated by all federal and state agencies.

Much more information is needed on the attitudes, values, desires and activities of lake users and lakeside residents in Idaho. A danger of not including subjective user information into a social analysis is that "unless monitoring can include the meaning behind choice, the social construction of reality, it remains empty statistical reckoning" (Meyersohn, 1972). A random sample of the lake user population provides managers with a view of the users' desires, expectations, and reactions. This data too, is more revealing in eutrophication studies if gathered at different times. Changing perceptions of trophic status can then be correlated with the changing trophic status as reflected by the water quality data.

LAKEUSE PLANNING

The first questions (or objections) when developing management strategies for any resource are usually, "Why do it, what is the benefit?" and "Who is going to pay for it?". The first question can be answered on a number of levels. On a statewide level, tourism is Idaho's third largest industry and the tourist dollar could become even more important to the state's economy. One of the main "draws" of the state is her beautiful lakes. It is in everyone's interest to maintain the water quality of the lakes at as high a level as possible. The tourist dollar effects the economy all the way from the state coffers to the local store and gas station. Lakeshore homeowners, local residents, regular users, and other area residents benefit from increased property values, recreation benefits, and an enhanced quality of life. Some of these have an easily computed economic value, others, such as the value of swimming in a clean lake, don't so easily carry a price tag.

The other question, who pays, is more difficult to answer. In some cases, federal money is available and this is appropriate because some of the lakes are national resources, and others are partially or entirely on federal land. State money is available for some programs. The other governmnet units, counties and towns, sometimes contribute their share, usually when their activities are directly involved in the water quality problems.

It is apparent that for some lakes, not enough money is available to solve their problems. Innovation and public involvement are perhaps the greatest assets to lake managers in their approach to lakeuse planning. The first step is to determine who are the lake/wateshed users. These would be the people who's actions are possibly influencing the trophic status of the lake and who would benefit most from improved trophic status. The population data collected for this project is especially pertinant to this stage of planning. The people within the watershed and within fifty miles are the primary members of the user group. People within one hundred miles are secondary users. The non-local visitor is a third group. The population data collected for this research provides managers with an idea of the size of their different user populations and how they have changed over the last twenty years.

On the local level, informational public meetings would educate the lake users on current lake conditions with emphasis on cause and effect relationships. Perceptions on the condition of the lake, influences on that condition, and benefits of improvement are factors which reside in the cultural system of a group. They are the myths, beliefs, goals, values, and attitudes, which when interplayed with social, psychological, and environmental systems, make up a group's perception of the world around them. These perceptions can be based on faulty information, not enough information, misunderstanding, and uneducated opinions about our environment and how we relate to it. While a truly "ecological" understanding is a rare bird indeed, approaching that ideal is not impossible. By providing information and allowing for an airing of beliefs, values, etc., lake managers are able to make a giant step in incorporating that elusive but ubiquitous cultural system into their plans.

The discussion of benefits is an especially important topic to be discussed at public meetings. The economic costs and benefits are the bottom line and of interest to everyone concerned. The managers job will be to also enter hard and soft quality of life aspects of lakes into the discussion. Hard aspects are those with an easily computed price tag. Soft aspects are those benefits which usually have no price tag, but which most people value to some extent and which may have been major influences on many people in their decision to move to the lake area. These discussions are an attempt to come to a group concensus on which lake uses are important and how they financially and socially benefit the individual, family, group, community, town, county, etc. During this process and at later meetings, those present would refine the concept of lake and what it means to them as a group.

The major impetus to the need for lakeuse planning on lakes like Payette Lake, Lake Pend Orielle and the Kootenai County lakes is the large population growth in those areas during the last ten years. With this change comes an overall change in the social value of the lake, those values, rules and acceptable uses of the lake which have prevailed in the past. Acceptable uses are often nebulous and individualistic anyway, so with high population growth conditions, a lack of planning would seem to only contribute to a eutrophication problem.

The immediate response to lakeuse planning is usually negative: it is believed that common landuse and lakeuse practices will be prohibited and the individual's "rights" will be infringed upon. If the planning meetings are educational, and the channels for a two-way flow of information maintained, much of the immediate negativism can be overcome. An example of the bad experiences that can occur in a community when lakeuse planning isn't implimented is the recent controversy near Payette Lake. The planning for a sorely needed lakeside sewage system became embroiled in controversy, and suits and counter-suits were filed. In this case everyone agreed that a sewage system is needed, the problem is how to go about it. After a long planning process, all planning had to begin again.

CONCLUSION

The findings presented here basically confirm the emphasis of lake management programs around the state. In the case of specific landuses, agriculture and range, the conclusion from the analysis is that they are adversely affecting trophic status, though different aspects of trophic status. For other human activities, the analysis does not offer such firm conclusions. While there is the temptation to point an accussing finger at certain uses, and to suggest trends which appear to exsist, the major findings are more relational than causal. This report's major contribution to the field of lake water quality, and to the understanding of the trophic condition of Idaho lakes, is that major social variables have been identified, measured, and incorporated into an ecological analysis of trophic status.

Culture and society are not often discussed in the same study with pH, turbidity, clarity, and chlorophyll. This paper has attempted to explore the link between human activities and the trophic status of Idaho's lakes. The major emphasis has been on those activities which have an adverse influence on trophic status. The link can also lead to an improvement in trophic status. Once the influences are recognized, management strategies developed, and social value of the lake recognized, the eutrophication process can be slowed or reversed.

Currently, there are some ambitious and farsighted lakeuse plans being developed in Idaho. There is still a ways to go. The term "cultural lag" might apply to the area of lakeuse planning. Cultural lag means that there is a marked discrepency between the degrees of development of various aspects of a culture. In less modern societies, it is usually the technological capabilities that are lagging behind the changing values, desires and needs of the people. In our society, it is recognition of the public value of our natural resources, the social value of lakes, that is lagging behind our technological capability of culturally accelerating the eutrophication process.

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APPENDIX A

THE IDAHO CLEAN LAKES PROJECT

DATA FILE

	LAKE NAME	COUNTY	TOWNSHIP	RANGE	LONGITUDE	LATITUDE	BASIN #	BASIN: MAJOR	MAJOR SUB-BASIN	MINOR SUB-BASIN
1	ALTURAS L	BLAINE	T07N	R14E	114 51	43 55	6	SALMON	SALMON R	ALTURAS L CK
2	AMERICAN FALLS R	POWER	T07S	R31E	112 50	42 50	9	UPPER SNAKE		
3	ANDERSON RANCH R	ELMORE	T01S	R08E	115 25	43 23	8	SOUTHWEST	BOISE R	SFK BOISE R
4	ARROWROCK R	ELMORE	T03N	R04E	115 52	43 35	8	SOUTHWEST	BOISE R	
5	ASHTON R	FREMONT	T09N	R42E	111 29	44 06	9	UPPER SNAKE	HENRYS FORK	
6	BASIN L	IDAHO	T23N	R02W	116 33	45 20	7	LOWER SNAKE	SHEEP CK	WFK SHEEP CK
7	BAYHORSE L	CUSTER	T13N	R17E	114 24	44 24	6	SALMON	SPOKANE R	BAYHORSE CK
8	BEAR L	BEAR LAKE	T15S	R44E	111 20	42 05	11	BEAR		
9	BENEWAH L	BENEWAH	T46N	R03W	116 41	47 21	3	COEUR D'ALENE	ST JOE R	
10	BLACK CANYON R	GEM	T07N	R01W	116 24	43 56	8	SOUTHWEST	PAYETTE R	
11	BLACKFOOT R	CARIBOU	T05S	R40E	111 36	42 55	9	UPPER SNAKE	BLACKFOOT R	
12	BROWNLEE R	WASHINGTON	T17N	R05W	116 55	44 49	8	SOUTHWEST		
13	C J STRIKE R	OWYHEE	T05S	R04E	115 55	42 57	8	SOUTHWEST		
14	CASCADE R	VALLEY	T14N	R03E	116 05	44 35	8	SOUTHWEST	PAYETTE R	NFK PAYETTE R
15	CAVE L	KOOTENAI	T48N	R02W	116 37	47 27	3	COEUR D'ALENE	COEUR D'AL L	ST. JOE R
16	CEDAR CREEK R	TWIN FALLS	T14S	R13E	114 53	42 12	9	UPPER SNAKE	SALMON FALLS CK	CEDAR CK
17	COCOLALLA L	BNR-BONNER	T55N	R02W	116 37	48 07	2	PEND OREILLE	COCOLALLA	
18	CRANE CREEK R	WASHINGTON	T12N	R02W	116 35	44 22	8	SOUTHWEST	WEISER R	CRANE CK
19	DEADWOOD R	VALLEY	T11N	R07E	115 40	44 19	8	SOUTHWEST	PAYETTE R	DEADWOOD R
20	DEEP CREEK R	ONEIDA	T14S	R37E	112 10	42 12	11	BEAR	DEEP CK	
21	DWORSHAK R	CLEARWATER	T37N	R01E	116 15	46 30	5	CLEARWATER	NFK CLEARWATER	
22	ECHO L	IDAHO	T23N	R02W	116 34	45 19	7	LOWER SNAKE	L GRANITE CK	
23	FERNAN L	KOOTENAI	T50N	R03W	116 43	47 40	3	COEUR D'ALENE	COEUR D'ALENE	
24	GEM L	IDAHO	T23N	R02W	116 33	45 20	7	LOWER SNAKE	SHEEP CK	
25	GOLDEN L	FREMONT	T12N	R42E	111 29	44 21	9	UPPER SNAKE	HENRYS FORK	LAKE CK
26	GOOSE L	ADAMS	T20N	R02E	116 10	45 05	6	SALMON	L SALMON	GOOSE CK
27	HAUSER L	KOOTENAI	T51N	R05W	117 01	47 46	3	COEUR D'ALENE	SPOKANE	
28	HAYDEN L	KOOTENAI	T51N	R03W	116 42	47 46	3	COEUR D'ALENE	SPOKANE	
29	HEDEVIL L	IDAHO	T22N	R02W	116 33	45 19	7	LOWER SNAKE	L GRANITE	
30	HELLS CANYON R	ADM-ADAMS	T22N	R03W	116 42	45 13	8	LOWER SNAKE		
31	HENRYS L	FREMONT	T15N	R43E	111 22	44 37	9	UPPER SNAKE	HENRYS FORK	
32	HOODOO L	BNR-BONNER	T54N	R04W	116 49	48 03	2	PEND OREILLE	HOODOO CK	
33	ISLAND PARK R	FREMONT	T13N	R43E	111 30	44 24	9	UPPER SNAKE		
34	LAKE CHATCOLET	BENEWAH	T46N	R03W	116 45	47 22	3	COEUR D'ALENE	COEUR DALEN L	ST JOE R
35	LAKE COEUR D'ALENE	KOOTENAI	T50N	R04W	116 45	47 40	3	COEUR D'ALENE		
36	LAKE LOWELL	CANYON	T03N	R03W	116 40	43 33	8	SOURTHWEST	BOISE R	N YORK CANAL
37	LAKE PEND OREILLE	BNR-BONNER	T56N	R01E	116 28	48 07	2	PEND OREILLE		
38	LAKE WAHA	NEZ PERCE	T33N	R04W	116 50	46 12	5	CLEARWATER	LAPWAI CK	WFK SWEETWATER
39	LAKE WALCOTT	CASSIA	T09S	R25E	113 24	42 40	9	UPPER SNAKE		

40	LAMONT R	FRANKLIN	T15S	R40E	111 48	42 06	6	BEAR	CUB R	WORM CK
41	LITTLE CAMAS R	ELMORE	T01S	R09E	115 22	43 20	8	SOUTHWEST	SFK BOISE R	ANDERSON
42	LITTLE WOOD R	BLAINE	T01N	R20E	114 02	43 26	9	UPPER SNAKE	BIG WOOD R	LIT. WOOD R
43	LOWER BERNARD L	IDAHO	T13N	R08E	115 30	44 27	6	LOWER SNAKE	BEAR VALLEY	PORTER CK
44	LOWER PRIEST L	BNR-BONNER	T60N	R04W	116 51	48 31	2	PEND OREILLE	PRIEST R	
45	LUCKY PEAK R	ADA	T02N	R03E	116 03	43 32	8	SOUTHWEST	BOISE R	
46	MACARTHUR L	BOUNDARY	T60N	R01W	116 27	48 31	1	KOOTENAI	DEEP CK	
47	MACKAY R	CUSTER	T07N	R23E	113 42	43 57	9	UPPER SNAKE		
48	MAGIC R	BLAINE	T02S	R18E	114 22	43 16	9	UPPER SNAKE	MALAD R	BIG WOOD R
49	MANN'S CREEK R	WASHINGTON	T12N	R05W	116 54	44 23	8	SOUTHWEST	WEISER R	MANN CK
50	MANN'S L	NEZ PERCE	T35N	R04W	116 51	46 22	5	CLEARWATER	CLEARWATER	LINDSAY CK
51	MILNER R	TWIN FALLS	T10S	R21E	114 00	42 31	9	UPPER SNAKE		
52	MOOSE CREEK R	LATAH	T41N	R01W	116 25	46 52	5	CLEARWATER	POTLATCH R	MOOSE CK
53	MORMON R	CAMAS	T02S	R14E	114 49	43 15	9	UPPER SNAKE	BIG WOOD R	CAMAS CK
54	MOUNTAIN HOME R	ELMORE	T03S	R07E	115 39	43 09	8	SOUTHWEST		
55	MURTAUGH LAKE R	TWIN FALLS	T11S	R20E	114 08	42 27	9	UPPER SNAKE	TW F M CANAL	
56	MYRTLE L	BOUNDARY	T62N	R02W	116 37	48 45	1	KOOTENAI	BALL CK	
57	OXBOW R	ADM-ADAMS	T19N	R04W	116 50	44 56	8	SOUTHWEST		
58	PALISADES R	BNL-BONNEV	T01S	R45E	111 08	43 17	10	PALISADES		
59	PAYETTE L	VALLEY	T18N	R03E	116 05	44 57	8	SOUTHWEST	PAYETTE R	NFK PAYETTE
60	PERKINS L	BOUNDARY	T62N	R03E	116 05	48 45	1	KOOTENAI	CURLEY CK	
61	PETIT L	BLAINE	T08N	R13E	114 52	43 58	6	SALMON	ALTURAS L CK	
62	PORTNEUF R	CARIBOU	T06S	R38E	112 58	42 54	9	UPPER SNAKE	PORTNEUF R	
63	REDFISH L	CUSTER	T09N	R13E	114 56	44 07	6	SALMON	SALMON R	L REDFISH
64	RIRIE R	BNL-BONNEV	T03N	R40E	111 44	43 32	9	UPPER SNAKE	WILLOW CK	
65	ROSE L	KOOTENAI	T49N	R01W	116 28	47 33	3	COEUR D'ALENE	COEUR D'ALENE	
66	ROUND L	BNR-BONNER	T56N	R03W	116 38	48 09	2	PEND OREILLE	COCOLALLA CK	
67	SALMON FALLS CREEK R	TWIN FALLS	T14S	R15E	114 45	42 07	9	UPPER SNAKE	SALMON FALLS CK	
68	SEVEN DEVILS L	IDAHO	T23N	R02W	116 31	45 20	6	SALMON	RAPID R	WEST FORK
69	SHELF L	IDAHO	T23N	R02W	116 33	45 20	7	LOWER SNAKE	SHEEP CK	WFK SHEEP CK
70	SILVER L	FREMONT	T12N	R42E	111 28	44 20	9	UPPER SNAKE	HENRYS FORK	
71	SODA POINT R	CARIBOU	T09S	R41E	111 40	42 39	11	BEAR		
72	SOLDIERS MEADOW R	NEZ PERCE	T33N	R03W	116 44	46 09	5	CLEARWATER	LAPWAI CK	SWEETWATER
73	SPIRIT L	KOOTENAI	T53N	R04W	116 53	47 56	3	PEND OREILLE	GROUNDWATER	
74	STANLEY L	CUSTER	T11N	R12E	115 03	43 14	6	SALMON	VALLEY CK	STANLEY L
75	STEVENS L	SHOSHONE	T47N	R05E	115 45	47 26	3	COEUR D'ALENE	WILLOW CK	EFK WILLOW CK
76	SWAN FALLS R	ADA	T02S	R01E	116 23	43 14	8	SOUTHWEST		
77	SWAN L	BENEWAH	T46N	R02W	116 34	47 20	3	COEUR D'ALENE	COEUR D'ALENE	ST JOE R
78	TOLO L	IDAHO	T30N	R02E	116 14	45 55	6	SALMON	ROCK CK	TELCHER CK
79	TRINITY L	ELMORE	T03N	R09E	115 26	43 37	8	SOUTHWEST	TRINITY CK	FEATHER CK
80	TWIN LAKES LOWER L	KOOTENAI	T52N	R04W	116 55	47 53	3	KOOTENAI	RATHDRUM C	
81	TWIN LAKES UPPER L	KOOTENAI	T52N	R05W	116 55	47 55	3	KOOTENAI	RATHDRUM C	
82	TWIN LAKES NORTH R	FRANKLIN	T14S	R38E	111 57	42 12	11	BEAR	DEEP CK	
83	TWIN LAKES SOUTH R	FRANKLIN	T14S	R38E	111 57	42 12	11	BEAR	DEEP CK	
84	UPPER BERNARD L	IDAHO	T13N	R08E	115 30	44 27	7	LOWER SNAKE	BEAR VALLEY	PORTER CK
85	UPPER PRIEST L	BNR-BONNER	T63N	R04W	116 52	48 46	2	PEND OREILLE	PRIEST R	L PRIEST L
86	WARM L	VALLEY	T15N	R06E	115 40	44 38	8	SOUTHWEST	SFK SALMON R	WARM L CK
87	WILLIAMS L	LEMHI	T20N	R21E	113 58	45 01	6	SALMON	LAKE CK	
88	WILSON LAKE R	JEROME	T09S	R20E	114 08	42 37	9	UPPER SNAKE		
89	WINCHESTER L	LEWIS	T33N	R02W	116 37	46 14	5	CLEARWATER	LAPWAI CK	

		MAP NAME	NATIONAL FOREST	DAM HEIGHT (FT)	SURFACE ELEVATION (FT)	SURFACE ELEVATION (M)	SURFACE AREA (ACRE)	SURFACE AREA (HECTARE)	VOLUME (ACRE-FEET)	VOLUME (CUBIC METRE)	OWNERSHIP CODE *
1	ALTURAS L	ALTURAS LAKE	SAW	.	7016	2138	840.2	340.0M	77600	95685857M	1
2	AMERICAN FALLS R	*AMERICAN FALLS SW		80	4354	1327	56055.0	22684.7I	1700000	2096932558I	7 2
3	ANDERSON RANCH R	*HOUSE MOUNTAIN	BOI	332	4196	1279	4740.0	1918.2I	502700	620000000I	1
4	ARROWROCK R	*ARROW ROCK DAM	BOI	257	3216	980	3100.0	1254.5I	286600	353518159I	1
5	ASHTON R	*ASHTON, ID		56	5154	1571	398.0	161.1I	7457	9200000I	7
6	BASIN L	HE DEVIL, ID-OR	NEZ	.	7700	2347	5.8	2.3A	.	.	1
7	BAYHORSE L	BAYHORSE LAKE, ID	CHA	.	8584	2616	27.9	11.3M	372	458452M	1
8	BEAR L	*BEAR LAKE NO, ID		.	5923	1805	70400.0	28490.0A	1432000	1766357307P	7 2
9	BENEWAH L	ST MARIES, ID		.	2142	653	573.0	231.9M	1529	1885869M	5
10	BLACK CANYON R	MONT UR, ID		112	2454	760	1100.0	445.2I	44800	55300000I	7
11	BLACKFOOT R	HENRY, ID		35	6111	1863	19000.0	7689.1I	410000	506000000I	4
12	BROWNLEE R	COPPERFIELD		297	2070	631	15000.0	6070.0I	1430000	1760000000I	2 7
13	C J STRIKE R	MOUTH OF BRUNEAU		105	2455	748	7500.0	3035.2I	250000	308372435I	2 3 7
14	CASCADE R	CASCADE, ID	PAY	75	4828	1472	28300.0	11500.0I	703200	867389985I	7 1
15	CAVE L	ST MARIES, ID		.	2140	652	63.7	257.6M	5618	6929385M	7
16	CEDAR CREEK R	*CEDAR CREEK RSV, ID		86	5225	1593	1500.0	607.0I	30000	37000000I	2 7
17	COCOLALLA L	*COCOLALLA,ID		.	2203	671	811.0	328.0M	21118	26048626M	7
18	CRANE CREEK R	CRANE CREEK RSV		73	3191	973	3270.0	1323.3I	51700	63771420	7 2
19	DEADWOOD R	DEADWOOD RES	BOI	147	5311	1619	3200.0	1295.0I	161900	199701989	1
20	DEEP CREEK R	MALAD CITY EAST,ID	CAR	79	5155	1571	179.0	72.6M	1500	1850235	1 7
21	DWORSHAK R	DENT, ID	CLE	633	1600	488	16417.0	6640.0I	3453000	4259240072	2 1 7
22	ECHO L	HE DEVIL	NEZ	.	7250	2210	8.2	3.3M	0	247	1
23	FERNAN L	LANE, ID	CDN	6	2150	655	421.0	170.3M	.	.	1
24	GEM L	HE DEVIL, ID-OR	NEZ	.	7740	2359	22.4	9.1M	1	.	1
25	GOLDEN L	LAST CHANCE, ID	TAR	.	6133	1869	48.0	19.4P	.	.	1 7
26	GOOSE L	BRUNDAGE MTN, ID	PAY	21	6362	1939	520.0	210.0I	3500	4317214	1
27	HAUSER L	NEWMAN LAKE, WA-ID		.	2185	666	598.0	242.2M	2300	2837026	7
28	HAYDEN L	*HAYDEN LAKE, ID	CDN	10	2238	682	4200.0	1699.7I	.	.	1 7
29	HEDEVIL L	HE DEVIL, ID-OR	NEZ	.	7460	2274	4.8	1.9M	0	.	1
30	HELLS CANYON R	CUPRUM	PAY	318	1688	515	2500.0	1011.7I	170000	209693256	1 7
31	HENRYS L	*TARGHEE PEAK, ID-MONT	TAR	22	6472	1973	7501.5	3035.8M	90451	111570000M	7 3 2
32	HOODOO L	EDGEMERE, ID	KAN	.	2144	653	93.0	37.6P	.	.	1 7
33	ISLAND PARK R	*ICEHOUSE CRK, ID	TAR	73	6302	1921	7794.0	3154.1I	127000	156653197	1 7 2
34	LAKE CHATCOLET	*PLUMMER, ID		.	2125	648	2055.0	831.5M	.	.	4
35	LAKE COEUR D'ALENE	COEUR D'ALENE, ID		.	2125	648	56000.0	22700.0P	238500	294187303	4 3 7
36	LAKE LOWELL	*LAKE LOWELL, ID		.	2531	771	9840.0	3980.0P	190100	234486400	5
37	LAKE PEND OREILLE	*BAYVIEW	KAN	.	2063	629	105000.0	42500.0P	1552000	1914376076	1 7 2
38	LAKE WAHA	WAHA, ID		.	3389	1033	96.0	38.9P	6900	8511079	7
39	LAKE WALCOTT	*LAKE WALCOTT, ID		74	4195	1279	10702.7	4331.3M	218170	269110000M	5 2

40	LAMONT R	FRANKLIN, ID		65	4873	1485	89.0	36.0M	.	.	7
41	LITTLE CAMAS R	*ANDERSON RANCH DAM	BOI	32	4924	1501	1455.0	588.8I	22300	27506821	1
42	LITTLE WOOD R	LITTLE WOOD RIVER RES		116	5235	1596	575.0	233.0I	30000	37004692	7
43	LOWER BERNARD L	HEDEVIL, ID.	BOI	.	7240	2207	3.0	1.2M	.	.	1
44	LOWER PRIEST L	COOLIN, ID	KAN	8	2438	743	23000.0	9307.9M	2239257	2762100000M	1 7 3
45	LUCKY PEAK R	BOISE, ID.	BOI	240	3060	933	2850.0	1153.4I	310000	382381819	7 1 3
46	MACARTHUR L	NAPLES, ID		15	2085	636	133.0	53.9M	.	.	5
47	MACKAY R	MACKAY, ID		70	6061	1847	1341.0	542.7I	44370	54729940	7 2
48	MAGIC R	BELLEVUE, ID		128	4797	1462	3776.0	1530.0I	192000	236830030	7
49	MANN'S CREEK R	MANN CK		124	3061	933	1023.0	413.8M	13000	16035367	2
50	MANN'S L	*SWEETWATER, ID		57	1810	552	120.0	48.6I	3000	3700469	4
51	MILNER R	*MILNER, ID		73	4134	1260	1946.4	787.7M	1784	220098584	7 2
52	MOOSE CREEK R	BOVILL, ID		15	2883	879	23.0	9.2M	.	.	7
53	MORMON R	*FAIRFIELD, ID		23	5043	1537	2700.0	1090.0I	31400	.	2 3 7
54	MOUNTAIN HOME R	MOUNTAIN HOME NC, ID		43	3283	1001	406.0	164.3I	5700	7030892	7 2
55	MURTAUGH LAKE R	MURTAUGH, ID		40	4128	1258	827.0	335.0I	8950	11039733	7 2
56	MYRTLE L	SMITH PEAK, IDAHO		.	5946	1812	15.0	6.1A	.	.	5
57	OXBOW R	COPPERFIELD		205	1805	550	1230.0	498.0P	52500	.	7
58	PALISADES R	PALISADES DAM, ID	CAR	245	5620	1713	16100.0	6515.5I	1402000	1729352615	1 7
59	PAYETTE L	MCCALL, ID		8	4986	1520	5337.0	2159.8I	35000	43172141	3 7
60	PERKINS L	LINE POINT, ID-MT	KAN	.	2632	802	72.5	29.3M	.	.	1
61	PETTIT L	*ALTURAS LAKE	SAW	.	6996	2132	395.0	159.9A	.	.	1
62	PORTNEUF R	PORTNEUF, ID		49	5391	1643	1593.0	644.7I	23700	29233707	4 7
63	REDFISH L	*MOUNTCRAMER, ID	SAW	.	6547	1996	1510.0	611.0P	.	.	1
64	RIRIE R	POPLAR		181	5000	1524	1560.0	631.3I	26000	32070733	2 7
65	ROSE L	KINGSTON, ID		.	2117	645	382.0	154.5M	.	.	7
66	ROUND L	MORTON, ID		.	2122	647	52.0	21.0M	.	.	3
67	SALMON FALLS CREEK R	*METEOR, ID		8	5007	1526	3400.0	1380.0I	230650	284504408	2 3
68	SEVEN DEVILS L	HE DEVIL, ID-OR	NEZ	.	7560	2304	2.4	1.0M	.	.	1
69	SHELF L	HE DEVIL, ID-OR	NEZ	.	7420	2262	12.0	4.7M	0	.	1
70	SILVER L	LAST CHANCE, ID	TAR	.	6119	1865	183.0	74.1P	.	.	1
71	SODA POINT R	SODA SPRINGS, ID		58	5719	1743	1135.0	459.0I	11800	14555179	7
72	SOLDIERS MEADOW R	WINCHESTER WEST, ID		50	4522	1378	120.0	48.6I	2000	2466979	7
73	SPIRIT L	*SPIRIT LAKE WST, ID		4	2440	744	1552.0	628.2M	.	.	7
74	STANLEY L	STANLEY LAKE	CHA	.	6513	1985	193.0	78.2M	.	.	1
75	STEVENS L	WALLACE ID-MONT	CDN	.	5553	1693	10.0	4.0A	.	.	1
76	SWAN FALLS R	SINKER BUTTE		24	2314	705	900.0	364.2I	6900	8511079	2 3
77	SWAN L	ST MARIES, ID		1	2135	651	660.0	267.0I	.	.	7
78	TOLO L	GRANGEVILLE WEST, ID		.	3232	985	40.0	16.1M	0	111	7
79	TRINITY L	TRINITY MTN, ID	BOI	.	7750	2362	26.0	10.7M	0	493	1
80	TWIN LAKES LOWER L	*SPIRIT LAKE WEST		.	2306	703	378.0	152.9M	.	.	7
81	TWIN LAKES UPPER L	*SPIRIT LAKE WEST		10	2306	703	523.0	211.6M	.	.	7
82	TWIN LAKES NORTH R	BANIDA, ID		22	4763	1452	218.0	88.1M	.	.	7
83	TWIN LAKES SOUTH R	BANIDA, ID		30	4763	1452	218.0	88.2M	.	.	7
84	UPPER BERNARD L	DEADWOOD RES, ID.	BOI	.	7240	2207	3.9	1.6M	.	.	1
85	UPPER PRIEST L	*CARIBOU CREEK, ID	KAN	.	2438	743	1304.0	527.8M	.	.	1
86	WARM L	WARM LAKE	BOI	.	5298	1615	408.0	165.1M	11	13815	1
87	WILLIAMS L	SALMON, ID	SAL	.	5252	1601	208.0	84.2M	.	.	1 2
88	WILSON LAKE R	*EDEN, ID		19	4012	1223	658.0	266.4M	18500	22819560	7 2
89	WINCHESTER L	*WINCHESTER EAST, ID		32	3902	1189	79.0	31.8M	.	.	2

* 1: NATIONAL FOREST; 2: BUREAU OF LAND MGT; 3: STATE;

4: INDIAN RESERVATION; 5: RESERVES, ENCOURAGE USE;

6: RESERVES, DISCOURAGE USE; 7: PRIVATE

		Shoreline Length (MI)	Shoreline Length (KM)	Shoreline Index	Lakeshore Ownership % Federal	Lakeshore Ownership % State	Lakeshore Ownership % Private	Lakeshore Ownership % Other	Watershed Area In Idaho	Watershed Area Total	Watershed Area % In Idaho	Watershed Ownership % Federal	Watershed Ownership % State	Watershed Ownership % Private	Watershed Ownership % Other
1	ALTURAS L	5.0	8.1M	1.23	100	0	0	0	32.9	.	.	100	0	0	0
2	AMERICAN FALLS R	114.4	184.2A	3.45	5	0	50	45	7358.7	13580.0	54	30	5	40	25
3	ANDERSON RANCH R	45.1	72.7A	4.68	100	0	0	0	932.1	980.0	100	90	3	7	0
4	ARROWROCK R	49.8	80.1A	6.38	90	10	0	0	2078.7	2210.0	100	90	5	5	0
5	ASHTON R	13.9	22.3A	4.96	5	0	95	0	1055.4	1040.0	100	84	1	15	0
6	BASIN L	0.4	0.6A	1.12	100	0	0	0	1.7	.	.	100	0	0	0
7	BAYHORSE L	0.7	1.6M	1.06	100	0	0	0	0.6	.	.	100	0	0	0
8	BEAR L	47.0	75.6A	1.26	0	10	85	5	146.6	.	.	35	10	50	5
9	BENEWAH L	5.6	9.0M	1.23	0	60	40	0	53.9	.	.	0	10	90	0
10	BLACK CANYON R	22.0	35.5A	4.74	75	0	25	0	2715.5	2680.0	100	85	5	10	0
11	BLACKFOOT R	76.8	123.6A	3.98	80	0	20	0	569.2	581.0	100	25	15	60	0
12	BROWNLEE R	125.8	202.5A	7.94	60	0	40	0	34084.1	72590.0	47	45	5	50	0
13	C J STRIKE R	55.2	88.8A	4.55	60	0	40	0	22545.8	40786.0	55	80	10	8	2
14	CASCADE R	64.2	103.4A	2.65	0	2	98	0	629.3	620.0	100	33	7	60	0
15	CAVE L	5.2	8.4M	1.56	0	0	100	0	1407.5	.	.	5	0	20	75
16	CEDAR CREEK R	.	.	.	50	0	50	0	121.4	128.0	100	90	3	7	0
17	COCOLALLA L	5.9	9.4A	1.47	0	0	100	0	60.2	.	.	20	5	75	0
18	CRANE CREEK R	18.7	30.1M	2.09	25	0	75	0	244.0	242.0	100	45	5	55	0
19	DEADWOOD R	7.6	12.2A	0.96	100	0	0	0	108.9	112.0	100	100	0	0	0
20	DEEP CREEK R	2.9	4.7P	.	5	0	95	0	30.3	.	.	45	5	50	0
21	DWORSHAK R	183.0	294.5P	.	100	0	0	0	2420.8	2440.0	100	55	10	35	0
22	ECHO L	0.5	0.8M	1.17	100	0	0	0	1.0	.	.	100	0	0	0
23	FERNAN L	6.1	9.9M	1.99	0	20	80	0	19.2	.	.	40	15	45	0
24	GEM L	0.9	1.5M	.	100	0	0	0	0.5	.	.	100	0	0	0
25	GOLDEN L	2.7	4.3P	.	0	100	0	0	6.2	.	.	0	100	0	0
26	GOOSE L	6.5	10.4M	.	100	0	0	0	8.2	.	.	100	0	0	0
27	HAUSER L	4.3	7.0M	1.24	0	5	95	0	18.2	.	.	0	10	90	0
28	HAYDEN L	28.8	46.3A	3.17	1	0	95	4	68.9	.	.	65	5	30	0
29	HEDEVIL L	0.5	0.8M	.	100	0	0	0	0.6	.	.	100	0	0	0
30	HELLS CANYON R	185.8	299.0A	26.52	90	0	10	0	34369.6	73300.0	47	85	5	10	0
31	HENRYS L	22.7	36.6M	1.83	15	0	85	0	92.3	98.0	100	62	8	30	0
32	HOODOO L	2.8	4.6A	2.10	80	0	20	0	149.5	.	.	5	10	85	0
33	ISLAND PARK R	50.0	80.6A	4.05	50	0	50	0	527.8	481.0	.	82	3	15	0
34	LAKE CHATCOLET	20.3	32.7M	2.15	0	100	0	0	42.9	.	.	0	20	80	0
35	LAKE COEUR D'ALENE	121.0	194.7A	4.83	5	5	85	5	3699.1	.	.	60	10	30	0
36	LAKE LOWELL	24.6	39.6P	1.60	100	0	0	0	500.4	.	.	37	10	43	10
37	LAKE PEND OREILLE	200.1	322.1A	4.64	31	12	55	2	1013.1	.	.	65	5	30	0
38	LAKE WAHA	1.9	3.1P	.	0	0	100	0	7.1	.	.	0	0	100	0
39	LAKE WALCOTT	58.4	94.0M	.	97	3	0	0	9685.4	.	.	70	5	25	0

40	LAMONT R	2.5	4.0M	.	0	0	100	0	0.8	.	.	40	0	60	0
41	LITTLE CAMAS R	8.5	13.8A	1.60	65	15	20	0	42.9	.	.	40	10	50	0
42	LITTLE WOOD R	8.6	13.9A	2.51	0	2	98	0	267.5	279.0	100	65	10	25	0
43	LOWER BERNARD L	0.3	0.5M	.	100	0	0	0	0.7	.	.	100	0	0	0
44	LOWER PRIEST L	63.3	101.8M	3.15	33	35	20	12	474.0	.	.	30	30	20	20
45	LUCKY PEAK R	41.1	66.1A	5.49	45	10	45	0	2531.1	2680.0	100	73	20	7	0
46	MACARTHUR L	5.2	8.4M	2.45	0	100	0	0	34.3	.	.	8	17	75	0
47	MACKAY R	7.2	11.6A	1.41	70	0	30	0	730.6	.	.	85	5	15	0
48	MAGIC R	36.9	59.4A	4.45	50	0	50	0	1401.4	1600.0	100	50	10	40	0
49	MANN'S CREEK R	10.3	16.5M	4.38	0	0	100	0	55.5	.	.	65	5	30	0
50	MANN'S L	2.2	3.2A	1.31	0	0	0	100	8.3	.	.	0	0	20	80
51	MILNER R	35.1	56.5M	24.38	10	0	90	0	11344.3	.	.	27	3	70	0
52	MOOSE CREEK R	1.8	2.9M	1.85	0	100	0	0	7.8	.	.	0	50	50	0
53	MORMON R	.	.	.	70	10	20	0	63.7	.	.	30	10	60	0
54	MOUNTAIN HOME R	5.0	8.1A	1.78	95	0	5	0	127.7	.	.	85	5	10	0
55	MURTAUGH LAKE R	10.0	16.0M	2.40	5	0	95	0	111.4	.	.	45	5	50	0
56	MYRTLE L	0.7	1.2A	1.36	100	0	0	0	2.4	.	.	100	0	0	0
57	OXBOW R	.	.	.	60	5	35	0	34280.6	72800.0	47	85	5	10	0
58	PALISADES R	66.5	107.1A	3.74	40	0	60	0	671.8	5208.0	13	84	1	15	0
59	PAYETTE L	23.4	37.7A	2.29	0	75	10	15	142.2	.	.	80	15	5	0
60	PERKINS L	1.7	2.8M	1.43	85	0	15	0	3.2	.	.	80	0	20	0
61	PETIT L	4.7	7.6A	1.70	100	0	0	0	10.3	.	.	100	0	0	0
62	PORTNEUF R	10.8	17.3A	1.92	5	0	80	15	70.1	.	.	3	0	7	90
63	REDFISH L	9.6	15.5P	1.74	100	0	0	0	40.1	.	.	100	0	0	0
64	RIRIE R	7.9	12.7A	1.43	100	0	0	0	577.5	.	.	5	5	90	0
65	ROSE L	3.3	5.3M	1.19	5	0	95	0	5.4	.	.	25	0	75	0
66	ROUND L	1.2	1.9M	2.60	0	100	0	0	72.7	.	.	10	15	75	0
67	SALMON FALLS CREEK R	2.1	3.3A	3.32	70	5	25	0	128.8	1610.0	8	85	5	10	0
68	SEVEN DEVILS L	0.2	0.4M	0.96	100	0	0	0	0.3	.	.	100	0	0	0
69	SHELF L	0.6	0.9M	.	100	0	0	0	0.9	.	.	100	0	0	0
70	SILVER L	2.9	4.7P	3.24	0	100	0	0	18.4	.	.	0	100	0	0
71	SODA POINT R	15.1	24.3A	3.16	5	0	95	0	1153.7	.	.	10	5	85	0
72	SOLDIERS MEADOW R	3.8	6.1A	2.46	0	0	100	0	5.4	.	.	0	0	100	0
73	SPIRIT L	13.8	22.2M	2.62	0	2	98	0	28.1	.	.	8	10	72	10
74	STANLEY L	2.6	4.3M	1.34	100	0	0	0	14.5	.	.	100	0	0	0
75	STEVENS L	0.7	1.2A	1.65	100	0	0	0	8.0	.	.	100	0	0	0
76	SWAN FALLS R	23.9	38.5A	5.69	30	0	70	0	23728.7	.	.	78	7	15	0
77	SWAN L	1.9	3.1	.	0	0	100	0	0.1	.	.	0	0	100	0
78	TOLO L	0.9	1.6M	1.06	0	0	100	0	18.0	.	.	0	3	97	0
79	TRINITY L	1.0	1.6M	1.41	100	0	0	0	0.7	.	.	100	0	0	0
80	TWIN LAKES LOWER L	7.4	11.9M	2.89	0	5	95	0	41.3	.	.	5	15	70	10
81	TWIN LAKES UPPER L	4.6	7.4M	.	0	0	100	0	2.4	.	.	5	0	95	0
82	TWIN LAKES NORTH R	2.5	4.0M	23.79	0	0	100	0	2.4	.	.	0	0	100	0
83	TWIN LAKES SOUTH R	2.5	4.0M	1.69	0	5	95	0	41.3	.	.	5	15	70	10
84	UPPER BERNARD L	0.4	0.6M	.	100	0	0	0	0.3	.	.	100	0	0	0
85	UPPER PRIEST L	8.3	13.3M	1.67	57	43	0	0	125.2	.	.	35	20	3	42
86	WARM L	4.5	7.2M	1.46	100	0	0	0	9.4	.	.	100	0	0	0
87	WILLIAMS L	3.5	5.6M	.	100	0	0	0	14.5	.	.	100	0	0	0
88	WILSON LAKE R	8.5	13.7M	2.99	90	0	10	0	14.3	.	.	13	2	85	0
89	WINCHESTER L	3.3	5.4M	2.70	0	100	0	0	7.2	.	.	0	10	0	90

		LANDUSE %													
		WATERSHED								LAKESHORE					
		URBAN	AG	RANGE	FOREST	WATER	WETLAND	BAREN	TUNDRA	URBAN	AG	RANGE	FOREST	WETLAND	BAREN
1	ALTURAS L	0	0	29	56	3	0	13	0	0	0	0	100	0	0
2	AMERICAN FALLS R	0	19	41	23	2	1	12	0	5	78	7	0	10	0
3	ANDERSON RANCH R	0	1	35	60	1	0	3	0	0	12	69	19	0	0
4	ARROWROCK R	0	1	34	61	1	0	3	0	0	0	100	0	0	0
5	ASHTON R	0	2	26	69	2	0	1	0	0	50	50	0	0	0
6	BASIN L	0	0	0	10	0	0	90	0	0	0	0	50	0	50
7	BAYHORSE L	0	0	0	100	0	0	0	0	0	0	0	100	0	0
8	BEAR L	0	4	38	18	37	2	0	0	0	8	25	0	67	0
9	BENEWAH L	0	0	16	82	0	2	0	0	0	20	0	80	0	0
10	BLACK CANYON R	0	6	19	71	1	1	1	0	0	1	99	0	0	0
11	BLACKFOOT R	0	13	50	32	4	0	0	0	0	35	65	0	0	0
12	BROWNLEE R	0	19	55	18	1	0	6	0	0	0	100	0	0	0
13	C J STRIKE R	0	20	59	10	1	0	9	0	0	27	73	0	0	0
14	CASCADE R	0	13	11	66	5	3	1	0	0	0	15	28	57	0
15	CAVE L	3	1	0	95	0	1	0	0	0	33	0	33	34	0
16	CEDAR CREEK R	0	5	95	0	0	0	0	0	0	0	100	0	0	0
17	COCOLALLA L	0	11	0	87	2	0	0	0	0	20	0	80	0	0
18	CRANE CREEK R	0	19	79	0	2	0	0	0	0	55	45	0	0	0
19	DEADWOOD R	0	0	3	93	4	0	0	0	0	0	0	100	0	0
20	DEEP CREEK R	0	0	94	6	0	0	0	0	0	0	100	0	0	0
21	DWORSHAK R	0	0	4	94	1	0	0	0	0	0	2	98	0	0
22	ECHO L	0	0	0	50	0	0	50	0	0	0	0	100	0	0
23	FERNAN L	2	0	0	95	3	0	0	0	40	0	0	60	0	0
24	GEM L	0	0	0	33	0	0	67	0	0	0	0	33	0	67
25	GOLDEN L	0	0	0	100	0	0	0	0	0	0	0	100	0	0
26	GOOSE L	0	0	20	74	6	0	0	0	0	0	0	100	0	0
27	HAUSER L	3	0	0	93	4	0	0	0	33	0	0	67	0	0
28	HAYDEN L	8	0	0	84	8	0	0	0	50	0	0	50	0	0
29	HEDEVIL L	0	0	0	50	0	0	50	0	0	0	0	70	0	30
30	HELLS CANYON R	0	19	55	19	1	0	6	0	0	0	100	0	0	0
31	HENRYS L	0	0	57	25	10	0	6	2	0	0	100	0	0	0
32	HOODOO L	0	19	0	81	0	0	0	0	0	0	0	100	0	0
33	ISLAND PARK R	0	2	41	51	4	0	2	0	0	0	55	45	0	0
34	LAKE CHATCOLET	0	21	0	74	4	0	0	0	0	0	0	64	36	0
35	LAKE COEUR D'ALENE	1	3	3	91	2	1	0	0	6	3	0	85	6	0
36	LAKE LOWELL	2	39	56	0	2	1	0	0	0	26	26	0	48	0
37	LAKE PEND OREILLE	1	6	0	80	13	0	0	0	10	9	0	78	3	0
38	LAKE WAHA	0	0	10	90	0	0	0	0	0	0	0	100	0	0
39	LAKE WALCOTT	0	21	46	18	2	1	11	0	0	0	100	0	0	0

40	LAMONT R	0	81	0	0	19	0	0	0	0	100	0	0	0	0
41	LITTLE CAMAS R	0	0	76	20	4	0	0	0	0	0	100	0	0	0
42	LITTLE WOOD R	0	4	81	12	0	0	2	1	0	50	50	0	0	0
43	LOWER BERNARD L	0	0	0	100	0	0	0	0	0	0	0	100	0	0
44	LOWER PRIEST L	0	0	0	66	34	0	0	0	0	0	0	100	0	0
45	LUCKY PEAK R	0	1	31	65	1	0	2	0	0	0	100	0	0	0
46	MACARTHUR L	0	8	0	90	2	0	0	0	0	5	0	95	0	0
47	MACKAY R	0	6	66	20	0	0	4	4	0	5	95	0	0	0
48	MAGIC R	0	17	59	20	0	0	2	1	0	0	100	0	0	0
49	MANN'S CREEK R	0	0	61	39	1	0	0	0	0	0	100	0	0	0
50	MANN'S L	0	87	13	0	0	0	0	0	0	100	0	0	0	0
51	MILNER R	0	25	46	16	2	1	10	0	10	50	40	0	0	0
52	MOOSE CREEK R	0	0	0	100	0	0	0	0	0	0	0	100	0	0
53	MORMON R	0	14	83	0	4	0	0	0	0	14	86	0	0	0
54	MOUNTAIN HOME R	0	1	98	1	0	0	0	0	0	0	100	0	0	0
55	MURTAUGH LAKE R	0	37	60	1	1	0	0	0	0	100	0	0	0	0
56	MYRTLE L	0	0	0	100	0	0	0	0	0	0	0	100	0	0
57	OXBOW R	0	19	55	18	1	0	6	0	0	0	100	0	0	0
58	PALISADES R	0	4	30	61	4	0	2	0	0	0	4	96	0	0
59	PAYETTE L	1	0	17	76	6	0	0	0	17	0	0	83	0	0
60	PERKINS L	0	0	0	94	6	0	0	0	0	0	0	100	0	0
61	PETIT L	0	0	25	50	5	0	20	0	0	0	30	70	0	0
62	PORTNEUF R	0	13	83	1	2	0	0	0	0	75	25	0	0	0
63	REDFISH L	0	0	16	58	5	0	19	2	0	0	0	100	0	0
64	RIRIE R	0	16	59	17	2	6	0	0	0	45	55	0	0	0
65	ROSE L	7	0	0	57	9	26	0	0	5	0	0	45	50	0
66	ROUND L	0	12	0	87	2	0	0	0	0	40	0	60	0	0
67	SALMON FALLS CREEK R	0	2	96	0	2	0	0	0	0	0	100	0	0	0
68	SEVEN DEVILS L	0	0	0	40	0	0	60	0	0	0	0	66	0	34
69	SHELF L	0	0	0	10	0	0	90	0	0	0	0	67	0	33
70	SILVER L	0	0	4	94	2	0	0	0	0	0	0	100	0	0
71	SODA POINT R	1	23	46	19	6	6	0	0	5	57	38	0	0	0
72	SOLDIERS MEADOW R	0	0	0	100	0	0	0	0	0	0	0	100	0	0
73	SPIRIT L	1	0	0	89	10	0	0	0	0	0	0	100	0	0
74	STANLEY L	0	0	12	77	1	0	10	0	0	0	0	100	0	0
75	STEVENS L	0	0	38	0	63	0	0	0	0	0	100	0	0	0
76	SWAN FALLS R	0	20	60	9	1	0	9	0	0	5	95	0	0	0
77	SWAN L	0	100	0	0	0	0	0	0	0	0	0	60	0	40
78	TOLO L	0	31	37	33	0	0	0	0	0	100	0	0	0	0
79	TRINITY L	0	0	100	0	0	0	0	0	0	0	0	50	0	50
80	TWIN LAKES LOWER L	0	6	0	90	4	0	0	0	0	0	0	100	0	0
81	TWIN LAKES UPPER L	0	77	0	0	23	0	0	0	0	100	0	0	0	0
82	TWIN LAKES NORTH R	0	77	0	0	23	0	0	0	0	100	0	0	0	0
83	TWIN LAKES SOUTH R	0	6	0	90	4	0	0	0	0	0	0	100	0	0
84	UPPER BERNARD L	0	0	0	100	0	0	0	0	0	0	0	0	100	0
85	UPPER PRIEST L	0	0	0	2	98	0	0	0	0	0	0	100	0	0
86	WARM L	0	0	0	95	5	0	0	0	0	0	0	100	0	0
87	WILLIAMS L	0	0	56	42	2	0	0	0	0	0	0	100	0	0
88	WILSON LAKE R	4	71	20	0	4	0	0	0	0	50	50	0	0	0
89	WINCHESTER L	0	50	0	50	0	0	0	0	0	0	0	100	0	0

No.	Name	REC ACCESS	DISTANCE TO HIWAY (SCALE)	SHORE DEV %	SHORE ROAD %	1980 POPULATION WATERSHED	1980 POPULATION W/IN 50 MILES	1980 POPULATION W/IN 100 MILES	POPULATION GROWTH FACTORS: WATERSHED 1960 -- 1970	WATERSHED 1970 -- 1980	1960 -- 1970 W/IN 50 MILES	1970 -- 1980 W/IN 50 MILES	1960 -- 1970 W/IN 100 MILES	1970 -- 1980 W/IN 100 MILES
1	ALTURAS L	4	6.0	1	60	0	3602	355676	0.00	0.00	0.35	0.46	0.10	0.42
2	AMERICAN FALLS R	1	0.1	8	35	107509	134082	412501	0.06	0.26	0.06	0.24	0.16	0.26
3	ANDERSON RANCH R	5	7.0	4	60	87	180969	411570	-0.24	0.04	0.19	0.43	0.08	0.41
4	ARROWROCK R	2	1.0	1	42	374	295646	394100	0.11	1.17	0.13	0.45	0.09	0.40
5	ASHTON R	2	0.1	2	7	1219	12002	199615	-0.04	0.03	-0.07	0.35	0.13	0.27
6	BASIN L	1	82.0	0	0	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
7	BAYHORSE L	1	34.0	5	0	0	3602	355676	0.00	0.00	0.35	0.46	0.10	0.42
8	BEAR L	2	0.1	47	90	1366	97365	1048000	-0.08	0.24	0.03	0.27	0.19	0.36
9	BENEWAH L	1	1.0	30	80	215	454027	597492	.	0.65	0.05	0.19	0.05	0.17
10	BLACK CANYON R	2	0.1	4	60	4054	295646	394100	-0.03	0.36	0.13	0.45	0.09	0.40
11	BLACKFOOT R	4	18.0	4	12	800	165400	356350	.	1.67	0.06	0.28	0.04	0.28
12	BROWNLEE R	2	0.1	16	55	23225	143649	407354	-0.12	0.11	0.04	0.31	0.08	0.37
13	C J STRIKE R	6	0.1	21	30	22072	197398	417772	0.04	0.23	0.17	0.50	0.09	0.40
14	CASCADE R	9	0.1	14	55	2073	11190	365197	-0.13	0.50	-0.05	0.29	0.40	0.37
15	CAVE L	2	1.2	35	50	190	454027	597492	.	0.27	0.05	0.19	0.05	0.17
16	CEDAR CREEK R	1	6.0	0	20	32	80304	163720	0.18	1.46	-0.04	0.31	0.06	0.23
17	COCOLALLA L	1	0.4	60	80	1366	126291	617913	0.10	1.27	0.09	0.42	0.06	0.24
18	CRANE CREEK R	2	14.0	2	20	270	143649	407354	-0.12	-0.08	0.04	0.31	0.08	0.37
19	DEADWOOD R	3	71.0	7	40	0	15464	365197	0.00	0.00	0.02	0.34	0.40	0.37
20	DEEP CREEK R	2	11.0	4	70	40	97365	1048000	.	.	0.03	0.27	0.19	0.36
21	DWORSHAK R	12	5.0	10	10	2769	119009	630397	0.36	-0.14	0.19	0.10	0.06	0.18
22	ECHO L	2	106.0	0	0	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
23	FERNAN L	2	0.1	35	40	1244	443303	638230	.	0.95	0.04	0.24	0.08	0.20
24	GEM L	1	58.0	0	0	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
25	GOLDEN L	2	8.0	10	30	0	27071	199615	0.00	0.00	0.21	0.30	0.13	0.27
26	GOOSE L	1	15.8	2	40	0	11190	365197	0.00	0.00	-0.05	0.29	0.40	0.37
27	HAUSER L	2	1.6	37	100	1520	440754	590742	0.31	1.00	0.03	0.27	0.08	0.25
28	HAYDEN L	3	1.4	85	100	5525	443303	638230	.	1.05	0.04	0.24	0.08	0.20
29	HEDEVIL L	1	114.0	0	0	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
30	HELLS CANYON R	1	22.0	2	50	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
31	HENRYS L	2	2.0	12	22	122	12002	199615	-0.04	1.54	-0.07	0.35	0.13	0.27
32	HOODOO L	1	10.2	10	20	683	126291	617913	0.10	1.26	0.09	0.42	0.06	0.24
33	ISLAND PARK R	3	3.0	12	10	454	27071	199615	0.19	1.20	0.21	0.30	0.13	0.27
34	LAKE CHATCOLET	2	1.5	35	50	1562	454027	597492	.	1.67	0.05	0.19	0.05	0.17
35	LAKE COEUR D'ALENE	12	0.1	80	80	54934	443303	638230	.	0.20	0.04	0.24	0.08	0.20
36	LAKE LOWELL	2	1.0	10	90	27183	309962	368529	0.10	0.21	0.13	0.44	0.09	0.38
37	LAKE PEND OREILLE	9	0.1	56	50	16582	126291	617913	0.01	0.52	0.09	0.42	0.06	0.24
38	LAKE WAHA	2	14.0	7	10	15	123452	309199	.	0.50	0.18	0.11	0.11	0.16
39	LAKE WALCOTT	4	15.0	5	40	3154	75084	216671	-0.06	0.28	0.06	0.21	-0.05	0.23

40	LAMONT R	1	0.1	6	75	147	97365	1048000	-0.17	0.30	0.03	0.27	0.19	0.36
41	LITTLE CAMAS R	4	1.0	3	65	44	180969	411570	-0.24	0.05	0.19	0.43	0.08	0.41
42	LITTLE WOOD R	1	15.0	5	5	10	71583	390475	.	.	0.00	0.33	0.12	0.36
43	LOWER BERNARD L	1	90.0	0	0	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
44	LOWER PRIEST L	9	26.0	56	70	1324	69216	612144	0.04	0.63	-0.01	0.26	0.07	0.23
45	LUCKY PEAK R	4	0.1	2	20	660	295646	394100	0.02	1.24	0.13	0.45	0.09	0.40
46	MACARTHUR L	2	1.0	20	15	302	41402	571468	0.05	0.62	-0.01	0.37	0.04	0.26
47	MACKAY R	3	0.1	1	30	350	12824	309075	0.25	0.09	-0.18	0.27	0.12	0.24
48	MAGIC R	6	8.0	17	25	9653	71583	390475	0.22	0.90	0.00	0.33	0.12	0.36
49	MANN'S CREEK R	1	1.0	2	60	143	143649	407354	-0.15	0.16	0.04	0.31	0.08	0.37
50	MANN'S L	2	9.5	2	30	15	123452	309199	.	0.50	0.18	0.11	0.11	0.16
51	MILNER R	4	0.1	22	15	36675	75084	216671	0.08	0.19	0.06	0.21	-0.05	0.23
52	MOOSE CREEK R	1	3.6	5	50	0	119009	630397	0.00	0.00	0.19	0.10	0.06	0.18
53	MORMON R	2	10.0	2	5	48	71583	390475	-0.20	0.20	0.00	0.33	0.12	0.36
54	MOUNTAIN HOME R	2	0.1	1	60	93	180969	411570	0.13	0.82	0.19	0.43	0.08	0.41
55	MURTAUGH LAKE R	1	1.0	15	5	1097	75084	216671	-0.21	0.01	0.06	0.21	-0.05	0.23
56	MYRTLE L	1	70.8	5	0	0	69216	612144	0.00	0.00	-0.01	0.26	0.07	0.23
57	OXBOW R	2	35.0	2	60	64	143649	407354	.	.	0.04	0.31	0.08	0.37
58	PALISADES R	6	0.1	6	55	6905	105491	260779	0.00	0.50	0.16	0.35	0.47	-0.06
59	PAYETTE L	4	0.1	72	75	3038	11190	365197	0.14	0.43	-0.05	0.29	0.40	0.37
60	PERKINS L	2	8.4	0	5	30	31826	437008	.	0.50	0.11	0.23	0.11	0.27
61	PETIT L	1	3.0	20	50	0	3602	355676	0.00	0.00	0.35	0.46	0.10	0.42
62	PORTNEUF R	4	23.0	1	60	0	165400	356350	-1.00	0.00	0.06	0.28	0.04	0.28
63	REDFISH L	3	2.0	2	20	40	3602	355676	.	.	0.35	0.46	0.10	0.42
64	RIRIE R	2	2.5	0	5	925	136009	276688	.	1.68	0.13	0.29	0.06	0.29
65	ROSE L	1	0.5	70	40	190	454027	597492	.	0.27	0.05	0.19	0.05	0.17
66	ROUND L	1	0.2	10	5	205	126291	617913	0.11	1.25	0.09	0.42	0.06	0.24
67	SALMON FALLS CREEK R	5	11.0	1	5	69	80304	163720	0.05	0.68	-0.04	0.31	0.06	0.23
68	SEVEN DEVILS L	1	48.4	0	0	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
69	SHELF L	1	90.0	0	0	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
70	SILVER L	3	2.0	0	2	30	27071	199615	-0.08	1.50	0.21	0.30	0.13	0.27
71	SODA POINT R	1	0.1	3	40	8908	165400	356350	-0.03	0.28	0.06	0.28	0.04	0.28
72	SOLDIERS MEADOW R	2	41.0	2	20	50	123452	309199	.	.	0.18	0.11	0.11	0.16
73	SPIRIT L	2	2.0	57	58	1980	440754	616286	0.07	0.93	0.03	0.27	0.08	0.24
74	STANLEY L	2	8.0	20	40	0	3602	355676	0.00	0.00	0.35	0.46	0.10	0.42
75	STEVENS L	1	24.0	0	0	0	57867	729269	0.00	0.00	0.04	0.15	0.09	0.21
76	SWAN FALLS R	1	0.1	11	30	573	197398	417772	0.11	0.39	0.17	0.50	0.09	0.40
77	SWAN L	1	3.7	0	0	0	454027	597492	0.00	0.00	0.05	0.19	0.05	0.17
78	TOLO L	3	26.0	1	50	48	11190	365197	0.00	.	-0.05	0.29	0.40	0.37
79	TRINITY L	2	89.0	10	30	0	180969	411570	0.00	0.00	0.19	0.43	0.08	0.41
80	TWIN LAKES LOWER L	3	0.1	62	40	764	440754	616286	0.55	1.83	0.03	0.27	0.08	0.24
81	TWIN LAKES UPPER L	2	3.0	46	35	764	440754	616286	0.55	1.83	0.03	0.27	0.08	0.24
82	TWIN LAKES NORTH R	2	9.0	2	80	36	97365	1048000	-0.17	-0.05	0.03	0.27	0.19	0.36
83	TWIN LAKES SOUTH R	1	3.0	2	75	36	97365	1048000	-0.17	-0.05	0.03	0.27	0.19	0.36
84	UPPER BERNARD L	1	94.0	0	0	0	15287	282224	0.00	0.00	-0.06	0.17	0.07	0.14
85	UPPER PRIEST L	4	71.0	10	0	0	69216	612144	0.00	0.00	-0.01	0.26	0.07	0.23
86	WARM L	3	26.0	50	50	210	11190	365197	.	0.31	-0.05	0.29	0.40	0.37
87	WILLIAMS L	2	14.0	32	60	144	10845	115745	.	.	-0.03	0.27	-0.04	0.10
88	WILSON LAKE R	1	7.0	5	5	496	75084	216671	-0.09	0.25	0.06	0.21	-0.05	0.23
89	WINCHESTER L	4	0.1	10	70	397	123452	309199	-0.30	0.25	0.18	0.11	0.11	0.16

		MAX DEPTH (M)	MEAN DEPTH (M)	SECCHI DEPTH (M)	EUPHOTIC ZONE (M)	O2 PROFILE	EPIL. TEMPERATURE MAX DEG C	EPIL. TEMPERATURE MEAN DEG C	O2 CONCENTRAT. MIN MG/L	O2 CONCENTRAT. MEAN MG/L	H2S ?	CHLA MG/L	PH	CONDUCT MICRO MHO	TURBID NTU	ALKALIN MG/L
1	ALTURAS L	52.0	7.0	13.0	35.1	4	17.3	17.2	4.3	6.4	NO	0.0	6.31	49	0.3	19
2	AMERICAN FALLS R	16.8	16.8	2.1	5.7	7	22.5	19.3	4.2	5.5	NO	18.3	8.35	335	8.5	144
3	ANDERSON RANCH R	38.0	6.0	4.2	11.3	7	21.5	21.1	7.3	7.8	NO	6.4	9.50	60	1.4	36
4	ARROWROCK R	44.0	4.0	5.5	14.9	1	20.7	20.5	6.3	0.7	NO	8.6	9.33	50	2.0	27
5	ASHTON R	13.7	14.3	.	.	6	19.7	18.4	3.1	5.5	NO	4.7	7.92	115	1.1	61
6	BASIN L	11.5	3.0	11.0	29.7	5	16.0	15.2	7.4	8.1	NO	1.3	6.69	38	0.3	10
7	BAYHORSE L	7.0	3.0	5.5	14.9	7	17.3	16.9	1.3	2.1	NO	2.6	6.99	40	0.6	21
8	BEAR L	63.4	11.4	6.7	18.1	1	20.7	19.9	8.0	8.2	NO	2.5	8.39	600	1.3	257
9	BENEWAH L	4.3	4.2	1.8	4.9	1	10.1	9.7	6.8	6.5	NO	11.5	7.10	51	3.6	25
10	BLACK CANYON R	16.5	16.5	2.3	6.2	1	20.7	19.9	3.6	7.8	NO	7.9	9.17	45	1.5	36
11	BLACKFOOT R	7.5	7.5	2.5	6.8	7	21.3	.	1.0	.	NO	7.9	8.00	340	12.0	204
12	BROWNLEE R	84.4	20.0	3.0	8.1	7	24.9	24.2	0.6	0.8	NO	5.8	9.13	248	0.6	115
13	C J STRIKE R	30.0	30.0	1.5	4.1	1	21.1	18.8	9.1	9.3	NO	17.5	9.63	305	20.0	152
14	CASCADE R	17.3	8.5	5.0	13.5	7	19.5	18.8	3.3	5.2	NO	11.8	8.97	32	1.0	17
15	CAVE L	5.5	5.5	2.7	7.3	1	11.3	11.4	7.1	7.1	NO	9.0	6.90	50	3.5	17
16	CEDAR CREEK R	5.5	5.5	0.2	0.5	7	18.2	18.1	3.8	4.5	NO	10.8	7.25	88	34.0	38
17	COCOLALLA L	13.7	13.6	0.9	2.4	1	17.1	16.5	5.0	4.9	NO	44.6	6.30	55	6.5	21
18	CRANE CREEK R	13.3	13.2	0.2	0.5	1	19.3	16.0	4.2	5.0	NO	2.5	9.15	83	90.0	77
19	DEADWOOD R	30.3	7.0	1.3	3.5	3	22.1	19.9	4.8	6.0	NO	9.9	8.51	37	4.6	15
20	DEEP CREEK R	20.7	13.9	4.5	12.2	7	21.7	19.2	1.1	3.0	NO	4.6	8.11	300	1.7	147
21	DWORSHAK R	192.4	5.0	7.6	20.5	6	24.1	22.6	5.8	7.7	YES	4.4	8.00	30	0.8	15
22	ECHO L	11.0	4.0	.	.	3	17.8	16.3	7.7	7.9	NO	0.0	6.20	18	0.3	1
23	FERNAN L	7.6	7.6	3.0	8.1	1	20.1	19.3	5.9	5.9	NO	4.2	6.43	39	1.3	13
24	GEM L	24.7	4.0	13.5	36.5	5	15.3	14.7	3.0	6.9	NO	0.9	6.40	18	0.5	19
25	GOLDEN L	3.0	3.0	3.0	8.1	7	20.3	17.0	8.6	10.0	NO	1.7	8.70	164	1.0	71
26	GOOSE L	7.3	3.5	6.4	17.3	.	21.0	19.8	.	.	NO	.	6.20	16	0.6	4
27	HALSER L	12.2	5.5	5.2	14.0	7	20.4	19.6	0.0	0.2	NO	4.8	6.65	45	0.8	19
28	HAYDEN L	54.2	10.0	12.7	34.3	1	19.4	19.3	7.1	7.8	NO	1.0	7.00	50	0.7	25
29	HEDEVIL L	5.8	5.8	5.8	15.7	1	20.4	19.6	8.1	8.3	NO	5.9	6.15	12	0.4	4
30	HELLS CANYON R	64.9	64.9	1.8	4.9	7	23.4	23.2	6.8	7.0	NO	.	9.17	235	0.5	113
31	HENRYS L	5.2	5.2	4.3	11.6	1	20.0	19.9	5.7	5.8	NO	2.8	7.99	248	2.7	126
32	HOODOO L	1.2	1.2	1.2	3.2	1	10.3	10.3	6.9	6.9	YES	5.6	7.50	372	1.3	91
33	ISLAND PARK R	21.9	6.0	4.5	12.2	1	21.2	19.5	3.5	6.0	NO	5.7	8.60	150	1.4	71
34	LAKE CHATCOLET	10.7	11.2	1.5	4.1	1	11.4	11.4	6.4	6.3	NO	7.1	7.10	51	3.2	25
35	LAKE COEUR D'ALENE	54.9	22.0	5.0	13.5	6	13.3	13.3	4.0	4.8	NO	4.9	6.90	50	1.0	21
36	LAKE LOWELL	12.1	12.1	1.0	2.7	3	22.1	22.3	0.0	4.0	NO	32.4	9.47	136	18.0	86
37	LAKE PEND OREILLE	351.0	15.0	9.0	24.3	1	18.0	16.5	.	11.1	NO	1.4	7.42	114	0.4	71
38	LAKE WAHA	30.0	3.0	1.4	3.8	3	23.0	21.3	1.6	7.6	NO	19.9	7.60	77	14.0	31
39	LAKE WALCOTT	15.2	15.2	1.1	3.0	1	19.8	19.5	4.8	4.7	NO	4.2	7.79	345	3.5	142

40	LAMONT R	14.7	11.0	1.5	4.1	7	22.8	20.9	0.0	0.0	NO	4.3	8.28	165	2.4	117
41	LITTLE CAMAS R	4.3	2.5	0.8	2.2	7	23.1	22.5	6.2	7.5	NO	10.8	10	60	7.3	33
42	LITTLE WOOD R	15.2	15.2	1.5	4.1	7	20.6	19.8	0.0	1.7	NO	7.2	8.60	148	5.3	165
43	LOWER BERNARD L	8.2	2.5	7.8	8.2	5	20.4	19.0	9.0	9.2	NO	1.4	6.59	28	0.4	12
44	LOWER PRIEST L	102.1	4.0	5.5	14.9	1	22.5	16.7	6.8	6.8	NO	2.6	6.99	38	0.7	19
45	LUCKY PEAK R	63.6	4.0	5.0	13.5	1	18.2	17.5	10.2	10.5	NO	2.5	9.20	70	10.0	71
46	MACARTHUR L	2.7	2.7	1.3	3.5	1	18.5	18.5	6.1	6.5	NO	14.9	8.15	.	47.0	75
47	MACKAY R	9.0	9.0	4.5	12.2	7	17.5	.	0.2	4.5	NO	1.3	8.05	219	1.1	113
48	MAGIC R	26.1	6.0	4.5	12.2	7	22.3	22.1	0.0	2.7	NO	10.6	8.00	160	2.2	98
49	MANN'S CREEK R	29.8	5.0	1.9	5.1	7	21.9	20.9	4.8	4.9	NO	4.9	9.00	150	20.0	169
50	MANN'S L	15.0	3.0	2.7	7.3	7	24.0	23.2	5.3	6.8	NO	1.2	7.50	124	11.0	54
51	MILNER R	12.1	12.1	1.0	2.7	7	20.5	20.0	5.2	5.2	NO	13.8	8.21	348	3.8	150
52	MOOSE CREEK R	4.3	4.2	2.4	4.2	.	27.0	24.6	.	.	NO	3.7	7.90	40	1.3	18
53	MORMON R	2.4	2.4	0.7	1.9	7	23.4	21.8	3.7	4.8	NO	12.2	8.11	302	16.0	170
54	MOUNTAIN HOME R	.	.	0.3	0.8	.	23.1	21.0	.	.	NO	22.3	8.80	45	55.0	33
55	MURTAUGH LAKE R	5.2	5.2	0.1	0.2	1	19.1	19.1	4.8	5.2	NO	14.5	8.20	355	5.2	147
56	MYRTLE L	.	.	.	.	.	13.0	.	.	.	?	1.5	6.20	.	0.4	6
57	OXBOW R	38.1	38.1	3.2	8.6	7	21.7	21.0	2.8	3.0	NO	.	8.90	230	0.7	111
58	PALISADES R	32.3	12.0	3.5	9.5	7	19.8	19.4	5.1	5.2	NO	1.5	8.00	220	1.5	92
59	PAYETTE L	87.9	5.0	7.8	21.1	4	21.0	19.6	6.7	7.9	NO	0.1	7.10	32	0.3	15
60	PERKINS L	5.5	1.5	3.9	10.5	7	18.8	18.0	0.0	0.0	NO	7.2	6.55	.	12.0	52
61	PETIT L	.	.	.	.	.	.	.	.	.	?	.	6.20	22	0.3	7
62	PORTNEUF R	10.5	10.5	1.5	4.1	7	21.3	.	0.0	.	NO	31.1	8.20	290	15.0	152
63	REDFISH L	90.0	6.0	14.0	37.8	1	17.9	17.7	7.0	7.7	NO	0.0	6.22	28	0.3	8
64	RIRIE R	35.0	10.0	.	.	7	20.0	19.7	2.1	3.8	NO	2.3	8.10	310	0.7	169
65	ROSE L	5.2	5.2	1.3	3.5	1	16.3	16.4	4.1	4.2	NO	30.7	6.51	40	6.3	13
66	ROUND L	10.3	5.0	2.5	6.8	7	14.3	14.1	0.0	0.0	NO	17.3	7.65	68	2.9	29
67	SALMON FALLS CREEK R	23.3	8.0	1.2	3.2	7	18.0	17.4	2.1	2.3	NO	5.1	8.30	190	7.8	90
68	SEVEN DEVILS L	6.4	6.4	6.4	17.3	5	16.8	16.4	5.3	6.5	NO	1.5	6.40	18	0.4	4
69	SHELF L	12.2	4.0	11.3	30.5	5	16.4	15.8	10.6	10.9	NO	1.0	6.10	22	0.4	10
70	SILVER L	1.8	1.8	1.8	4.9	7	22.1	20.0	1.8	5.7	NO	3.7	9.61	137	1.1	55
71	SODA POINT R	18.3	8.8	1.2	3.2	7	22.5	20.0	5.0	5.2	NO	5.6	8.09	650	2.5	290
72	SOLDIERS MEADOW R	14.0	3.0	3.3	8.9	3	21.6	20.5	1.1	5.9	NO	1.5	7.00	63	13.0	27
73	SPIRIT L	29.0	8.0	4.2	11.3	7	16.5	16.1	0.6	1.5	NO	3.5	6.43	20	1.5	9
74	STANLEY L	25.9	7.0	11.0	29.7	4	17.7	17.0	2.6	4.8	NO	0.0	6.49	38	0.4	17
75	STEVENS L	.	.	.	.	.	.	.	.	.	?	1.7	7.05	51	0.4	29
76	SWAN FALLS R	6.8	6.8	0.8	2.2	1	19.4	16.8	9.0	9.0	NO	19.4	9.47	320	22.0	161
77	SWAN L	.	.	0.1	0.2	.	.	.	.	.	YES	139	7.90	118	24.0	58
78	TOLO L	1.2	1.3	0.3	0.8	1	19.8	17.2	5.8	5.8	NO	3.3	8.05	375	52.0	238
79	TRINITY L	18.6	4.0	4.9	13.2	5	17.5	17.4	1.3	3.3	NO	0.0	7.15	29	0.6	12
80	TWIN LAKES LOWER L	10.418.3	18.3	2.5	6.8	1	16.3	16.2	1.6	3.5	NO	6.8	6.37	21	0.8	12
81	TWIN LAKES UPPER L	4.2	4.2	4.0	10.8	1	16.1	16.0	6.0	6.1	NO	3.9	6.23	22	1.0	12
82	TWIN LAKES NORTH R	8.5 6.7	6.7	4.5	12.2	4	22.8	20.0	6.0	7.0	NO	0.6	7.90	180	2.3	120
83	TWIN LAKES SOUTH R	5.8	5.8	2.5	6.8	4	22.7	20.2	5.3	6.2	NO	2.3	7.98	188	1.9	123
84	UPPER BERNARD L	2.7	2.0	2.7	7.3	2	21.1	20.1	7.7	7.8	NO	1.6	6.60	20	0.5	10
85	UPPER PRIEST L	30.0	4.0	6.0	16.2	.	17.0	11.2	.	.	NO	3.1	7.22	70	0.5	41
86	WARM L	25.6	4.8	5.0	13.5	7	19.8	19.7	0.0	2.1	NO	0.0	7.10	46	1.1	23
87	WILLIAMS L	56.4	.	3.0	8.1	.	.	.	.	.	NO	5.0	8.00	108	.	50
88	WILSON LAKE R	6.1	6.1	0.1	0.2	1	20.0	19.6	6.7	7.0	NO	17.5	8.25	333	5.5	150
89	WINCHESTER L	10.0	2.0	1.2	3.2	1	28.0	26.3	10.3	10.3	NO	32.9	9.05	125	4.3	68

		TSS MG/L	ORGANIC CONTENT %	TOTAL P MG/L	NO3 MG/L	NH3 MG/L	TKN MG/L	TOTAL COLIF #/100 ML	FECAL COLIF #/100 ML	COLOR	ODOR	TOTAL N MG/L	N/P
1	ALTURAS L	0.60	.	0.009	0.04	0.00	0.16	27	0	5	0	0.20	22.2
2	AMERICAN FALLS R	2.20	1.2	0.061	0.02	0.02	0.24	.	.	15	1	0.24	4.0
3	ANDERSON RANCH R	2.40	.	0.014	0.02	0.00	0.19	0	0	5	0	0.20	14.3
4	ARROWROCK R	1.40	.	0.030	0.02	0.02	0.07	0	0	25	0	0.08	2.7
5	ASHTON R	2.20	0.4	0.050	0.02	.	0.18	2	1	10	0	0.19	3.8
6	BASIN L	0.80	.	0.017	0.02	0.00	0.12	.	.	5	0	0.13	7.6
7	BAYHORSE L	.	0.0	0.015	0.02	.	.	.	.	10	0	.	.
8	BEAR L	.	.	0.026	0.02	0.02	0.19	.	.	5	0	0.20	7.7
9	BENEWAH L	5.60	4.0	0.038	0.02	0.92	0.36	70	0	10	0	0.37	9.7
10	BLACK CANYON R	1.60	.	0.038	0.02	0.02	0.11	10	14	5	0	0.12	3.2
11	BLACKFOOT R	6.60	4.0	0.080	0.04	0.16	0.56	.	.	5	0	0.60	7.6
12	BROWNLEE R	1.00	.	0.034	0.23	0.07	0.27	0	0	5	.	0.49	14.6
13	C J STRIKE R	8.00	4.6	0.042	0.23	0.01	0.12	0	0	5	0	0.35	8.3
14	CASCADE R	0.20	.	0.050	0.02	0.03	0.40	15	0	5	0	0.42	8.4
15	CAVE L	4.40	3.0	0.035	0.02	0.35	0.13	11	0	15	0	0.14	4.0
16	CEDAR CREEK R	47.2	0.2	0.245	0.16	.	0.19	0	1	5	0	0.35	1.4
17	COCOLALLA L	5.40	0.0	0.035	0.02	0.01	0.18	39	0	15	0	0.19	5.4
18	CRANE CREEK R	14	4.6	1.511	0.05	.	1.85	0	0	15	0	1.90	1.3
19	DEADWOOD R	8.40	2.0	0.030	0.02	0.03	0.18	0	0	10	0	0.19	6.3
20	DEEP CREEK R	.	.	0.066	0.02	0.38	0.07	.	.	5	0	0.08	1.2
21	DWORSHAK R	.	.	0.021	0.02	0.03	0.20	15	0	.	.	0.22	10.6
22	ECHO L	.	1.8	0.006	0.02	0.00	0.19	.	.	5	.	0.20	33.3
23	FERNAN L	6.00	0.0	0.029	0.02	0.21	0.16	5	0	10	0	0.17	5.9
24	GEM L	0.80	.	0.008	0.02	0.00	0.04	.	.	5	0	0.05	6.3
25	GOLDEN L	.	.	0.042	0.02	0.00	0.12	1	0	5	0	0.13	3.1
26	GOOSE L	.	.	0.019	0.02	0.03	0.34	0	0	5	0	0.35	18.4
27	HAUSER L	8.80	0.6	0.015	0.02	0.03	0.26	0	0	20	.	0.27	18.0
28	HAYDEN L	2.80	0.0	0.042	0.02	0.02	0.18	0	0	5	0	0.19	4.5
29	HEDEVIL L	2.60	.	0.017	0.02	.	0.10	.	.	5	.	0.11	6.5
30	HELLS CANYON R	2.80	.	0.037	0.14	0.03	0.28	0	0	5	0	0.42	11.4
31	HENRYS L	2.20	.	0.058	0.06	0.00	0.29	1	0	10	.	0.35	6.0
32	HOODOO L	1.00	0.0	0.030	0.02	0.59	0.31	.	5	10	0	0.32	10.7
33	ISLAND PARK R	1.20	.	0.017	0.02	0.02	0.18	0	0	5	.	0.19	11.2
34	LAKE CHATCOLET	5.20	3.8	0.040	0.02	0.01	0.06	15	0	10	1	0.07	1.8
35	LAKE COEUR D'ALENE	2.30	2.3	0.018	0.02	0.02	0.16	12	0	5	0	0.18	9.2
36	LAKE LOWELL	12.8	12.8	0.051	0.03	0.05	0.52	24	0	25	0	0.54	10.7
37	LAKE PEND OREILLE	2.20	0.0	0.008	0.02	0.05	0.35	6	0	5	0	0.36	45.0
38	LAKE WAHA	6.60	5.1	0.110	0.23	0.13	0.71	79	6	.	.	0.94	8.5
39	LAKE WALCOTT	9.60	0.0	0.106	0.20	0.01	0.28	0	0	5	0	0.48	4.5

40	LAMONT R	7.00	1.6	0.040	0.02	0.00	0.08	.	.	5	0	0.09	2.3
41	LITTLE CAMAS R	12	5.2	0.089	0.02	0.00	0.20	0	0	15	2	0.21	2.4
42	LITTLE WOOD R	5.60	2.2	0.060	0.02	0.00	0.24	0	0	10	0	0.25	4.2
43	LOWER BERNARD L	1.20	.	0.013	0.02	.	0.07	.	.	5	.	0.08	6.2
44	LOWER PRIEST L	0.80	0.8	0.004	0.02	0.08	0.20	2	0	5	0	0.21	52.5
45	LUCKY PEAK R	5.00	5.0	0.030	0.01	0.16	0.08	0	0	5	1	0.09	3.2
46	MACARTHUR L	8.60	0.0	0.057	0.02	0.01	0.13	0	0	.	0	0.14	2.5
47	MACKAY R	1.60	0.6	2.658	0.02	0.31	3.35	.	.	5	0	3.36	1.3
48	MAGIC R	5.80	0.2	0.022	0.02	0.02	0.15	0	0	10	1	0.16	7.3
49	MANN'S CREEK R	4.00	4.0	0.032	0.02	0.25	0.13	1	0	20	0	0.14	4.4
50	MANN'S L	5.00	3.9	0.150	0.21	0.12	1.57	413	56	.	.	1.78	11.9
51	MILNER R	8.60	2.6	0.152	0.28	0.59	0.24	0	0	15	0	0.52	3.4
52	MOOSE CREEK R	0.60	0.6	.	0.02	.	0.12	.	.	30	.	0.13	.
53	MORMON R	22.2	3.8	0.769	0.02	0.01	0.20	0	3	20	1	0.21	0.3
54	MOUNTAIN HOME R	42	8.8	0.093	0.02	0.01	0.18	0	3	25	3	0.19	2.0
55	MURTAUGH LAKE R	56	5.6	0.148	0.29	0.01	0.44	34	93	5	0	0.73	4.9
56	MYRTLE L	1.40	0.0	0.004	0.02	0.00	0.14	0	0	.	0	0.15	37.5
57	OXBOW R	3.60	.	0.045	0.25	0.04	0.29	0	0	5	.	0.54	12.0
58	PALISADES R	4.80	2.6	0.039	0.03	0.02	0.16	.	.	5	0	0.18	4.7
59	PAYETTE L	.	0.0	0.014	0.02	0.04	0.44	.	.	.	.	0.46	33.0
60	PERKINS L	1.00	0.0	0.018	0.02	0.01	0.08	0	0	.	0	0.09	5.0
61	PETIT L	1.60	0.0	0.016	0.02	0.00	0.16	2	0	5	0	0.17	10.6
62	PORTNEUF R	9.00	7.0	0.045	0.02	0.00	0.16	.	.	5	0	0.17	3.8
63	REDFISH L	1.40	0.0	0.004	0.02	0.03	0.12	0	0	5	0	0.13	32.5
64	RIRIE R	2.00	1.4	0.015	0.02	0.36	0.07	.	.	5	0	0.08	5.3
65	ROSE L	3.80	2.0	0.032	0.02	0.12	0.47	.	1	25	0	0.48	15.0
66	ROUND L	3.00	0.0	0.024	0.02	0.03	0.16	0	0	10	0	0.17	7.1
67	SALMON FALLS CREEK R	7.80	1.8	0.086	0.02	0.26	0.08	0	0	15	1	0.09	1.0
68	SEVEN DEVILS L	3.00	1.8	0.017	0.02	0.00	0.14	.	.	5	.	0.15	8.8
69	SHELF L	.	3.4	0.015	0.02	0.02	0.05	.	.	5	0	0.06	4.0
70	SILVER L	2.00	.	0.037	0.02	0.00	0.29	0	0	10	0	0.30	8.1
71	SODA POINT R	1.80	1.2	1.067	0.02	.	1.56	.	.	5	0	1.57	1.5
72	SOLDIERS MEADOW R	5.40	1.8	0.080	0.19	0.16	0.85	167	20	.	.	1.04	13.0
73	SPIRIT L	7.00	0.0	0.018	0.02	0.45	0.07	16	0	5	0	0.08	4.4
74	STANLEY L	1.00	0.0	0.011	0.02	.	0.19	0	0	5	0	0.20	18.2
75	STEVENS L	2.20	0.0	0.004	0.02	0.00	0.16	1	0	5	0	0.17	42.5
76	SWAN FALLS R	.	7.8	0.060	0.11	0.00	0.10	17	3	15	1	0.21	3.5
77	SWAN L	92	24.8	0.239	0.02	.	0.54	0	35	60	2	0.55	2.3
78	TOLO L	43.6	2.4	1.551	0.02	0.01	0.24	0	0	10	1	0.25	0.1
79	TRINITY L	2.00	0.8	0.024	0.02	0.00	0.26	0	0	5	0	0.27	11.3
80	TWIN LAKES LOWER L	2.80	0.0	0.015	0.02	0.04	0.24	30	0	5	.	0.25	16.7
81	TWIN LAKES UPPER L	1.60	0.0	0.023	0.02	0.04	0.31	19	0	5	.	0.32	13.9
82	TWIN LAKES NORTH R	3.60	2.4	0.016	0.02	0.00	0.10	.	.	5	0	0.11	6.9
83	TWIN LAKES SOUTH R	3.20	1.4	0.016	0.02	0.00	0.10	.	.	5	.	0.11	6.9
84	UPPER BERNARD L	1.60	.	0.037	0.02	0.00	0.17	.	.	5	0	0.18	4.9
85	UPPER PRIEST L	0.80	0.8	0.006	0.07	0.09	0.13	0	0	5	0	0.20	33.0
86	WARM L	0.60	0.0	0.010	0.02	0.00	0.11	12	14	5	0	0.12	12.0
87	WILLIAMS L	.	.	0.070	0.05	0.04	0.61	14	1	.	.	0.66	9.4
88	WILSON LAKE R	35.2	4.0	0.125	0.29	0.00	0.13	0	0	10	0	0.42	3.4
89	WINCHESTER L	13.6	.	0.062	0.02	0.00	0.22	0	0	25	3	0.23	3.7

APPENDIX B

An Annotated Bibliography of Research Related to the Sociological/Recreational Considerations of the Idaho Clean Lakes Project

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AESTHETICS

Bagley, Marilyn D., Cynthia A. Kroll and Kristin Clark.

1973 Aesthetics in Environmental Planning. Washington, D.C.: Environmental Protection Agency (600/5-73-009).

Probably the most complete review of visual analysis methods available today. Eighteen different methodologies are discussed in detail, then are evaluated on seven criteria. Many of the methodologies emphasize the aesthetic attributes of water. Litton's (1975) work is given the highest rating among the other four "nonnumerical" visual analysis methods, and is rated higher than all the other methods reviewed. Bagley et al., did an excellent job and their review is highly recommended.

KEY WORDS: aesthetics, visual analysis, environmental planning.

Litton, R. Burton, Jr., R. J. Tetlow, Jens Sorensen and R. A. Beatty

1975 Water and Landscape: An Aesthetic Overview of the Role of Water in the Landscape. Port Washington, New York: Water Information Center, Inc.

This is a detailed discussion of the aesthetic attributes of water and how to measure them. The authors have developed a visual classification system based on three major visual boundaries: the landscape unit, the setting unit, and the water scape unit. The system is intended for compiling very detailed inventories, so is meant to be informative and not evaluative. Potentially a very useful tool for environmental planning as the method is comprehensive and straight forward.

KEY WORDS: aesthetics, water, environmental planning.

USDA, Forest Service

1973 National Forest Landscape Management, Volumes 1 and 2.
1974 Agricultural Handbooks No.'s 434 and 462. Washington, D.C.: Government Printing Office.

The Forest Service's visual management system.

KEY WORDS: aesthetics, forest management, visual analysis.

USDA, Forest Service, Pacific Southwest Region

1979 Proceedings of Our National Landscape. A Conference on Applied Techniques for Analysis and Management of the Visual Resources. Berkeley: Pacific Southwest Forest and Range Experiment Station.

A large collection of papers on visual analysis and management (752 pages).

KEY WORDS: aesthetics, visual resources.

USDI, Bureau of Land Management

1976 Upland Visual Resource Inventory and Evaluation. Washington, D.C.: Government Printing Office.

The BLM's visual management system.

KEY WORDS: aesthetics, visual resource management, BLM.

AERIAL PHOTOGRAPHY

Anderson, James and Richard Witmer

1981 Land resource planning applications of land use mapping and inventory from remotely sensed data. Pp. 429-443 in Proceedings of the 14th International Symposium on Remote Sensing of Environment. Ann Arbor: Environmental Research Institute of Michigan.

Discussion of the U.S. Geological Survey's nationwide land use and land cover mapping and data compilation program. It is a well organized standardized approach to the collection and presentation of land use and land cover information and should be an essential element in any framework or system that intends to study economics, energy, or environmental conditions and problems. About 26 states have been mapped by political units, hydrological units, census county subdivisions and federal lands.

KEY WORDS: aerial photography, land use, resource planning, remote sensing.

Anderson, James R., Ernest E. Hardy, John T. Roach, Richard E. Witmer

1976 A Land Use and Land Cover Classification System for use with Remote Sensor Data. Washington, D.C.: U.S. Geological Survey, Circular 964c.

This publication is the history, philosophy and description of the land use classification system that is widely used throughout the United States. There are 9 categories at the level I classification, 37 at level II, and Levels III and IV are left open for special needs. It is a "resource" oriented system rather than a "people" oriented system. It satisfies three major attributes: (1) it gives names to categories by simply using accepted terminology; (2) it enables information to be transmitted; and (3) it allows inductive generalizations to be made.

KEY WORDS: aerial photography, land use, remote sensing.

Green, Norman E.

1957 Aerial photographic interpretation and the social structure of the city. Photogrammetric Engineering 23:89-96.

Green is a pioneer in reported use of aerial photos for sociological research. These studies are the first systematic attempt to use aerial photos as a research tool by sociologists. The purpose was to identify poor housing sections in urban areas. The photographic interpretation of residential sub-areas succeeded in portraying their true relative structural characteristics.

KEY WORDS: aerial photo interpretation, urban sociology, human ecology.

Green, Norman E. and Robert B. Monier

1959 Aerial photographic interpretation and the human ecology of the city. Photogrammetric Engineering 25:770-73.

Similar findings as the 1957 paper. It is a continuation of the study, done in another city. It was discovered that discrepancies in the photographic observations were distributed non-randomly. This situation provides for a basis for constructing systematic correction factors through knowledge of the nature, amount and direction of the errors.

KEY WORDS: aerial photo interpretation, urban sociology, human ecology.

Harrington, Roscoe B. and S. Ross Tocher

1967 Aerial Photo Techniques for a Recreation Inventory of Mountain Lakes and Streams. Ogden, Utah: Intermountain Forest and Range Experiment Station, U.S. Forest Service.

Describes results of aerial photo techniques tested in Utah to measure the characteristics of mountain lakes and streams. Finds aerial photos very useful as long as some field checking is done.

KEY WORDS: aerial photography, lake survey.

Kraus, Steven P., Leslie W. Singer, and James M. Ryerson

1974 Estimating population from photographically determined residential land use types. Remote Sensing of Environment 3:35-42.

Estimates of population were found by using aerial photos for determining four types of residential land use, estimating area of each, then multiplying this by the estimated population density. There was an average underestimation of 4.5% for four U.S. cities. Recommends using the largest scale photos available and cautions about "hidden" residential use within commercial areas.

KEY WORDS: aerial photography, population estimation.

Lyons, Thomas R. and Thomas E. Avery

1977 Remote Sensing: A Handbook for Archeologists and Cultural Resources Managers. Washington, D.C.: U.S. Department of the Interior.

A very good introduction to aerial photography. The emphasis is on archeological interpretation, but it does treat general interpretation techniques fairly well.

KEY WORDS: aerial photography, cultural features, remote sensing.

Lyons, Thomas R., Robert K. Hitchcock and Wirth H. Wills

1980 Remote Sensing. Aerial Anthropological Perspectives: A Bibliography of Remote Sensing in Cultural Resource Studies. Washington, D.C.: U.S. Department of the Interior.

Appears to be a very complete bibliography of aerial photo use in the social sciences up through 1977.

KEY WORDS: aerial photography, remote sensing, cultural interpretation.

Mumbower, L. and J. Donoghue

1967 Urban poverty study: Aerial photographs facilitate the analysis of a variety of socio-economic aspects of a city. Photogrammetic Engineering 33:610-618.

Quantitative and qualitative descriptions of urban areas were made in terms of the time the photographs were taken and the changes occurring over time through the use of repetitive photo coverage. The authors conclude that aerial photos are extremely useful as a unique source of certain data and in facilitating the use of other data.

KEY WORDS: aerial photography, remote sensing, urban sociology.

Nettles, M. Eugene

1974 Determining landuse changes in watersheds by aerial photographic measurements. South Carolina: Clemson University, Water Resources Research Institute.

A study of two watersheds in South Carolina which utilize aerial photos taken from 1944-1970. The author concludes that periodic aerial photos are an excellent method for determining progressive landuse changes in watersheds.

KEY WORDS: aerial photography, remote sensing, landuse.

O'Malley, James R.

1978 Application of remote sensing in the analysis of the rural cultural landscape. Pp. 239-257 in B. F. Richason (ed.), Introduction to Remote Sensing of the Environment. Dubuque, Iowa: Kendall/Hunt Publishing Company.

Points out two major considerations: scale and sensor type. When correct scale and sensor selection is made most aspects of the rural landscape are captured.

KEY WORDS: aerial photography.

Peplies, Robert W.

1976 Cultural and landscape interpretation. Pp. 483-507 in Joseph Linty, Jr. and David S. Simonett (eds.), Remote Sensing of Environment. Reading, Massachusetts. Addision-Wesley.

Three approaches can be used for interpreting remote sensor imagery: (1) to consider the image as a direct representation of the earth object or process; (2) to consider the image as a surrogate or proxy of some earth object or process; (3) to consider the image as a direct representation of an earth object or process which is normally not detectable within the visual range of the electromagnetic process.

KEY WORDS: aerial photography, remote sensing, cultural features.

Shelton, Ronald C. and Ernest E. Hardy

1974 Design concepts for land use and natural resource inventories and information systems. Pp. 517-535 in Proceedings of the Ninth International Symposium on Remote Sensing of Environment. Ann Arbor: Environmental Research Institute of Michigan.

The design, implementation, application and maintenance of inventories and information systems for land use and natural resources data are described in terms of the remote sensing and computer technology which has in recent years become an important feature of information system development. Basic concepts in use of the technology are outlined from the perspective of potential users of systems and data. Seventeen steps are suggested as guides in the design of systems and projects.

KEY WORDS: aerial photography, land use, natural resources, information systems.

Silberman, Leo

1959 Sociogrammetry. Photogrammetric Engineering 25:419-23.

A study on the use of aerial photos to gather demographic data in Kenya. A small ground sample was done first to determine average number of people dwelling in different types of complexes, then the study of aerial photos was carried out to determine the number of complexes. The

photos were especially advantageous for this situation due to their unobstrusiveness. The author discovered many uses of aerial photos: more exact classification and description of social structures and housing types, determining landuse and economic activities, and determining important correlations between physical and social distributions.

KEY WORDS: aerial photography, remote sensing, human ecology.

Stokes, George A.

1950 The aerial photograph: A key to the cultural landscape. The Journal of Geography 49:32-40.

Conclusion is that the cultural landscape may be studied with greatly reduced expenditure of time and money. The stereographic pair is the most highly recommended type of photo. Familiarity with the landscape under study is highly desirable but not absolutely essential. If field investigation is required, the time needed to satisfactorily complete such investigation will be materially reduced by a careful photographic study made prior to going into the field.

KEY WORDS: aerial photography, remote sensing, cultural features.

IDAHO Research and Data Source

Bovay Engineers

1970 Comprehensive Plan for Kootenai County, Phase II: Evaluation and Forecast. Spokane: Bovay Engineers.

Includes description and location of public recreation sites.

KEY WORDS: Idaho, Kootenai County.

Carlson, John E. and Merle J. Sargent

1979 A Dynamic Regional Impact Analysis of Federal Expenditures of a Water and Related Land Resource Project--Part IV--A Social Impact Analysis of Federal Expenditures on a Water Related Resource Project: Boise Project. Moscow: University of Idaho, Idaho Water Resources Research Institute.

Assessment of the effects of Boise reservoir project on the people of Ada and Canyon counties, from 1940 to 1970. Most significant impacts are increased population and increased water-based recreation. A recommendation is for long range monitoring processes for each public-funded project, with particular emphasis on subjective measures.

KEY WORDS: Idaho, water development, Boise project.

Corbett, M. E.

1973 Recreational capability and land use planning, Priest Lake, Idaho. Edmonton: University of Alberta, unpublished thesis.

Provides much information about recreational use and development on Priest Lake. Eighty percent of the visitors spend the night, (it is a destination area), the average length of visit is 3 1/2 days, and 67% of the visitors live within 150 miles, the majority living in Spokane. Corbett combined a land use classification of the lake shore, with an analysis of water quality, with a questionnaire survey of campers and lakeside campers. Cottagers think of themselves as more environmentally aware than campers, yet they are very intent on locating their cabins close to the water. Her conclusion stresses planning rather than management.

KEY WORDS: Idaho, Priest Lake, land use.

Executive Office of the Governor

1977 Idaho Almanac. Boise: Statehouse.

KEY WORDS: Idaho, almanac, statistics.

Glazanfar, S. M.

1980 Idaho Statistical Abstract. Moscow: University of Idaho.

KEY WORDS: Idaho, statistics.

Hamilton, Joel R.

1971 Idaho Population Changes, Density, and Migration. Moscow: University of Idaho Agricultural Experiment Station, Report 153.

A study of population change in Idaho, 1950-1970. Conclusions are (1) Idaho has slow growth and rapid out migration; (2) dense counties continue to gain residents and sparse are losing (or growing slowly); (3) many counties have too few people and are losing business to other areas due to poor transportation; (4) out migration is state wide (except for 10 counties). The 1980 census reveals that these conditions have changed considerably.

KEY WORDS: Idaho, population, migration.

Harmsworth, Harry

1964 Population Trends in Idaho 1950-1960. Moscow: University of Idaho.

Good source of 1950 data.

KEY WORDS: Idaho, statistics.

Idaho Department of Fish and Game

1980 Pend Oreille Lake fisheries investigations. Lake and Reservoir Investigations. Job Performance Report, Project F-73-R-2.

Primarily a study of Kokanee fishing. Includes tables of angler day activity.

KEY WORDS: Idaho, angler days.

Idaho Department of Health and Welfare

1980 Idaho Water Quality Standards and Wastewater Treatment Requirements, Title I: Chapter 2. Boise: Idaho Department of Health and Welfare, Division of Environment.

Water Quality Standards for Idaho.

KEY WORDS: Idaho, water quality.

Idaho Department of Parks and Recreation

1980 Outdoor Recreation Facilities Inventory, Volumes I and II. Boise: Statehouse.

Volume I is a fairly comprehensive inventory of recreation sites in Idaho, including a detailed inventory of dates, costs, facilities, owners, size, capacity and other factors. Volume II is the county maps which illustrate the location of each site. Most entries are 1976, but the Inventory is in a form that can be easily updated.

Idaho Department of Parks and Recreation

1978 Idaho Outdoor Recreation Plan, 1977. Boise: Statehouse.

A very fine update in the ongoing planning process. Includes an overview of state wide social, environmental, and economic characteristics; more comprehensive data, maps, and discussion on each of the six major planning regions; and data from a 1975 telephone survey of Idaho residents' recreational participation.

KEY WORDS: Idaho, recreation plan, SCORP.

Idaho Department of Parks and Recreation

1973 Idaho Outdoor Recreation Plan, 1973. Boise: Statehouse.

A continuation of data gathering and planning for recreational use in Idaho.

KEY WORDS: Idaho, recreation plan.

Idaho Department of Water Resources

1975 Water Related Land Use - 1975. Boise: Idaho Department of Water Resources.

Includes irrigated acres in 16 southern Idaho counties.

Idaho Department of Water Resources

1975 Idaho Environmental Overview by Hydrologic Basin. Boise: Statehouse.

An excellent report on the condition of many environmental features in Idaho: air, lakes, rivers, elk, fish, etc. Clearly presented by seven hydrologic regions. Conditions are rated as: positive, stable, or negative. Includes a comprehensive bibliography and listing of state agencies in Idaho. Major influences on lake water quality are: mining, dumps and landfills, and housing development.

KEY WORDS: Idaho, environmental quality.

Idaho State Parks and University of Idaho

1967 Idaho Outdoor Recreation Plan. Boise: State of Idaho.

The first of a series. All quantifiable data have been grouped by resource service areas of 0-50 mile (day use) and 50 to 125 mile (weekend trips) radii in relation to zones of population.

KEY WORDS: Idaho, recreation.

Idaho Travel Committee

1980 Idaho travel: An investment in our future. Boise: Idaho Travel Committee.

The travel industry is Idaho's third largest industry and tourism and travel account for 12% of the state's income. The four million visitors to Idaho generate 1 billion dollars in income and 39 million dollars in local tax receipts. Additionally, the travel industry in Idaho provide jobs for 25,000 people.

KEY WORDS: Idaho, recreation, travel industry.

McAlindin, Dave and Alan Porter

1980 County Profiles of Idaho. Boise: Idaho Division of Economics and Community Affairs.

Very useful and accessible statistical report.

KEY WORDS: Idaho, statistics, census, county data.

Milligan, J. H. and C. C. Warnick

1973 Recreation Water Classification System and Carrying Capacity. Moscow: University of Idaho, Water Resources Research Institute.

A classification system using a factor profile approach--a graphical method of presenting important parameters that relate to management and allocation problems. Points to major needs of data collection and further development of the methodology.

KEY WORDS: Idaho, recreation, lake classification.

Murphy, Philip J.

1977 Monitoring recreational activities on six Idaho lakes using remote sensing techniques. Moscow: University of Idaho, unpublished Master's thesis.

Study primarily deals with Lake Coeur d'Alene. Divides the lake into seven sections, finds that boat usage is well below carrying capacity as outlined in State Comprehensive Outdoor Recreation Plan (1973). Uses a formula, deviation index of shoreline, for categorizing lakes based on shoreline configuration.

KEY WORDS: Idaho, remote sensing.

Nybroten, Norman

1971 Idaho Statistical Abstract. Moscow: University of Idaho.

Good source of 1960 data.

KEY WORDS: Idaho, statistics, Idaho population figures.

Pacific Northwest River Basins Commission

1973 Ecology and the Economy: A Concept for Balancing Long-Range Goals. The Pacific N.W. Example. Vancouver, Washington: Pacific Northwest River Basins Commission.

This report is an interesting synthesis of human ecological concepts, economics, and data about the N.W. Good discussion of the use and limitations of the carrying capacity concept. Points out that carrying capacities and bench mark definitions of quality of life aren't fixed for all time. Interesting recommendations and good bibliography.

KEY WORDS: Idaho, Northwest, carrying capacity, ecology, recreation, human ecology.

Pacific Northwest River Basins Commission

1971 Recreation, Appendix XIII. Vancouver, Washington: Pacific Northwest River Basins Commission.

A most complete and enlightening report on recreation in the Northwest. Very strong encouragement for the development of recreation planning strategies. Recognizes the importance of "recreational extension". An educated public, cognizant of and sympathetic with inherent problems, is essential to the success of imaginative, realistic and qualitative planning. The Commission was instrumental in initiating recreation planning and data-collection in the Northwest, but no longer exists.

KEY WORDS: Idaho, Northwest, recreation.

Panhandle Planning and Development Council

1974 Overall Economic Development Plan for the Panhandle Economic Development District. Coeur d'Alene: Panhandle Planning and Development Council.

Includes a comprehensive list of campgrounds and resorts in the Idaho Panhandle.

KEY WORDS: Idaho, Panhandle Region.

Payne, Richard D.

1976 An Inventory of Recreation Home Development in Idaho. Boise: Center for Research, Grants and Contracts, Boise State University.

Gives county by county figures on the number of recreational sites (subdivisions and dispersed) and the number of sites with houses in Idaho. Conclusions are: the majority of recreational housing lots are purchased for purposes of speculation and investment rather than for recreation solely; of the 41,870 recreation lots in the state, only 25% have improvements; the largest concentration of recreation activity is located in counties ill-prepared for it; and, in certain areas potential blockage to recreation access could occur.

KEY WORDS: Idaho, recreational homes.

Payne, Richard D.

1977 Recreation Home Developments in Idaho: Five Case Studies. Boise: Center for Research, Grants, and Contracts, Boise State University.

An indepth look at second home development in five recreation areas of Idaho - Hayden Lake, Priest Lake, Payette Lake, Island Park, and Sun Valley. Besides detailed analysis of available county records and data, a questionnaire survey was distributed to second home owners in each area except Hayden, dealing with demographics, economic issues, and attitudes. This study and its companion volume (Payne, 1976) are an ambitious and commendable study of recreation housing in Idaho.

KEY WORDS: Idaho, recreation homes, resort areas.

Pierce, John C., et al.

1981 Water resource policy and collective representation in Idaho: Legislators, activists, and the general public. Idaho Journal of Politics 4:1-27.

A questionnaire survey of 1056 individuals, 273 signers of the Hydro-Power Protection and Water Conservaton Act Initiative (1977), and all members of the Idaho State Legislature. There was a high return from each group. Findings: water problem areas are allocation, supply, and quality - in that order. The respondents ranked the most important water related activities: agriculture (highest), domestic, energy, industry, preservation, recreation and transportation. Legislators are more developmental and the public is more preservationist, but due to other constraints, federal, interest groups, etc., the actual policy may be pretty close to what the public wants.

KEY WORDS: Idaho, water use, water planning.

Pizzadili, James and Charles McKetta

1979 Idaho's Wildland Resources: Availability and Use. Moscow: Univerity of Idaho Forest, Wildlife and Range Experiment Station.

A collection of statistics divided into seven major sections: resource land, timber resources and forest products, range resources and livestock production, wildland recreation opportunities and participation, water resources, mineral production, and wildlife and fisheries resources.

KEY WORDS: Idaho, natural resources, resource use, statistics.

Pope, Clem L. and Ervin G. Schuster

1975 The Role of Socio-Economic Data in Idaho Land Use Planning. Moscow: University of Idaho, Forest, Wildlife and Range Experiment Station.

A state-wide questionnaire survey of 35 agency planners in which they were asked to rank the importance and availability of 65 examples of socio-economic data. The data was categorized as recreation, community, population, income and employment, and industry. Recreation data was determined to be the most important and the least available. Large gaps also exist between importance and availabiltiy of the other type of data, except population. Many planners have little experience in using socio-economic data and have problems interpreting and communicating the results and relating the data to planning efforts. Meshing the time and space parameters of the research with that of the available data is the major problem.

KEY WORDS: Idaho, socio-economic data, recreation.

Porter, Alan

1973 Proposed Land Use Classificaton System: A Working Paper. Boise: State Planning and Community Affairs Agency.

A good system, very similar to Anderson's, et al. (1976), developed in accordance with the Federation of Rocky Mountain States (Colorado, Idaho, Montana, New Mexico, Utah, and Wyoming).

KEY WORDS: Idaho, land use classification.

Simpson, Claude and Catherine

1981 North of the Narrows: Men and Women of the Upper Priest Lake Country, Idaho. Moscow: The University Press of Idaho.

A history of the Priest Lake area from 1914 to the present. Includes many photographs.

KEY WORDS: Idaho, Priest Lake.

Strowens, J. P.

1982 Pend Oreille Lake Master Plan. Coeur d'Alene: J. P. Stevens Planning Consultants.

A description of land type, land use, and lake use in the vicinity of Lake Pend Oreille. There are thirteen major recommendations addressing water quality monitoring, protection of critical habitat, fisheries, historic sites, aesthetic features, planned development, and regional cooperation and planning. This is only the first step in the process of developing plans, rules, and regulations. Public meetings and city council and county board approval must follow.

KEY WORDS: Idaho, Pend Oreille, lake use planning.

Thorsen, David M.

1979 Sandpoint Mountain Lake Management Plan and Inventory. Sandpoint: Sandpoint Ranger District, Idaho Panhandle National Forests.

A comprehensive, interrelated study of the use and condition of twelve mountain lakes, six in the Selkirk Mountains and six in the Cabinet Mountains. Reasoning behind the study is stated as: "the recreational user is the focal point regarding all management of mountain lakes. The physical, chemical, and biological characteristics are all interrelated and the recreational use a lake receives is a very important portion of that relationship" (p. 41). The study of each lake includes an aerial photo, a description of the flora and fauna near the lake; physical description of the lake; results from biological and chemical tests; study of the fish population; description of trails and campsites; and an analysis of user questionnaires acquired from voluntary, remote questionnaire boxes located at the trail head to each lake. A uniquely

comprehensive study of remote lakes. A follow-up study will soon be available.

KEY WORDS: Idaho, mountain lakes, Panhandle National Forests.

U.S. Army Corp of Engineers

1981 Recreation Statistics. Washington, D.C.: Department of the Army.

The latest of a yearly report on recreational use of Army Corp reservoirs. Idaho reservoirs reported on are Albeni Falls (Lake Pend Oreille), Dworshak, and Lucky Peak. Use is measured in "recreation days", a visit by one individual to a recreation area for recreation purposes during any reasonable portion or all of a 24 hour period. An individual may make more than one visit and participate in more than one activity.

KEY WORDS: Idaho, recreation data, Army Corp, reservoirs.

U.S. Army Corps of Engineers

1979 Water resources development in Idaho. Washington, D.C.: Army Corp of Engineers.

A fairly comprehensive discussion of past, present, and future activities of the corps in Idaho. Their basic policy on recreation is: "Recreational and fish and wildlife enhancement features may be developed as part of a federal water resource project, provided they are compatible with authorized purposes of the project, and: such features are economically justified, i.e., benefits would exceed costs; nonfederal entities agree to administer the project land and water areas for recreation and fish and wildlife purposes; and, nonfederal entities agree to bear 50% of the costs for recreation and 25% of the costs for fish and wildlife" (p. 10). The report states that so far, joint-use management agreements between the Corps, State Land Board, Potlatch, and Idaho Fish and Game have not been too successful.

KEY WORDS: Idaho, water development, Army Corps.

Zimmer, David W. and J. Eric Glover

1980 Algae Blooms and Phosphorus Loading in Lake Lowell, Boise Project, Idaho. Boise: Water and Power Resources Service.

Part of an on-going study of water quality problems at Lake Lowell. Algal blooms sometimes limit the recreational use of the lake. In some years the lake has been closed for recreational use in late summer because of poor aesthetic conditions. Feral coliform bacteria counts occasionally exceed Idaho water quality standards from primary contact recreation waters. The study also states that limnological studies of north temperate lakes and reservoirs strongly suggest that the magnitude of

algal blooms is determined by the concentration of phosphorus in the surface water. A conclusion is that the aesthetics and fishery of Lake Lowell would be enhanced if nuisance algal blooms and related water quality problems were controlled. Research on the water quality problems at Lake Lowell is ongoing.

KEY WORDS: Idaho, Lake Lowell, water quality, recreation, phosphorus.

LAKE STUDIES

Burdge, Rabel J. and Paul Opryszek

1981 Coping with Change: An Interdisciplinary Assessment of the Lake Shelbyville Reservoir. Urbana: University of Illinois. Institute for Environmental Studies.

An indepth retrospective assessment of the environmental and socio-economic impacts of a major reservoir project. Possibly the most comprehensive, interdisciplinary study of a water project impacts that is available today.

KEY WORDS: lake studies, water development, social impact assessment.

Environmental Protection Agency

1980 Clean Lakes Program Guidance Manual. Washington, D.C.: Office of Water Regulations and Standards.

The guide for the Clean Lakes Project, including information on entrophication and rehabilitation techniques.

KEY WORDS: lake studies, regulations, Clean Lakes Project.

Hardy, Rudolph W.

1977 The Impact of Urbanization on New England Lakes: An Experiment in Regional Interdisciplinary Research to Assist Lake Management Efforts, Volume I. Boston: The New England Council of Water Center Directors.

A quite detailed, primarily social analysis, of six New England lakes. Almost as informative about carrying out interdisciplinary, team research as it is about lakes. The objective of this study is to uncover and understand the basic problems resulting from interactions between urbanization processes and lake ecology. The conceptual model of the physical and social aspects of lakes includes three major factors: (1) The social system (urbanization); (2) The ecological-physical system (lakesheds); (3) The lake quality management system.

KEY WORDS: lake studies, human ecology, urbanization, New England.

Honey, William D. and Thomas C. Hogg

1978 A Research Strategy for Social Assessment of Lake Restoration Programs. Corvallis, Oregon: Corvallis Environmental Research Lab (EPA/600/5-78/004).

The purpose of this study is to provide a methodology for research and data analysis to assess the social impact of lake restoration programs. A cultural ecological model is employed and appears to be useful because it calls for examination of both spatial and temporal parameters. This document could be very useful to anyone studying cultural ecology of lakes because it offers a framework, a research strategy, and a list of variables that need to be considered. This is still a preliminary study. The authors are currently testing their method on lake restoration projects in Oregon.

KEY WORDS: lake studies, social impact assessment, lake restoration, cultural ecology, ehtnology, social anthropology.

O'Sullivan, P. E.

1979 The ecosystem-watershed concept in the Environmental Sciences - A review. International Journal of Environmental Studies 13:273-281.

The ecosystem-watershed concept provides a framework for inter-disciplinary studies of the dynamics and processes of lakes. It is a logical step in the evolution of lake study methodologies. It involves the integration of the approach and findings of a number of previously separate areas of research: ecology, hydrology, meteorology, limnology, and sociology. The basis of the concept is that in many watersheds, inputs, outputs and processes are dominated by cultural factors. Many effects of humans are thus transmitted and expressed via the material pathways of the ecosystem-watershed. This transmitting of effects via the hydrological cycle necessitates the inclusion of feedback loops in the model. Cultural systems impact the non-human ecosystem, having reciprocal effects in the cultural system and also impacting output changes. Some of the output changes (or indirect effects) such as increased run-off, landform changes and eutrophication, can then also have an impact on the cultural system, affecting agriculture, forestry, mining and recreation uses of the ecosystem-watershed.

Also see: many of the other sections, especially "Idaho", the recreation sections, "Social Indicators", and "Water Development".

POPULATION

Huszar, Paul

1979 Projecting regional population with an input-output model. Growth and Change 10:2-11.

Discusses the use of a regional input-output model for projecting jobs, migration and population. Special economic characteristics of the region are explicitly recognized, the projections are based upon local industry and growth estimates, and the model provides internally consistent projections.

KEY WORDS: population, migration, economic forecasting.

Long, Larry H. and Kristen A. Hansen.

1979 Reasons for Interstate Migration: Job, Retirement, Climate, and other Influences. Washington, D.C.: U.S. Gov. Printing Office, Current Population Reports, Series P-23, No. 81.

A nationwide sample of 16,332,000 people, using data from the 1974, 1975, and 1976 Annual Housing Surveys. Jobs appear the main influence on migration: 23.8% moved because of job transer, 23.6% for a new job or looking for work, 7.5% moved to be closer to family, 5.1% for a change in climate, and 3.4% retirement. Conclusion is that although jobs appear to be the main factor in migrating, retirees and part-time workers probably constitute a rising proportion of migrants who are not looking for a full-time job (a neglected aspect of many past attempts to model migration flow.)

KEY WORDS: population, interstate migration.

Morrill, Richard L.

1978 Population redistribution, 1965-75. Growth and Change 9:35-43.

Useful maps illustrating national routes of migration: 1965-70, 1970-75. Briefly discusses economic, social, technological, and environmental influences. Environmental factors are: retirement to an agreeable location, recreation, and rural preference.

KEY WORDS: population, recreation, migration.

Shryock, Henry S. and Jacob S. Siegel and Associates

1976 Methods and Materials of Demography. Academic Press: New York.

Probably the most comprehensive, yet easy to understand, sourcebook on population studies. First published in a two-volume set by the U.S. Bureau of the Census in 1971. This abridged volume retains the organization and topics of the earlier volumes and is designed to be used as a textbook and as a reference for the professional. Anyone required to work with population data would be well advised to consult Shryock.

KEY WORDS: population, demography.

Wardwell, John M.

1980 Toward a theory of urban-rural migration in the developed world. Pp. 71-114 in David M. Brown and John M. Wardwell (eds.), New Directions in Urban-Rural Migration. New York: Academic Press.

A good discussion of urban to rural migration in an international context. Wardwell develops a paradigm of nonmetropolitan turnaround which contains twelve major elements. A major conclusion is that planners should be concerned with the duration of impacts. Since the new migration has been occuring for the last 10 to 15 years, the impacts may last for several decades.

KEY WORDS: population, migration.

Wardwell, John M. and David L. Brown

1980 Population redistribution in the United States during the 1970's. Pp. 5-35 in David L. Brown and John W. Wardwell (eds.), New Directions in Urban-Rural Migration. New York: Academic Press.

For the first time in the twentieth century, the rate of population growth in nonmetropolitan areas (9.1%) has exceeded that in metropolitan areas (5.4%). Three interrelated factors appear to be at the root: economic decentralization, preference for rural living, and modernization of rural life.

KEY WORDS: population, migration, quality of life.

Wolf, Peter

1981 Land in America: Its Value, Use, and Control. New York: Pantheon Books.

Chapters 11 (Migration) and 13 (Recreational Lots and Second Homes) offer interesting discussion of the link between land, power, and wealth in America. Encourages a more careful examination of the intricate and intimate connections between these factors and a more purposeful land use policy.

KEY WORDS: population, landuse.

RECREATION IMPACTS ON WATER QUALITY

Aukerman, Robert and William T. Springer

1976 Effects of recreation on water quality in wildlands: Eisenhower Consortium, Bulletin 2. Ft. Collins: Colorado State University.

Stream water testing was done near eight campgrounds (along a river) in the Colorado front range west of Fort Collins from July 21, 1974 to July 20, 1975. The objective was to determine if bacterial densities increase in water as recreational user (camper) concentrations increase in nearby campgrounds. While some bacterial pollution was found to be contributed at each campground, the amount was insignificant. Scattered camping along the river, R. V. camping, and easy access were determined to be an important contributing factor to bacterial pollution.

KEY WORDS: recreation impacts on water quality, recreation, water quality.

Dietrich, Paul and George Mulamoottil

1974 Does recreational use of reservoirs impair water quality? Water Pollution Control, (February):16-18.

Two years of study during the summers of 1971 and 1972 on Laurel Ck. Reservoir in Ontario, Canada, examined bacteriological quality from six sampling stations - total and fecal coliform results show some correlation between recreational use and coliform count, but it is a pretty vague relationship. Recommendations are: regular sampling, testing for fecal rather than total coliform, regular estimations of urea, compilation of more accurate attendance records, including activity breakdown.

KEY WORDS: recreation impacts on water quality.

Funk, William H.

1977 The natural function of lakes. Pp. 13-17 in William Funk and Linda McKenzie (eds.), Issues in Competing Uses of Lakes and Reservoirs. Pullman: Washington State Water Resources Research Center.

Funk points out that the release of phosphorus from sediments is about 4 to 5 times greater if you have turbulence. So there can be a much higher induced eutrophication by having extensive motor boat use on very shallow lakes.

KEY WORDS: recreational impacts on water quality.

Johnson, Bruce

1975 Water quality as an approach to managing recreational use and development on a mountain watershed. Logan: Utah State University, unpublished thesis.

Bacterial parameters were found to be most sensitive indicators of water quality changes caused by recreation, agricultural, or grazing activity. Total coliform seems to be a better indicator of water quality changes when comparing different sites, while fecal coliforms are more sensitive in indicating seasonal differences in recreational activity. There appears to be a better correlation between number of visits and contamination than between visitor days and contamination.

KEY WORDS: recreation impacts on water quality, Ogden River, Utah, bacteriological contamination.

Manning, R. E.

1979 Impacts of recreation on riparian soils and vegetation. Water Resources Bulletin 15:30-43.

Purpose is to review and synthesize the literature dealing with the physical impacts of recreation on soil and vegetation. A major problem is the time lag between intensity of use and resultant ecological effects. The author emphasizes the need for early indicators--not noticeable to the subjective viewer--such as pH or breakdown of health and age distribution in plant material. An important point is raised about environmental impacts by recreationists. The level of environmental change is a management function, even light use has impact, so the manager must decide when the impacts become excessive in light of the objectives the area is to serve.

KEY WORDS: recreation impacts on water quality, riparian soils and vegetation, recreation management.

Skinner, Quentin D., John C. Adams, Paul A. Rechard, and Alan A. Bettle

1974 Effect of summer use of a mountain watershed on bacterial water quality. Journal of Environmental Quality 3:329-35.

This study compares natural, grazing, and recreational effects on coliform counts in a stream system in the Nashfork Watershed Study Area, Wyoming, during the summer of 1970, 1971, and 1972. The main finding is that recreational areas appear more polluted than the natural areas. So this finding stands in disagreement with the finding of Stuart (1971).

KEY WORDS: recreation impacts on water quality, water pollution.

Snyder, Gordon

1980 Monitoring on wilderness water quality. Pp. 504-516 in Symposium on Watershed Management 1980. New York: American Society of Civil Engineers.

A methodological sound study of recreation impacts on three wilderness lakes in the Anaconda-Pintlar Wilderness Area. Fecal coliforms were found at trail-side stations, but not in lakes; while fecal streptococci were found at several lake stations, but only one trail station. Four parameters were statistically and logically chosen to represent lake trophic status: field conductivity, field pH, suspended solids, and potassium. Conclusion is that increasing recreational use of wilderness areas will result in large scale impacts.

KEY WORDS: recreation impacts on water quality, wilderness lakes.

Stuart, David G., Gary K. Bissonnette, Thomas D. Goodrich, and William G. Walter

1971 Effects of multiple use on water quality of high-mountain watersheds: Bacteriological investigations of mountain streams. Applied Microbiology 22:1048-54.

Study of two watersheds near Bozeman, Montana during 1968, 1969 and 1970. One has been closed to human use since 1917, the other was open to recreational use. Opening of the closed drainage to recreation in 1970 coincided with an unexpected decrease in bacterial contamination. The authors suspect that less wild animal use of the watershed due to human influence may be the reason for lowered bacterial contamination.

KEY WORDS: recreation impacts on water quality, recreation, watershed pollution.

RECREATIONAL USE OF WATER

Conner, Karen A. and Gordon L. Bultena

1981 Social class differences in reservoir visits. Water Resources Bulletin 17:1086-88.

A questionnaire study of Des Moines, Iowa, residents on their usage of two reservoirs, one 74 miles, the other 198 miles round trip from Des Moines. One finding is that upper class respondents (based on income, ed., and occ.) were twice as likely to visit the distant reservoir.

KEY WORDS: recreational use of water, lake use.

Chiang, Sie Ling and William A. Gast

1977 A methodology for outdoor recreation analysis in a state water resources planning study. Water Resources Bulletin 13:677-89.

Their methodology, developed for Pennsylvania, utilizes the variables of population, participation rate, and participation frequency. They caution that a sophisticated method doesn't guarantee a superior result due to changing national priorities, changing social values, and technology. They also remind the researcher to include turnover-factor when figuring recreation area capacities: camping = 1, swimming = 2.

KEY WORDS: recreational use of water, methodology, prediction.

Field, Donald R. and Neil H. Cheek

1981 Focused and diffuse patterns of aquatic recreation behavior. Water Resources Bulletin 17:16-22.

Data obtained from a 1975-76 Washington statewide outdoor recreation survey. Looks at two independent variables: focused households, those participating in only water-based activities and diffused households, those participating in water and non-water based activities. They find that focused households are more likely to participate in fishing while diffused households are more likely to be swimmers. A conclusion is that the conditions and kinds of recreational settings and the mix of household types set the stage for perceived crowding to be expressed, rather than the mere presence of large numbers of individuals.

KEY WORDS: recreational use of water, focused and diffused households, water activities, activity clusters, recreation place, crowding.

Merewitz, Leonard

1966 Recreational benefits of water resources development. Water Resources Research 2:625-40.

Study took place at Lake of the Ozarks. Population, density, distance, and income were found to be important variables when determining amount of use. Mobility and alternative sites were found to be not so important. The authors stress that recreation is a tangible project output whose benefits can be quantified in monetary terms.

KEY WORDS: recreational use of water, reservoirs, economic benefits, recreational use forecasting.

Stevens, Joe B.

1966 Recreation benefits from water pollution control. Water Resources Research 2:167-82.

Fishing is the recreation activity discussed in this research. The author develops a method for determining the economic benefit of fishing for an area (Yaquina Bay, Oregon).

KEY WORDS: recreational use of water, water quality, economic benefits.

Storey, E. H. and R. B. Ditton

1970 Water quality requirements for recreation. Pp. 57-63 in Earnest F. Gloyna and W. Wesley Eckenfelder, Jr. (eds.), Water Quality: Improvement by Physical and Chemical Processes. Austin: University of Texas Press.

A general discussion of the recreation and water quality relationship. Points out that recreation activity demand hinges upon four major determinants: leisure time, disposable income, population increase, and mobility. Agrees with many other researchers on the dependence of perceptions of water quality on the personality and activity of the user.

KEY WORDS: recreational use of water.

Turner, R. K.

1977 The recreational response to changes in water quality: A survey and critique. International Journal of Environmental Studies 11:91-98.

A good general survey and review of literature. Turner makes explicit what is usually seldom referred to, that the value of water for any single recreation use will depend on a number of water quality characteristics.

In addition, an improvement in one quality parameter may affect on recreation use favorably while simultaneously affecting an late native recreational use negatively.

KEY WORDS: recreation, water quality, perception of the environment.

Tussey, Robert C., Jr.

1967 Analysis of Reservoir Recreation Benefits. Lexington: University of Kentucky, Water Resources Institute.

A study of recreational use of two reservoirs in Kentucky (Rough River and Dewey). Determines that the most important variables for determining reservoir use are population and route-distance while the variables of income, competition from other reservoirs and age were found not to have an influence on reservoir use. An interesting finding is that air distance was selected as most significant among the distance parameters of air, time, and road.

KEY WORDS: recreational use of water, reservoirs, recreational use forecasting.

SOCIAL INDICATORS

Anderson, James G.

1973 Causal models and social indicators: Toward the development of social models. American Sociological Review 38:285-301.

Uses health care as an example for causal modeling which treats social indicators as components of social system models. Changes in the values of these social statistics over time tell us something about the functioning of the social system.

Andrews, Wade H., Clay W. Hardin, and Gary E. Madsen

1981 Social assessment indicators in water resource development. Environment and Behavior 13:64-82.

This article is a result of years of research into water development problems in Utah. The authors point to seven issues and problems in social impact assessment that require special consideration. (1) Levels of causation: direct, indirect, second order indirect, (also, threshold effects are variable for different communities). (2) Objective versus subjective measures. (3) Protective vs. evaluative assessment. (4) Economic vs. psychological vs. social motivation models indicate the need for interdisciplinary research. (5) Microlevel and macrolevel impacts, (beware of the ecological fallacy). (6) Homogeneous vs. subcultural view of America (7) Phases of development. Valuable food for thought for anyone working with social impact assessments. If all these problem areas are addressed and if some attempt is made to deal with them in a SIA, then its validity and chances for acceptance will undoubtedly increase.

KEY WORDS: sociological analysis, social impact assessment, water development, social indicators.

Andrews, Wade H., Gary E. Madsen, and Clay W. Hardin

1979 Testing Social Indicators in the Techcom Model for Water Development. Logan: Utah State University, Institute for Social Science Research on Natural Resources.

This report could be the most complete review and analysis of research and social indicator concepts related to water development projects. The authors review of current techniques is actually a state-of-the-art report on social impact assessment. An interesting addition to their evaluation of the Techcom model is the solicited reactions of a number of experts in the field of social impact assessment. The authors are very critical of the proliferation of lists of variables as attempts to measure social well-being. A lack of specificity and clarity of purpose results in a wide range of indicators that do not add up to a theoretically consistent set of items and leads to collecting data on everything in hopes that nothing will be missed. A reoccuring problem surfaces throughout the study, how to develop a mix of objective and subjective indices that truly measures social well-being. The collection of primary data whenever possible is a major recommendation.

KEY WORDS: social indicators, water development, Utah.

Fitzsimmons, Stephen J., Lorrie I. Stuart, and Peter C. Wolff

1977 Social Assessment Manual. Boulder, Colorado: Westview Press.

One of the most complete manuals on social impact assessment related to water development projects. A major portion is devoted to the research and analysis related to a social well-being account. Quality of life is discussed as an expression of the degree to which individuals and families enjoy their lives in good health, economic security, and general peace of mind. While social well-being is evaluated at a higher level of aggregation and is an expression of social values at the level of the community. Evaluated in Andrews, et al. (1979).

KEY WORDS: social indicators, social impact assessment, water resource assessment.

Harris, Douglas H.

1974 The Social Dimensions of Water-Resource Planning. Santa Barbara, California: ANACAPA Sciences, Inc.

There are three interacting domains influencing resource planning: technical, economic, and social. This report identifies forty-two social aspects of water, derived from 388 water resource concepts. Five major dimensions are determined to represent the forty-two factors: quality, allocation and conservation, public involvement, natural beauty, and public access. This report is also evaluated by Andrews et al. (1979).

KEY WORDS: resource planning, social indicators, water use.

Johnston, Denis F.

1977 Basic Disaggregations of Main Social Indicators: The OECD Social Indicators Development Programmme. Paris: Organization for Economic Co-operation and Development, Special Studies #4.

Social indicators serve five main purposes: description, analysis, programme evaluation, policy development and normative considerations. The disaggregation of composite indicators is restricted to a reversal of the procedure whereby they were originally constructed. The attempt to disaggregate a composite index into units which did not enter directly into its composition is one form of the "fallacy of the wrong level."

KEY WORDS: social indicators.

Klaus, J.

1978 Economic and environmental assessment of a water quality management system (River Water). Pp. 203-224 in District F. Burkhardt et al. (eds.), Environment Assessment of Socio-economic Systems. New York: Plenum Press.

A discussion of economically based social indicators. Assuming that men, as consumers, behave rationally according to the economic principle, the monetary outlay for obtaining a consumer good can never be larger that the resulting subjective utility. By identifying all recreation expenses, a lower limit of the actual benefits from fishing, boating, and swimming can be estimated. Also discusses the change in economic value of recreation based on water quality.

Machlis, Gary E.

1978 Social indicators approach. Pp. 71-133 in Assessing Energy/Society Relations. Washington, D.C.: Department of Energy.

Discussion of social indicators, data sources, and social systems. Useful appendices: census data sources for selected social indicator measures, key social indicators from census data, and selected social indicators from a variety of data sources.

KEY WORDS: social indicators, social impact assessment.

Machlis, Gary E. and Donna A. Chickering

1981 Social indicators for Olympic National Park Biosphere Reserve. Moscow: University of Idaho, College of Forestry.

An experiment in using social statistics to help monitor ecological change in a biosphere reserve. The basis is that since activities of society which cause ecological change can themselves be measured by social indicators, the indicators can then be used to determine broad trends concerning environmental change in a particular area. Four variables were chosen for study (population growth, utilization of natural resources, industrial growth, and tourism) based on three criteria: had to be readily available, recorded over a period of time, and related to the ecological conditions of the area under study. The indicators of each variable were combined into an "Human Activity Index" which is fairly simple to determine, use, and understand and thus has great potential use by resource managers for assessment, planning, and education. This study is a valuable addition to social indicators research.

KEY WORDS: social indicators, human ecology, biosphere reserves.

Perle, Eugene D.

1970 Editor's introduction. Urban Affairs Quarterly 6:135-143.

There are five major themes in the social indicators literature: improved descriptive reporting on the state of the society, analysis of social trends and social change, assessing the performance of society, anticipating alternative social futures, and social knowledge for societal control. Very little discussion of these themes.

KEY WORDS: social indicators.

Rossi, Robert J. and Keven J. Gilmartin

1980 The Handbook of Social Indicators: Sources, Characteristics and Analysis. New York: Garland STPM Press.

A very useful primer on the development, use, and display of social indicators. Each chapter is well summarized, allowing easy access to the large amount of information contained in the book. Pros and cons are given on many issues so the reader gains a good understanding of the "state of the art" in social indicators research.

KEY WORDS: social indicators.

WATER DEVELOPMENT

Andrews, Wade and Dennis Geersten

1970 The Function of Social Behavior in Water Resource Development. Logan: Utah State University, Institute for Social Science Research on Natural Resources.

Determining socio-psychological value patterns and the interrelatedness of basic cultural and social organizational arrangements will lead to an understanding of beliefs and attitudes towards water projects. This understanding is especially important when attempting to eliminate opposition.

KEY WORDS: water development.

Andrews, Wade, Gary Madsen and Gregory Legaz.

1974 Social Impacts of Water Resource Developments and their Implications for Urban and Rural Development: A Post-Audit Analysis of the Weber Basin Project in Utah. Logan: Utah State University, Institute for Social Science Research on Natural Resources.

A very detailed discussion of the social concepts related to water resource development. Reports on a comprehensive sociological research project on the impacts of a large reservoir project in northern Utah. The area appeared to be undergoing rather dramatic social change. Urbanization was a big factor, also large increases in water related outdoor recreation. The study compared farmers and non-farmers throughout. For both groups, 33% felt that the aesthetics of an area was the most enjoyable aspect of recreation. Two findings are: camping and picnicking increased by 62% in the area between 1960 and 1971, and reservoir planning projections tended to underestimate recreational use.

KEY WORDS: social indicators, water based recreation.

Honey, W. D. and T. C. Hogg

1976 Dam the River: The Proposed Days Creek Dam and the Human Ecology of the South Umpqua. Corvallis: Oregon State University, Department of Anthropology and Water Resources Research Institute.

A very comprehensive study of the South Umpqua region, using human ecological models as the basis of study. The researchers differentiate between quality of life and social well-being. Quality of life includes measures of social well-being and happiness, it is a subjective measure of individual satisfaction with his position in a cultural and environmental relationship. Social well-being is more of an objective measurement in which observations are made as to people's income, physical and mental health, nutrition, education, and so on. They conclude that the main impacts of the proposed dam would be on the relocatees, because impacts on cultural subsystems show major relationships to 1) property and distribution of goods and services, 2) territorial unit relationships and associations, and 3) patterns of order and control. These factors are most disrupted for those who are required to move from their homes.

KEY WORDS: water development, human ecology, quality of life, social well-being.

Pierce, John C. and Harvey R. Doerkson

1975 Public Attitudes Toward Water Allocation in the State of Washington: Citizens, Interest Groups, and Agencies. Pullman: Washington State University and State of Washington Water Research Center. Report #22.

A discussion of findings from a state wide questionnaire of 687 Washington citizens and an extensive questionnaire survey of the members of five river basin committees, a sample of the public in those basins, leaders of water interested organizations, managers of irrigation districts, and directors of public works. One finding is that water managers don't view public participation too favorably. Another is that citizen advisory committees are seen as very useful and as representing the public's attitudes. Rank of water uses: agriculture, domestic, energy, industry, preservation, transportation, recreation.

KEY WORDS: water development, water use, politics of water.

Smith, Courtland and Thomas C. Hogg

1971 Benefits and beneficiaries: Contrasting economic and cultural distinctions. Water Resources Research 7:254-263.

The authors encourage determining who are the benefactors and who are the beneficiaries of a water development project. Benefit-cost decision making is not an objective, value free logical system, but is a logical system conceived to optimize a unique set of cultural values. The consequences of this is very often conflictive social interaction. Refinements to benefit-cost decision making are suggested which include: awareness of the roles being performed by all persons involved, their willingness to perform the roles, and their evaluation of the roles.

KEY WORDS: water development, cost-benefit analysis.

U.S. Water Resources Council

1973 Water and related land resources: Establishment of principle and standards for planning. Federal Register: September 10.

The overall purpose of water and land resource planning is to promote the quality of life by (1) enhancing national economic development and (2) enhancing the quality of the environment.

KEY WORDS: water development, water quality.

WATER QUALITY

Billings, Wayne M.

1981 Water-associated human illness in Northeast Pennsylvania and its suspected association with blue-green algae blooms. Pp. 243-255 in Wayne W. Carmichael (ed.), The Water Environment: Algal Toxins and Health. New York: Plenum Press.

Investigation of wide-spread sickness over a three week period in two lake-shore communities in Pennsylvania during the summer of 1979. A thorough investigation concluded that very large numbers of blue-green algae, genus anabaena, were the culpret. Symptoms ranged from gastrointestinal flu-like symptoms to hayfever-like symptoms. Young children had more of the flu symptoms while adults had more of the hayfever symptoms, possibly because children tend to "drink" more water while swimming. No discussion of the causes of the algae bloom.

KEY WORDS: water quality, water-related illness, algae.

Cannon, Kessler R.

1976 The problem in persepctive. Pp. 1-8 in Non-Point Sources of Water Pollution. Corvallis: Oregon State University, Water Resources Research Institute.

In the entire Pacific N.W. Columbia Basin region, 60% of pollution loads is from non-point sources: 45% comes from agricultural land, 28% from range, 23% from forest (2/3 from logging roads), and 4% from other.

KEY WORDS: water quality, non-point pollution, land use.

Cutter, Susan Caris

1981 Community concern for polllution. Social and environmental influences. Environment and Behavior 13(1):105-24.

A study of 940 Chicago residents which assesses the social and environmental influences on community concern for pollution of Lake Michigan. It was found that attitudes toward pollution are inversely related to the social characteristics of the community. High concern for the environment was related to low neighborhood stability (high mobility rates coupled with high densities). This was true regardless of the racial composition of the community. Environmental quality was also found to be an influence on community concern for pollution. Social and environmental influences were found to be equally important predictors.

KEY WORDS: water quality, community concern, urban attitudes.

David, E. C.

1971 Public perceptions of water quality. Water Resources Research 7:453-57.

A representative sample of 574 Wisconsin adults to determine the effects of perceived pollution on recreation. Respondents were given a list of 6 types of pollution. When asked which would be most likely to keep them from swimming, 80% said algae and green scum, 70% said glass and cans on bottom. When asked which 3 most likely indicated pollution, 40% said algae and scum, 25% said suds and foam, 20% said dark water. Women are more likely than men to think that water pollution is bad. The author thinks that this may be because it is the mother that usually takes children swimming.

KEY WORDS: water quality, recreation, perceptions.

Dinius, S. H.

1981 Public perceptions in water quality evaluation. Water Resources Bulletin 17:116-21.

A laboratory experiment which uses slides of different degrees of water pollution to test laymen's perceptions of water quality. The degree of pollution was systematically controlled by adding measured amounts of litter and colored water for the series of slides. No significant findings other than that lack of color and litter was perceived as high water quality.

KEY WORDS: water quality, perceptions, simulation techniques.

Jordening, David

1974 Estimating Water Quality Benefits. Washington, D.C.: Environmental Protection Agency (EPA 600/5-74/014).

The objective of this report is to present a state of the arts summary in the estimation of water quality associated benefits. The summary is presented by specific pollutants and by beneficial use, devoting special attention to hypothesized and documented use/water quality relationships. Beneficial uses considered include recreation, aesthetics, property values, and ecology. Probably the most complete review of this subject up to that time, utilizing 134 references. Especially useful because of the extensive and descriptive tables which give: the type of pollutant, the critical level (if known), the reference(s) where it is discussed, and a short summary.

KEY WORDS: water quality, benefit assessment, recreation.

Komarov, Boris

1980 The Destruction of Nature in the Soviet Union. White Plains, New York: M. E. Sharpe, Inc.

A book of short chapters on different aspects of environmental pollution in Russia, written under a pseudonym by a ministry official who stills lives in Russia. The first chapter deals primarily with the pollution of Lake Baikal. The conclusion is an appeal for an ecological approach to environment problems, problems which will require simultaneous change both in the economy and in the social and moral foundations of society.

KEY WORDS: water quality, Russia, ecology, Lake Baikal.

Sinha, Evelyn

1971 Lake and River Pollution: An Annotated Bibliography. La Jolla, California: Ocean Engineering Information Services.

No references to social (recreation, population growth, development) influences on water quality.

KEY WORDS: water quality, lake and river pollution.

Uttormark, P. D., J. D. Chapin, and K. Green

1974 Estimating Nutrient Loadings of Lakes from Non-Point Sources. Corvallis, Oregon: United States Environmental Protection Agency.

Major contributing factors are: general topography (contour), precipitation (total, duration, frequency, etc.), soil properties, vegetation cover (type, density, permanence), manipulative (paving, plowing, fertilizing), and animal populations (type, density). A conclusion is that the estimate of nutrient loading is as much an art as it is a science. It is the logical first step in developing management plans.

KEY WORDS: water quality, non-point pollution, land use.

White, Gilbert

1969 Strategies of American Water Management. Ann Arbor: The University of Michigan Press.

Another valuable contribution by one of the foremost thinkers on water and water management. This book stresses the importance of public attitudes and values to water management. "Any effort to maintain or enhance the quality of water requires a definition of the uses to which it may be put and a judgement of the human preferences for each of those uses

in a specifc setting of land and water" (p. 59). In conclusion, gauging public opinions and preferences (utilizing attitude surveys and public meetings and hearings) is the most important task of water planners.

KEY WORDS: water quality, water management, values.

Yoesting, Dean R. and Dan L. Burkhead.

1971 Sociological Aspects of Water Based Recreation in Iowa. Ames: Iowa State University, Sociology Report 94.

A questionnaire survey of Iowa residents to determine: beliefs and attitudes toward water-based recreation; attitudes toward water management agencies and policies; relationship between personal and social characteristics of individuals and their beliefs and attitudes toward water based recreation and management. Three hypothesis related to perception of pollution were tested. Findings were: 1) Farmers are less likely to perceive agricultural practices as major sources of pollution than are non-farmers. 2) Knowledge of polluted areas is not a meaningful variable in measuring perception of agricultural practices as sources of water pollutants. 3) Personal experience has no relationship with perception of water pollution as a major problem.

KEY WORDS: water quality, social indicators, water-based recreation, environmental sociology.

WATER QUALITY GUIDELINES FOR RECREATIONAL WATER

Inland Water Directorate

1979 Water Quality Sourcebook: A Guide to Water Quality Parameters (Addendum). Ottawa, Canada: Environment Canada.

Page 32 (Table 20): Guidelines of Recreational Waters, lists 15 parameters and the level where they will begin to impact recreational use of water. Most of the levels were determined in 1972, except for arsenic, cadmium, chromium, and mercury, which were set in 1979. The basis for the levels is not given. Some of the levels are: fecal coliform .100/dL; total coliform, 500/dL; light penetration, 1.2. M; oil and grease, 5 mg/L; pH, greater than 6; cadmium, .01 mg/L; chromium, .1 mg/L; mercury, .001 mg/L.

KEY WORDS: recreation, water quality, water pollution parameters.

National Technical Advisory Committee

1968 Water Quality Criteria. Washington, D.C.: Department of Interior.

Recommendations on water quality criteria for recreation and aesthetic uses. For nonprimary contact waters: fecal coliform content should not exceed a log mean of 1,000/100 ml, nor equal or exceed 2,000/100 ml in more than 10% of the samples. For primary contact recreation: fecal coliform should not exceed 200/100 ml or 400/100 ml for more than 10% of the samples during any 30 day period, pH should be within the range of 6.5-8.3, and the secchi depth should be at least 4 feet.

KEY WORDS: water quality, water quality criteria, recreation.

Todd, David Keith

1970 The Water Encyclopedia. Washington, New York: Water Information Center.

Table 6-29 (p. 338): Guides for Evaluating Recreational Waters. Twelve parameters are listed. The table is divided into two types of uses: "water contact" and "boating and aesthetic". The "noticeable" and "limiting" threshold is given for each parameter and for both uses. The levels are very similar to those given by Inland Waters Directorate (1979). The source for these levels is the California State Water Quality Control Board (1963).

KEY WORDS: recreation, water quality parameters.