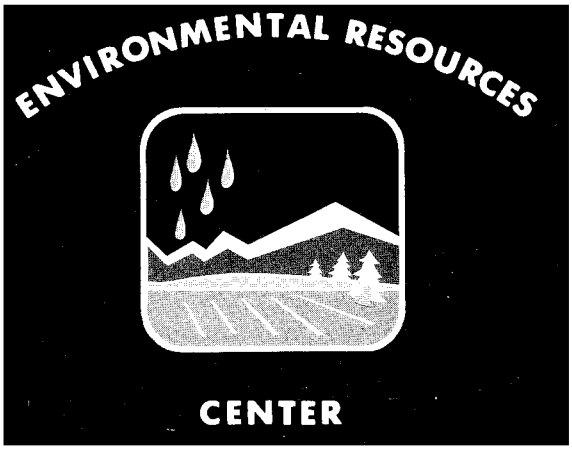
FEASIBILITY AND POTENTIAL OF ENHANCING WATER RECREATION OPPORTUNITIES ON HIGH COUNTRY RESERVOIRS

by
Robert Aukerman

June 1975



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FEASIBILITY AND POTENTIAL OF ENHANCING WATER RECREATION OPPORTUNITIES ON HIGH COUNTRY RESERVOIRS

PHASE I

Completion Report

OWRT Project No. B-104-COLO

by

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Department of Recreation Resources

Colorado State University

submitted to

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PROJECT OBJECTIVES

The research project from which this report emanates is divided into two phases. The overall objective of both phases is to provide the scientific rationale necessary for recommending management practices which will lead to increased use of high-country reservoirs.

This report represents Phase I of the research.

Phase I Objectives

A. To describe the existing water reservoir situation and its potential for recreation;

B. To identify the management practices necessary to meet recreation user desires on high-country reservoirs;

C. To study the actual potential of the reservoirs to provide a recreation fishery resource.

Although these three objectives are interrelated, they will be treated separately in the methodology and findings sections of this report.

Due to the overwhelming amount of data being analyzed, only those results representing major findings and/or representing outstanding examples are presented in this report. Many additional data will be presented in detail in the masters theses of Brad Buckner, Scott Forssell, Peter Humm, and Neal Lewis. Other data are presented and will continue to be presented in appropriate professional journals.

LIST OF FIGURES

STUDY AREA

The study area is shown by the cross-hatched pattern on the map in Figure 1. It covers the length of Colorado and is bordered on the north and south by the Wyoming and New Mexico state lines. The eastern boundary is the 6,000-foot-elevation contour. The western boundary is the Continental Divide from the Wyoming border to approximately the center of the state, where the boundary becomes the Park and Fremont County lines. In the southern portion of the state, the western boundary is the Sangre de Cristo Mountains. The large park areas (North, Middle, South) of the state are excluded in order to retain reservoir settings in the montane, subalpine and alpine life zones.

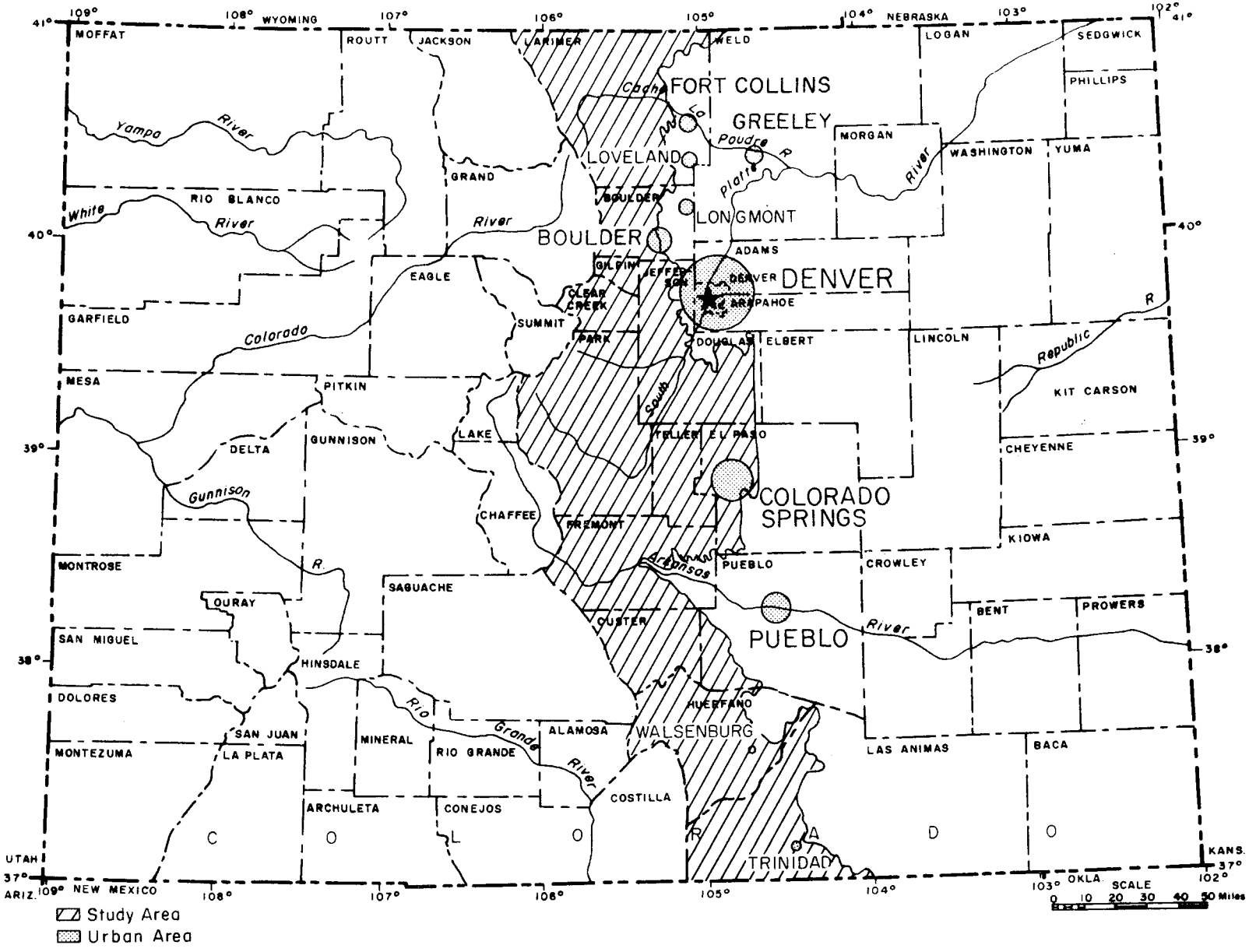

Figure 1. Study area.

INTRODUCTION

The Front Range of the Rocky Mountains in Colorado is one of the most beautiful spots in the United States. High in this country is a series of glacial and man-made lakes surrounded by dense forests and majestic snow-capped peaks. On any given day the changing aura of the surroundings are reflected in the lakes, providing a focal point, unsurpassed in nature, for man in his leisure.

Recreationists in Colorado and throughout the country and world are aware of this recreation opportunity. The result is bumper-to-bumper caravans of people jockeying for existing public areas on the high country lakes. Even the most fragile and inaccessible lakes hidden in the cirques of the highest peaks are constantly being assaulted by increasing numbers of backpackers, jeepers, and horsepackers.

The result has been the inevitable overcrowding and overuse of the existing water sites open to the public. With this overuse has come destruction of the very physical environment which the recreating public seeks.

The mere numbers of people packed together in a near-wilderness setting cause degradation of the recreation experience. Furthermore, the management problems created by overuse call for unpopular solutions in order to save the environment.

Current management practices and projected plans call for restricting the numbers of recreation users. Even without restrictions, current demands exceed available public facilities. People are regularly being turned away, not just from one water area, but from all areas. On weekends,

the news media along the Front Range of the Rockies in Colorado frequently announce that people should stay out of the mountains because all open public areas in the high country are full. Most of these areas are near water. With projected further cutbacks and restrictions placed by public agencies on use of facilities and areas surrounding water sites, the situation can only become worse.

Compounding the problem is the rapid population growth along the Front Range which, according to recent census figures, is one of the fastest in the country. This alone will create demands far outstripping available public resource supplies.

The situation is, therefore, critical. A rapidly-increasing demand for water recreation in the high country is and will continue to be met by a cutback in use of existing public water areas and facilities.

Managing existing usable public water areas for even heavier recreation use is not the answer. Just the opposite is being done.

The problem is twofold:

1. Additional extensive water resources which are now being used for recreation but have the potential for recreation use need to be found. Such areas would necessarily provide additional user days for handling the existing and potential surplus user demand, and these areas would, hopefully, help alleviate the overuse of existing areas by distributing the recreation user load.
2. The actual social-psychological profile and behavior patterns need to be identified in order to understand the desires of users and how they react to various management practices.

Knowing this would allow managers to make intelligent decisions to optimize the recreation use of the resource.

We know that just such a resource does exist in the high country of the Rockies. This resource takes the form of water-storage reservoirs. At present many of these reservoirs are receiving no use or, at best, minimal use by recreationists. This is due to the fact that private and public water owners and managers either restrict use or do not manage for recreation, thereby ignoring the potential recreation use by drawing down the reservoirs during the critical recreation-use times.

This problem is but a part of the larger problems associated with Colorado and arid regions of the United States in general. Lack of adequate knowledge of physical, legal, political, and social potentials and/or constraints with regard to water reservoirs has prohibited the fullest and best utilization of the water that is available. And the concern over limited amounts of water allocated to first interests has so overshadowed other considerations where they might be incorporated into the agri-industrial, municipal ones, that other benefits remain largely ignored. Hence, a resource such as water, which is in short supply and high demand, is not managed in the most advantageous manner for all who are concerned.

If enlightened ways and means were devised through management procedures such as providing access, desired facilities, and timed water delivery with little or no conflict with primary user rights, then the various publics involved in the use of water might take major strides toward realizing the multiple use of this critical resource.

In this research we have shown the management practices desired on the high-country reservoirs by recreation users. We have provided the basic researched knowledge necessary to help water owners and managers to manage the high country reservoirs in Colorado for multiple use which means the inclusion of recreation. Our next step is to determine what is physically, socially, and legally possible in order to increase the recreation opportunities for the public.

Hopefully, we will succeed in our efforts; if we fail in the near future to provide new and expanded water resource opportunities in the high country of Colorado, environmental and social pressures may lead to the destruction of existing usable areas. The time is now. The water resource exists. We must do something before it is too late!

NEED FOR THE STUDY

Rapid urban growth along the Front Range of the Rocky Mountains in Colorado, coupled with the growing tourism industry, has created an overwhelming demand for water-oriented recreation. According to the 1970 Outdoor Recreation Plan for Colorado, a deficit in sites for fishing, boating, swimming, tent camping, trailer camping, and hiking already exists in the Front Range region. Predicted urban population growth along the Front Range from 1.6 million in 1970 to 2.5 million by 1980 and to 3.8 million by the year 2000 (State Planning Office, 1969) will undoubtedly be accompanied by a rapid increase in demand for water-oriented recreation.

In the Western United States, the supply of water is limited. In most cases water comes from snow melt and is stored in a complex series of reservoirs. The water is owned as a property right and used mainly for agricultural, industrial, and domestic purposes. Recreation, in most cases, is only an incidental use of water. The majority of reservoirs are single-purpose. Some reservoirs are open for public recreation, but most are not. Few reservoirs are managed for recreation.

In a time when recreation demand for water already exceeds existing available resources, and in a time of projected increases in demand for water recreation, it seems inconceivable that reservoirs will continue to be managed for single purposes, excluding recreation as a use of the water resource. However, since water is a property right, the owner must be convinced that there is a legitimate demand, that there are practical reasons for him to make his reservoir available for recreation and that the management of water for recreation is not in direct conflict with his major purposes.

In this research, legitimate demand is studied, categorizing the users into groups based upon their behavior patterns and preferences related to facilities, access, drawdown, likes and dislikes, expectations, satisfactions, etc.

Many studies of user characteristics, patterns, and preferences for warmwater reservoirs greater than 300 surface acres (Bertrand and Hover, 1973; Carson, 1972; Brewer and Gillespie, 1969; Pankey and Johnston, 1969) have been conducted. Most of those studies were oriented to provide inventory data for planning.

Few studies (Gahan, 1970) have been found in the literature on reservoirs less than 300 surface acres in size. Nothing has been found on high mountain reservoirs. Since such reservoirs offer a very different type of recreation experience, there exists a void in water-recreation research on them. A study of eight small lakes in Arkansas (Munson, 1968) provided some useful information on activity preferences and user site preferences which included scenery, water depth, access, size of lake, usable space, water quality, vegetation, facilities and services, and management practices and policies.

Three major limitations are inherent in the above-mentioned studies. First, the geographic locations were primarily limited to the southern and midwest plains areas of the country. Second, the focus was on large federal-project reservoirs. Third, they are warmwater reservoirs.

More recent research (Hoagland, 1973; Hendee, Clark, Dailey, 1973; Kennedy and Brown, 1974) on high-mountain lakes offers the best site corollaries to this study. Those researchers, although primarily concerned with fishing behavior and motivations, found that users were attracted to sites

by a complex set of motivations and activity preferences. They also recommended that managers consider recreation behavior patterns and motivations before making management decisions.

From the literature it appears that the complexities of water recreation experiences are quite varied and not yet well documented. Further research on user expectations, motivations, and satisfactions is needed to better identify the parameters of the recreation experience. Recreation resource managers also need this information to inventory physical resources in a manner that reflects the ability of the resource to provide various types of recreation experiences (USFS Northwest Region, 1974).

At present, little data is available to help answer such basic questions as what reservoirs exist; what facilities exist; who is responsible for management; what do people want in terms of recreation; what are people doing; what do they expect; are they satisfied with present management practices; what public demand exists; how is the public reacting to such management practices as drawdown; and the many other questions necessary to make intelligent management decisions for including recreation as one of the multiple uses of high-country reservoirs.

This report attempts to answer many of these questions through the development of a profile of recreation reservoir users. This study attempts to provide the scientific rationale for recommending practical management practices which will lead to increased recreation use of high-country reservoirs.

RESEARCH OBJECTIVE A

To describe the existing water reservoir situation and its potential for recreation.

In order to meet Objective A, it was necessary to test our hypothesis that a physical resource, in the form of high-country reservoirs, does exist with the potential to meet recreation demands. To prove this hypothesis, the following sub-objectives had to be achieved:

Sub-objective 1. To identify the number of high-country reservoirs which exist along the Front Range of the Colorado Rocky Mountains

Sub-objective 2. To determine where these reservoirs are located
- General geographic location
- Existing map coordinates
- Water Districts
- Life Zones

Sub-objective 3. To identify the present ownership of each reservoir
- Reservoir's water
- Adjacent land

Sub-objective 4. To compile a physical description for each reservoir
- Surface acres
- Storage capacity
- Mean depth
- Water quality
- On-stream or off-stream reservoirs
- Scenic location
- Flora or fauna
- Existing fishery
  - Population
  - Growth
  - Types of fish
  - Average size
  - Spawning habitat
  - Winter kill
  - Productivity

Sub-objective 5. To identify existing management practices at each reservoir
- Who is responsible for management
- Open or closed to the public
- Maintenance
- Drawdown practices
- Is the reservoir drawn down
- To what degree
- Do drawdowns occur during peak recreation-use periods

Sub-objective 6. To determine the present access to each reservoir
- Proximity to population centers
- Road conditions or trails

Sub-objective 7. To identify the existing facilities

Sub-objective 8. To assess the present usage
- Existing use
- Number of users
- Types of reservoir activities
- Fishing pressure

Originally only a portion of this inventory was considered necessary. However, as the research progressed, it became apparent that all of the sub-objectives presented were essential to provide a base for meeting Objectives B and C, and for the physical and legal studies to be undertaken later in Phase II of the research.

Limitations--Objective A

The mere volume of data which has been collected for each reservoir in total makes it impossible to present all the detailed findings in this report. What is presented is a synopsis of some of the more important findings common to the 36 reservoirs selected for this study plus certain other important specific findings.

The total data from Objective A will be published later in a special limited edition by the Environmental Resources Center, Colorado State University.

Originally, Objective A was expected to be a fairly easy and quick compilation of existing data. Surprisingly, such data was not readily available. In fact, a major portion of the data presented in this report and in the "special report" is new data collected by our researchers and not previously available from any other known sources. No compilation of data was found to answer simple questions such as the actual number of

reservoirs existing along the Front Range. Little existing data was available on the physical description or the management practices. Much on-site observation and collaboration was necessary to compile information on access, facilities usage, drawdowns, maintenance, fishery, scenics, biotic community, and many other factors. Other data required a complicated search for and compilation of historical records from a variety of sources.

Obviously, these processes take considerable time and money--much more than was available for this project. Therefore, it was necessary to limit the search for data. No limitation was placed on the questions necessary to complete the research. However, limitations were placed on the number of reservoirs on which data were collected. Complete information was collected for all 36 sample reservoirs which were selected for detailed study in Objectives B and C. Only partial data were collected on the remaining 116 reservoirs. Availability of the data was the limiting factor here.

The limiting factors on the total number of reservoirs studied were:

1. The reservoirs had to be in the study area (See Study Area Map, Figure 1);
2. They had to be listed as reservoirs by the Colorado State Engineer's Office; and
3. The reservoirs had to be greater than ten and less than 300 surface acres in size.

In spite of the limitations outlined, a good cross section of Front Range reservoirs with recreation potential has been studied, and a fairly detailed data base is now available for research purposes and for making management decisions.

Methodology--Objective A

A combination of data-collection methods was used to provide an extensive resource inventory. An historical research approach was adopted to collect all existing records on reservoirs, reservoir water rights, adjoining landownership rights, access, and stocking records. A descriptive and collaborative research approach was adopted to collect information on present recreation use, management practices, and physical site capabilities. An informal survey of reservoir managers was conducted to help record and categorize recreation management practices. All reservoirs were visited and a physical capability inventory completed on the basis of the on-site visit, historical records, and aerial photos.

On the basis of the above data, 36 reservoirs presently open to the public for recreation use were selected and studied for the summer recreation seasons of 1973 and 1974. The peak recreation season extended from May through September, and each reservoir was visited four times each year during that period.

After the data were collected they were organized for further research purposes and for future use by managing agencies. A set of data was collected for each reservoir, and was also tabulated and combined for all reservoirs. Some data have been used for comparative purposes for Objectives B and C and Phase II of the research. The remaining data have direct management implications in and by themselves.

Results--Objective A

As indicated in the limitations section, the inventory findings presented in this section reflect only a sampling of the overall findings. No data are

presented for individual reservoirs, and only the combined data which have either broad management implications or research implications for Objective B are presented here. All inventory data dealing with the reservoir fishery are presented under Objective C.

Sub-objective 1: To identify the number of reservoirs which exist along the Front Range of the Colorado Rocky Mountains

The extensive inventory procedure described in the methodology section resulted in the identification of 167 reservoirs along the Front Range. These sites are within the study area, are listed as reservoirs by the State Water Engineer's Office, and are greater than ten and less than 300 surface acres in size. On-site visits resulted in the reduction of the total number of study sites to 153. Fourteen sites that reflect plains characteristics rather than those of the montane, subalpine, and alpine life zones were eliminated.

Sub-objective 2: To determine where these reservoirs are located

Figure 2 shows the geographical location and distribution of the sites. A large percentage of reservoirs exists on public lands, mainly U.S. Forest Service, or as inholdings surrounded by public lands. Reservoirs cluster around the major drainages that feed the cities adjacent to the Front Range. Most of the major east-west transportation corridors follow these natural waterways, creating excellent access close to most reservoirs.

The separate "special report" will detail the existing map coordinates, water districts, and life zones for each reservoir--all essential information for Phase II of the research.

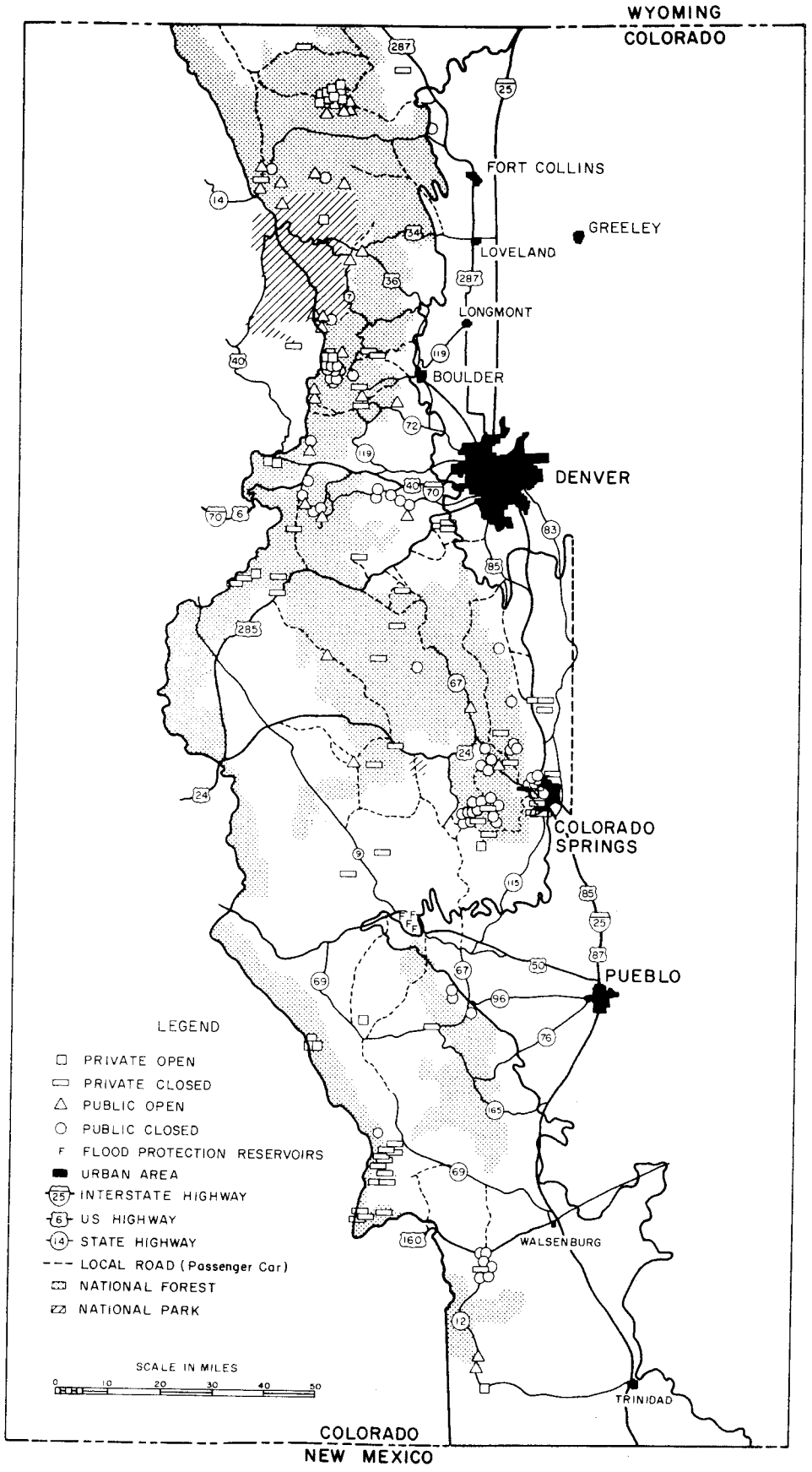

Figure 2. Map showing urban centers, landownership, and access.

Sub-objective 3: To identify the present ownership of each reservoir

Table 1 indicates the ownership of sites and their availability to the general public for recreation use. In Table 1, "Private" means sites owned

Table 1. Reservoir ownership and recreation use.

RESERVOIR SITES	NUMBER	PER CENT
Total Study Sites	153	100
Private Open	23	15
Public Open	31	20
Private/Closed	44	29
Public/Closed	55	36

or leased by a private individual, corporation, ditch company, etc.; "Public" means owned or leased by a public agency of municipal, county, state, or federal government; "Open" means open to the general public for recreation use; and "Closed" means closed to the general public for recreation use. In the "Private/Closed" category, about 20 of the reservoirs are used for private recreation such as fishing clubs, camps, etc. In the "Public/Closed" category, about ten reservoirs are used indirectly for recreation as habitat for part of the state's trout brood stock, or for other experimental fishery purposes. Thus, of the total reservoir sites, only 55% are presently used for recreation.

This means that there does exist a tremendous physical resource for meeting recreation demand in the form of reservoirs not presently being used for recreation. The findings show an even greater recreation potential is available because most of the open reservoirs are not managed for recreation. Many of those reservoirs managed for recreation are not adequately managed. Adequate management refers to the ability to meet the needs of the recreation-user groups with respect to facilities, desires, and drawdown.

Specific information on ownership of water and adjacent land is reported in detail in the "special report."

Sub-objective 4: To compile a physical description for each reservoir

Surface Acres

Table 2 shows that the majority of reservoirs with available data are between ten and 150 surface acres in size. Only six reservoirs are between 150 and 300 surface acres in size. Interestingly, it was found that reservoir user expectations, user satisfactions, and user desires had no relationship to the size of the reservoir.

Table 2. Reservoir size (surface acres).

	ACRES						
	10-25	25-50	50-100	100-150	150-200	200-250	250-300
NUMBER OF RESERVOIRS	26	10	14	14	0	3	3

On or Off-Stream

Whether a reservoir is on a stream or off is important to the fishery biology aspects of this study and for fishery management of the reservoirs. The information is essential in predicting fish survival, reproduction, growth and other factors. In general, Table 3 indicates that three-fourths of all reservoirs inventoried for this factor were on a stream. This indicates that in most high country reservoirs, even with complete drawdown, there is a chance for fish survival, growth and reproduction.

Table 3. Reservoir location (on or off stream).

	ON STREAM	OFF STREAM
NUMBER OF RESERVOIRS	28	9

Scenery

Table 4 shows that most reservoirs (all but five) are located in good to excellent scenery. This correlates highly with user expectations and satisfactions listed later in this report and is one important explanation why users are satisfied with their current recreation experience at reservoirs.

Table 4. Reservoir location (scenery).

	EXCELLENT SCENERY	VERY GOOD SCENERY	GOOD SCENERY	FAIR SCENERY	POOR SCENERY
NUMBER OF RESERVOIRS	2	15	15	5	0

All other data describing these reservoirs are reported in the "special report" except for a detailed discussion of the existing fishery which is reported in the fishery section of this report.

Sub-objective 5: To identify existing management practices at each reservoir

Management Responsibility

Table 5 shows the current agnecies responsible for management of existing reservoirs open for recreation use.

Table 5. Reservoir managing agency.

NUMBER OF RESERVOIRS	AGENCY
14	United States Forest Service
4	Colorado Division of Wildlife
4	National Park Service
3	Cities (Greeley, Idaho Springs, Estes Park)
2	Public Service
1	Bureau of Reclamation
1	Boulder and United States Forest Service
2	Colorado Division of Wildlife and Individual Cities
1	Catlin Canal Company
1	Walton League and Trinidad
1	American Metal, Climax
1	Evergreen Bergen Ditch
1	Deweese Dye Irrigation Company

Open or Closed to Public

Data on reservoirs open or closed to the public have already been reported under Sub-objective 1. Other management data will be reported in the "special report."

Sub-objective 6: To determine the present access to each reservoir

Proximity to Population Centers

Table 6 shows the average travel time to the 36 reservoirs. This is undoubtedly a key variable in their present use. Previous studies show travel time of two hours is not usually a major limiting factor in recreation user behavior. This is further substantiated by our user social-psychological profile from Objective B which shows that most users, 95.1%,

Table 6. Travel time for all high-country reservoir users.

DRIVING TIME	PER CENT OF USERS
Less than 1 hour	33.8
1 hour - less than 2 hours	32.5
2 hours - less than 3 hours	18.6
3 hours - less than 4 hours	5.4
Greater than 4 hours	7.5

say they are willing to travel an additional one-half to two hours to a reservoir site offering the desired type and quality of a recreation experience. In this study a wide variety of reservoir site types exists within relatively short driving times to the user population. This would seem to allow for the elimination of driving time as a major controlling variable. Yet, actual user behavior at the study reservoirs, seems to contradict this assumption--as discussed in Objective B, Sub-objective 1.

Road Conditions or Trails

As reported earlier, access to the reservoirs by major roads is excellent. However, actual access from major transportation corridors to a specific reservoir ranges from paved secondary roads to hiking trails. In fact, of the 36 reservoirs where the user surveys were conducted, eight required hikes ranging from one to ten miles. Table 7 shows road conditions at 68 of the study reservoirs. Two-thirds of all reservoirs have dirt access.

Table 7. Reservoir immediate access--road condition or trails.

	ROAD CONDITION OR TRAILS			
	DIRT	4-WHEEL TRAIL		PAVED
NUMBER OF RESERVOIRS	41	4	9	14

Sub-objective 7: To identify the existing facilities

Table 8 shows the actual number of reservoirs having specific types of facilities.

Table 8. Types of facilities at reservoirs.

11	None	1	Tent Camping, Outhouses
1	Camping, Boat Launch	2	Tent Camping, Outhouses, Parking
1	Tent Camping, Restrooms	1	Camping, Picnic, Tent Camping, Outhouses
1	Camping, Grills, Outhouses, Water	1	Ranger Station, Camping, Outhouses
1	Camping, Boat Launch, Outhouses, Tent Camping	1	No Camping, Tent Camping, Picnic, Grills, Outhouses
1	Camping, Water	1	No Camping, Ice Skating, Tent Camping
1	No Camping, Outhouses	1	No Camping, Outhouses, Tent Camping
1	No Camping, Picnic, Tent Camping	1	Camping, Water, Outhouses, Tent Camping, Boat Docks
2	No Camping, Outhouses, Tent Camping, Grills, Picnic, Parking	1	Camping, Boat Launch, Water, Tent Camping
1	Camping, Picnic, Water, Outhouses, Tent Camping (must pay)	1	Camping, Horse Facilities, Picnic Grills, Water, Parking, Outhouses
1	Boat Launch, No Camping, Picnic, Grills, Restrooms, Tent Camping	1	Camping, Grills, Picnic, Pit Toilets, Water Pumps
1	Camping, Grills, Cabin	1	No Camping, Tent Camping, Restrooms, Parking
1	No Camping, Picnic, Tent Camping, Restrooms, Outhouses		
		or	
11	No Facilities	26	With Facilities

Sub-objective 8: To assess the present usage

Present use is covered in detail under Objective B, Sub-objective 1.

Summary--Objective A

As indicated in the limitations section, the inventory findings presented in this section reflect only a sampling of the overall findings. No data are presented for individual reservoirs, and only the combined data which have either broad management implications, research implications for Objectives B and C, or implications for Phase II are presented here. All inventory data dealing with the reservoir fishery are presented under Objective C.

RESEARCH OBJECTIVE B

To identify the management practices necessary to meet the recreation user desires on high-country reservoirs.

This objective represents the core of the research. The actual user behavior patterns, expectations, satisfactions, interests, attitudes, and beliefs combine to provide a profile of the recreation water users. These profiles can then be translated directly into very practical management alternatives which allow a manager to make decisions on which user group he can or should accommodate, and on how to provide these various user groups with satisfying recreation experiences.

In order to meet Objective B, this project concentrates on three broad areas of research. First, the behavior patterns of users were studied to determine who is using the reservoirs, and for what reasons. Second, the actual reservoir users were studied in an attempt to identify their social-psychological characteristics. An attempt was made to identify the user expectations and satisfactions with their experience. Those expectations and satisfactions were then compared and combined with behavior to determine actual user desires (preferences). From those user desires, management practices are recommended.

Third, an in-depth fisherman profile has been developed to provide a base for comparing fisherman desires to the actual physio-biological ability of the reservoir fishery to meet these desires.

Both the in-depth fisherman profile and the physio-biological (Objective C) studies have been undertaken, in part, to provide a test case and example for Phase II research in which other users and reservoir characteristics will be compared.

For clarity and scientific purposes, the three broad areas outlined above have been translated below into a series of sub-objectives which define the parameters of the research:

Sub-objective 1. Behavior
To identify the management implications based upon the actual behavior patterns of users and the related physical characteristics of high-country reservoirs

a. What characteristics of the reservoirs affect the actual user behavior? In what ways?

b. What are the behavior patterns of users of high-country reservoirs?

c. What are the management implications inherent in the actual behavior patterns of the users of high-country reservoirs?

Sub-objective 2. To identify the management practices at high-country reservoirs which reflect a social-psychological profile of recreational users.

a. What are the overall recreational expectations, satisfactions, and desires of high-country reservoir users?

b. Are there any significant differences between the expectations, satisfactions, and desires of users of high-country reservoirs?

c. If there are significant differences between the social-psychological profiles of the users, what are the management implications of those differences?

Sub-objective 3. To identify the management practices necessary to meet the fisherman's desires at high-country reservoirs.

a. What is the demographic composition of the high-country reservoir fisherman? Is there more than one group of fishermen using the reservoirs? Do demographic factors have an effect on a fisherman's experience?

b. What are the fishermen's expectations of the reservoirs? Do the reservoirs fulfill their expectations? What are the differences between expectations and on-site likes?

c. What are the fisherman's satisfactions with his experience? Are return visits a measure of satisfaction? Are return visits dependent upon fishing quality? What improvements do fishermen desire? Are fishermen willing to pay for fishing improvements?

d. What are fishermen's attitudes towards suggested management practices which might affect their fishing experience?

e. What impact does drawdown have on the fisherman?
Are fishermen familiar with drawdown?
Are their activities altered by drawdown?
How does drawdown affect their experience?

Limitations--Objective B

Few limitations on Objective B were experienced. However, one major limitation altered the basic design of the original user "criteria model."

After many attempts and much bargaining it became apparent that it would be impossible to get any water even through purchase, and that it would be too costly to make management changes at any of the existing 164 reservoirs. This meant that actual manipulation and implementation of management practices at the reservoirs was impossible. Had this been possible, this research approach would have lead to the soundest data base. However, an alternate model had to be designed and proved adequate for meeting our research objectives. Both the original model and the model used are presented in Figures 3 and 4 respectively. The basic difference lies in the method of testing the recommended management practices.

If the orignial model could have been implemented, changes would have been made in the reservoirs to reflect user desires; then the behavior of users would have been monitored to test the management practices to see if they actually elicited the expected behavior.

In the model used, the recommended management practices were tested through a comparison of actual behavior at existing reservoirs to professed user desires (see methodology for further detail).

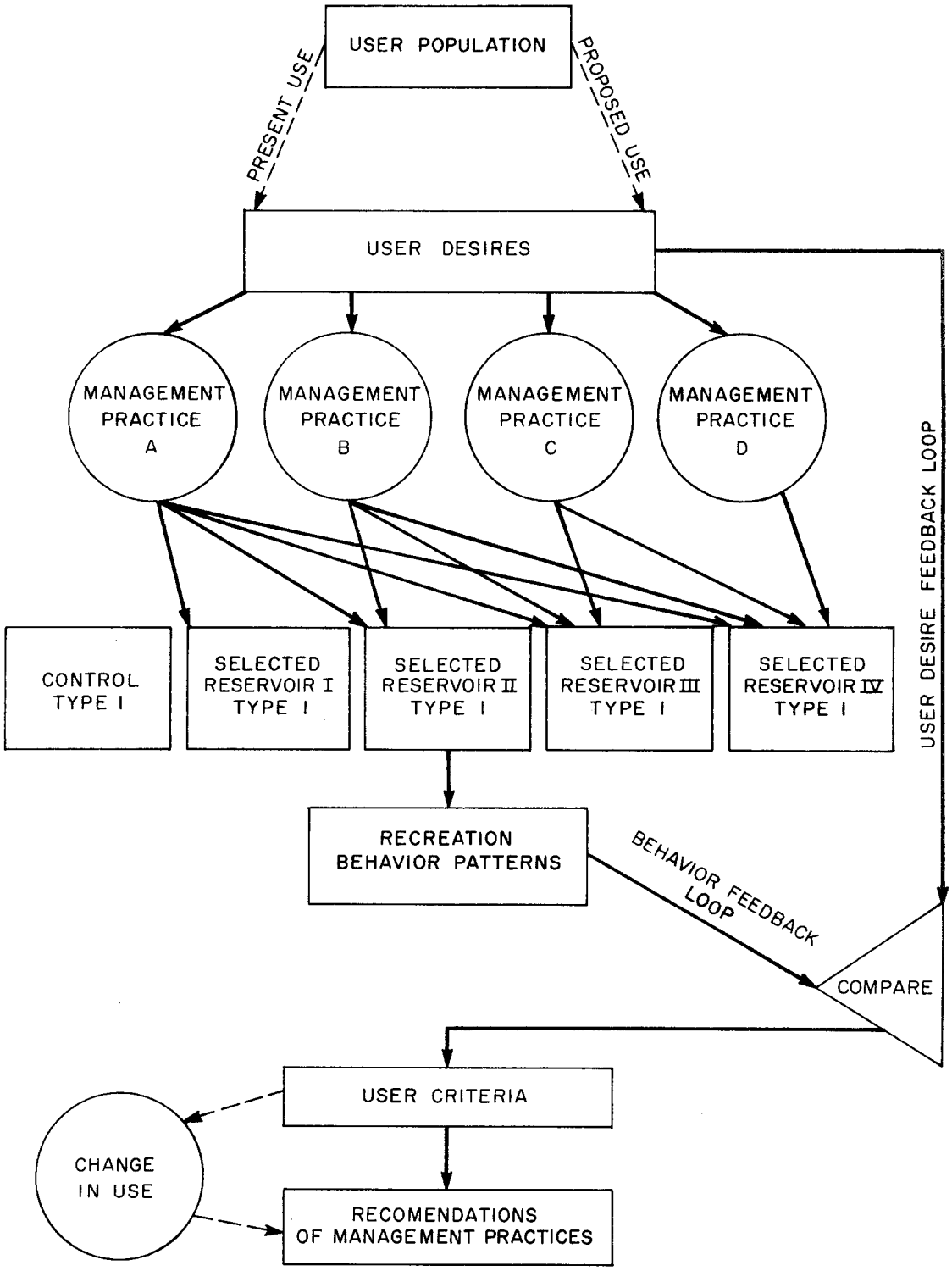

Figure 3. Original user criteria model.

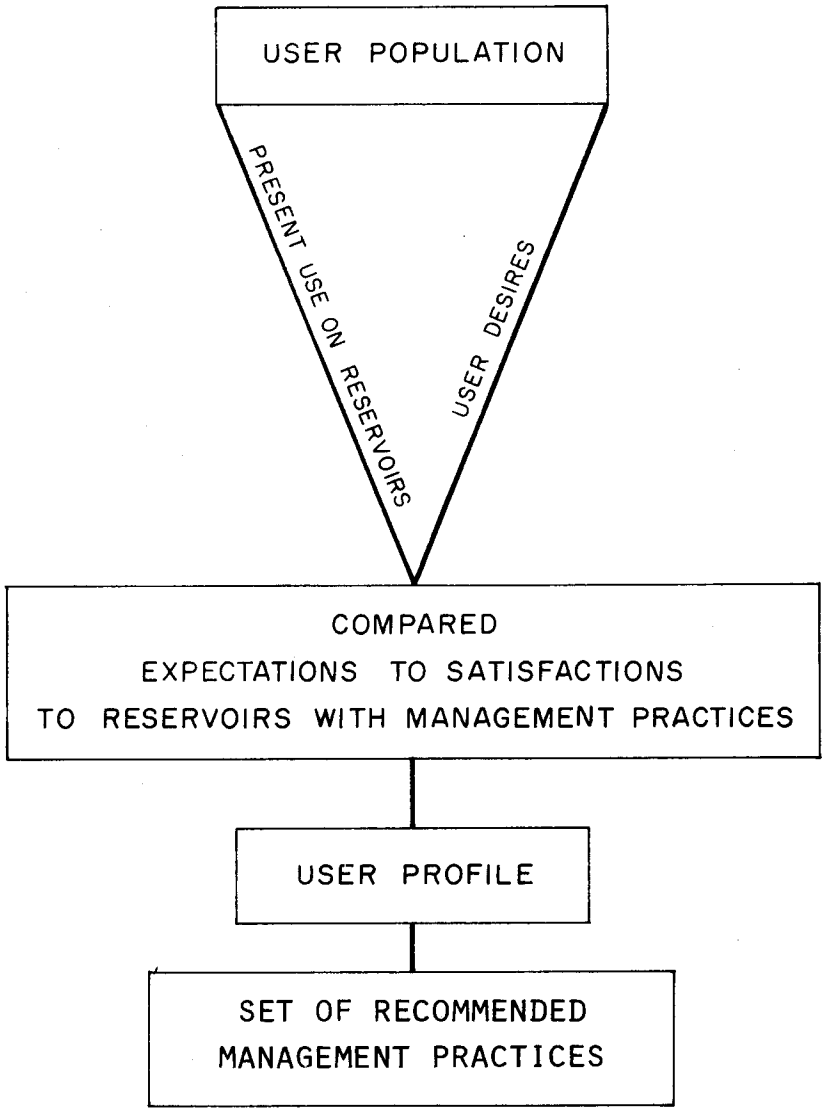

Figure 4. User criteria model-(actually used).

Since the research objective was to study recreation user behavior and interests, it was necessary to contact the public on site. Therefore, the following limitations were placed on the selection of study sites. They must be:

Open to the public;

Show signs of regular use;

Public owned.

Public-owned reservoirs were selected because it became evident that it was virtually impossible to get cooperation from private reservoir owners to conduct research on their reservoirs.

Another limitation resulted from a degree of non-response to questionnaire items by users of high-country reservoirs. Whenever possible, the interviewers obtained answers to every question. But in some cases, the reservoir user refused to answer, or did not have any knowledge or opinion of the question asked. In some instances, these "no response" users form a significant part of the sample. However, it is possible to draw some conclusions from the fact that a user gave no response to a question.

Although we could not combine certain data because of limitations in the capacity of the Statistical Package for Social Sciences (SPSS) system which was utilized for computer processing of data, this proved to be a help. Although SPSS is very versatile, it did not have the capability to combine data for both years of interviews. This proved to have very little limiting effect on data analysis. Since our sample size was so large for each year, it was possible to treat each year separately and compare the two. This worked quite nicely since the data was similar in all but a few cases, usually where management practices had changed over the two-year

period. Actually, studying the changes in management helped in providing answers to questions concerning management implications for the future.

Another limitation was an inability to study the Front Range population of Colorado to determine the desires of non-reservoir users. However, extensive study and discussions with other researchers have convinced us that a cross section of all potential users now exists since all probable types of reservoirs with all combinations of management practices have been studied.

Strange as it may seem, the availability of too much data created a limitation. The more we pursued the research questions, the more questions arose. This is nothing new, yet the number of questions asked made it impossible to find answers to all the questions in the time allotted. Answers to many questions will continue to be pursued and reported in theses and appropriate publications after this report is published.

Methodology--Objective B

Interviews were conducted at 36 of the 164 reservoirs found along the Colorado Front Range. Table 9 lists those reservoirs and the number of interviews taken at each. All sites were visited at least four times per year for two years.

The subjects were 1693 adults randomly selected at each reservoir over the two-year period. During the summer period (June-Sept.) 1973, 1103 reservoir users were interviewed, and 590 users were interviewed during the summer of 1974.

The sampling, interviewing, and coding of questionnaires were done by trained interviewers and the study staff. The sampling was not,

Table 9. Number of interviews obtained at each reservoir site.

RESERVOIR	NUMBER INTERVIEWED 1973	1974
BARKER MEADOW	51	47
BELLAIRE LAKE	40	17
BLUEBIRD LAKE	11	3
BRAINARD LAKE	43	41
CLEAR CREEK	32	22
CHAMBERS LAKE	61	27
CHICAGO CREEK	39	8
CHINNS LAKE	23	4
COMMANCHE RESERVOIR	18	4
DOWDY LAKE	41	30
LAKE ESTES	47	28
EVERGREEN LAKE	29	12
ISABELLE LAKE	38	8
JASPER LAKE	14	6
JEFFERSON LAKE	46	31
LAWN LAKE	23	5
LEFT HAND PARK	44	28
LONG LAKE	24	10
MANITOU PARK	29	5
MARY'S LAKE	70	24
MONUMENT LAKE	37	24
NORTH LAKE	33	19
PARVIN LAKE	12	3
PEAR RESERVOIR	9	7
PETERSON LAKE	8	6
PINEWOOD LAKE	28	24
RED DEER LAKE	9	3
SAND BEACH	22	10
LAKE ISABEL (SAN ISABEL)	43	26
SKAGWAY RESERVOIR	40	16
SKYSCRAPER RESERVOIR	3	7
TWIN LAKE	19	5
LOWER URAD	26	14
WEST LAKE	42	22
WRIGHTS RESERVOIR	39	34
ZIMMERMAN LAKE	10	10
TOTALS	1103	590

strictly speaking, random because the interviews were conducted at the site while the respondent was engaged in a recreation activity. This made it difficult to identify precisely a priori the target population and to select

respondents from it by a single random-sampling process. The population was roughly defined to be all reservoir visitors 18 years of age and older.

Trained field interviewers went to selected sites on selected days at selected times to conduct interviews. While at the site, the interviewer had the responsibility of actually selecting the persons to be interviewed. Each interviewer did this by a random-sampling procedure as much as possible. The interviewer also had the responsibility of recording data on conditions at the reservoir, the number of people present, and the type and amount of time spent in an activity.

Interviews were conducted at various times of the week and at various times during the day throughout the summer.

A two-part questionnaire was administered (Appendix B). The first section of the questionnaire was composed of a self-administered questionnaire which included a modification of Hendee's Wildernism Scale (Hendee, Catton, Marlow, Brockman 1968), a series of demographic questions, and a set of questions about fishing. The second part contained a series of preference questions oriented to measure both beliefs and attitudes about sites (Fishbein 1963). This section also contained a group of questions about willingness to pay, travel time, and return visits.

All data have been incorporated into a data bank using the Statistical Package for Social Scientists (Nie, Bent, Hull 1970). This system provides capability to compare combinations of reservoir types, user types, and management practices, and to use a wide variety of statistical tests, including factor analysis.

All questionnaires were pre-coded and the data were punched onto data processing cards and verified. The data were then "cleaned" by checking for

keypunching and coding errors and missing data. Sample programs were run to further check the data. Finally, the data were stored on computer tapes for ready access.

The data analysis techniques used included three kinds of statistical presentations of data: (1) one-way frequency tables showing the number and percentage of responses to each question; (2) two-way frequency tables showing the relationships between each of the responses to the questions on the questionnaire; and (3) factor analysis used to a limited extent in early analysis of data. These data presentations had the capability of being analyzed by any one or a group of study reservoirs so that common characteristics could be analyzed individually. It was also possible to select a group of users who answered any questions commonly and perform any of the above techniques of data analysis.

The Chi Square and F-ratio statistics were used to test the reliability of the various relationships and differences.

Results--Objective B

Sub-objective 1. Behavior--To identify the management implications based upon the actual behavior patterns of users and the related physical characteristics of high-country reservoirs

Three major questions had to be answered in attaining this objective. They deal with: (1) the characteristics of reservoirs; (2) behavior patterns of users; and (3) management implications.

Characteristics of Users

What characteristics of the reservoirs affect the actual user behavior--in what ways? The characteristics of the reservoirs that affect actual user behavior were determined by asking the following questions:

1. Type of access. Is the use of high-country reservoirs related to the type of access?
2. Size. Does the size of the reservoir affect its use?
3. On-site facilities. Are the types of facilities significant factors influencing its use?
4. Location. Does the location of a reservoir affect its use? Is the reservoir's proximity to other reservoirs related to its use?
5. Scenic quality. Does the scenic quality have an effect on its use?
6. Fishing quality. Is the fishing quality related to its use?
7. Travel time. Is the driving time related to use?
8. Effect of drawdown. What effect, if any, does drawdown at the reservoir have on its use?

It was necessary to determine which reservoirs were drawing the largest number of users as a first step. The 36 high-country reservoirs selected for intensive study were then classified into three categories: high-use; moderate-use; and low-use.

Table 10. High-country reservoirs classified by number of users.

CLASSIFICATION BY USE	NUMBER OF RESERVOIRS	AVERAGE USE PER DAY (NUMBER OF PEOPLE) JUNE - AUGUST	PERCENTAGE OF TOTAL HIGH-COUNTRY RESERVOIR USE
HIGH	11	76.5	61
MODERATE	9	32.8	25
LOW	16	12.0	14
TOTAL	36		100%

The characteristics of the reservoirs in each group were then analyzed to determine the common factors that accounted for variability in use.

The high-use reservoirs (11 out of the 36) accounted for 61% of the total use of high-country reservoirs. The characteristics of the high-use

reservoirs compared to those of the other two user categories, are of greatest significance to this research project and to reservoir managers. However, managers must consider all major reservoir users in meeting public desires.

It is interesting to note here that although 61% of all users are at high-use reservoirs, these reservoirs represent only 30% of all the high-country reservoirs. The largest number of reservoirs serve the smallest group of users--hike-in users.

Table 11 shows the average number of users per day for both 1973 and 1974, and the total number of user days per season. The data should give reservoir managers a good indicator of expected use or actual use at their reservoir. This should help in planning to meet recreation desires.

1. Type of access. The data in Table 12 indicate that access to the high-use reservoirs is either by paved roads or by well-maintained unpaved roads. The same was the case with the access to moderate-use reservoirs with one exception--it being accessible by a hike-in trail.

Two-thirds of the reservoirs in the low-use category are accessible only by hike-in trails. This represents a significant difference from high use and moderate use. Therefore, type of access, is a significant factor in use.

2. Size. Present data indicate that the size of a reservoir (surface area) is not a significant determinant of use.

3. On-site facilities. The on-site facilities vary markedly between reservoirs, and are detailed in Table 13. The data indicate that reservoirs having the most-developed facilities attracted the highest number of users. Two-thirds of the reservoirs classified as "low-use" had no facilities at

Table 11. Total number of user days per season.

RESERVOIR	AVERAGE NUMBER OF USERS PER DAY 1973	AVERAGE NUMBER OF USERS PER DAY 1974		TOTAL NUMBER OF USER DAYS PER SEASON JUNE 1 THRU SEPTEMBER 30
HIGH USE				
BRAINARD	92.0	105.3		12,041.4
DOWDY	83.6	106.0		11,565.6
SAN ISABEL	113.2	73.2		11,370.4
CHAMBERS	83.0	89.8		10,540.8
BARKER	103.9	56.4		9,784.4
ESTES	89.0	64.9		9,394.0
WEST	57.7	82.7		8,564.4
SKAGWAY	40.0	95.0		8,235.0
CLEAR CREEK	44.8	77.7		7,478.6
MONUMENT	94.6	27.3		7,442.0
NORTH	13.0	89.4		6,222.0
TOTAL DAY GROUP USE	814.8	867.7	1974 INCREASE 6.5%	
GROUP AVERAGE	74.1	78.7		9,330.8
TOTAL SEASON GROUP USE				102,638.6
MODERATE USE				
PINEWOOD	23.9	67.9		5,599.8
LEFT HAND	43.0	43.8		5,294.8
BELLAIRE	26.2	59.1		5,209.4
MARY'S	39.1	37.8		4,697.0
JEFFERSON	32.3	44.0		4,660.4
EVERGREEN	43.7	28.8		4,428.6
WRIGHTS	23.3	44.7		4,148.0
URAD	29.4	32.6		3,782.0
ISABELLE	(48.3)	(7.3)		3,391.6
TOTAL DAY GROUP USE	309.2	366.0		
GROUP AVERAGE	34.4	40.7		4,579.1
TOTAL SEASON GROUP USE				41,211.6
PER CENT CHANGE 1974		16.4% INCREASE		

Table 11. Total number of user days per season (cont.)

RESERVOIR	AVERAGE NUMBER OF USERS PER DAY 1973	AVERAGE NUMBER OF USERS PER DAY 1974	TOTAL NUMBER OF USER DAYS PER SEASON JUNE 1 THRU SEPTEMBER 30
LOW USE			
MANITOU	18.2	29.0	2,879.2
SAND BEACH	16.1	26.9	2,623.0
CHICAGO	33.1	8.5	2,537.6
ZIMMERMAN	11.6	16.4	1,708.0
CHINNS	19.0	6.0	1,532.0
LONG	12.6	9.3	1,342.0
LAWN	11.6	10.2	1,329.8
JASPER	11.8	9.2	1,281.0
COMMANCHE	15.5	4.0	1,195.6
PETERSON	10.1	9.3	1,183.4
SKYSCRAPER	4.3	14.9	1,171.2
PEAR	5.9	12.1	1,098.0
BLUEBIRD	10.7	6.7	1,061.4
RED DEER	8.0	8.7	1,024.8
PARVIN	8.0	4.0	732.0
TWIN	6.5	4.8	695.4
TOTAL DAY GROUP USE	203.0	180.0	
GROUP AVERAGE	12.7	11.3	1,462.2
TOTAL SEASON GROUP USE			23,394.4
PER CENT CHANGE 1974		11.3% DECREASE	

Table 12. Access to high-country reservoirs with high, moderate and low use.

TYPE OF ACCESS	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
PAVED ROAD	6	54.5
LIGHT DUTY DIRT ROAD	5	45.5
FOUR-WHEEL DIRT ROAD	-	----
HIKE-IN TRAIL	-	----
TOTAL	11	100%
MODERATE		
PAVED ROAD	4	44.4
LIGHT DUTY DIRT ROAD	4	44.4
FOUR-WHEEL DIRT ROAD	-	----
HIKE-IN TRAIL	1	11.2
TOTAL	9	100%
LOW		
PAVED ROAD	1	6.3
LIGHT DUTY DIRT ROAD	3	18.7
FOUR-WHEEL DIRT ROAD	2	12.5
HIKE-IN TRAIL	10	62.5
TOTAL	16	100%

all and the remainder had only minimum facilities.

It is concluded that, in general, there is higher use at high-country reservoirs that provide highly-developed day-use and camping facilities. It is also concluded that the reservoirs can be distinguished from each other by the extensive difference found in the facilities desired by the users. The data also seem to indicate that except for the low-use reservoirs where no facilities were desired, both high and moderate users seemed to require mainly day-use facilities.

Table 13. Types of facilities at reservoirs with high, moderate, and low use.

FACILITIES	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
DAY USE (PICNIC TABLES, GRILLS, TRASH CANS, OUTHOUSES)	11	100%
BOATING	5	45.5
CAMPING	7	63.6
COMMERCIAL DEVELOPMENTS	3	27.3
TRASH CANS, OUTHOUSES, AUTO PARKING	0	----
OUTHOUSES	0	----
NONE	0	----
MODERATE		
DAY USE	7	88.9
BOATING	2	22.2
CAMPING	3	33.3
COMMERCIAL	1	11.1
TRASH CANS, OUTHOUSES, AUTO PARKING	0	----
OUTHOUSES	0	----
NONE	1	11.1
LOW		
DAY USE	1	6.2
BOATING	0	----
CAMPING	0	----
COMMERCIAL DEVELOPMENT	0	----
TRASH CANS, OUTHOUSES, AUTO PARKING	3	18.8
OUTHOUSES	2	12.5
NONE	10	62.5

4. Location. Although all of the reservoirs in this study are located along the Front Range, some are closer to the major urban areas than others. High-use reservoirs tended to group into three categories.

One group of high-country reservoirs located near major population centers (e.g. Denver, Boulder) experienced high use of day facilities. A

second group contained reservoirs located some distance from the major population centers. Any high-use of reservoirs in this group was largely dependent on superior camping facilities.

A third group consisted of high-country reservoirs in isolated locations. Any reservoir in this group that received high use tended to be one of only a few possible recreational sites in that region. Moreover, such high-use isolated reservoirs were all located in the southern section of the study area where only a few reservoirs exist.

Most "moderate-use" reservoirs either were close to major population centers or in close proximity to a high-use reservoir.

"Low-use" reservoirs are located farther back along routes having accesses to more-easily-reached sites. Consequently, their low use was largely the result of the high-use and moderate-use reservoirs filtering out potential users.

The location of a reservoir in relation to population centers and to other reservoirs has a definite effect on its use. This, of course, is only one factor in the larger complex of determinants.

5. Scenic quality. High-country reservoirs were classified in Table 14 according to their scenic quality. Categories of "fair," "good," "very good," and "excellent" were established and classification was based upon the subjective interpretation of the on-site interviewers.

The data indicate no definitive relationship between degree of scenic quality and use, except for the fact that those judged to be "most scenic" were in the "low use" category.

Table 14. Scenic quality of reservoirs with high, moderate and low use.

SCENIC RATING	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
FAIR	3	27.3
GOOD	6	54.5
VERY GOOD	2	16.2
EXCELLENT	0	----
TOTAL	11	100%
MODERATE		
FAIR	2	22.4
GOOD	4	44.3
VERY GOOD	3	33.3
EXCELLENT	0	----
TOTAL	9	100%
LOW		
FAIR	0	----
GOOD	8	50.0
VERY GOOD	5	31.6
EXCELLENT	3	18.4
TOTAL	16	100%

It should be obvious that isolation was the determinant of low use rather than scenic beauty. Nevertheless, it will be shown later that scenery is the major attraction for users of the reservoirs.

6. Fishing quality. Quality of fishing was defined as catch per fishing effort (See Also "Fishing Behavior"). The relationship of fishing quality was found to be inverse to the number of users (Table 15). Low-use reservoirs had the highest fishing quality. At the high-use and moderate-use sites, fishing quality was classified predominately as "fair."

Table 15. Fishing quality of reservoirs with high, moderate and low use.

FISHING QUALITY	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
POOR	0	----
FAIR	8	72.7
GOOD	2	18.1
EXCELLENT	1	9.1
TOTAL	11	99.9
MODERATE		
POOR	0	----
FAIR	6	66.7
GOOD	3	33.3
EXCELLENT	0	----
TOTAL	9	100%
LOW		
POOR	1	6.2
FAIR	2	12.5
GOOD	7	43.8
EXCELLENT	6	37.5
TOTAL	16	100%

7. Travel time. One hour and forty-five minutes was the average travel time to reach the sites (Table 16). Using that as a base, the percentage of users at each reservoir who traveled 1 3/4 hours or less was computed. It was found that two-thirds of the users of "high-use" and "moderate-use" reservoirs traveled 1 3/4 hours or less to reach the sites. Less than half of the users of "low-use" reservoirs were able to reach the sites in 1 3/4 hours.

These facts may be interpreted to mean that (1) more local people use "moderate-use" and "high-use" reservoirs; or (2), that people using predominately "hike-in" reservoirs (which are the majority of low-use areas) are willing to drive further and longer to reach those sites.

Table 16. The predominant time of travel to reservoirs with high, moderate and low use.

TRAVEL TIME	HIGH	MODERATE	LOW
1 and 3/4 hours	74.0%	64.2%	44.6%

8. Effect of drawdown. It was assumed that users of high-country reservoirs would be familiar with the term, "drawdown." Such was not the case, and the large percentage of "no-response" to "drawdown" questions in the first year's data renders a conclusion on the effect of drawdown on use impossible.

During the second year, the same drawdown question was asked. However, this time "drawdown" was defined to the user. Again little response was obtained and the few people responding were not concerned with drawdown. Only around 5% of all users had negative reactions to drawdown. This is a surprising finding in light of the original hypothesis that drawdown would elicit a strong negative response and behavior from users.

These findings indicate either that reservoir users are not concerned with drawdown and have, over the years, already changed their behavior patterns to accept existing drawdown practices, (this would be further substantiated by the fact that most users are from Colorado); or that our definition of drawdown was still inadequate to acquaint users to the practice.

Because of the importance of the drawdown question for management, an attempt will be made to elicit additional user response by further defining drawdown in a question administered to users this coming summer.

Furthermore, actual altered use relating to drawdown is being studied to determine the behavioral reaction of users to the practice.

Behavior Patterns of Users

What are the behavior patterns of users of high-country reservoirs? On-site interviews with users at the high-country reservoirs generated a behavior profile based upon the following questions:

1. Activities. What activities does the user participate in?
2. Relative importance of activities. What activity does the user consider most important?
3. Types of camping. What types of camping does the user participate in?
4. Types of equipment. What types of equipment does the user bring with him?
5. Length of stay. What is the average length of stay?
6. Incidence of return. What is the incidence of return of users?
7. Use fees. What percentage of users would be willing to pay a use fee? How high a use fee would they be willing to pay?

As a result of interviews utilizing the above questions, the following findings are reported. They are presented according to the three "use" categories: "high use," "moderate use," and "low use."

1. Activities. Fishing and camping are the two activities universal to all 36 reservoirs selected for intensive study (Table 17).

2. Relative importance of activities. Fishing was top priority at more than three-fourths of the "moderate use" and "low use" reservoirs and at two-thirds of the "high-use" reservoirs (Table 18). Camping was second in importance at three-fourths of the "high-use" reservoirs and was first in importance at the remaining one-fourth.

Table 17. Activities participated in at reservoirs with high, moderate and low use.

ACTIVITY	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
CAMPING	4	36.1
FISHING	7	63.6
HIKING	-	----
TOTAL	11	100%
MODERATE		
CAMPING	2	22.2
FISHING	7	77.8
HIKING	-	----
TOTAL	9	100%
LOW		
CAMPING	4	25.0
FISHING	12	75.0
HIKING	0	----
TOTAL	16	100%

Table 18. Most important activity at reservoirs with high, moderate and low use.

ACTIVITY	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
FISHING	11	100%
CAMPING	0	0
HIKING	0	0
NONE	0	0
TOTAL	11	100%
MODERATE		
FISHING	8	88.9
CAMPING	1	11.1
HIKING	0	----
NONE	0	----
TOTAL	9	100%
LOW		
FISHING	7	43.7
CAMPING	4	25.0
HIKING	3	18.8
NONE	2	12.5
TOTAL	16	100%

3. Types of camping. "High-use" reservoirs were found to have the highest number of trailer camping areas; they also showed the highest number of campers (Table 19).

Table 19. Predominant type of camping at reservoirs with high, moderate and low use.

TYPE OF CAMPING	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
TENT	2	18.2
TRAILER	5	45.5
NONE	4	36.3
TOTAL	11	100%
MODERATE		
TENT	1	11.1
TRAILER	1	11.1
NONE	7	77.8
TOTAL	9	100%
LOW		
TENT	8	50.0
TRAILER	2	12.5
NONE	6	37.5
TOTAL	16	100%

"Low-use" reservoirs showed the second-highest number of campers. However, the camping at those reservoirs was predominately tent type, inasmuch as most such reservoirs have only "hike-in" access.

Three-fourths of the "moderate-use" reservoirs were classified by users as areas where they do not camp.

4. Types of equipment. Table 20 contains data indicating types of equipment brought to "high-use", "moderate-use", and "low-use" reservoirs.

Regardless of use, fishing gear is listed as the universal type of equipment brought to all sites (Table 21).

Table 20. Equipment brought to reservoirs with high, moderate and low use (user's first response to question).

PREDOMINANT EQUIPMENT	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
FISHING GEAR	11	100%
CAMPING GEAR	--	----
HIKING BOOTS	--	----
CAMERA	--	----
NONE	--	----
TOTAL	11	100%
MODERATE		
FISHING GEAR	9	100%
CAMPING GEAR	--	----
HIKING BOOTS	--	----
CAMERA	--	----
NONE	--	----
TOTAL	9	100%
LOW		
FISHING GEAR	11	68.6
CAMPING GEAR	1	6.3
HIKING BOOTS	3	18.8
CAMERA	--	----
NONE	1	6.3
TOTAL	16	100%

Camping gear of various types was the second most prevalent type of equipment brought by users to reservoir sites.

5. Length of stay. The data collected on the average amount of time spent at each reservoir--and separated by use categories shows an approximate even distribution between day-use and longer visitation periods, (Table 22).

Three-fourths of all users at "moderate-use" reservoirs indicated they were there only for the one day.

The superior camping facilities at the "high-use" reservoirs accounts for the longer stay of users.

Table 21. Equipment brought to reservoirs with high, moderate and low use (user's second response to question).

PREDOMINANT EQUIPMENT	NUMBER OF RESERVOIRS	PERCENTAGE
HIGH		
FISHING GEAR	--	----
CAMPING GEAR	7	63.6
HIKING BOOTS	--	----
CAMERA	4	36.4
NONE	--	----
TOTAL	11	100%
MODERATE		
FISHING GEAR	1	11.1
CAMPING GEAR	5	55.6
HIKING BOOTS	1	11.1
CAMERA	1	11.1
NONE	1	11.1
TOTAL	9	100%
LOW		
FISHING GEAR	--	----
CAMPING GEAR	7	43.8
HIKING BOOTS	6	37.6
CAMERA	--	----
NONE	3	18.6
TOTAL	16	100%

Table 22. Amount of time spent at reservoirs with high, moderate and low use.

USE	DAY	WEEK END	LONGER	TOTAL
HIGH	53.2	29.7	17.1	100%
MODERATE	72.9	21.7	5.3	100%
LOW	51.9	37.5	10.5	100%

The isolation and difficulty of access related to "low-use" sites accounts for the usual overnight stay of the hikers who use those sites.

6. Incidence of return. Two-thirds of the users of "high use" and "moderate use" reservoirs tend to be those who return. The "hike in" users at the "low use" reservoirs tend to stay overnight and

then seek out new experiences (Table 23). Some users indicated a fondness for certain sites and returned frequently to them. This was more prevalent at the "high use" and "moderate use" reservoirs. Because of wide variations, an average incidence of return appears to be meaningless.

7. Use fees. Approximately one-half of all users at reservoirs in each of the three groups indicated a willingness to pay a use fee for the reservoir as it is at present (Table 24). Users at "high use" sites showed a slightly higher willingness to pay a use fee. This may be because of the superior facilities at those reservoirs.

The use fees that users agreed they might be willing to pay ranged from $1 to $4 with the majority willing to pay $2. These amounts are in keeping with use fees charged at private reservoir sites.

When asked what they would be willing to pay as a use fee if their desired improvements were provided, a significantly lower percentage of users expressed a willingness to pay at all.

In the few cases where user fees are charged at high-country reservoirs the fee has no negative affect on use. In fact, sites with user fees had higher than average use. This is probably because the reservoir sites had other desired management practices such as easy acres, proximity to urban centers, facilities, etc.

Table 23. Frequency of return visits to reservoirs with high, moderate and low use.

USE	RANGE	AVERAGE RETURN (PERCENTAGE)
HIGH	55.8-86.5%	68.3
MODERATE	39.5-81.5%	61.9
LOW	0-69.2%	35.3

Table 24. Willingness to pay a fee at reservoirs with high, moderate and low use.

	FEE	PERCENTAGE
HIGH	1-2 Dollars	52.3
	3-4 Dollars	4.8
	None	40.3
	N/A	1.4
		100.0
MODERATE	1-2 Dollars	40.4
	3-4 Dollars	6.2
	None	50.7
	N/A	2.7
		100.0
LOW	1-2 Dollars	34.3
	3-4 Dollars	13.3
	None	36.8
	N/A	14.6
		100.0

Summary. A combination of variables accounts for the variations of use of high-country reservoirs for recreational purposes.

The most important determinants are: (1) ease of access, (2) types of facilities, (3) location, (4) driving time, and (5) proximity to other reservoirs.

Reservoirs that have easy access, superior facilities, and proximity to major population centers will most likely become "high use" sites. Those with no facilities and access only by trail will be "low use" sites. The latter will also have only overnight tent camping, whereas the former will attract longer-stay mobile campers.

Although scenic quality tends to be dependent upon subjective values, it appears that the more remote, low-use reservoirs have the highest scenic quality.

More remote, low-use reservoirs also provide the highest fishing quality. This is most important, for fishing is undoubtedly the prime activity at all reservoir sites, with camping a close second.

It is interesting to note, however, that the findings related to Sub-objective #3 indicate that the quality or success of catching fish is not as significant an influence on the user as is the mere availability of the fishing experience.

Most reservoir sites are used only for a one-day overnight period. Although the publicly-owned reservoirs are free at present, about half of the users professed a willingness to pay a nominal use fee ranging from $1 to $4 and averaging $2.

In conclusion, it may be stated that no one factor accounts for variations in the intensity of recreational use of high-country reservoirs in the Front Range of the Colorado Rockies. However, only four variables account for most of the variance. These four variables nicely differentiate the three user groups.

Management Implications

What are the management implications inherent in the actual behavior patterns of the users of high-country reservoirs?

Implication #1. Small reservoirs of a few acres have equal recreation attraction to that of larger reservoirs up to 300 acres. This implies that managers should consider all high-country reservoirs equally in terms of size and number of users. However, environmental impact at a smaller area must be a consideration.

Implication #2. Management can greatly increase the recreational use of a reservoir by improving the facilities provided there. However, the more improved facilities serve only one of three distinct group of users. Some reservoirs are needed with no facilities while most reservoirs need only day-use facilities.

Implication #3. Management can increase the recreational use of a reservoir by providing a paved or well-maintained access road to the site.

Implication #4. Management of remote isolated reservoirs should minimize management of the sites, providing few, if any, facilities and trail access only.

Implication #5. Management should not anticipate that improved facilities will generate significantly-increased fees. According to responses on this survey, the opposite may occur.

Implication #6. Although only about 50% of users indicated a willingness to pay a nominal use fee, it could be that all users including backpackers would be willing to pay a nominal use fee if there were no alternatives.

Implication #7. Inasmuch as 50% of users indicated an unwillingness to pay a use fee, it may be that, if a use fee were instituted, attendance would drop 50%.

In view of all other factors stated in the introduction to this report, this is just a remote possibility.

Implication #8. Management should recognize that those people who desire improved facilities most are the least willing to support them with use fees.

Sub-objective 2. Social-psychological--To identify the management practices at high-country reservoirs which reflect a social-psychological profile of recreation users

Expectations, Satisfactions and Desires

What are the overall recreation expectations, satisfactions, and desires of high-country reservoir users? User expectations about a reservoir were established by asking the following questions:

Expectations--How did you find out about this particular site? What specific things did you expect to find that you liked?

On-site user satisfaction was determined by asking:

Satisfactions--Now that you are at this reservoir site, what do you specifically like about it? What do you specifically dislike about it?

User desires for future reservoir improvements were determined by asking:

Desires--What specific additions or improvements would you like to see at or around this reservoir?

Responses to these questions were classified by content and key words, and were grouped under one of seven headings. The following lists show which responses were grouped under each heading.

Favorable responses (likes).

FISHING: stocked well, fishing.

SOLITUDE: uncrowded, quiet, peaceful, solitude, privacy, remote, wild, wilderness.

SCENICS: scenery, trees, lake, mountains, clean air, wildlife, grassy shoreline, natural, mountain air, reservoir water clean.

FACILITIES: Campsites at reservoir, family area, clean restrooms, restrooms, drive-in site, drinking water, boating.

ACCESS: convenient, easy access, easy hike, off-road okay.

OTHER: hiking trails, swimming, size, few bugs, free, everything, other.

NONE: none or no response.

Unfavorable responses (dislikes).

POOR FISHING: poor fishing, fishing snags.

TOO CROWDED: too many people, boats.

SCENIC DEGRADATION: water dirty, dead trees at edge of reservoir, off-road vehicles in area, trash, man-made objects, dam.

POOR FACILITIES: no fires, no drinking water, not patrolled, poor facilities, paying a fee, can't camp at site, poor sanitation facilities.

POOR ACCESS: terrible road, poorly-marked trail or road, can't drive to lake.

OTHER: weather, bugs, no swimming, other.

NO DISLIKES: none or no response.

Desired improvements.

IMPROVE FISHING: stock lake, stock more often, stock larger fish, flies and lures only.

DECREASE CROWDING: no motor vehicles, campsites farther apart.

IMPROVE SCENICS: more trees, cleaner water in reservoir, keep area clean.

IMPROVE FACILITIES: improve sanitation, showers, cleaner restrooms, drinking water, picnic tables, wood available, trash cans, grills for cooking, more parking area, level banks near reservoir, more play area, boat ramp, better management, better camping facilities, drive-in camping facilities, more campsites.

IMPROVE ACCESS: improve road, paved roads.

OTHER: more trails off-road, other.

NO IMPROVEMENTS: none or no response.

Table 25 shows an overall comparison between the pre-visit favorable expectations and the actual on-site likes of the users. It is interesting to note the changes in user attitudes once the user is at the reservoir. Prior to their visit, the reservoir users put equal values on fishing and scenics. However, once the user is actually at the site he becomes overwhelmingly scenics oriented, and his favorable response for solitude factors increases as well. The favorable responses for fishing meanwhile decrease from 25% to 11%.

Table 26 compares the on-site likes, dislikes, and improvements desired by all users sampled. Most users are satisfied with the recreation experience provided at the high-country reservoirs. Half of all the users had no dislikes, and almost half wanted no improvements. The largest number of complaints were about poor sanitation and trash in the area. The second largest number of complaints were those about the weather and bugs, universal problems which managers have little chance of correcting. Although nearly half of the

Table 25. Pre-visit favorable expectations and on-site likes (all users).

RESPONSE CATEGORIES	PRE-VISIT EXPECTATIONS		ON-SITE LIKES	
	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL
FISHING	429	25.2	231	11.2
SOLITUDE	252	14.8	389	18.9
SCENICS	469	27.6	1070	51.9
FACILITIES	69	4.1	65	3.1
ACCESS	110	6.5	117	5.7
OTHER	105	6.2	141	6.8
NONE OR NO RESPONSE	266	15.6	49	2.4
TOTAL	1700	100.0	2062	100.0

Table 26. Overall on-site likes, on-site dislikes, desired improvements.

RESPONSE CATEGORIES (LIKES)	ON-SITE LIKES NO. OF RESPONSES	PERCENTAGE OF TOTAL	RESPONSE CATEGORIES (DISLIKES)	ON-SITE DISLIKES NO. OF RESPONSES	PERCENTAGE OF TOTAL	RESPONSE CATEGORIES (IMPROVEMENTS)	DESIRED IMPROVEMENTS NO. OF RESPONSES	PERCENTAGE OF TOTAL
FISHING	231	11.2	POOR FISHING	74	6.2	IMPROVE FISHING	79	6.2
SOLITUDE	389	18.9	TOO CROWDED	87	7.3	DECREASE CROWDING	10	0.8
SCENICS	1070	51.9	SCENIC DEGRADATION	96	8.1	IMPROVE SCENICS	69	5.4
FACILITIES	65	3.1	POOR FACILITIES	92	7.7	IMPROVE FACILITIES	375	29.2
EASY ACCESS	117	5.7	POOR ACCESS	28	2.4	IMPROVE ACCESS	58	4.5
OTHER	141	6.8	OTHER	174	14.6	OTHER	103	8.0
NONE OR NO RESPONSE	49	2.4	NO DISLIKES	638	53.7	NO IMPROVEMENTS	589	45.9
TOTAL	2062	100.0	TOTAL	1189	100.0	TOTAL	1283	100.0

recreation users at the high-country reservoirs do not want any improvements, nearly one-third want improvement of facilities. However, of the 29.2% who want improved facilities, 20% want only minor improvements such as restrooms, trashcans, picnic tables, and grills for cooking. This leaves only 9.2% of all reservoir users who want more elaborate and expensive facilities.

Differences Between Expectations, Satisfactions, and Desires

Are there any significant differences between the expectations, satisfactions, and desires of users of high-country reservoirs? According to responses given during the survey, nearly two-thirds of the recreational users of these reservoirs were making return visits. Furthermore, two-thirds of the respondents either read about the reservoir or heard about it from a friend prior to their first visit. These facts indicate that the typical reservoir user knows a fairly large amount about a reservoir before he actually visits that reservoir. It is, therefore, possible to assume that a recreationist will go to a reservoir that he believes will provide him with the most enjoyable recreation experience. It will later be shown that this is, indeed, the case, and that most users expected to like the reservoir prior to use. If it is further assumed that people with similar recreational desires and expectations will tend to go to reservoirs with similar characteristics. These assumptions will provide a basis for examination of attitudinal differences between reservoir users.

Based on the assumption that most users at any one high-country reservoir will have similar characteristics, the responses from users

of individual reservoirs were compiled and then compared to determine whether or not there were any factors common to groups of reservoirs.

The 36 high-country reservoirs surveyed were grouped according to similar facilities, use, access, fishing quality, and scenic values. Average user responses to Hendee's Wildernism Scale were then calculated for each reservoir, and were used as an index to user attitudes. It was found that there were significant differences between users of three groups of reservoirs, based on the criteria of use and access. The high use, easy vehicular-access reservoir users had an average wildernism score of 65.78 (N=872). The moderate use, difficult vehicular-access reservoir users had an average score of 70.64 (N=78). The low use, hike-in reservoir users compiled an average wildernism score of 75.10 (N=153). A Fisher's test of variance was run on these three scores and it was found that the differences between the three groups were statistically significant at the .01 level (F=82.18). However, because all three of these average scores were within a single category on Hendee's scale (Weak Wildernist), it was felt that the Wildernism Scale did not provide enough detailed information to divide reservoir users into attitudinal groups. Therefore, the Wildernism scores were used only as a guide to more detailed identification of discrete user groups.

The next step was to examine user expectations, satisfaction, and desired improvement responses at each reservoir. The responses were grouped according to the seven categories mentioned previously in the overall user analysis, and then users at each reservoir were compared to the overall group and to users at other reservoirs. Examination and analysis of category percentages at each reservoir showed that users

could be assigned to four discrete attitudinal groups, based on user responses to questions concerning likes, dislikes, and desires. Following are the four attitudinal groups:

Group 1: Facilities and access oriented. High-country reservoir users in this group tend to look for good facilities and easy access when they seek a reservoir for recreational purposes.

Group 2: Fishing and facilities oriented. Users in this group are similar to those in Group 1, but they are more oriented toward fishing than toward facilities.

Group 3: Solitude oriented. Users in this group tend to look for reservoirs that are less crowded than the average reservoir, even if they have to go to reservoirs requiring a four-wheel drive vehicle for access.

Group 4: Hiking and scenic oriented. This group of users is the most distinct of the four, since they are the only group that prefers hike-in reservoirs to drive-in ones. This group is also above average in their favorable responses toward scenic factors, and well below average in their desire for improved facilities.

Statistical analysis of each group of users shows that they are, in fact, distinct from each other as groups, and distinct in their primary identifying categories. The four groups were compared with each other and with the overall survey results on three different attitudinal factors: on site likes (Table 27), on-site dislikes (Table 28), and desired improvements (Table 29).

Group 4 (Hiking and scenics oriented) showed the most obvious differences from the other three groups. To ensure that the first three groups were distinct, Chi-square analyses were run on comparisons between the group members' on-site likes and desired improvements.

Table 27. On-site likes to attitudinal group.

RESPONSE CATEGORIES (LIKES)	GROUP I FACILITIES AND ACCESS ORIENTED		GROUP II FISHING AND FACILITIES ORIENTED		GROUP III SOLITUDE ORIENTED		GROUP IV HIKING AND SCENICS ORIENTED		OVERALL ALL USERS	
	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSE	PERCENTAGE OF TOTAL
FISHING	106	10.1	79	22.3	26	7.3	20	6.2	231	11.2
SOLITUDE	178	16.9	55	15.5	95	26.6	61	19.0	389	18.9
SCENICS	516	49.1	175	49.4	186	52.1	193	59.9	1070	51.9
FACILITIES	42	4.0	6	1.7	6	1.7	11	3.4	65	3.1
EASY ACCESS	93	8.9	14	4.0	5	1.4	5	1.6	117	5.7
OTHER	89	8.5	20	5.7	25	7.0	28	8.7	141	6.8
NONE OR NO RESPONSE	26	2.5	5	1.4	14	3.9	4	1.2	49	2.4
TOTAL	1050	100.0	354	100.0	357	100.0	322	100.0	2062	100.0

Table 28. On-site dislikes by attitudinal group.

RESPONSE CATEGORIES (DISLIKES)	GROUP I FACILITIES AND ACCESS ORIENTED		GROUP II FISHING AND FACILITIES ORIENTED		GROUP III SOLITUDE ORIENTED		GROUP IV HIKING AND SCENICS ORIENTED		OVERALL ALL USERS	
	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL
POOR FISHING	49	7.9	9	4.4	14	6.5	2	1.2	74	6.2
TOO CROWDED	55	8.8	8	3.9	12	5.5	15	9.0	87	7.3
SCENIC DEGRADATION	50	8.0	14	6.9	13	6.0	15	9.0	96	8.1
POOR FACILITIES	57	9.2	16	7.8	15	6.9	6	3.6	92	7.7
POOR ACCESS	8	1.3	6	2.9	13	6.0	1	0.6	28	2.4
OTHER	84	13.5	35	17.2	40	18.4	34	20.5	174	14.6
NO DISLIKES	319	51.3	116	56.9	110	50.7	93	56.1	638	53.7
TOTAL	622	100.0	204	100.0	217	100.0	166	100.0	1189	100.0

Table 29. Desired improvements by attitudinal group.

RESPONSE CATEGORIES (DESIRED IMPROVEMENTS)	GROUP I FACILITIES AND ACCESS ORIENTED		GROUP II FISHING AND FACILITIES ORIENTED		GROUP III SOLITUDE ORIENTED		GROUP IV HIKING AND SCENICS ORIENTED		OVERALL ALL USERS	
	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL
IMPROVE FISHING	51	7.7	11	4.7	14	6.3	3	1.8	79	6.2
DECREASE CROWDING	6	0.9	0	0.0	1	0.4	3	1.8	10	0.8
IMPROVE SCENICS	44	6.6	11	4.7	7	3.2	7	4.3	69	5.4
IMPROVE FACILITIES	209	31.5	83	35.3	57	25.7	26	16.0	375	29.2
IMPROVE ACCESS	11	1.7	14	6.0	32	14.4	1	0.6	58	4.5
OTHER	56	8.4	18	7.7	15	6.8	14	8.6	103	8.0
NO IMPROVEMENTS	286	43.1	98	41.7	96	43.2	109	66.9	589	45.9
TOTAL	663	100.0	235	100.0	222	100.0	163	100.0	1283	100.0

Analysis of differences between Group 1 (Facilities and access) and Group 2 (Fishing and facilities) showed a significant difference between the two user groups in their on-site likes. (χ^2=26.04, α=.05). These two groups did not show a significant difference in desired improvements, except in the desire for improved access. As can be seen in Tables 27 and 29, Group 2 is significantly less satisfied with the access at their reservoirs than Group 1. Apparently the reservoirs which are perceived as good fishing sites have poorer access than the reservoirs used by Group 1. Group 2 users are, therefore, similar to Group 1 users in their desire for easy access and good facilities. But Group 2 is, nonetheless, distinct due to its high fishing orientation.

Group 3 users (Solitude oriented) are distinct from the first two groups, particularly in relationship to Group 2 users' desires for a less crowded area. (χ^2=43.76, α=.01). However, this group is similar to the first two in that members of Group 2 would prefer better access to the reservoirs (Table 29). These solitude-oriented users do not want as high a level of facilities as the first two groups.

A brief examination of Tables 27, 28, and 29 will show that each group is typified by the factors previously mentioned: facilities and access (Group 1); fishing and facilities (Group 2); solitude (Group 3); and hiking and scenics (Group 4). Chi-square analyses confirm initial impressions of group differences. Throughout the following statistical analysis, all Chi-square comparisons were made on 2x2 tables with one degree of freedom.

In Group 1, on-site satisfaction with access is significantly higher than the overall average (χ^2=18.7, α=.01). Satisfaction with

facilities is not significantly greater than the average for all users, but Group 1 users are significantly more satisfied with their facilities than Group 2 or Group 3 users (χ^2=31.2, α=.01).

Within Group 2, the primary identification factor is orientation toward fishing. Group 2 is, in fact, significantly more satisfied with fishing than other user groups (χ^2=42.6, α=.01). The Group 2 users' desires for improved facilities are higher than average, but the difference is significant only at the .10 level (χ^2=3.4).

Group 3 users are significantly higher than the overall average in their enjoyment of solitude (χ^2=13.2, α=.01). These users are also significantly lower than average in their satisfaction with the access to the reservoirs (χ^2=11.7, α=.01), and much higher in their desire for better access (χ^2=46.2, α=.01).

Group 4 users differ from other groups in their means of access (hike-in versus drive-in), and also in their orientation toward scenic factors. Users in this hike-in group are significantly higher than average in their satisfaction with the scenics of their high-country reservoirs (χ^2=8.03, α=.01), and significantly lower than average in their desire for improved access (χ^2=5.16, α=.05), and their desire for improved facilities (χ^2=13.29, α=.01). In fact, this group is significantly higher than average in its percentage of users (66.9%) who do not want any improvements at all (χ^2=28.03, α=.01).

Management Implications

If there are significant differences between the social-psychological characteristics of the users, then what are the management implications of these differences?

Overall, high-country reservoir users have very high expectations prior to visiting a reservoir. Table 30 shows that two-thirds of high-country reservoir users either moderately or strongly liked what they heard about the reservoir. One-fourth of the users had no expectations at all. Once the recreationist is at the reservoir, he tends to increase his approval of the recreation experience offered at the site. Table 31 shows that an average of 58.7% of all users "strongly liked" the reservoir, with another 28.3% that "moderately liked" their experience. Only 2% had any negative reaction to the high-country reservoir.

Tables 30 and 31 show that the majority of users within each of the four attitudinal groups also liked the reservoirs. The three drive-in groups showed significant increases from their initial expectations to their final ratings in the "strongly liked" category. The hike-in group (Group 4) demonstrated a significantly higher percentage of maximum final ratings than did the other three groups (χ^2=17.9, α=.01). However, none of the attitudinal groups showed less than 84% favorable responses. It is evident that the high-country reservoirs are now providing excellent recreational experiences for a very large proportion of the users.

Table 32 shows the reservoir preferences of the four attitudinal groups of reservoir users. The demographic data provided by the survey are combined with previously-discussed group attributes to produce a user profile for each group. These profiles lead to specific management recommendations.

Group 1 users (facilities and access oriented) tend to prefer reservoirs with easy access (paved or good dirt roads) and extensive

Table 30. User expectations prior to visiting reservoir.

RESPONSE CATEGORIES (EXPECTATIONS)	GROUP I FACILITIES AND ACCESS ORIENTED		GROUP II FISHING AND FACILITIES ORIENTED		GROUP III SOLITUDE ORIENTED		GROUP IV HIKING AND SCENICS ORIENTED		OVERALL ALL USERS	
	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL
STRONGLY LIKE	199	35.3	86	44.6	84	43.3	104	68.0	473	42.9
MODERATELY LIKE	138	24.5	44	22.8	47	24.2	20	13.1	249	22.6
NEUTRAL	53	9.4	21	10.9	13	6.7	6	3.9	93	8.4
MODERATELY DISLIKE	2	0.4	0	0.0	3	1.5	1	0.7	6	0.5
STRONGLY DISLIKE	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
NO RESPONSE	171	30.4	42	21.7	47	24.2	22	14.4	282	25.6
TOTAL	563	100.0	193	100.0	194	100.0	153	100.0	1103	100.0

Table 31. User rating of reservoir (on-site likes and dislikes).

RESPONSE CATEGORIES (ON-SITE RATING)	GROUP I FACILITIES AND ACCESS ORIENTED		GROUP II FISHING AND FACILITIES ORIENTED		GROUP III SOLITUDE ORIENTED		GROUP IV HIKING AND SCENICS ORIENTED		OVERALL ALL USERS	
	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL	NO. OF RESPONSES	PERCENTAGE OF TOTAL
STRONGLY LIKED	302	53.6	124	64.2	107	55.2	114	74.5	647	58.7
MODERATELY LIKED	183	32.5	46	23.8	56	28.9	27	17.6	312	28.3
NEUTRAL	60	10.7	11	5.7	15	7.7	6	3.9	92	8.3
MODERATELY DISLIKED	9	1.6	4	2.1	4	2.1	0	0.0	17	1.5
STRONGLY DISLIKED	2	0.4	0	0.0	2	1.0	1	0.7	5	0.5
NO RESPONSE	7	1.2	8	4.1	10	5.1	5	3.3	30	2.7
TOTAL	563	100.0	193	100.0	194	100.0	153	100.0	1103	100.0

Table 32. Attitudinal groups and their reservoir preferences.

GROUP I FACILITIES AND ACCESS ORIENTED	GROUP II FISHING AND FACILITIES ORIENTED	GROUP III SOLITUDE ORIENTED	GROUP IV HIKING AND SCENICS ORIENTED
Barker Meadow	Chicago Creek	Clear Creek	Bluebird Lake
Bellaire Lake	Left Hand Park	Chinns Lake	Isabelle Lake
Brainard Lake	Monument Lake	Commanche Reservoir	Jasper Lake
Chambers Lake	North Lake	Jefferson Lake	Lawn Lake
Dowdy Lake	Skagway Reservoir	Parvin Lake	Long Lake
Lake Estes		Peterson Lake	Pear Reservoir
Evergreen Lake		Twin Lake	Red Deer Lake
Manitou Park		Lower Urad	Sand Beach
Mary's Lake		Zimmerman Lake	Skyscraper Reservoir
Pinewood Lake			
Lake Isabel			
West Lake			
Wrights Reservoir			

facilities. These users will travel up to two hours to reach a reservoir, and they are willing to use more crowded recreation areas than the other groups. These Group 1 users form the majority of all recreationists now using high-country reservoirs--over one-half of all users. The majority of users in this group do not care whether the fishing is good or bad at the reservoir they are visiting.

Members of Group 2 (fishing and facilities oriented) will be found at reservoirs with good fishing, provided that those reservoirs also have good vehicular access and moderate facilities. These users will also go to reservoirs with more facilities if the fishing is thought to be good. They will use reservoirs with only fair fishing if the access is good and if the users believe that their own chance of catching fish is good. Group 2 users are willing to travel up to two hours to reach a reservoir, but prefer a shorter drive. Users in this attitudinal group form 17.5% of the total reservoir user population.

Group 3 users (solitude oriented) are willing to travel up to three hours to find an uncrowded reservoir. These people will use a reservoir with little or no facilities, and they do not care if the fishing is poor. A significant percentage of these users would like better access roads into their reservoirs, but it should be noted that improved access will increase use of those uncrowded reservoirs by people from the first two attitudinal groups, thus destroying the solitude that is the main attraction for members of Group 3. Furthermore, improved access would lead to increased demand for facilities as the first two user groups move into these reservoirs. At present, users with a high solitude orientation make up 17.5% of all

high-country reservoir users. Managers whose reservoirs have few facilities and difficult access can expect to draw their users from Group 3, and can, therefore, expect only low to moderate use at their reservoirs--if the access is not improved.

The final group is the smallest (13.9%) and the least demanding for reservoir management. Group 4 is the hike-in group, and this group's primary orientation is toward the scenic factors of the high-country reservoir's setting. Members of this group tend to be younger than users from the other attitudinal groups (under 25 years), and they include a much higher percentage of students. Hike-in reservoirs do not need any facilities to satisfy these users, although outhouses and trash cans would be accepted. These high-country reservoir users are willing to travel for much longer periods of time to reach the reservoirs (up to four hours), so they are a potential use group for reservoirs far from population centers.

Summary and Comparison of Objective to Findings

The objective of this section was to establish a profile of recreational users at high-country reservoirs that would be useful to reservoir managers. The following user profile is the result of this report's attempt to achieve the above objective:

1) As a group, high-country reservoir users are satisfied with the recreational experience provided at the reservoirs open to public use.

2) Prior to their visit, reservoir users believe that fishing will be an important part of their experience at the reservoir. However, once they are on the site, reservoir users as a group feel that the

scenic aspect of the reservoir is the most important part of their experience.

3) The most frequently expressed complaints of reservoir users are those involving poor sanitation facilities and trash at the reservoirs.

4) Most reservoir users desire few or no improvements at the site. Of those who do want improvements, the majority want only improved sanitary facilities, more trashcans, grills, and picnic tables.

5) Reservoir users may be divided into four attitudinal groups, and members of each group will tend to use different reservoirs, depending on the type of access, facilities, fishing, degree of use, and quality of scenery at the different reservoirs.

6) The majority of reservoir users prefer easy access and good facilities (such as clean restrooms, picnic tables, camping facilities, and so on), but a significant proportion (one-third) of users are willing to exchange these conveniences for solitude or scenery.

7) One-half of all reservoir users do not wish to pay a fee for use of the reservoirs, but one-half would pay up to $2 for the use of reservoirs with desired facilities.

Conclusion

In conclusion, high-country reservoir managers can expect the majority of their users to be people who want easy access and good facilities at the recreation site. The findings in the previous behavior section of this report support this view, with high-use reservoirs tending to have paved access roads and well-developed

facilities. These high-use reservoirs are drawing Group 1 users (facilities and access oriented) and some Group 2 users (fishing and facilities oriented). The solitude-oriented Group 3 users and also some fishing-oriented Group 2 users tend to go to the moderate use reservoirs with poor access roads, while the hikers of Group 4 (hiking and scenic oriented) tend to be located at the low use, hike-in reservoirs.

Managers whose high-country reservoirs are located on or close to good roads can expect increased use and increased demand for facilities. Reservoir users are reluctant to pay fees for their recreation, but half would be willing to pay up to two dollars for reservoirs with adequate facilities. Very few of the reservoir users want elaborate facilities such as those available at commercial campgrounds; in fact, these users have come to the reservoirs to escape the extreme crowding generated by such elaborate facilities. However, many high-country reservoir visitors would like to see improved sanitation and trash pick-up at the reservoirs. At any event, the majority of high-country reservoir users are satisfied with their present recreational experience.

Table 33 is a specific breakdown of the actual user days which a manager can expect at a reservoir for a user group. This should help managers determine which reservoirs to manage for recreation and in what ways they should be managed.

Table 33. User days by social-psychological group.

	Group 1 Facilities and Access Oriented	Group 2 Fishing and Facilities Oriented	Group 3 Solitude Oriented	Group 4 Hiking and Scenics Oriented	Overall All Users
Number of User-Days for Period June 1 - September 30	100,223	29,732	22,959	14,322	167,237
Percent of Overall Total	59.9%	17.8%	13.7%	8.6%	100.0%
Average Daily Use (Users Per Day)	63.2	48.7	20.9	13.0	38.0

Sub-objective 3. To identify the management practices necessary to meet the fisheries desires at high-country reservoirs.

One of the biggest attractions that high-country reservoirs have to offer is their fishing potential. Over three-fourths of the reservoir users are fishermen, and fishing is the activity receiving the largest participation. This section of the report is devoted to developing a fisherman profile and to suggesting management practices to satisfy the fisherman's desires.

In the past there has been a tendency to think of the fisherman only in terms of a recreationist who wants to catch fish. However, very recent research (Knapf, 1973; Hendee, 1974; Andrews, 1972; Ballas, 1974; and Moeller, 1972) has indicated that catching fish is only one of a number of values that a fisherman attaches to his experience. That research clearly points out that catching fish is often of relatively minor importance for an enjoyable fishing experience. Fishery management must be concerned with the desires and preferred sites of both nonconsumptive fishermen and those fishermen who have more consumptive values regarding the fishing experience.

In this study, it became apparent early in the analysis of data that there are more than one group of fishermen. At first it seemed that two classes of fishermen-consumptive and nonconsumptive-would be adequate categories for helping determine management implications. Upon closer inspection, however, it was found that there are two groups of nonconsumptive fishermen who have differing desires, expectations, and behavior. The nonconsumptive fishermen were then divided into "avid" and "casual" types. This classification of types coincides closely with a study conducted on fishermen in Gallatin Canyon, Montana

(Ballas, 1974). An enjoyable experience for the consumptive fisherman centers around one thing--a good catch of fish. The avid nonconsumptive fisherman considers fishing his major activity, but is not concerned about the number of fish he catches for an enjoyable experience. The casual nonconsumptive fisherman does not care about catching fish, and does not rate fishing as his major activity.

Results

Demographic composition. What is the demographic composition of the high-country reservoir fisherman?

Consumptive-----The consumptive fisherman was identified as one who answered "yes" to the question, "Is it important that you catch your limit?" Only 14% of the fishermen in the survey were found to be consumptive. This represents 118 out of 828 total fishermen (Figure 5).

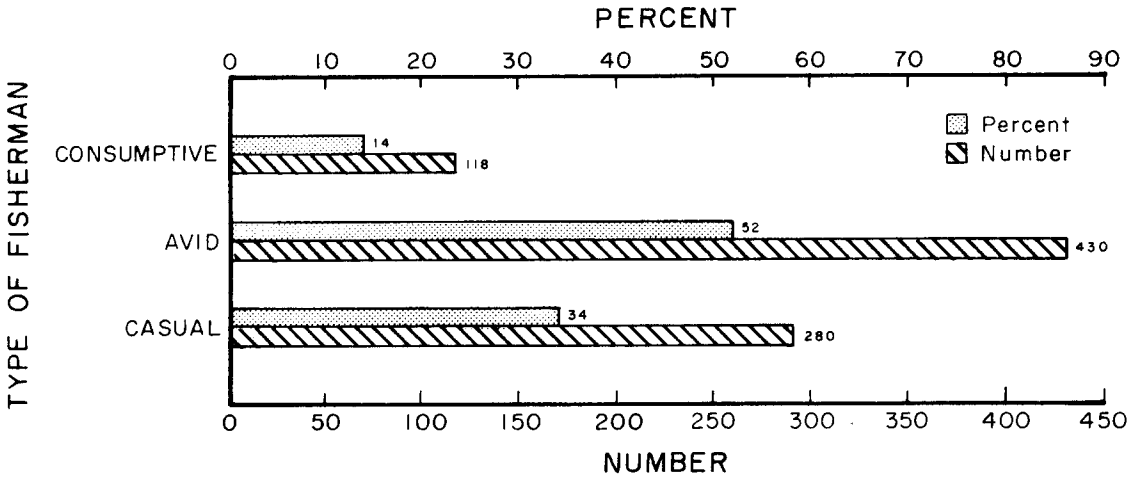

Figure 5. Types of fishermen.

The consumptive fishermen had some very well-defined characteristics (see Figure 6). Their age was predominantly over 45 (40%), and the number under age 30 was significantly lower than the

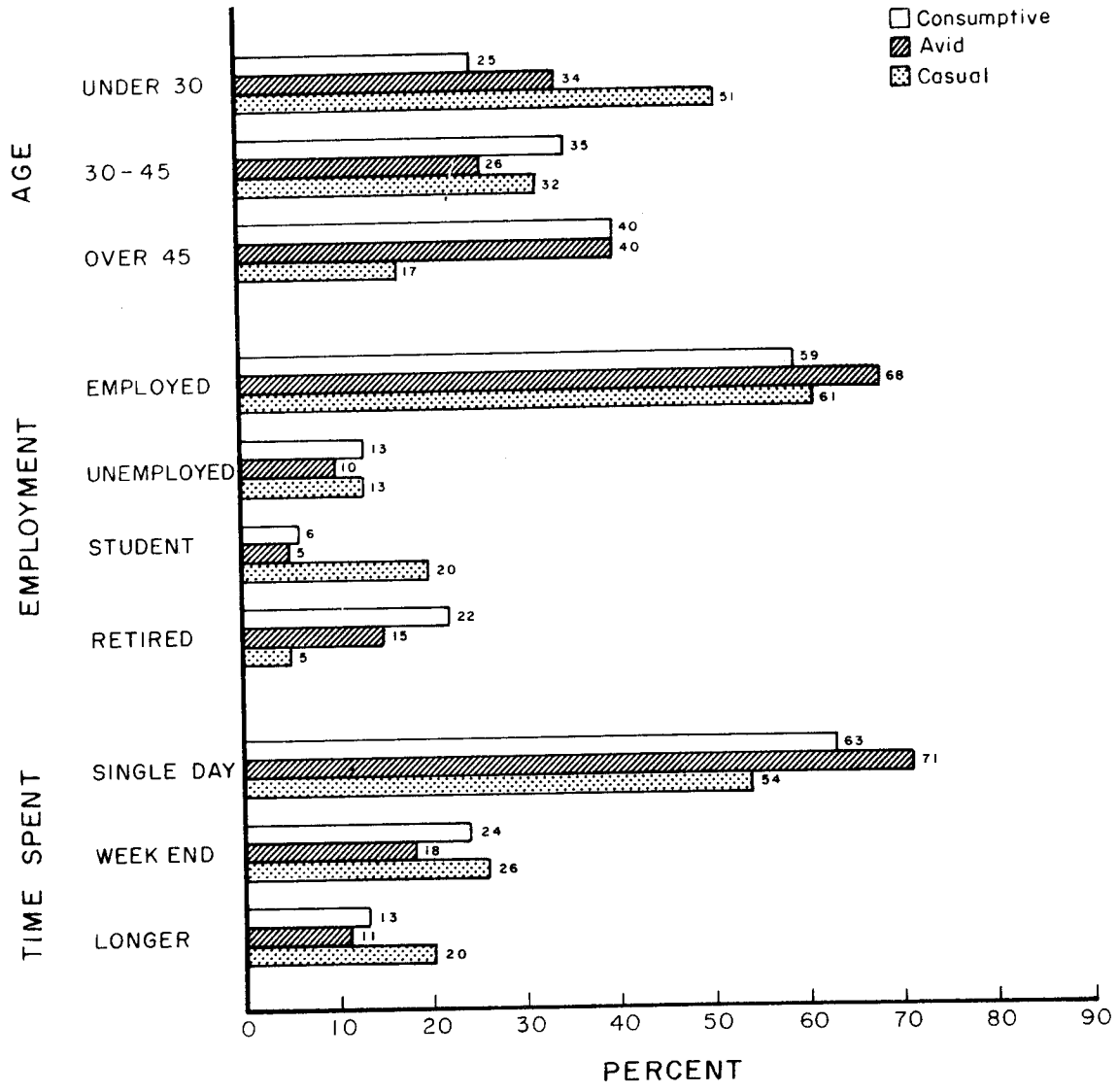

Figure 6. General characteristics of fishermen.

other two groups. This is the opposite of the findings of Moeller (1972) who reported that younger fishermen studied were more consumptive than older fishermen. Ballas (1974) found years of fishing experience, rather than age, to be the factor determining consumptive behavior. In the present study the fisherman was not asked about his years of fishing experience, but, using Ballas' conclusions, it is possible that older consumptive fishermen had less fishing experience than older fishermen in the nonconsumptive groups.

Employment seems to support the older age of consumptive fishermen; 22% of them are retired, a higher percentage than in either of the nonconsumptive categories. Approximately 6% of consumptive fishermen are students, which is consistent with the percentage of students who are avid fishermen but much lower than those in the casual fishermen group.

Most consumptive fishermen spend only a single day at the reservoir. They seem to be interested in catching their quota of fish and leaving on the same day. This is in keeping with the fact that almost all of the consumptive fishermen visit reservoirs that are within two hours' driving time of their homes.

Avid nonconsumptive-----The avid nonconsumptive fisherman was identified as one who: 1) answered "no" to the question, "Is it important that you catch your limit?" and 2) said that fishing was his most important activity at the reservoir. Of those using the reservoirs, 52% of the fishermen were classified as avid nonconsumptive. This is consistent with other research (Moeller, 1973; Knopf, 1973; Ballas, 1974; Sport Fishing Institute, 1964) which has found that the majority of fishermen are not that interested in catching fish. Their primary interest in the sport is involved with the total fishing experience, i.e., being with friends, escape, experiencing nature, etc.

The avid fishermen are similar in some respects to the consumptive fishermen (see Figure 6). Both groups contain 40% who are over 46 years of age. However, 34% of the avid nonconsumptive fishermen are under 30 years old compared to 25% of the consumptive fishermen. In the

over-45 age group, 15% of the avid nonconsumptive fishermen are retired compared with 22% of the consumptive fishermen.*

Avid nonconsumptive fishermen have more of a tendency to spend a single day at a reservoir than do consumptive fishermen. Over 70% responded that they spend only a single day. Like the consumptive group, avid nonconsumptive fishermen have high visitation rates at reservoirs near the population centers. Driving time is almost always under two hours. The fact that avid nonconsumptive fishermen heavily use "day-use" reservoirs around population centers lends support to the hypothesis that fishermen in urban areas find a need to temporarily escape from their environment (Knopf, 1973).

Casual nonconsumptive-----Casual nonconsumptive fishermen were identified as those fishermen who said: 1) that it was not important that they catch their limit, and 2) that fishing was not their most important activity. They composed 34% of all fishermen. The casual group was more interested in the aesthetics of the area than in the fishing experience there.

There are significant differences between the age groups of casual fishermen and the other two types (see Figure 6). Over 50% of the casual users are under age 30. There is a low percentage of casual fishermen over 45 years of age (17%). There are four times more students in the casual group than in the other two.

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*This difference is significant at $\alpha=.01$ using Chi Square. Throughout the remainder of this discussion, all differences termed "significant" were determined by using a Chi Square Test at $\alpha=.05$, although many differences are significant at $\alpha=.01$.

Casual fishermen have a much greater tendency to spend more than one day at a reservoir and to camp in tents than the other two groups. They spend more time traveling to the reservoir (40% spend more than two hours traveling) and say that they are willing to drive farther for the same experience than the other two groups.

Fishermen's expectations. What are the fishermen's expectations of the reservoirs? To determine what the fishermen expected to find at the reservoir, they were asked what they had heard about the reservoir that they liked. Then, in a later part of the interview, they were asked what they liked about the reservoir after they had arrived. Their responses were then analyzed for similarities between expectations and on-site likes (see Figures 7 and 8).

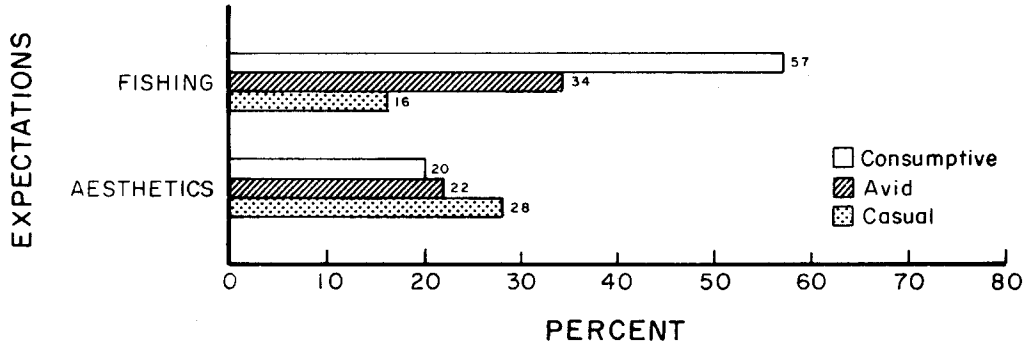


Figure 7. Fishermen's expectations.

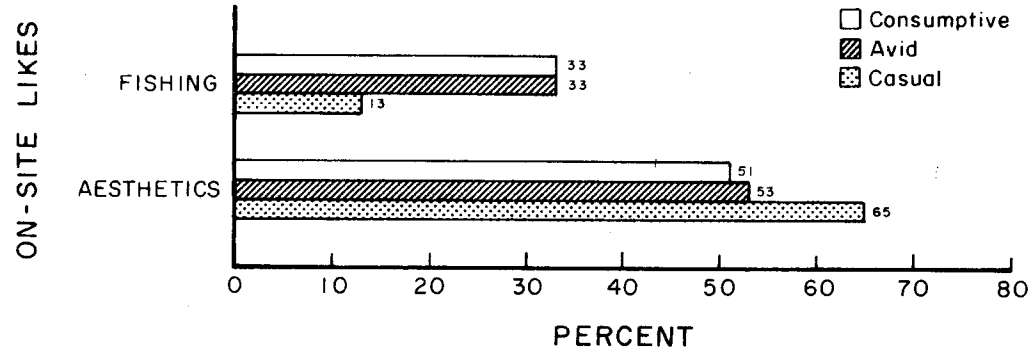


Figure 8. Fishermen's on-site likes.

Consumptive fishermen had the highest expectations for fishing. Most of them had heard from friends or read about good fishing at the reservoirs. Between 55-65% of the consumptive fishermen had heard about the fishing at the reservoir before they came, while about 20% of them had heard about the aesthetics of the area. An aesthetic response included scenery, mountains, solitude, mountain air, and peaceful or uncrowded conditions. However, when asked what they liked about the reservoir since they had arrived, there was a significant change in their answers. "Good fishing" responses were cut in half to about 30%, while responses regarding the aesthetics almost tripled to approximately 60%. This change in response indicates the high impact of scenics on fishermen who stated that they originally visited the reservoir for a completely different reason (fishing). While it may be argued that the fishing experience includes the natural setting, it is pointed out that these fishermen are, by definition, at the reservoirs to catch fish. This finding indicates that catching fish is much more important as an expectation and attractant than an actuality during the on-site recreation experience. In fact, on-site fishing becomes secondary to aesthetics at reservoirs even to the consumptive fisherman.

Avid nonconsumptive fishermen had a much lower fishing expectation than did the consumptive fishermen. About 30% had fishing expectations, and the same number had aesthetic expectations. At the reservoir the number of avid nonconsumptive fishermen who specifically liked fishing dropped by about half to only 16%, while the aesthetics of the area were mentioned by 57%. These results substantiate the belief that avid

fishermen are more interested in the aesthetics and less interested in fishing at the site than are consumptive fishermen.

Casual fishermen had the lowest expectations for fishing (15%) and the highest expectation for aesthetics (30%). At the reservoir, fishing dropped slightly (to 12%) in specific likes, while aesthetics more than doubled (67%). This is explained by the fact that casual fishermen do not visit the reservoir primarily for the fishing but are drawn instead by the aesthetics of the area. This accounts for the minor drop in fishing likes and the high aesthetic rating.

Expectations and on-site likes were then compared to the fishing quality of the reservoir. "Fishing quality" was defined in terms of catch per unit of effort by the fishermen (see Table 34).

Table 34. Rating of fishing quality.

Classification	Catch/Unit Effort	Number of Reservoirs
Excellent	>1 Fish/Hour	7
Good	.5-1 Fish/Hour	12
Fair	.25-.5 Fish/Hour	16
Poor	<.25 Fish/Hour	1
TOTAL		36

Since a creel census (see "Implications for Further Research") was not conducted at these reservoirs, fishing quality was estimated by the study staff and Vidar G. Wespestad, a fishery biologist, who analyzed the fishery at each of the study reservoirs (see Objective C). The estimation was based upon the fish population at each reservoir.

While somewhat crude, the fishing quality analysis does give a basis for comparing the fishing quality of the different reservoirs.*

It is anticipated that the highest number of fishing expectations would be found at the "excellent" fishing reservoirs, with decreasing fishing expectations at the lower quality fishing reservoirs, but this did not happen (see Figure 9). The "excellent" fishing reservoirs had

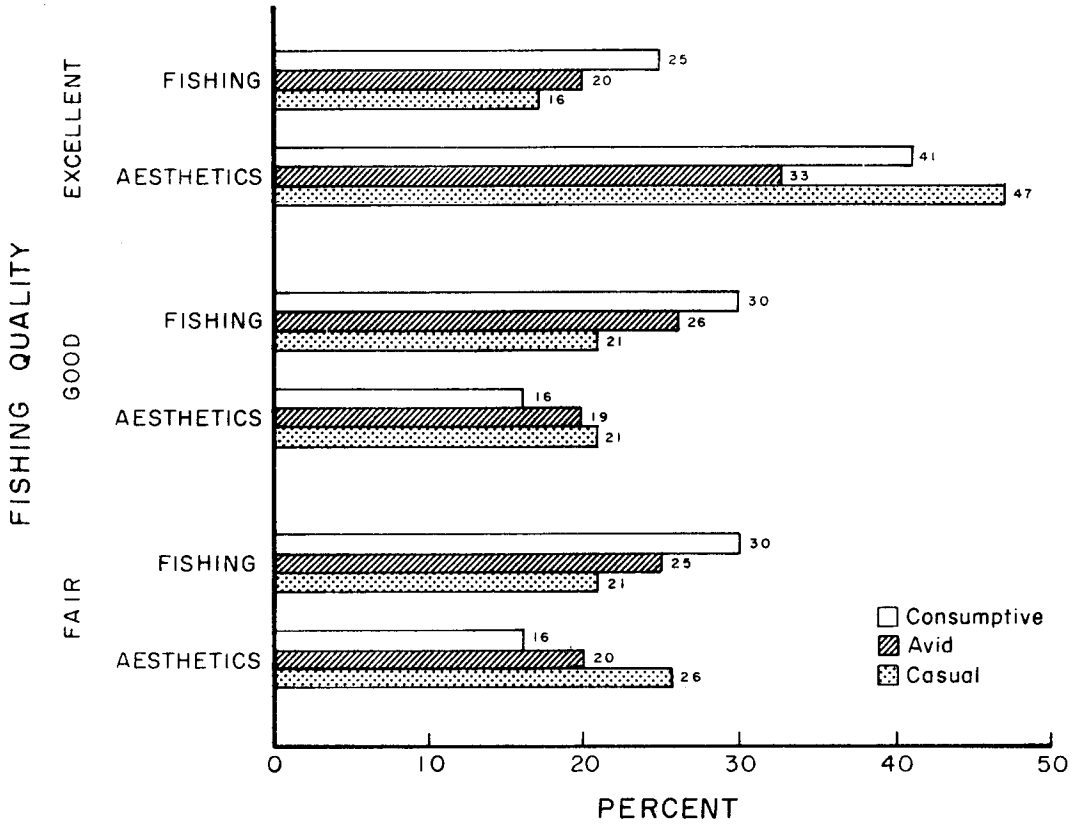


Figure 9. Fishermen's expectations according to fishing quality of reservoir.

*Mary's Lake was the only "poor" quality fishing reservoir, and the interviews were too few in number to permit a significant sample. For this reason, the "poor" category will be deleted from future analysis.

the lowest fishing expectations and the highest aesthetic expectations. The "fair" and "good" fishing reservoirs each had about the same expectations. It was concluded that the fishing quality of the reservoirs did not have a significant influence on the expectations of the fishermen.

Expectations of fishing experience were then compared with the types of access to the reservoirs (see Figure 10). The two categories selected were "drive in" where the fisherman could drive his car to the reservoir and "hike in" where the fisherman had to walk to the reservoir. The "drive in" category includes paved, dirt, gravel, and four-wheel drive roads. Access was, perhaps, the largest single determining factor in a fisherman's site selection, although access in this study was found to be inversely related to the fishing quality of the reservoir. Hike-in reservoirs tended to have the better fishing,

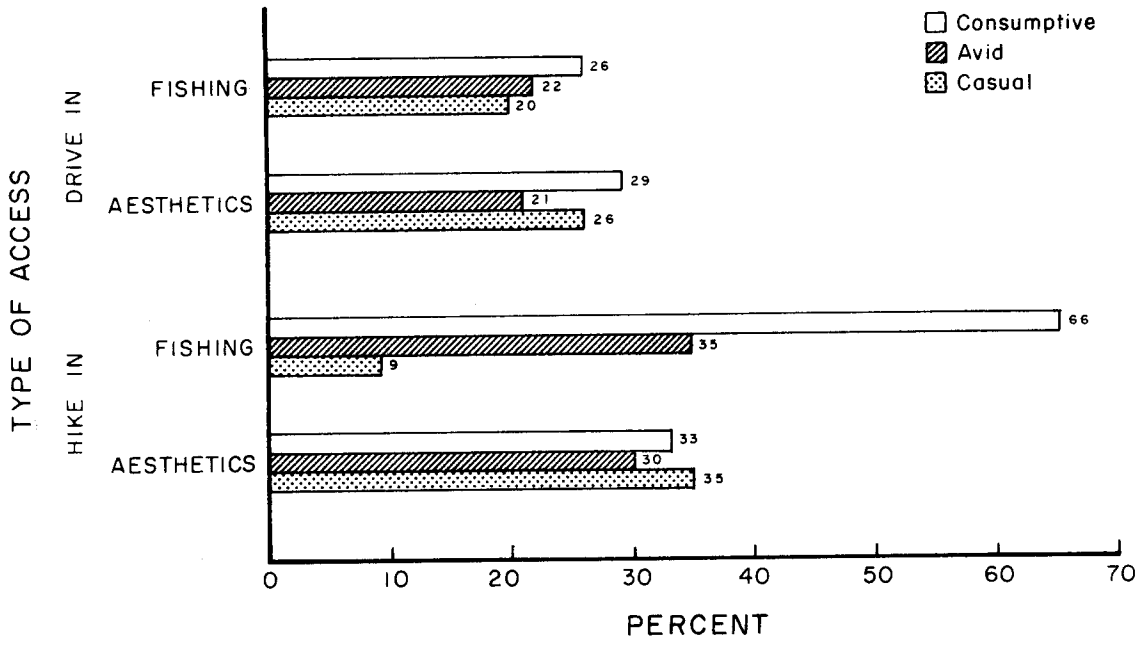


Figure 10. Fishermen's expectations according to type of access.

while drive-in reservoirs tended to have poorer fishing. Consumptive fishermen had higher fishing expectations at hike-in than at drive-in reservoirs. This may have been due to their belief that harder work (hiking) would discourage others from reaching the remote reservoir and thus would provide better fishing. At the site, fishing likes dropped dramatically and were replaced by aesthetic factors at the hike-in reservoirs. Fishing likes dropped by about half at the drive-in reservoirs, while aesthetic factors attained first place. The pattern was similar for the avid nonconsumptive fishermen, but fishing expectations were approximately half those of the consumptive fishermen.

Casual fishermen reacted differently. Fishing expectations of casual fishermen at hike-in reservoirs were less than half of those at drive-in reservoirs. On-site likes dropped only slightly in both cases. This, together with previous data which has shown that casual fishermen are the large majority of fishermen using hike-in reservoirs and the fact that all of the hike-in reservoirs have "excellent" or "good" fishing, led to the conclusion that casual fishermen at the hike-in reservoirs were not going there to catch fish but for the aesthetic experience. Although there are fewer numbers of consumptive and avid nonconsumptive fishermen using the hike-in reservoirs, they have higher fishing expectations than do those fishermen at drive-in facilities.

There are several inferences from the above information. Since fishing was mentioned twice as frequently as an expectation than as an on-site like for consumptive fishermen but about equally for avid and casual fishermen, it was concluded that the reservoirs did not satisfy the expectations of the consumptive fishermen, but that they

did meet the expectations of the avid and casual nonconsumptive fishermen.

In all cases, the on-site aesthetics exceeded all fishermen's expectations. It is possible that the impact of the scenics displaced the fishing expectations, although there is no way of proving this hypothesis. It was further concluded that access to a reservoir had more impact on a fisherman's expectations than did the fishing quality of the reservoir which he visited.

Fishermen's satisfactions. What are the fishermen's satisfactions with his experience?

Two factors were used to measure a fisherman's satisfaction, return visits and improvements desired. "Return visits" were used as a measurement on the assumption that, if a fisherman was basically satisfied with his experience, he would return. It was also assumed that any part of his experience that he was not satisfied with would be revealed in the improvements which he desired.

Return visits-----In general, both consumptive and avid nonconsumptive fishermen have a high incidence of return. Three-fourths of those two groups of fishermen were returnees to the reservoir which they were visiting. Just under one-half of the casual fishermen were returnees.

Some insight into these figures may be obtained by comparing return visitation to the fishing quality of the reservoir (Figure 11). Consumptive fishermen had the highest return visitation rate at the "excellent" fishing reservoirs. Causal fishermen had the lowest overall return rate. The highest incidence of return visitation was noted for casual fishermen at the "fair" fishing reservoirs. The "excellent"

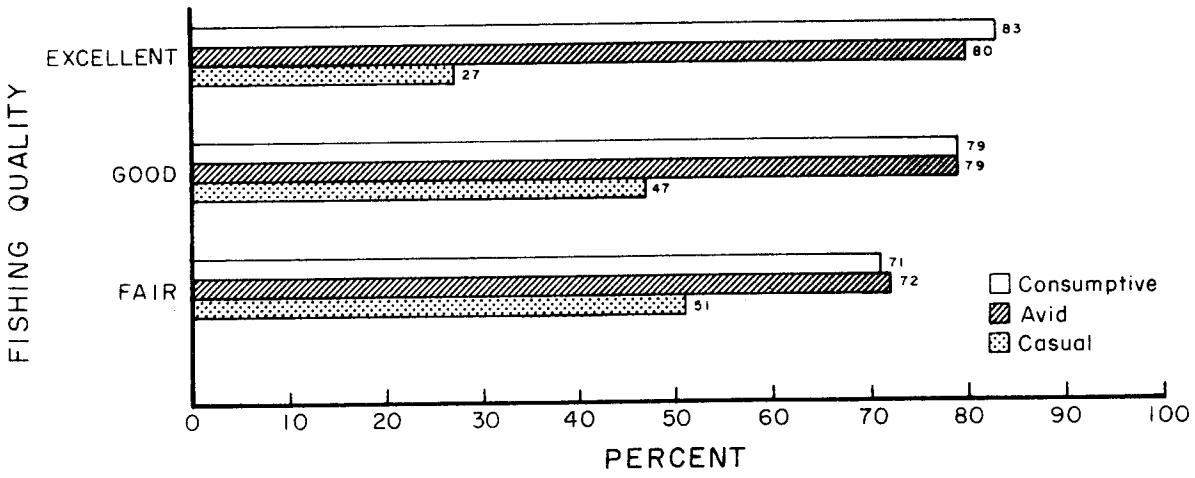


Figure 11. Return visitation according to fishing quality of reservoir.

fishing reservoirs had the lowest return visitation rate for these casual fishermen--only about one in four.

In an attempt to understand why the casual fishermen differed so drastically from expected patterns, their expectations and on-site likes were investigated. It was found that casual fishermen who use the "excellent" fishing reservoirs (most of which are "hike-in" access) do not go there because of the fishing, but because of the aesthetics of the reservoir. Only 9% of the casual fishermen at "excellent" fishing reservoirs had fishing expectations, while 35% had expectations of the aesthetic experience. At the site, 6% liked the fishing and 71% liked the aesthetics. It is theorized that the casual fishermen at these reservoirs were there primarily for the adventure and sightseeing. Thus, the low return visitation rate was probably the result of not wanting to return to a place which they had already seen. Unfortunately, there is no way of proving this theory, but it has strong possibilities for further research.

Return visitation was then compared to the reservoir's access to test the hypothesis that fishermen were returning because of the type of access (see Figure 12). Casual fishermen did as was expected

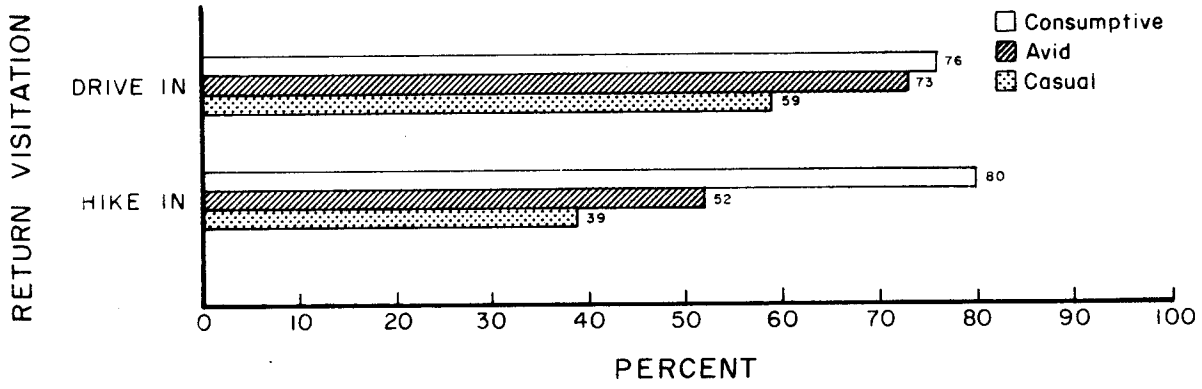


Figure 12. Return visitation according to reservoir access.

and showed lower return rates at hike-in reservoirs. As discussed above, the reason for this seems clear, since most hike-in reservoirs had "excellent" fishing, and casual fishermen at "excellent" fishing reservoirs usually put more emphasis on aesthetics than fishing. Consumptive fishermen also followed expected patterns, since hike-in reservoirs had the best fishing, and their return rate therefore was higher at hike-in than at drive-in reservoirs. The consumptive fishermen who used drive-in reservoirs had a surprisingly high return rate, considering that drive-in reservoirs generally had only fair fishing. This could be explained by the fact that consumptive fishermen are older and may desire more facility oriented reservoirs which would give them more comfort.

The avid nonconsumptive fisherman did not follow the expected pattern. His return rate at drive-in reservoirs was 20% higher than his return rate at hike-in reservoirs. There are several strong

relationships which may explain this finding. Since avid nonconsumptive fishermen are, by definition, not interested in catching many fish to fulfill their fishing experience, they may not find it necessary to exert the extra effort required to return to the hike-in reservoirs for fishing. Another possibility is that avid nonconsumptive fishermen who visit hike-in reservoirs like scenic variety, and do not care to return to a reservoir previously visited.

In summarizing the relationships of return visits to access and fishing quality, it is interesting to cite a special case. Monument Lake holds an interesting example for research purposes. It is classified as having "excellent" fishing and "drive-in" access--the only one of its kind in the study. Only 12% of the consumptive fishermen ordinarily use "excellent" fishing areas, but 83% of that 12% use that one reservoir. Over three-fourths of them were returnees to Monument Lake, indicating a high satisfaction with the experience. From this data it was concluded that consumptive fishermen will heavily use (and with high satisfaction) "excellent" fishing reservoirs with easy access.

Improvements desired-----Fishermen were then analyzed according to the improvements which they desired in order to determine if there were any unfulfilled satisfactions in their fishing experience. Most fishermen wanted no improvements at all (see Table 35). Consumptive fishermen wanted more stocking at the "fair" fishing reservoirs, and casual nonconsumptive fishermen wanted the least number of fishing improvements.

However, the following inconsistencies were found in their responses. Consumptive fishermen at "excellent" fishing reservoirs

Table 35. Fishermen's desired improvements according to fishing quality of the reservoir (in percentages).

	Fishing Quality		
	Excellent	Good	Fair
Consumptive:			
Stock	4.1	-	6.7
Camping Facilities	20.8	2.4	5.0
Sanitation	8.3	12.0	8.3
Other	12.5	16.7	11.7
None	54.2	69.0	66.7
	100.0	100.0	100.0
Avid:			
Stock	6.7	2.8	2.9
Camping Facilities	6.7	2.8	0.5
Sanitation	10.0	10.4	17.2
Other	10.0	13.2	12.1
None	66.7	70.8	66.1
	100.0	100.0	100.0
Casual:			
Stock	-	2.0	2.6
Camping Facilities	8.3	4.0	2.6
Sanitation	16.7	12.0	6.6
Other	25.0	18.0	13.2
None	50.0	64.0	73.7
	100.0	100.0	100.0

desired camping facilities at an area in which camping facilities already exist. Consumptive fishermen did not want any fishing improvements at "good" fishing reservoirs. Avid nonconsumptive fishermen wanted more than twice as many fishing improvements at "excellent" fishing reservoirs than at "good" or "fair" fishing reservoirs. These responses may be clarified by a creel census to be conducted in Summer, 1975, which would give the actual success of the fishermen. A measure of the fishing pressure at each reservoir may

also be helpful in explaining these inconsistencies, since fishermen may be comparing their success to that of those with whom they were fishing.

Willingness to pay for desired improvements-----The fishermen were then asked how much they would be willing to pay if their desired improvements were actualized. The improvements which specifically mentioned fishing quality were then compared to how much fishermen would be willing to pay for them. Over 96% of the fishermen were not willing to pay anything to improve the fishing quality at the reservoir which they were visiting.

Only one in ten consumptive fishermen was willing to pay for fishing improvements (see Table 36). Almost all who would pay wanted

Table 36. Fishermen willing to pay for fishing improvements (in percentages).

Improvement Desired	User Fee Willing to Pay (Dollars) $1 or $2	$3 or $4	$5 or $6	None	TOTAL
Consumptive:					
Stock more often	3.3	.8	2.5	3.3	10.1
Stock larger fish	0	0	0	0	0
Stock	.8	0	0	0	.8
TOTAL	4.1	.8	2.5	3.3	10.9%
Avid:					
Stock more often	3.2	.4	.9	2.1	6.7
Stock larger fish	.4	0	0	.7	1.1
Stock	.4	0	0	.2	.6
TOTAL	4.0	.4	.9	3.0	8.3%

the reservoirs stocked more often. For the private sector, this represents approximately 1750 consumptive fishermen who are willing

to pay in various degrees for a reservoir which already had a heavy stocking program. Even fewer avid nonconsumptive fishermen were willing to pay for fishing improvements. Only 8% were willing to pay anything, and most of those were only willing to pay for stocking more often.

The percentage of casual fishermen who were willing to pay anything to improve the fishing quality was negligible (less than 2%).

There are several possible reasons for this low number of fishermen willing to pay for fishing improvement. First, the findings indicate that they are basically satisfied with this experience as it is. Secondly, they might believe that at present they can find the same experience elsewhere without having to pay.

Regardless of the reason, it is clear that the economic benefits of improving the fishery would be small. However, fishermen who are willing to pay for an improved fishery represent 5001 user days, which may have a potential for exploitation by the private sector.

Attitudes toward management practices. What are their attitudes toward suggested management practices which might affect their fishing experience?

All fishermen were asked a series of 14 questions concerning their fishing experience, with five questions generating significant differences between types (see Figure 13).

The first question, "Is fish size important to you?" was answered affirmatively by three-fourths of the consumptive fishermen, whereas less than one-half of the nonconsumptive fishermen gave the same response.

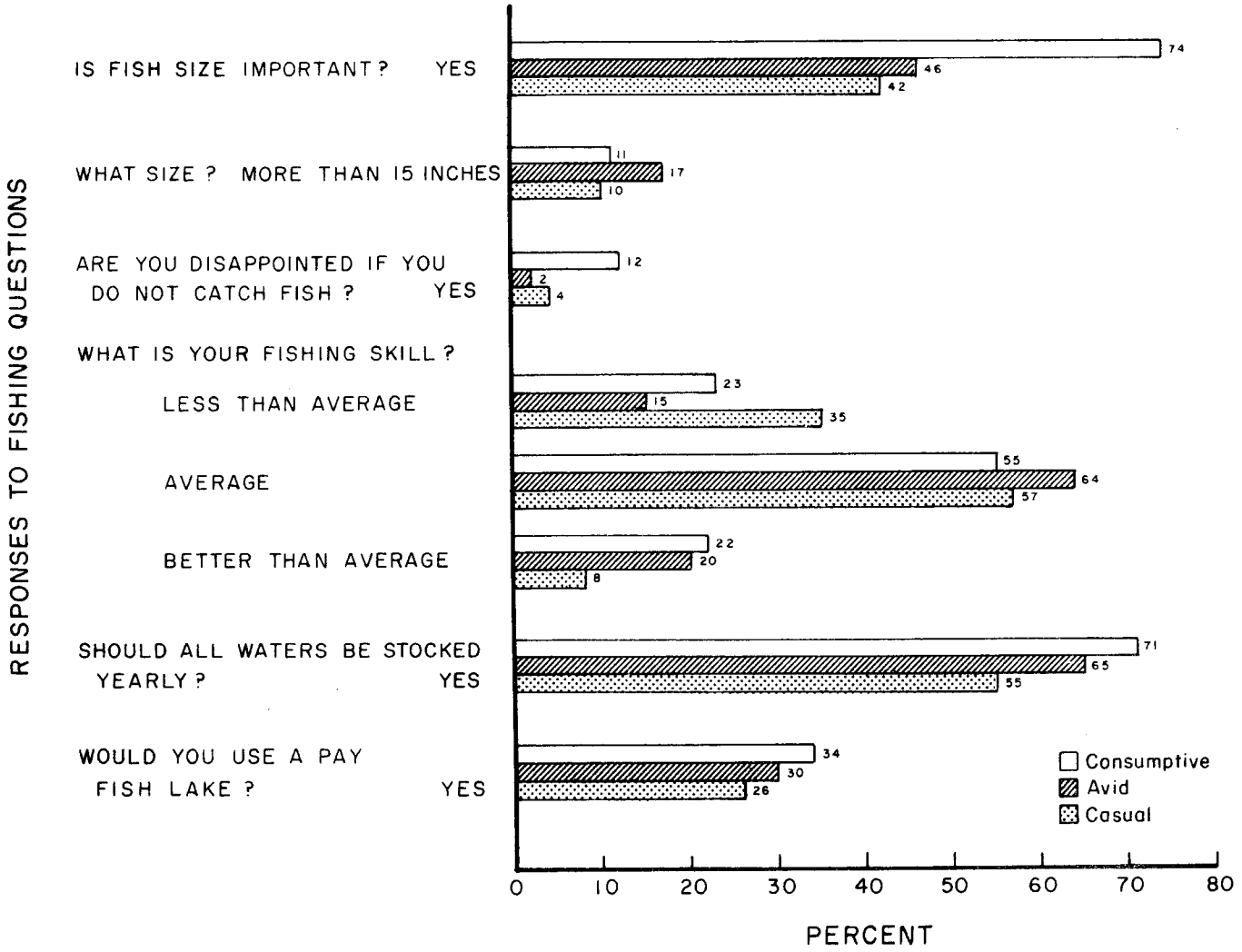


Figure 13. Responses to fishing management questions.

The second question, "What size?", showed that avid nonconsumptive fishermen are more interested in catching large fish (>15 inches) than either consumptive or casual.

The third question, "Are you disappointed if you don't catch fish?", revealed that consumptive fishermen are six times more interested in catching fish than avid, and three times more than casual.

The fishermen were then asked to rate their fishing skill. A higher proportion of avid nonconsumptive fishermen consider themselves to be average or above average than consumptive fishermen, while the casual nonconsumptive fishermen almost all consider themselves to be average or below.

The fourth question, "Should all waters be stocked yearly?", showed that the majority of all types of fishermen favored this practice including three-fourths of the consumptive fishermen, two-thirds of the avid fishermen, and one-half of the casual fishermen.

The last question, "Would you use a pay fish lake?", revealed the general unpopularity of the idea, with only 30% of the fishermen saying "yes." As might be expected, more consumptive fishermen were in favor of pay lakes than were the other two types.

The above data further substantiate the distinct difference between the three types of fishermen. The consumptive fisherman is interested in the number of fish caught, but does not care about the size of fish caught. Catching fish is a more important part of the fishing experience of the consumptive fisherman than it is for the nonconsumptive fisherman. For this reason, the consumptive fisherman is more interested in using a pay fishing lake than the other types.

The avid nonconsumptive fisherman is more selective in his fishing. He is more interested in catching large fish than in catching a great number. Yet, catching fish plays only a minor part of his experience. This accounts, in part, for the low acceptance of a pay fishing lake.

The casual nonconsumptive fisherman is least interested in the size of fish. Almost all members of this group believe that they are average or below-average fishermen, and are not interested in a pay fishing lake. The probable reason for these responses is that the casual nonconsumptive fishermen are not at the reservoir to catch fish, but to enjoy a total recreation experience in which fishing is secondary.

Impact of drawdown. What impact does drawdown have on the fisherman? Of the 23% of fishermen who had experienced drawdown conditions, less than 5% said that they left the site because of it. No groups were found to be particularly affected, and it was concluded that fishermen are generally unaffected by drawdown.

Summary and Conclusions of Comparison of Objectives and Findings

Demographic composition. What is the demographic composition of high-country reservoir fishermen?

Findings-----

1. 14% of the high-country reservoir fishermen are consumptive, 52% are avid nonconsumptive, and 34% are casual nonconsumptive.

2. The consumptive and avid nonconsumptive fishermen are older, many over age 45, whereas casual nonconsumptive fishermen are much younger with over half under age 30.

3. The greatest percentage of retired fishermen are in the consumptive group, while students comprise a large part of the casual fishermen group.

4. Avid fishermen have the largest percentage of single day use, while casual fishermen tend to spend the longest time at the reservoirs.

5. Consumptive and avid fishermen almost all use reservoirs within two hour's driving time of their homes. Casual fishermen have the longest driving times, often over four hours.

Conclusions-----

1. Only a small percentage of high-country reservoir fishermen care about catching a great number of fish.

2. Because of their age, consumptive and avid nonconsumptive fishermen use reservoirs within short driving distances.

3. Casual nonconsumptive fishermen are willing to drive farther and remain longer at a reservoir.

Fishermen's expectations. What are the fishermen's expectations of the reservoirs?

Findings-----

1. Consumptive fishermen had almost double the fishing expectations of the avid nonconsumptive fishermen, and almost four times the fishing expectations of the casual nonconsumptive fishermen.

2. Casual and avid nonconsumptive fishermen had the highest aesthetic expectations of the reservoirs, while only two-thirds as many consumptive fishermen had aesthetic expectations.

3. At the reservoir, fishing likes dropped by half for the consumptive fishermen, but remained about equal for both the avid and casual nonconsumptive fishermen.

4. At the site, aesthetic likes at least doubled in all cases and tripled in the case of the consumptive fishermen.

5. The lowest fishing expectations were projected toward reservoirs with the best fishing; while reservoirs with poorer fishing had higher fishing expectations.

6. Consumptive fishermen had higher fishing expectations at hike-in reservoirs than at drive-in reservoirs. Avid nonconsumptive fishermen followed the same pattern, but had less fishing expectations than did the consumptive fishermen.

7. Casual nonconsumptive fishermen had the lowest fishing expectations at hike-in reservoirs.

Conclusions-----

1. Scenics have a very high impact on the fishermen once they arrive at the reservoir site.

2. Fishing becomes secondary to aesthetics at the reservoir even in the case of consumptive fishermen.

3. Avid nonconsumptive fishermen are more interested in the entire fishing experience than in catching fish.

4. Casual nonconsumptive fishermen do not visit the reservoirs primarily for the fishing but for the aesthetics.

5. The fishing quality of the reservoir does not have a significant influence on the expectations of any group of fishermen.

6. The reservoirs do <u>not</u> meet fishing expectations for the consumptive fishermen but do meet the expectations of the avid and casual nonconsumptive fishermen.

7. The aesthetic expectations are met and exceeded for all groups of fishermen at the reservoir.

8. Access to a reservoir has more impact on a fisherman's expectations than does the fishing quality.

Fishermen's satisfactions. What are the fishermen's satisfactions with their experiences?

Findings-----

1. Consumptive and avid nonconsumptive fishermen have a high incidence of return visitations. Casual nonconsumptive fishermen have low return visitation.

2. Consumptive fishermen had the highest return visitation rate at the best fishing reservoirs. Casual nonconsumptive fishermen had the highest return visitation at poorer quality fishing reservoirs and the lowest return visitation at the best fishing areas.

3. Avid nonconsumptive fishermen had a higher return rate at drive-in than at hike-in reservoirs.

4. Most fishermen desired no improvements at the reservoirs.

5. Consumptive fishermen wanted more stocking at the poorer fishing reservoirs.

6. Casual nonconsumptive fishermen wanted the fewest fishing improvements.

7. Only 4% of the fishermen were willing to pay for fishing improvements.

8. Consumptive fishermen were willing to pay the most, avid nonconsumptive fishermen somewhat less, and casual nonconsumptive fishermen the least.

Conclusions-----

1. Casual nonconsumptive fishermen have low return visitation rates because they do not want to return to a reservoir which they have already seen.

2. Consumptive fishermen have a high return visitation rate at drive-in reservoirs because they are older and desire more facilities.

3. Avid fishermen have a higher return visitation rate at drive-in reservoirs than at hike-in reservoirs because they are interested in the whole fishing experience which they can get at either hike-in or drive-in reservoirs. They see no reason to do more work (hike) for the same experience.

4. The economic benefits of improving a fishery would be small, but might be profitable for a limited private enterprise.

Attitudes toward management practices. What are their attitudes toward suggested management practices which might affect their fishing experience?

Findings-----

1. Fish size is important to three-fourths of the consumptive fishermen, but only to one-half of the nonconsumptive fishermen.

2. Avid nonconsumptive fishermen are interested more in large fish than are consumptive or casual nonconsumptive fishermen.

3. Consumptive fishermen are six times more interested in catching fish than are avid nonconsumptive fishermen and three times more than casual nonconsumptive fishermen.

4. The majority of all fishermen favor stocking all waters yearly, including three-fourths of the consumptive, two-thirds of the avid, and one-half of the casual nonconsumptive fishermen.

5. Less than one-third of the fishermen are willing to use a pay fishing lake.

Conclusions-----

1. Avid nonconsumptive fishermen are more selective in their fishing habits.

2. Consumptive fishermen are more interested in the number of fish caught than either of the other two groups.

3. Casual fishermen were generally disinterested in management practices.

Impact of drawdown. What impact does drawdown have upon the user?

Findings-----

1. 23% of the fishermen had experienced drawdown, and 5% of the fishermen left the site.

Conclusions-----

1. Fishermen are generally unaffected by drawdown.

Implications and Recommendations for Management

These findings have some very interesting and practical implications for high-country reservoir management. The following are recommendations designed to aid in improving the fishing experience of each of the different types of fishermen, and a separate set of recommendations for increasing the effectiveness of fishery management.

Consumptive fishermen. The consumptive fishermen are generally not using the "excellent" fishing areas, almost all of which have hike-in access. A large proportion of the consumptive fishermen are older people who are less willing or less able to hike to the "excellent" areas. More easily accessible areas should be made available to them. This can be accomplished in two different ways. The access to existing "excellent" fishing reservoirs could be improved to drive-in, or

secondly, existing drive-in reservoirs with the potential of supporting a large fish population should be managed with the goal of enlarging the fishery. The second method seems the most feasible.

Because most "excellent" fishing reservoirs are well away from existing access routes, increased damage to both the environment and the scenics of the area might be the result of improving the access to these areas. This will be tested in Phase II of this research project. Also, better access would probably result in increased visitation, which the sub-alpine and alpine life zones might not be able to tolerate. Monument Lake is an example of an "excellent" fishing reservoir which does have drive-in access. More than 10% of all consumptive fishermen use that one lake.

The findings also show that, while 60% of the consumptive fishermen spend a single day at the reservoir, 40% spend a weekend or longer. They are also visiting the reservoirs that have facilities and poorer fishing, indicating that they are sacrificing good fishing for some comfort. These data indicate that some facilities and high-quality fishing would help attract consumptive fishermen.

Consumptive fishermen comprise only 14% of all reservoir fishermen, and it is obvious that it is not necessary to develop a large number of reservoirs for them. Reservoirs for them should be located near population centers since that is where most of them live, and consumptive fishermen seem unwilling to spend more than two hours driving.

The number of user days that consumptive fishermen represent is 17,574. There should be enough reservoirs opened up to meet this demand. Too few reservoirs for consumptive fishermen will lead to

overcrowding at the ones that already exist, and the depletion of the fishery will be almost assured. However, if there are enough reservoirs to meet their demand, fishing pressure will be eased and the fishery manager will be more able to manage the reservoir for a large fishery.

Avid nonconsumptive fishermen. The avid fishermen are not using the "excellent" or "good" fishing reservoirs, but, instead, are congregating at the "fair" fishing sites. They have high family orientation and strong aesthetic values. Avid fishermen tend to use two types of reservoirs: (1) day-use reservoirs in close proximity to population centers, and (2) reservoirs which have facilities for family camping and are within two hours of their homes. To satisfy this group of fishermen, reservoirs do not need to be managed for improved fishing as long as some fish are present. Management efforts to satisfy this group of fishermen should be concentrated on reservoirs that are close to the population centers and/or on reservoirs with family camping facilities.

Other studies have found that avid fishermen often use fishing as an escape from the city. This, combined with other findings in this study, suggest that day-use reservoirs near the city would be well used by avid fishermen.

Casual nonconsumptive fishermen. Casual fishermen rate fishing low in both their expectations and recreation activities. They are by far the majority of users at hike-in reservoirs, which are also the best fishing reservoirs. Yet they are not really interested in the fishing. They visit these reservoirs for the aesthetic experience.

Since the vast majority of fishermen at hike-in reservoirs do not care about the fishing, it is recommended that the stocking programs

at these reservoirs be minimized or stopped, and that, instead, fisheries managers re-direct their efforts to provide a stable native population. These reservoirs should be managed to maintain their beauty and quality aesthetics. The fishermen at these reservoirs are very sensitive to human impact and facilities should be avoided. These suggestions are based on the belief that it is not worth managing any fishery for casual fishermen because of the low value they ascribe to fishing in fulfilling their recreation experience.

General. At present, the day-use reservoirs near population centers are receiving heavy visitation by fishermen. The visitation that these reservoirs receive is highly correlated with their proximity to population centers. More day-use reservoir sites in these areas need to be opened to recreation to relieve the pressure on the existing ones. Conversely, day-use reservoirs away from population centers receive little fishing pressure. Stocking programs should be decreased at these reservoirs and should be redirected to reservoirs near the cities.

Another implication in this study points to the need for a system to provide fishing information to the public so that they may be directed to the areas provided for them. At one of the study reservoirs, Zimmerman Lake, a significant amount of fishing information was generated between the two sample periods. The results showed that the information provided may have significantly altered the types of users between the two years (see Table 37). Clearly more research is needed. However, it is believed that a system of providing fishing information may be able to orient fishermen to areas that will meet their desires.

Table 37. Zimmerman Lake fishing types: 1973-1974.

	1973 Fishing Information Provided	1974
Consumptive	0	5
Avid	3	0
Casual	$\frac{4}{7}$	$\frac{5}{10}$

The following tables have been included to give managers some concrete figures on the amount of use they can expect at their reservoirs.

Table 38. Total fisherman user days/year.

Fisherman Types	User Days/Year	Users/Day
Consumptive	17,574	143
Avid	65,282	535
Casual	42,684	349
TOTAL	125,540	1029

Table 39. Selected categories of fishermen per day.

	Category		
Fisherman Types	Day Use	Hike-In Access	Drive-In Access
Consumptive	36.6	12.2	129.3
Avid	127.5	31.2	506.3
Casual	72.4	76.2	273.6
TOTAL	236.5	119.6	909.2

Need for Further Research

1. Conduct a creel census and calculate the fishing pressure at each reservoir. This would provide a precise measure of success at each reservoir and might help to explain many inconsistencies in the data. At this time, a creel census is planned for the Summer of 1975. The results will be published at a later date.

2. Analyze the casual fishermen's expectations and behavior at reservoirs located near universities. Since 20% of all casual fishermen are students, a particular set of management implications might be specially applicable to those reservoirs.

3. Conduct further research into the possibility of developing a system of disseminating fishing information to the public.

RESEARCH OBJECTIVE C

To study the actual potential of the reservoirs to provide a recreation fishery resource

The Colorado Front Range area alone has 153 small mountain reservoirs above 6,000 feet. However, numbers alone are not a gauge of present or future potential for providing sport fishing.

To fully evaluate the potential of small mountain reservoirs for recreational fishing opportunities, it was necessary to answer the following questions:

1. How many reservoirs are there that contain suitable habitat for fish and are free of limiting factors to fish survival?
    a. What is the overall potential of the reservoir in providing a fishery?
    b. What is the potential of a reservoir to provide natural reproduction and a self-perpetuating fish community?
    c. Are there any factors that will prevent the establishment of fish or their continued survival?
    d. What percentage of the reservoirs could support trout species which are sought by anglers?
2. How many reservoirs are closed to fishing that could be opened to absorb future increases in fishing pressure?
    a. Who are the owners of closed reservoirs?
    b. Why are the reservoirs closed?
    c. What are the conditions for opening the reservoirs?
3. What are the effects of drawdown on fish, invertebrates, and abiotic factors in small mountain reservoir?
    a. Are drawdowns beneficial to game fish as in warmwater reservoirs, or are they detrimental as in large coldwater reservoirs?

b. How does, or in what part of the life cycle, does drawdown affect fish, game fish, and non-game fish?

c. What are the effects on invertebrates, the fishes' food supply?

d. What are the effects on physical and chemical factors and how do they interact with the fish and invertebrates?

4. What management methods could possibly be used if drawdowns proved to be detrimental?

a. Could spawning success be improved?

b. Could food chains be altered or modified?

c. What species can best cope with drawdown?

d. What changes could be made in reservoir operations to improve the fishery?

e. At what level of drawdown do effects begin to manifest themselves, and at what level of drawdown is water use and the fishery optimized?

In this study special attention has been placed upon water drawdowns as a determinator of fishery potential. In meeting the primary function of supplying irrigation and potable water, these reservoirs are subject to annual water withdrawals. In some reservoirs water remains only in the preimpoundment stream after drawdown is completed.

The literature on reservoir fisheries is extensive, but the majority deals with large impoundments (Fraser, 1970). Also, most of the available literature pertains to drawdown effects on warmwater species. The small mountain reservoirs primarily contain or are stocked with coldwater fish species.

The literature pertaining to drawdown effects on coldwater fish species is limited and primarily deals with the effects of water level fluctuations in large hydroelectric reservoirs (Aass, 1960; Miller and Paetz, 1959; Martin, 1955). Again these studies are of little value as the mountain reservoirs are small and are subject to continuous drawdown over a short period rather than long-term fluctuations.

The only study conducted on drawdown effects on a small reservoir concerned effects on a bass-bluegill community (Bennett, 1954). Bennett found that drawdown decreased the bluegill population and increased bass survival, but bass growth rates decreased. On large warmwater reservoirs drawdowns have been shown to be generally beneficial to survival and growth of game fish and deleterious to non-game species (Wood, 1951; Hulsey, 1956; Heman et al., 1969; Bennett, 1970). In the large coldwater hydroelectric impoundments water level fluctuations were found to produce detrimental changes in salmonid communities, principally in growth and reproduction.

Methodology

Reservoir Survey

To evaluate the potential productivity and suitability of habitat for fisheries in small mountain reservoirs, 72 of the 153 reservoirs in the Front Range study area were surveyed. Data for public reservoirs were collected by on-site surveys and examination of Division of Wildlife records; data for private reservoirs were a combination of on-site survey and interview. Data on surface acreage, volume, and drawdown were obtained from the State Engineer's Office, Division of Dams and Reservoirs.

On-site reservoir surveys consisted of physical, chemical, and biological measurements. Chemical parameters measured were dissolved

oxygen, pH, and alkalinity. These determinations were made using a Hach model AL-36-WR water chemistry kit. Physical measurements consisted of surface temperature, turbidity, maximum and mean depth. Temperature was measured with a mercury pocket thermometer, turbidity with a 15 cm Secchi disk, and depths with a graduated hand line.

Biological data consisted of fish species present along with relative abundance of invertebrates and rooted macrophytes. Fish were collected using a 38 m experimental gill net. Benthic invertebrates were collected with a 225 cm^2 Ekman dredge. Abundance of zooplankton and macrophytes was determined visually.

Surface area, mean depth, and alkalinity data were used to compute an index of productivity for each reservoir using the following formula:

$$\log PI = 0.031 + 7.31 \times 10^{-5} x_1 - 0.517 x_2 + 0.287 x_3$$

where PI = productivity index

$x_1 = \sqrt{10^8/\text{area in acres}}$

x_2 = log mean depth in feet

x_3 = log alkalinity in mg/l $CaCO_3$

This formula was derived by Hayes and Anthony (1964) from multiple regressions of area, mean depth, and alkalinity on catch statistics from North American lakes of various sizes.

Pearson correlation coefficients were computed for all of the reservoirs using the productivity index values, the variables used to compute P.I. values, plus altitude, latitude, and drawdown. The correlations were made to determine the relationship between productivity and the variables and the interrelationship of the variables.

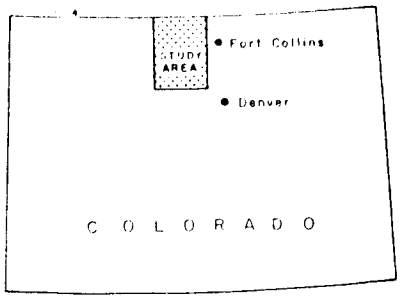
Survey of Closed Reservoir Owners

Owners or representatives of reservoirs presently closed to use by the general public were interviewed as to present use, planned future use, and willingness to open reservoirs to fishing or other recreational use. A standard interview was developed and administered to representatives of irrigation companies, municipalities, and private individuals.

Effects of Drawdown

The eight reservoirs used to study drawdown effects are located in the Northern Colorado Front Range within 100 km of Fort Collins (Figure 14). Four of the impoundments had relatively stable water levels, and four had fluctuating water levels. Two of the drawdown reservoirs were drained to conservation pools--Chambers Lake from 8% to 16% of total capacity and Peterson Lake to approximately 5% of total capacity. Commanche and Eaton Reservoirs were completely emptied; water remained only in small pools and in the streams crossing the reservoir bed at the completion of drawdown. Three of the stable reservoirs (Albion Reservoir and Zimmerman and Dowdy lakes) had only minor evaporative and seepage losses, while one (Lake Estes) had diurnal fluctuations of 30 to 60 cm resulting from power generation demands. The drawdowns which occurred during the study had not varied for at least the last five years (Annual Reservoir Reports, Colorado State Engineer's Office).

The reservoirs ranged in surface area from 7.69 ha to 114.1 ha with a mean of 50 ha (Table 40). The lowest reservoir (Lake Estes) is located at an altitude of 2,316 m and the highest (Albion Reservoir) at



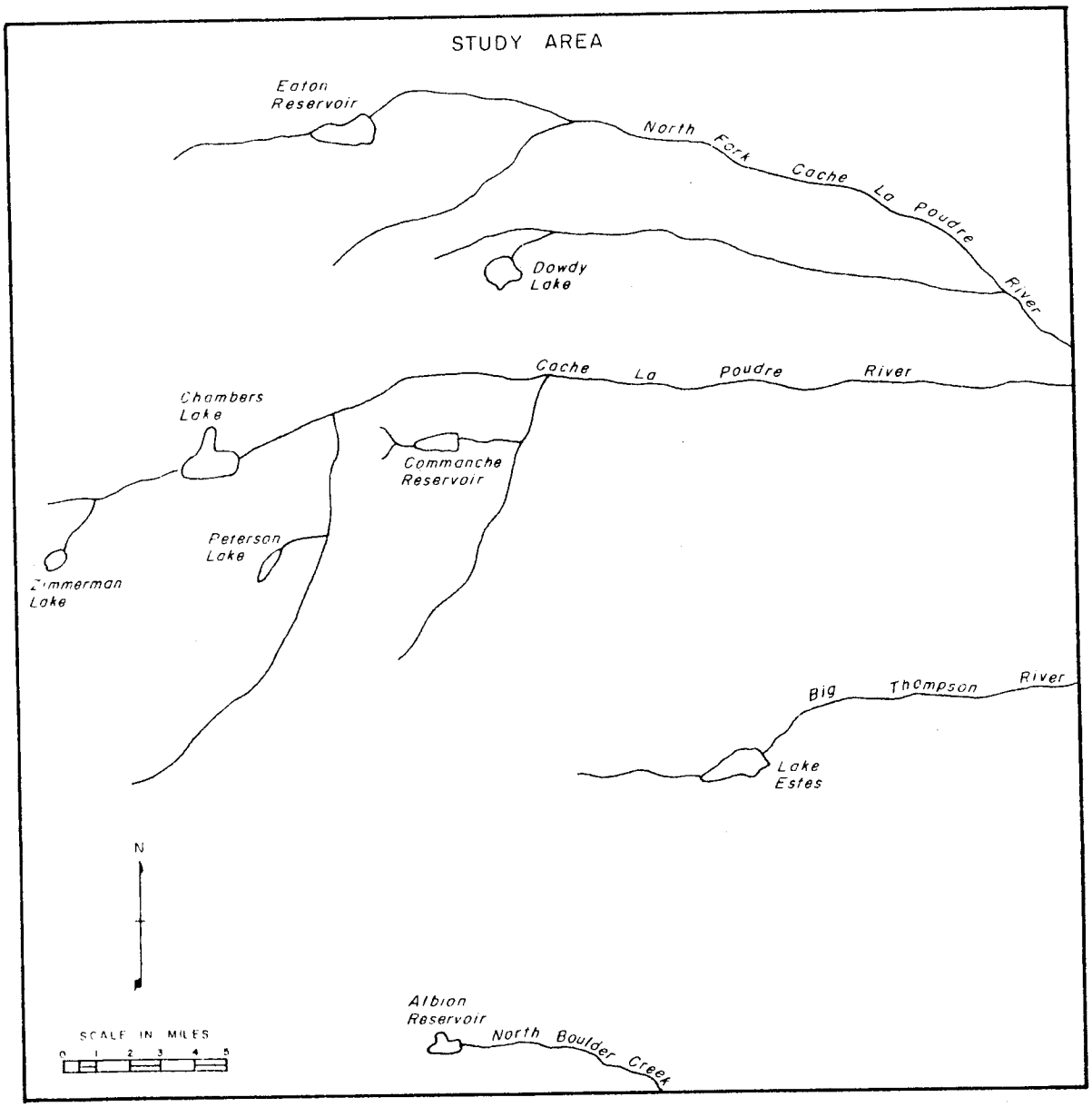


Figure 14. Location of study reservoirs.

Table 40. Major characteristics of the study reservoirs.

Characteristic	Reservoirs							
	Stable Reservoirs				Drawdown Reservoirs			
	Albion	Dowdy	Estes	Zimmerman	Chambers	Commanche	Eaton	Peterson
Surface area (hectares)	15.38	46.54	80.94	7.69	114.12	46.54	57.06	23.07
Volume (acre feet)	1072	1322	3000	173	8824	2000	3750	1100
Maximum Depth (meters)	18.29	7.62	13.70	5.49	27.74	9.75	16.46	10.36
Total Alkalinity (mg/l)	11.20	80.87	16.30	17.50	23.00	16.30	28.60	14.00
Elevation (meters)	3322	2479	2316	3199	2790	2865	2591	2865
Fish Species*	Bk	B,C,Rb, WS,LNS	B,Rb,WS, LNS	C,G	Rb,WS,LNS	Bk,WS,LNS	Bk,LNS	C
Fishing Pressure	Light	Heavy	Heavy	Moderate	Heavy	Light	Light	Moderate
Terrestrial Community	Subalpine	Montane	Montane	Subalpine	Montane	Montane	Montane	Montane

* B=brown trout, Bk=brook trout, C=cutthroat trout, G=grayling, LNS=longnose sucker, Rb=rainbow trout, WS=white sucker.

3,322 m. Total alkalinity was similar for all of the reservoirs except Dowdy Lake, where alkalinity was much higher.

Composition of the fish communities varied between reservoirs from single species to five species (Table 40). Rainbow trout (Salmo gairdneri) are stocked as fingerlings and catchables in Chambers, Estes and Dowdy Lakes but were not used for analysis of drawdown effects. The length of time that a rainbow trout was in a reservoir could not be determined, and hatchery effects rather than drawdown effects might have been measured. Four species, brook trout (Salvelinus fontinalis), cutthroat trout (Salmo clarki), white sucker (Catostomus commersoni) and longnose sucker (Catostomus catostomus), were present in stable and drawdown reservoirs and were used in the analysis.

Fishing pressure was variable between reservoirs but was similar by species groupings (Table 40). Fishing pressure was light to absent on reservoirs containing brook trout. Of the reservoirs containing cutthroat trout, Peterson and Zimmerman lakes both had moderate fishing pressure, but Dowdy Lake had heavy fishing pressure. Fishing pressure was assumed to be light or nonexistent for white and longnose suckers.

The study reservoirs were sampled monthly from May to October, 1974. Six samples were obtained from all reservoirs except Albion. No samples were obtained from Albion Reservoir in May because heavy snow prevented travel to the reservoir.

Physical and Chemical Sampling

A permanent station was established at the deepest point in each reservoir for determination of physico-chemical parameters. Measurements of dissolved oxygen, pH, and total alkalinity were made at the surface at each station with a Hach Water Chemistry kit (Model AL-36-B). Water

transparency was measured with a 15 cm diameter Secchi disk. Temperature profiles were obtained with an electrical resistance thermometer. A Kemmerer water sampling bottle was used to collect subsurface water samples for chemical determinations.

Invertebrate Sampling

Zooplankton and benthic invertebrates were sampled at each reservoir in May and October to determine their relative abundance. Zooplankton collections were made with a Wisconsin plankton net, 15 cm in diameter with #20 mesh. Collections, made at the point of maximum depth, consisted of three vertical hauls from 10 m to the surface. Plankton from the hauls was pooled into one sample and preserved in 4% formalin. Three collections (near shore, at mean depth, and at maximum depth) of benthic invertebrates were made with a 225 cm^2 Ekman dredge. The collections were pooled into one sample, and invertebrates in the sample were separated from detritus by washing through screens with apertures of approximately 1.0 and 0.5 mm. The invertebrates were picked from the screens and preserved in 4% formalin. Relative abundance of invertebrates was determined visually, and samples were ranked by order of abundance, with 1 being the most abundant and 8 the least abundant.

Fish Sampling

Prior to the study, fish in Commanche and Eaton reservoirs were captured and tagged with Carlin tags for use in population estimation, monitoring of individual growth, and study of movement into and out of the reservoirs. Tagging was done during Fall, 1973, when the reservoirs were drawn down to the stream beds. A Coffelt Model BP-1C backpack electrofishing unit was used to capture the fish. Fish were collected, tagged, and released into the streams within the perimeters of the full

reservoirs and in sections of the main tributaries from their entrance to the reservoirs to 400 m upstream.

During the intensive sampling period, fish were captured by gill-netting and electrofishing. Gill nets 38 m long with mesh gradations of 13 to 51 mm were used for sampling fish in all reservoirs during the first four months. In the last two months, a combination of gill nets and electrofishing was employed in Eaton and Commanche reservoirs. Gill nets were set overnight for 12-hr periods. The location of a net set was determined by the drawing at random of a number from 1 to 10 which corresponded to a numbered section in the reservoir. For the first half of the study, nets were set on the bottom; during the second half, floating nets were used.

Captured fish were measured and weighed (to the nearest millimeter of total length and gram of weight), and scales, otoliths,and stomachs were taken from some specimens of each species. The stomachs were examined in the field for type of contents (benthos or plankton), the numeric percentage of major food items,and degree of fullness. Otoliths and scales were placed in scale envelopes for subsequent aging.

Aging of scales and otoliths was accomplished with a Bausch & Lomb stereo zoom dissecting microscope. Scales were cleaned in water with a brush, mounted between glass slides,and partially air-dried before reading. Otoliths were placed in a depression slide, covered with water, and read. Length frequency distributions were developed from the scales and otoliths read to age other fish whose scales or otoliths were not studied.

All of the fish data were punched onto Hollerith cards for computer analysis. A card was prepared for each fish and contained a reservoir

designation, date, species code, age, length, weight, and condition factor. Condition factors ($K = 10^5 \cdot \text{weight}/\text{length}^3$) were calculated by means of a computer program. Multiple stepwise regression was used for analysis of growth and weight gain differences between reservoirs. One-way analysis of variance was used for analysis of differences in condition factors between reservoirs. Differences in catch per unit effort were analyzed using t-tests.

Results

In planning for future fisheries development and management in Colorado, considerable attention must be given to the Front Range where two-thirds of the state's population reside. The fishing areas, particularly mountain trout waters, within one to two hours driving time from these highly populated areas will be the ones to carry the bulk of future fishing pressure. At present many public fishing areas near population centers are overutilized and are environmentally degraded. To ease present overuse and to facilitate future use, management strategies must be developed to fully utilize all available fishing waters, particularly those near population centers.

In Colorado and in other western states small mountain irrigation and domestic water supply reservoirs are a part of the water resource that has been largely overlooked or underdeveloped as to fishery potential. Neel (1963) noted that small reservoirs in general have been largely ignored in reservoir studies.

The following represents the findings which reflect this study's attempt to answer the questions outlined at the beginning of this section under Research Objectives.

Reservoir Survey - potential productivity and suitability of reservoir habitat.

The reservoirs examined were located between 6,000 and 12,000 foot elevations and were in montane, subalpine, or alpine life zones. Reservoirs at these altitudes and in these life zones were found along the entire Front Range from the Wyoming to New Mexico borders with the majority of reservoirs located in the northern two-thirds of the state between 8,000 and 10,000 feet. The size of reservoirs surveyed ranged from 10 to 2,808 surface acres with 95.08 as the mean size.

On-site examination of reservoirs revealed no physical or chemical factor that would preclude the establishment of a fish population. Observed levels of dissolved oxygen, temperature,and pH were all within the tolerance limits prescribed for coldwater fish species by the Committee on Water Quality Criteria (1973).

A few reservoirs may become untenable for fish at certain times. High pH values (9-10) were recorded in some stable reservoirs in which dense algal blooms were present. Diurnal pH fluctuations may occur in these reservoirs which may at the least stress fish if not cause mortalities.

Winter-kill may also be a problem in some reservoirs. Two of the reservoirs examined, one private and one public, have documented histories of complete or partial winter-kill of fish from oxygen depletion. One of the reservoirs used to study drawdown effects is also suspected of winter-kill. The reservoirs in which winter-kill occurred or was suspected are all off-stream reservoirs. Off-stream reservoirs receive water from temporary streams, from direct run-off from surrounding snow packs,and from regulated ditches. Generally, these water sources do not flow during the winter. While there is heavy ice and snow cover on the reservoirs photosynthesis is curtailed. With no flows of oxygenated water into the reservoir during these periods respiration depletes the oxygen and fish kills occur. In the on-stream reservoirs this does not occur, since continuous stream flow into the reservoir maintains oxygen levels.

Trout are the principal sport fish in the small mountain reservoirs. Rainbow trout, cutthroat trout, brown trout, and brook trout are the species that comprise the bulk of the fishery. Rainbow trout are the most widespread, occurring in 70% of the reservoirs. Cutthroat trout

were found in 20% of the reservoirs, and brown and brook trout occurred in 10% of the reservoirs. Stocking is the principal means of maintaining fish stocks. Rainbow trout are stocked at catchable size (8-10") and as fingerlings (2-4"). Brown trout are occasionally stocked as fingerlings in some reservoirs, but most populations of brown trout and all brook trout populations are maintained by natural reproduction.

Natural reproduction is possible in the on-stream reservoirs; however, fish survival is generally low and the populations small in reservoirs subjected to drawdown. Off-stream reservoirs with complete drawdowns were devoid of fish. In off-stream reservoirs the best fish populations were found in stable reservoirs or in those where drawdowns were moderate and water replacement was rapid.

Aquatic invertebrate abundance was variable among the reservoirs, as was composition and diversity of the community. The most abundant and diverse invertebrate communities were found in stable reservoirs. In general, declines in quality and quantity of the invertebrate community occurred with increased levels of drawdown.

Rooted aquatic vegetation, important for cover for young fish and invertebrates, was absent or scarce in the majority of reservoirs. Only in stable reservoirs did large amounts of rooted macrophytes occur.

For the reservoirs surveyed the only major limiting factor found that could inhibit the establishment of a viable sport fishery was water drawdowns. The mean drawdown for the 72 reservoirs examined was 31% of total volume with a standard deviation of 32%. No man-made or natural sources of pollution, high temperatures, or other physico-chemical factors were found. Winter-kill from low oxygen levels did occur in some reservoirs, two from decomposition of organic bottom material, and one from abundant vegetation. The two with organic

decomposition were drawn down to winter conservation pools when winter-kill occurred and future kills can be averted by increasing the water level of the pool. The stable reservoir with abundant vegetation can be corrected by application of herbicide.

One limitation was found that would preclude the self-perpetuation of trout species in off-stream reservoirs, which is the absence of suitable spawning streams. Many of the on-stream reservoirs also lacked adequate amounts of spawning sites to provide adequate recruitment to meet fishing pressure. Therefore, stocking of fish may be the only way to continue a fishery satisfactory to anglers in these reservoirs.

The productivity indices computed for the reservoirs survey were quite low in comparison to values for other North American lakes and reservoirs reported by Hayes and Anthony (1964). The indices of potential productivity obtained for 72 small mountain reservoirs had a mean of -0.0385 and a range of -0.5981 to 0.6112.

These indices of potential productivity cannot be used to predict the potential catch or standing crop of fish from a reservoir as intended by the authors, since 50% of the reservoirs had negative production values. The negative values are likely a result of the method by which the formula was derived. Hayes and Anthony obtain the coefficients for the equation by regression of the equation factors on standing crop and catch data on a size range of lakes from Lake Superior to small farm ponds. The reservoirs examined in this study are all clustered near the lower end of the size range of Hayes and Anthony. Due to the narrow clustering and the overall low productivity of the reservoirs, normal variation in the slopes of the regression could easily result in negative production values. However, the negative production values do not

totally negate the value of the indices. The reservoirs can still be ranked as to relative productivity, general productivity relationships can be discerned and some management plans can be formulated from the productivity indices.

Pearson correlations were computed for productivity indices and the equation variables along with latitude, altitude and drawdown (Table 41). Mean depth and surface area were negatively correlated with productivity, and alkalinity was positively correlated with productivity. This implies that the smaller, shallower reservoirs that are high in dissolved carbonates are the most productive reservoirs. Altitude and productivity were negatively correlated showing that productivity is greater at lower altitudes. Latitude, which was coded by township from North to South, was positively correlated with productivity, indicating that the most productive waters are in the southern Front Range. Drawdown and productivity were negatively correlated showing that productivity increases with decreasing amounts of drawdown.

The small mountain reservoirs in comparison to plains reservoirs and similar reservoirs in other regions are very infertile (Pennak, 1949). The low fertility, coupled with low water temperatures and short growing seasons, means that total fish production in these reservoirs is low and decreases with altitude and drawdown, being theoretically lowest in the large deep reservoirs at 10,000 feet or greater with extreme drawdowns.

What the demonstrated low productivity means as far as a sport fishery is concerned is that nature's unwillingness to grow large amounts of fish in this type of an environment must be circumvented. The traditional method of doing so has been to stock catchable size fish.

Table 41. Pearson correlation coefficients of productivity index and physical factors for 72 Front Range reservoirs.

Productivity Index	Alkalinity	Mean Depth	Surface Area	Latitude	Altitude	Drawdown
Productivity Index	.6258 1.0000*	-.7334 1.0000*	-.1772 0.927*	.2380 0.976*	-.3676 0.999*	-.4343 1.000*

* Significance Level (P)

However, this method may no longer be economically feasible or acceptable to the average fisherman who pays for the stocking. Current costs for raising catchable fish which average 2/lb are $1.50-$2.00/lb. Marshall (1973) estimated that with catchable fish 10% of the fishermen catch 90% of the fish and the 1970 National Survey of Hunting and Fishing estimated that the majority of fishermen catch no fish at all during a fishing season. It seems that there are better ways to spend this amount of money and provide a more equitable means of distributing fish and fishing opportunities.

Aukerman and McLaughlin (1974) reported that most fishermen using small mountain reservoirs were not concerned with catching fish, but rather with crowding and aesthetics. From these results it would seem that the money presently spent on catchable fish could be rechanneled into other programs that would meet the desires of the fishing public.

One method would be to rechannel this money to purchase water rights in existing waters in the mountains and close to population centers, or to construct small fishing waters on suitable streams and off-stream areas. In the Colorado Front Range the southern area between Colorado Springs and Trinidad has the lowest opportunity for coldwater fishing in the Front Range. The mountainous area in this region is the most productive of the Front Range so that a coldwater fisheries program in this area would produce the most fish/unit area. There are many small intermittent streams in this area on which small (10-25 surface acre) fishing reservoirs could be constructed and filled using junior water rights as run-off is rapid and not all of the water can be used (District Water Commissioner, pers. comm.).

Another method of meeting angler desires of uncrowded conditions and providing for future increases in use is to acquire existing waters

by purchase or lease for public use or to convince private owners to open closed reservoirs to public or private use as entrepreneurs. To find what the potential is for opening these closed reservoirs a survey of reservoir owners was undertaken.

Owner Survey

In the survey of reservoir owners ten individual owners, three representatives of irrigation companies, and representatives from four municipalities were contacted and interviewed. The interviews were directed toward determining the reasons for the closures, what conditions were necessary for opening the reservoir, and if the reservoir were presently used for any form of recreation.

Irrigation company-owned reservoirs are largely open for recreational use by the general public and a few are leased to private groups. Reservoirs owned by irrigation companies and closed to recreational use will probably remain closed in the near future, and some presently open reservoirs may be closed to public use. Officials of irrigation companies cited safety hazards and liability as major reasons for not opening closed reservoirs and vandalism as a reason for wanting to close some reservoirs that are now open. The closed reservoirs have either high dams or outlet structures that pose safety hazards. Company officials voiced concern over people drowning, boats washing over dams, and other accidents and fatalities which could occur on these reservoirs and result in liability. Officials of two of the companies contacted related incidence of vandalism to outlet structures and other facilities at open reservoirs as another reason for not opening closed reservoirs. Vandalism, littering, and other abuses by users were given as causes that may lead to closure of presently open reservoirs.

Municipal-owned reservoirs comprise 36% of Front Range mountain reservoirs and the largest block of reservoirs closed to recreational use. As in the case of irrigation reservoirs, some are open to public use, some are leased to private groups, but most are closed to all recreational use. Protection of potable water supplies from contamination was given as the major reason for closures. However, in several cases water stored in closed reservoirs is delivered to water treatment plants via rivers in which fishing and some swimming occur. Safety and liability were given as reasons for not opening some reservoirs that could otherwise be open.

The majority of the reservoirs owned by private individuals and open for recreation are either operated as fishing clubs by the owner or are leased to local fishing clubs. Most of these reservoirs have well-maintained fish populations that are restocked annually or biennually with trout from commercial trout farms. Recreational use on these reservoirs is generally far lower than on public reservoirs. Membership in most clubs is limited, with waiting lists for membership in several clubs. Prevention of overuse and preservation of quality fishing were the most-given reasons for limiting membership. The reservoir owners were opposed to opening their reservoirs to use by the general public through leasing to State agencies because the leasing fee of $2.00 per surface acre is less than what they receive through private leasing. They also fear overuse, damage and litter to surrounding lands, and loss of control over their land if leased for unrestricted public access.

Reservoirs owned by private individuals and closed to recreation comprise 29% of Front Range reservoirs. Most are small (under 25 surface

acres) ranch ponds used for stock water and hay meadows, and are off-stream. The value of these reservoirs for providing recreational fisheries is marginal as they are drawn down completely or nearly so annually and usually do not refill until the following Spring. In the southern part of the state water supplies are inadequate to fill many reservoirs in dry years. Some of these reservoirs are stable or relatively so, and are stocked with fish by the owners. Fishing on these reservoirs is limited to the family and friends of the owners. All owners of these reservoirs interviewed were adamantly opposed to opening their reservoirs to use by the general public or private groups. One individual contacted did open his reservoir and land to a commercial sportsman group, but closed it within a year due to littering and failure of users to close stock gates.

The results of the owner survey show that there is presently little chance of increasing the fishery resource through opening of closed reservoirs unless the objections of the owners can be overcome. Municipalities hold the greatest percentage of presently closed reservoirs and appear to be the best area to attempt to open reservoirs as they are a part of the public sector and are, in theory, subject to the will of the people. The argument of protection of water supplies is not a valid defense as many municipal watersheds have long been open to public recreation without any contamination (Stroud, 1966).

It appears that there is little opportunity for opening presently closed reservoirs now or in the immediate future. Therefore, methods must be found to improve the existing fishery on reservoirs open to public use. Such improvements should correspond to angler desires. This would spread out use and minimize crowding and damage to the resource.

Quantification of the effects of drawdown on fish species in these reservoirs was necessary in order to determine the effects and methods that could be used to overcome them or how to utilize drawdown in management of the reservoirs. Eight reservoirs with varying drawdown regimes were investigated. These reservoirs had four species (two game and two non-game) that occurred both in the stable control reservoirs and in the drawdown reservoirs. The results are presented by each species grouping.

Effects of Drawdown

Brook Trout

Three of the reservoirs, Albion, Commanche, and Eaton contained brook trout populations. Commanche and Eaton reservoirs are used for irrigation storage and are drawn down annually to approximately 1% of capacity. The 1% remaining after drawdown consists of dead storage pools of 0.91 - 1.3 ha with 1 m average depths. In late October, both reservoirs were refilled. Commanche is brought up to half capacity, and water remains at that level until spring run-off commences. Eaton refills slowly through the winter and reaches 0.3 to 0.5 capacity by spring. During the period of maximum drawdown, fish survive in the pools and in the permanent streams crossing the reservoirs. Albion Reservoir is a reserve water storage reservoir for a municipality and is not drawn down regularly. It's last drawdown occurred in 1966, when approximately 60% of the volume was withdrawn.

Physical and chemical measurements were similar for the three reservoirs prior to drawdown (Table 42). After drawdown began, turbidity increased in Commanche and Eaton reservoirs, and Secchi disk

Table 42. Monthly physical and chemical parameters of study reservoirs.

Reservoir	Month	Temperature (C) Surface	Temperature (C) Bottom	Dissolved Oxygen (mg/l) Surface	Dissolved Oxygen (mg/l) Bottom	pH	Secchi disk (m)	Alkalinity (mg/l)	Capacity (% storage)
Albion	May								
	Jun	9.0	7.0	9.0	9.0	7.0	3.0	7.0	100
	Jul	11.0	8.0	9.0	8.0	7.0	3.5	7.0	100
	Aug	10.0	7.0	9.0	9.0	7.0	3.3	7.0	100
	Sep	7.0	7.0	9.0	9.0	7.5	3.4	14.0	100
	Oct	4.0	5.0	9.0	9.0	7.0	3.2	21.0	100
Chambers	May	10.0	7.0	9.0	7.0	7.0	2.2	21.0	100
	Jun	11.0	7.0	10.0	10.0	7.5	3.0	21.0	100
	Jul	12.0	6.0	7.0	7.0	7.5	2.7	21.0	100
	Aug	12.0	8.0	7.0	7.0	7.0	3.0	21.0	100
	Sep	10.0	10.0	8.0	8.0	7.5	3.1	27.0	50
	Oct	5.0	5.0	9.0	9.0	8.0	2.4	27.0	12
Commanche	May	6.0	6.0	10.0	10.0	7.0	2.0	14.0	100
	Jun	11.0	6.0	8.0	8.0	6.5	2.0	14.0	100
	Jul	11.0	8.0	9.0	8.0	6.5	2.5	14.0	100
	Aug	11.0	11.0	8.0	8.0	7.0	2.0	14.0	90
	Sep	9.0	9.0	9.0	9.0	7.0	0.2	21.0	1
	Oct	6.0	6.0	9.0	9.0	7.0	0.1	21.0	1
Dowdy	May	11.0	8.0	9.0	3.0	8.5	2.0	82.0	100
	Jun	16.0	10.0	8.0	1.0	8.5	2.5	82.0	100
	Jul	16.0	11.0	9.0	8.0	9.0	1.3	82.0	100
	Aug	14.0	14.0	8.0	8.0	8.5	0.6	82.0	100
	Sep	12.0	11.0	8.0	7.0	8.5	1.2	82.0	100
	Oct	5.5	7.0	8.0	8.0	8.5	1.5	75.0	100

Table 42. Continued

Reservoir	Month	Temperature (C) Surface	Temperature (C) Bottom	Dissolved Oxygen (mg/l) Surface	Dissolved Oxygen (mg/l) Bottom	pH	Secchi disk (m)	Alkalinity (mg/l)	Capacity (% storage)
Eaton	May	7.0	7.0	11.0	10.0	7.5	2.0	21.0	100
	Jun	12.0	7.0	8.0	7.0	7.0	3.0	21.0	100
	Jul	15.0	10.0	7.0	6.0	7.0	2.5	21.0	100
	Aug	15.0	10.0	9.0	9.0	8.0	0.1	21.0	10
	Sep	8.0	8.0	10.0	9.0	7.5	0.3	34.0	1
	Oct	5.5	5.5	9.0	9.0	7.5	0.8	34.0	1
Estes	May	8.0	8.0	10.0	10.0	7.5	2.5	14.0	100
	Jun	12.0	9.0	9.0	9.0	7.0	2.5	21.0	100
	Jul	13.0	10.0	8.0	7.0	7.5	2.3	14.0	100
	Aug	15.0	12.0	8.0	6.0	7.5	2.0	14.0	100
	Sep	13.0	11.0	8.0	6.0	7.5	2.2	21.0	100
	Oct	8.0	8.0	8.0	7.0	7.0	2.5	21.0	100
Peterson	May	11.0	9.0	9.0	8.0	7.0	1.5	14.0	100
	Jun	14.0	6.0	7.0	6.0	7.0	2.5	7.0	100
	Jul	13.0	7.0	6.0	6.0	7.0	3.0	14.0	100
	Aug	13.0	7.0	7.0	4.0	7.0	2.1	14.0	100
	Sep	7.0	4.0	7.0	3.0	7.5	2.3	21.0	100
	Oct	5.0	5.0	9.0	9.0	7.0	2.2	14.0	5
Zimmerman	May	7.0	6.0	9.0	9.0	7.0	3.5	14.0	100
	Jun	13.0	7.0	9.0	9.0	7.0	2.3	21.0	100
	Jul	10.0	8.0	8.0	8.0	7.0	3.0	14.0	100
	Aug	12.0	11.0	8.0	8.0	7.0	3.2	14.0	100
	Sep	8.0	8.0	9.0	9.0	7.5	3.0	21.0	100
	Oct	5.0	5.0	9.0	9.0	7.0	3.0	21.0	100

transparency was sharply reduced. Secchi disk readings were lower in the drawdown reservoirs at the start of the study than in the stable reservoir.

Invertebrate abundance varied between reservoirs (Table 43). Benthic invertebrates were most abundant in Albion Reservoir, low in Commanche, and extremely scarce in Eaton. Zooplankton abundance was greatest in Eaton Reservoir, moderate in Commanche, and lowest in Albion. In all of the reservoirs, chironomids comprised the bulk of the benthic fauna, and the zooplankton mainly consisted of Cladocera and Copepoda.

Food habits of brook trout generally reflected the abundance and composition of the invertebrate fauna of the reservoir. Examination of stomach contents of brook trout from Albion Reservoir revealed that benthic invertebrates accounted for approximately 70% of the diet and terrestrial insects accounted for the remainder. Zooplankton was infrequently found over trace amounts in brook trout from Albion. Many of the stomachs of Albion trout examined were empty or contained few food items.

The diet of brook trout in Commanche Reservoir consisted of approximately 50% benthos and 50% zooplankton. The utilization of benthic invertebrates was high in comparison to the abundance of benthic invertebrates in benthos samples. Only a small percentage of the stomachs examined were full or empty; most were half full or less.

Brook trout in Eaton Reservoir fed almost exclusively on zooplankton. Benthic invertebrates were rarely found over trace amounts in stomachs. Nearly all of the stomachs examined were full, and no empty stomachs were found.

Table 43. Relative ranking of zooplankton and benthic invertebrate abundance.

Reservoir	Zooplankton Abundance	Benthic Invertebrate Abundance
Albion	7	3
Chambers*	8	7
Commanche*	6	6
Dowdy	4	4
Eaton*	2	8
Estes	3	2
Peterson*	5	5
Zimmerman	1**	1**

*Drawdown
**Most abundant

Growth in length and weight were significantly greater in Eaton than in Commanche or Albion, which were not significantly different ($p<0.01$) (Figures 15a and 15b). Regression least-square equations for growth in length and weight of brook trout in Commanche and Albion were negatively curvilinear, while growth in length and weight of brook trout in Eaton were linear (Table 44).

Table 44. Regression least-squares equations for growth in length and weight of brook trout.

Reservoir	Length Equation	Weight Equation
Albion	$71.85 + 60.58\ A - 4.45\ A^2$	$-12.09 + 45.48\ A - 2.30\ A^2$
Commanche*	$84.60 + 60.68\ A - 5.82\ A^2$	$-12.09 + 43.09\ A - 2.30\ A^2$
Eaton*	$142.05 + 40.53\ A - 0.79\ A^2$	$31.45 + 31.28\ A + 8.91\ A^2$

A = age, A^2 = age squared
* Drawdown

The differences in the rates of growth in length and weight are reflected in the condition of the fish (Figure 15c). Condition factors (K) were significantly different between populations ($p<0.05$). Mean condition factor was highest in Eaton and lowest in Albion (Table 45). All of the brook trout captured in Eaton Reservoir were heavy robust fish, while those from Commanche and Albion had large heads and thin bodies characteristic of stunted populations.

Table 45. Mean condition factor and 95% confidence interval of brook trout.

Reservoir	Mean condition factor	95% C.I.	Sample size
Albion	0.9269	0.9062 to 0.9478	108
Commanche*	1.0034	0.9853 to 1.0215	162
Eaton*	1.1716	1.1519 to 1.1912	238

*Drawdown

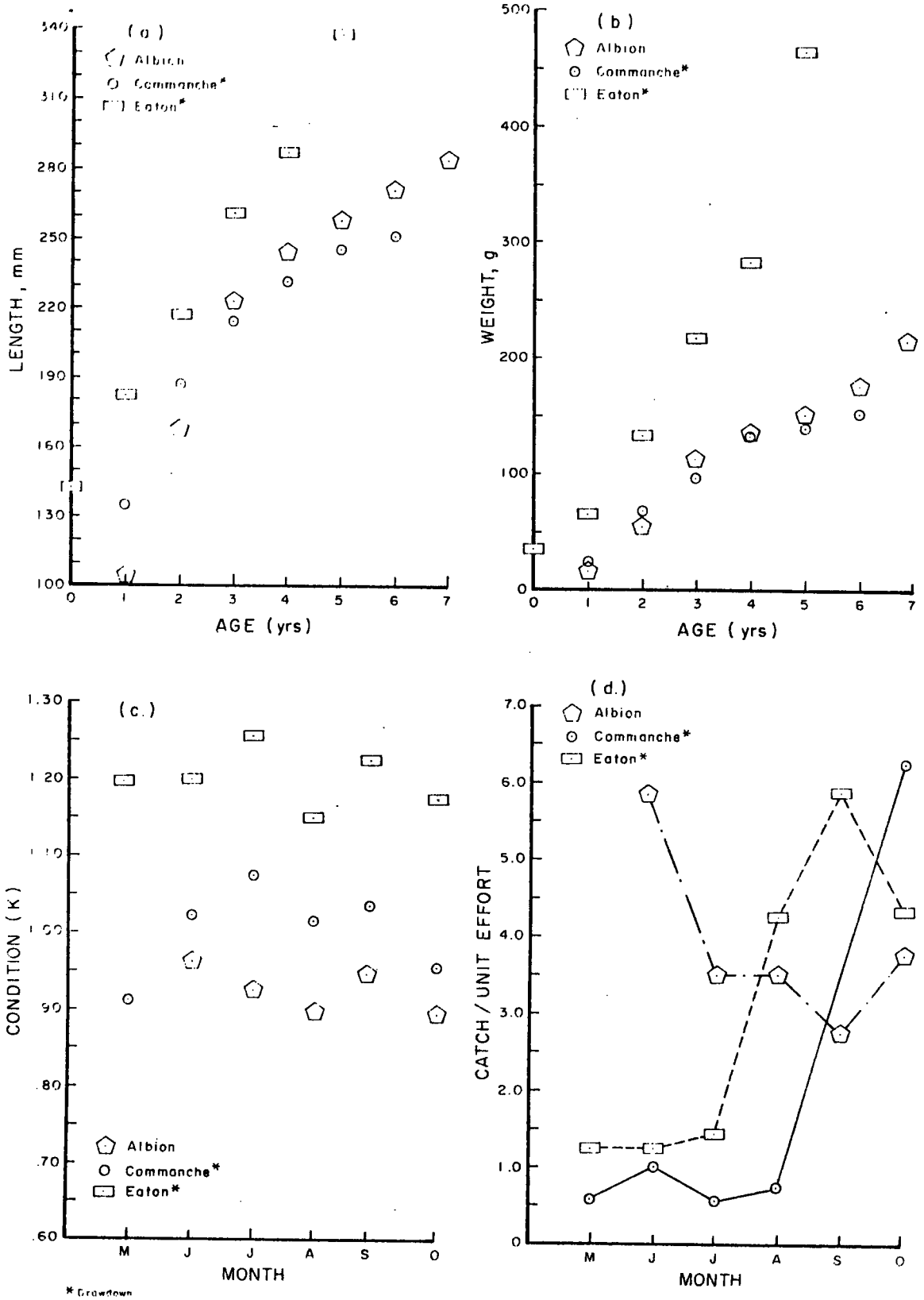


Figure 15. Growth in length, growth in weight, condition and catch/unit effort of brook trout.

Catch per unit effort prior to drawdown was significantly higher in Albion than in Commanche or Eaton ($p<0.05$). After drawdown, catch rose sharply in Commanche and Eaton, as the population was restricted to a smaller area (Figure 15d). Catch per unit effort was not significantly different between Eaton and Commanche ($p<0.05$). The initial high catch in Albion was due to the placement of a gill net in the delta of the main tributary where brook trout concentrated to feed on drift from the stream and terrestrial insects blown in by the prevailing winds.

Petersen population estimates were computed for Commanche and Eaton from tag returns. Estimates obtained were 4,879 (748 - 27,527; $p=0.05$) brook trout in Eaton and 2,450 (1,025 - 4,987; $p=0.05$) brook trout in Commanche. A Petersen estimate was also made in Eaton with fish fin clipped in September and recaptured in October; this resulted in a population estimation of 1,525 (337 - 5,629; $p=0.05$) brook trout. The validity of these estimates is questionable because the recapture of tagged and fin-clipped fish was extremely low.

After drawdown, 400-m sections immediately above and below the reservoirs were electrofished for recovery of tagged fish. No tagged fish were found below Eaton, and only two were recovered below Commanche. Walburg (1971) found that during drawdown the greatest flushing of fish occurred in age 0 fish in Lewis and Clark Lake, Missouri River. All fish tagged in Commanche and Eaton were age I or older, and age 0 fish could have been flushed in large numbers without being detected.

The low abundance of brook trout in Commanche and Eaton reservoirs can be related to destruction of spawning sites. Brook trout spawned in these reservoirs during maximum drawdown, and redds were observed

in the streams crossing the reservoirs. Survival of the eggs in these redds was probably extremely low in Eaton and only slightly higher in Commanche because of fall and winter refilling of the reservoirs after drawdown.

Eaton Reservoir fills slowly through the winter. As it fills, the stream crossing the reservoir meanders and cuts new channels. As the stream meanders, fine silt which covers the reservoir bed is deposited in the old channels and probably suffocates incubating eggs deposited in the stream. The stream bed above Eaton Reservoir is impacted with sand and fine silt which would permit only limited spawning and egg removal.

Commanche Reservoir fills rapidly to half capacity in late autumn and then remains stable until spring. When at half capacity, approximately 70% of the reservoir bed is inundated. Spawning occurs prior to refilling, and eggs deposited in the inundated stream sections are either silted in or suffocate from lack of water circulation. Egg survival in the 30% of the stream not inundated is probably high, as the stream is well-incised and siltation is low. The stream above the reservoir contains excellent spawning beds, which are readily accessible from the reservoir and probably produce large numbers of fry.

The low growth-rate of brook trout in Commanche Reservoir, similar to the growth-rate of the more abundant population in Albion Reservoir, is a consequence of reproduction exceeding the supply of invertebrate food organisms. Grimas (1962) found that fall drawdowns eradicated littoral invertebrate species and greatly reduced chironomids. Fillion (1967) found invertebrate abundance to be greatest at the level of drawdown, but the greatest abundance of chironomids occurred below the level of drawdown. The reservoirs studied by Grimas and Fillion were

large hydroelectric reservoirs where drawdown did not exceed 25% of total depth. When drawn down, 99% of the reservoir bed is exposed and dessicated in Commanche Reservoir, leaving little chance for invertebrate survival. Limiting drawdown at some level above complete removal could increase the abundance of benthic invertebrates in Commanche Reservoir and lead to increased growth rates and larger size of brook trout.

In Commanche and Eaton reservoirs, flushing of fish during drawdown appears to be a minor factor in population reduction. However, this may not be true for young-of-the-year, which were not studied. Young-of-the-year of warmwater species suffered greatly during flushing according to Walburg (1971).

Cutthroat Trout

Cutthroat trout were present in three reservoirs; Dowdy, Peterson, and Zimmerman. Dowdy and Zimmerman are recreational reservoirs and are not drawn down. Peterson is used for irrigation storage and is drawn down to a conservation pool of approximately 5% of the total capacity. None of these reservoirs is located on a permanent stream. Water is supplied to Dowdy in the spring via a ditch, and Peterson and Zimmerman are fed by intermittent streams and springs originating from snow packs. As a consequence, no natural reproduction is possible, and the cutthroat populations are maintained by annual stocking of 50-mm fingerlings.

Chemical and physical parameters measured show Dowdy to be much more productive than Peterson or Zimmerman (Table 40). Total alkalinity was four to five times higher in Dowdy than in Peterson or Zimmerman. Carlander (1955) showed that alkalinity is positively correlated with fish production. Dowdy also had the lowest Secchi disk readings,

which were due to phytoplankton rather than inorganic turbidity. Peterson had a low initial Secchi disk reading, but turbidity did not increase after drawdown. Dissolved oxygen in the hypolimnion dropped below 4 mg/l, the minimum recommended by the Committee on Water Quality Criteria (1973), in Dowdy and Peterson reservoirs. It is doubtful that the low hypolimnion oxygen levels had any adverse effects on the fish, since the epilimnion remained high in dissolved oxygen and temperatures were within salmonid tolerance limits.

Abundance of intertebrates was highest in Zimmerman and lowest in Peterson and Dowdy (Table 43). Zimmerman had a rich and varied benthic fauna with chironomids predominating. Amphipods, Gammarus sp., were also abundant in Zimmerman. Zooplankton was abundant in Zimmerman. Samples contained Cladocera, Copepoda, and large numbers of emerging chironomids. Benthic invertebrates were in low abundance, but zooplankton abundance was good in Peterson. The high primary productivity evident in Dowdy by a dense phytoplankton community did not carry over to the invertebrates. Benthic invertebrate abundance in Dowdy was only slightly higher than that in Peterson, and zooplankton, consisting primarily of small Daphnia, was comparable in Dowdy and Peterson. The low abundance of invertebrates in Dowdy was chiefly due to a large population of white suckers which was feeding heavily on both benthos and zooplankton.

Cutthroats in Zimmerman fed largely on emerging chironomids; Gammarus were the second most abundant item in their diets. In Peterson, Daphnia accounted for 90% of the diet and the remainder was primarily emerging chironomids. Daphnia were the major food item of cutthroats in Dowdy; other items occurred infrequently and in small quantities.

No empty stomachs were encountered in samples from Zimmerman, Dowdy, or Peterson, but very few full stomachs were taken from Dowdy.

Age II cutthroats were used for analysis of growth, weight gain, and catch per effort, because age II fish were the only age class present in Dowdy and the only age class in Peterson present in significant numbers that had experienced drawdown prior to sampling. Peterson had not been stocked since 1968, and very few of these older fish remained. Ages I through VI were present in Zimmerman; the majority were in ages II and III.

For age class II, growth in length and weight were not significantly different between populations ($p<0.01$) (Figures 16a and 16b). The quadratic slope of the least squares equations for Dowdy cutthroats was higher but was not significant from Peterson or Zimmerman (Table 46).

Table 46. Regression least-squares equations for growth in length and weight of cutthroat trout.

Reservoir	Length Equation	Weight Equation
Dowdy	$0.349 + 47.89\ A + 19.69\ A^2$	$0.724 - 63.37\ A + 43.26\ A^2$
Peterson*	$0.349 + 47.89\ A + 14.60\ A^2$	$0.724 - 63.37\ A + 40.09\ A^2$
Zimmerman	$0.349 + 47.89\ A + 14.60\ A^2$	$0.724 - 63.37\ A + 40.09\ A^2$

A = age, A^2 = age squared
* Drawdown

A significantly-higher ($p<0.05$) mean condition factor of the cutthroat trout population in Zimmerman (as compared to Dowdy and Peterson reservoirs, Table 47) was positively correlated with the higher invertebrate abundance in Zimmerman reservoir (Table 43). The lower condition factors of cutthroats in Peterson and Dowdy may be a reflection of the lower abundance of invertebrates, but the mean condition factors for these reservoirs were within the range of condition factors for cutthroat

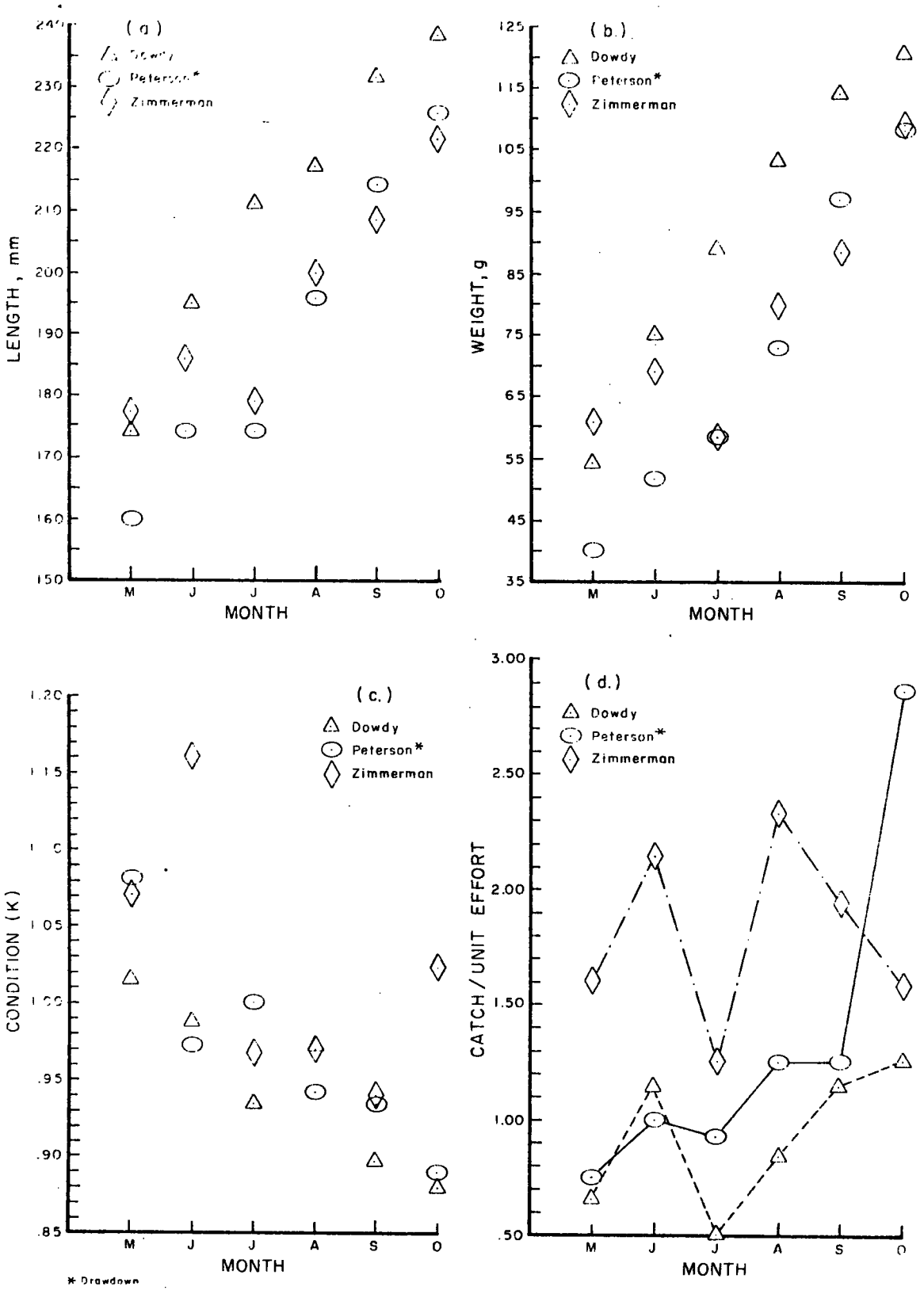


Figure 16. Growth in length, growth in weight, condition and catch/unit effort of cutthroat trout.

trout from other similar lakes and reservoirs (Carlander, 1969). Condition factors dropped through the summer in all three populations (Figure 16c). This was due to more rapid growth in length than in weight, which is characteristic of immature cutthroats (Colburn, 1966).

Table 47. Mean condition factor and 95% confidence interval of cutthroat trout.

Reservoir	Mean condition factor	95% C.I.	Sample size
Dowdy	0.9412	0.9248 to 0.9525	68
Peterson*	0.9526	0.9328 to 0.9725	114
Zimmerman	1.0220	0.9956 to 1.0485	135

*Drawdown

Catch per unit effort prior to drawdown was significantly higher ($p<0.05$) in Zimmerman than in Dowdy or Peterson (Figure 16d). Colorado Division of Wildlife stocking records show mean stocking rates for age II cutthroats of 38.5/acre in Dowdy, 181.1/acre in Peterson and 126.8/acre in Zimmerman. Examination of catch per unit effort in light of stocking rates indicates that there has been a severe reduction in the cutthroat population in Peterson.

The exact causes of the reduction in the cutthroat trout population in Peterson Reservoir are unknown, but the most plausible causes are partial winter-kill and flushing of fish during drawdown. Partial winter-kill caused by heavy ice and snow cover, low inflows of water, and high oxygen demand by organic sediments could have occurred in the conservation pool. Winter oxygen levels may be very low; values as low as 3 mg/l were recorded in the hypolimnion in summer. Flushing of fish during drawdown could also have been a factor in population reduction in Peterson Reservoir. The outlet of Peterson Reservoir is situated

below the level of the conservation pool, which is located in a depression in the middle of the reservoir. Fish may have been drawn near the outlet during drawdown and forced to exit when the water level fell to the level of the conservation pool.

Whatever caused population reduction must have happened during drawdown or soon thereafter or must not have involved competition for food. Condition factors of cutthroat trout in Peterson Reservoir were not significantly different from those in Dowdy and only slightly lower than those in Zimmerman Lake. Rates of growth were not significantly different between the three populations. If competition had been involved, it would seem that all of the fish in Peterson would have suffered before part of the population died. Condition factors would have been lower, and growth rates would have been altered.

White Suckers

Four reservoirs (Chambers, Commanche, Dowdy, and Estes) had populations of white suckers. Chambers was drawn down to a conservation pool of 8 to 16% of total capacity and Commanche to 1% of capacity. Dowdy was stable and Estes, used for hydroelectric generation, fluctuated approximately 0.3 to 1 m diurnally.

Physical and chemical parameters were similar between reservoirs except for the previously-noted low dissolved oxygen and Secchi disk readings in Dowdy. Turbidity increased in Chambers and Commanche with drawdown but was not as severe in Chambers. Estes was the only reservoir that did not develop a thermocline, presumably because of its shallow depth and the high flushing rate from power generation.

Invertebrates, both planktonic and benthic, were more abundant in the stable reservoirs than in the drawdown reservoirs (Table 43). Of the reservoirs containing white suckers, Estes had the greatest abundance of plankton and benthos. Dowdy had zooplankton density nearly equal to that of Estes, but benthic invertebrates were lower in abundance in Dowdy. The two drawdown reservoirs, Chambers and Commanche, had low benthic invertebrate densities, but Commanche had more zooplankton.

Determination of white sucker food habits was difficult due to the grinding of ingested food by their pharyngeal teeth. However, the presence of clam and snail shells and detritus in the gut indicated that white suckers were feeding primarily on benthos in all of the reservoirs except Dowdy. White suckers stomachs examined from Dowdy had more plankton than benthos; many stomachs contained only plankton.

Growth rates were not significantly different ($p>0.01$) between the four populations (Figure 17a and Table 48). The rate of weight gain was significantly lower ($p<0.01$) (Figure 17b and Table 48). Mean condition factor was also significantly lower ($p<0.05$) for white suckers in Chambers than in the other reservoirs (Figure 17c and Table 49).

Table 48. Regression least squares equations for growth in length and weight of white suckers.

Reservoir	Length Equation	Weight Equation
Chambers*	$-38.43 + 81.61\ A - 4.35\ A^2$	$-143.05 + 51.20\ A + 2.44\ A^2$
Commanche*	$56.65 + 81.61\ A - 5.03\ A^2$	$-77.21 + 95.91\ A + 0.74\ A^2$
Dowdy	$36.30 + 81.61\ A - 4.35\ A^2$	$-143.05 + 95.91\ A + 2.44\ A^2$
Estes	$52.95 + 81.61\ A - 5.26\ A^2$	$-92.19 + 95.91\ A + 0.38\ A^2$

A = age, A^2 = age squared
* Drawdown

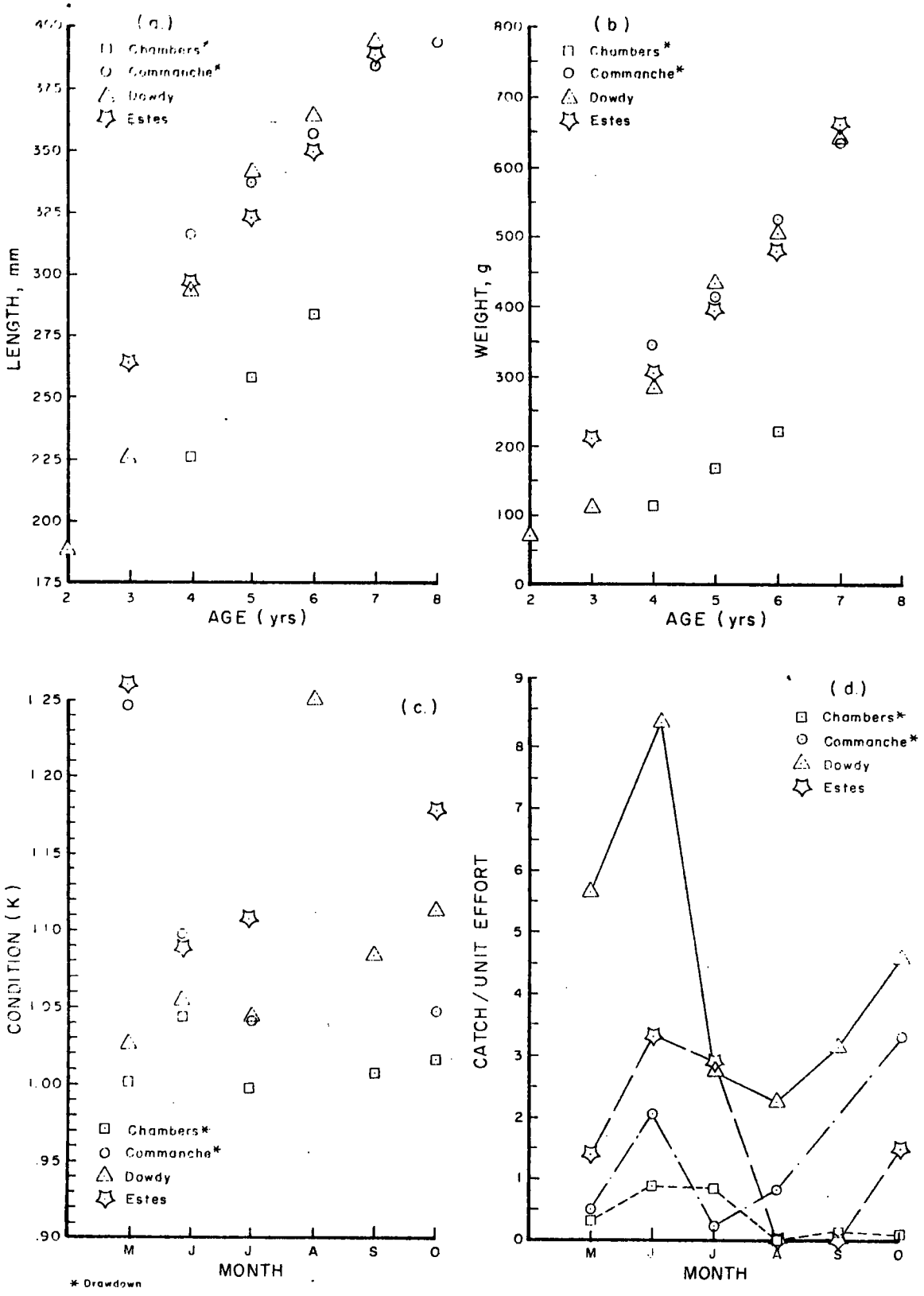


Figure 17. Growth in length, growth in weight, condition and catch/unit effort of white suckers.

Table 49. Mean condition factor and 95% confidence interval of white suckers.

Reservoir	Mean condition factor	95% C.I.	Sample size
Chambers*	0.9812	0.9500 to 1.0123	19
Commanche*	1.1041	1.0717 to 1.1364	58
Dowdy	1.0553	1.0424 to 1.0682	319
Estes	1.1368	1.1158 to 1.1577	109

*Drawdown

Catch per unit effort of white suckers was higher in the stable reservoirs than in the drawdown reservoirs (Figure 17d). Catch went up in Commanche following drawdown but did not do so in Chambers. The failure of catch to increase with drawdown in Chambers was probably caused by a combination of low abundance and use of floating nets set in 4 to 6 m of water. Bottom sets were used the first three months and floating sets the second three months.

Longnose Suckers

Chambers, Commanche, Eaton, and Estes contained large populations of longnose suckers. Longnose suckers were also found in Dowdy, but only seven were captured and not included in the analysis. Chambers, Commanche, and Eaton were drawn down, and Estes was stable.

Food items eaten by longnose suckers were, as with white suckers, difficult to identify but appeared to be entirely benthic. Even in Eaton Reservoir, where the benthic fauna was almost non-existent, longnose suckers fed on benthic invertebrates. Most of the items eaten in Eaton may have been drift from the tributary streams, as the highest catch of longnose suckers was from a gill net set near the inlet of the main stream.

Growth rates were significantly different ($p<0.01$) between all populations (Table 50). Rate of growth was highest in Chambers and the lowest in Eaton. However, the plots of mean length and weight at age (Figures 18a and 18b) do not show any striking differences, and statistical significance may be an artifact of sample sizes in age groups. The condition factor of longnose suckers was significantly lower ($p<0.05$) in Chambers Lake than in the other reservoirs, which were not significantly different from one another (Table 51).

Table 50. Regression least squares equations for growth in length and weight of longnose suckers.

Reservoir	Length Equation	Weight Equation
Chambers*	$-49.66 + 96.46\ A - 5.72\ A^2$	$-92.00 + 30.45\ A + 5.53\ A^2$
Commanche*	$81.59 + 39.00\ A + 0.89\ A^2$	$34.04 - 24.23\ A + 14.08\ A^2$
Eaton*	$81.59 + 47.34\ A - 2.65\ A^2$	$17.32 + 0.00\ A + 6.73\ A^2$
Estes	$47.46 + 62.89\ A - 2.65\ A^2$	$-37.78 + 25.97\ A + 6.73\ A^2$

A = age, A^2 = age squared
* Drawdown

Table 51. Mean condition factor and 95% confidence interval of longnose suckers.

Reservoir	Mean condition factor	95% C.I.	Sample size
Chambers*	0.8365	0.8184 to 0.8535	133
Commanche*	1.0136	0.9911 to 1.0361	106
Eaton*	1.0289	1.0074 to 1.0502	83
Estes	1.0182	0.9813 to 1.0550	25

*Drawdown

Catch per unit effort for longnose suckers was different from results obtained with the other species studied (Figure 18d). With brook trout, cutthroat trout, and white suckers, abundance was lower in the drawdown

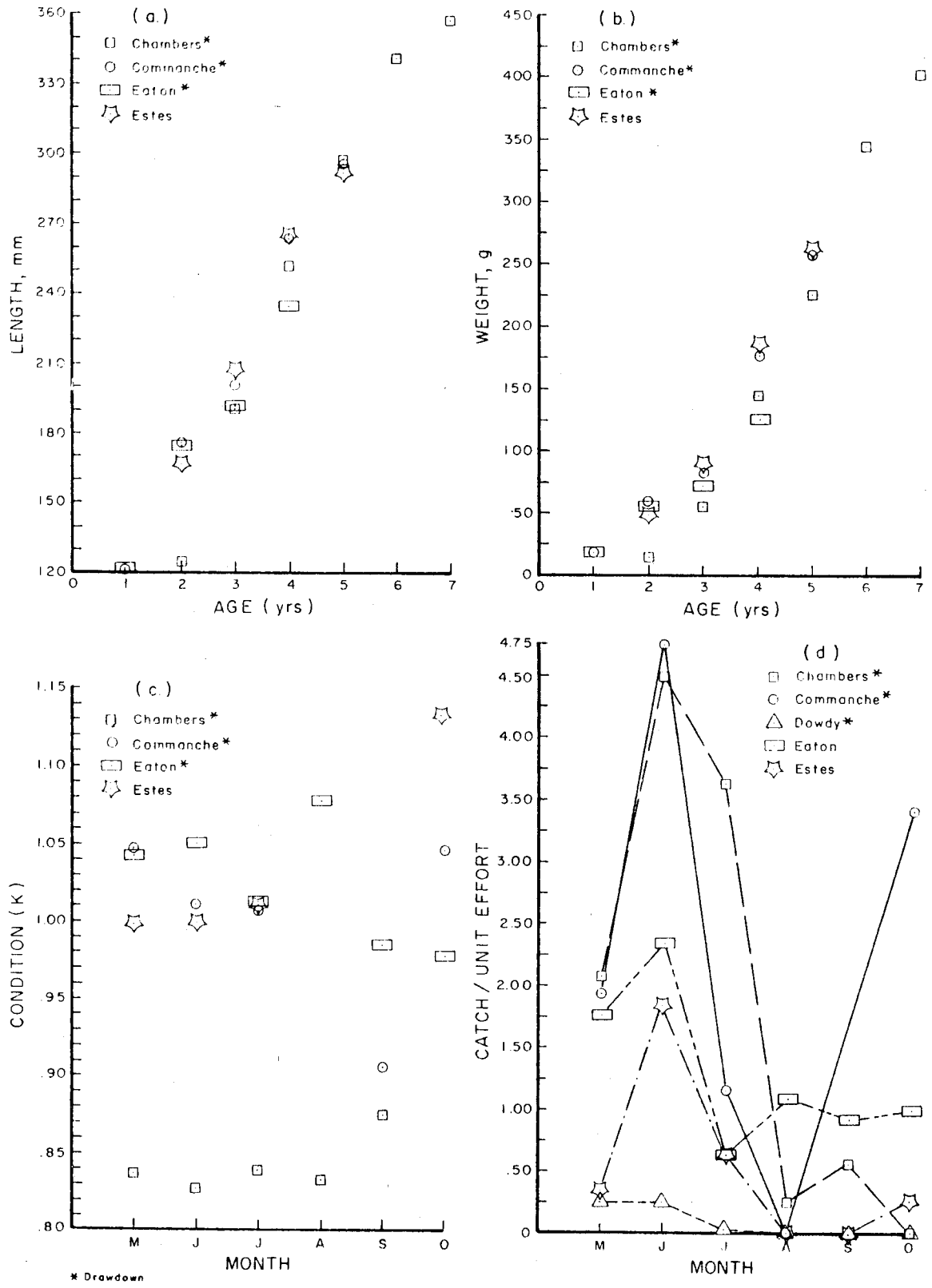


Figure 18. Growth in length, growth in weight, condition and catch/unit effort of longnose suckers.

reservoirs. The same scheme of bottom and floating net sets as used for white suckers was followed for capture of longnose suckers. Catch rose sharply in Commanche after drawdown, increased slightly in Eaton, but did not increase in Chambers. Failure of catch to increase in Chambers was likely due to the use of a floating net in deep water (4-6 m).

Greater abundance of longnose suckers than of white suckers in drawdown reservoirs cannot readily be explained, especially since white and longnose suckers do not differ greatly in life histories or food habits (Scott and Crossman, 1973). Differences in their abundance can possibly be explained by habitat preferences. Longnose suckers are native to the small mountain streams of the Front Range, while white suckers originally inhabited only the larger streams of the plains and foothills (Beckman, 1963). Longnose suckers may be better adapted to conditions in drawdown reservoirs; they originally occupied habitats more severe than those occupied by white suckers. Conversely, white suckers may be better able to exploit the environment of stable reservoirs than can longnose suckers.

Differences in growth and condition were not consistent with drawdown. The populations of white and longnose suckers in Commanche Reservoir did not differ in growth or condition from populations in stable reservoirs, indicating that factors other than drawdown or characteristics of the reservoir may be canceling drawdown effects. Condition factors were low for white and longnose suckers in Chambers Lake and attributable to low benthic invertebrate abundance. In Eaton Reservoir, longnose suckers exhibited poor growth and were in low abundance because of the sparse benthic fauna and poor condition of spawning areas. Commanche Reservoir sucker populations should have been similar to

Chambers and Eaton, since drawdown in Commanche was similar to that in Eaton and greater than in Chambers Lake.

Miller and Paetz (1959) reported the water chemistry and zooplankton abundance in natural lakes impounded for hydroelectric storage were unaltered by impoundment and water drawdown, but that fish and benthic invertebrate populations were reduced and fish growth rates were lower. In the present investigation, it was found that the water chemistry was similar between stable and drawdown reservoirs, and that turbidity was the only physical or chemical parameter altered by drawdown. These results differ from those of Miller and Paetz in that zooplankton abundance as well as fish and benthic invertebrate abundance was reduced by drawdowns. Comparison of zooplankton and benthic invertebrate abundance for the eight reservoirs shows that zooplankton and benthic invertebrates were more abundant in the stable reservoirs (Figure 19). The two outliers in Figure 19, Albion and Eaton, can be accounted for by fish abundance and physical characteristics of the reservoirs. The low abundance of zooplankton in Albion was probably due to heavy predation by the large brook trout population. Low benthic invertebrate abundance and high zooplankton abundance in Eaton was due to the unstable reservoir bottom and the low abundance of fish.

Overall, drawdowns were deleterious to the fish species studied in this investigation. It was not possible to determine at what level of drawdown effects became apparent, because the reservoirs studied were all drawn down completely or to extreme levels. Studies by Grimas (1962) and Aass (1960) indicate that slight drawdowns can greatly reduce benthic fauna. The critical limit of drawdown, from these studies, appears to be within the littoral zone. Once drawdown proceeds beyond the high water littoral zone, little additional damage occurs to benthic fauna,

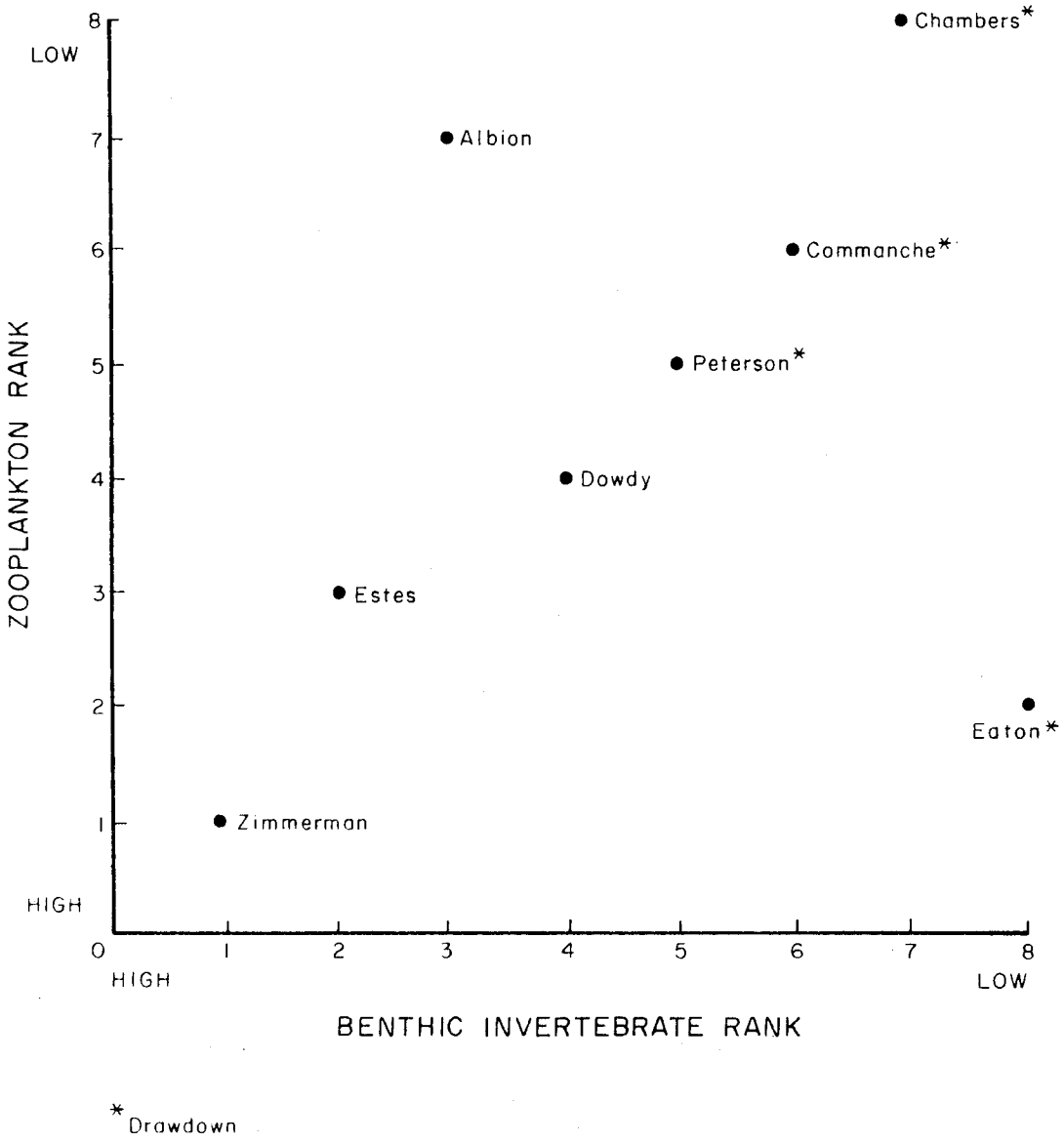


Figure 19. Comparison of zooplankton and benthic invertebrate relative abundance rankings.

since the majority of benthic species are littoral. However, Fillion's (1967) findings of maximum invertebrate abundance at the level of maximum drawdown (10 m in a 40 m deep reservoir) and high chironomid abundance below that limit suggests that, in some reservoirs, benthic invertebrate populations are adequate to sustain good fish survival and growth.

Mortality of spawn, flushing of fish during drawdown, and winter-kill are drawdown effects which might preceed effects of reduced invertebrate fauna and lead to adjustment of the fish community to the available food fupply. Limiting drawdown would also increase the abundance of benthic invertebrates, so increased fish survival should not result in a decrease in growth rates.

No drawdown in the mountain reservoirs of Colorado would probably result in the best fisheries. However, since the water stored in these reservoirs is needed for agricultural and for domestic use, drawdowns cannot be completely curtailed. Drawdowns in many of these reservoirs could be limited to some level above complete removal or minimal conservation pools which would provide better fisheries while allowing for water use.

Conclusions and Recommendations

The small mountain reservoirs in the montane, subalpine, and alpine zones of the Front Range are all suitable habitat for salmonid game fish. However, providing suitable habitat production is limited by low fertility, short growing seasons, and, in the majority of reservoirs, by water drawdown. Water drawdowns in small mountain storage reservoirs were found to be detrimental to fish communities in these reservoirs.

Drawdown effects to the fish community include low survival of spawn, flushing of fish from the reservoir, increased probability of winter-kill, and loss or destruction of invertebrates. The size of fish populations was the most affected by drawdown. Rates of growth and condition factors did not differ significantly between drawdown and stable reservoirs except where fish survival exceeded the available invertebrate food supply. In the case of brook trout in Eaton Reservoir, growth was enhanced by drawdown as the population was reduced and the food supply, zooplankters, remained abundant.

Invertebrates were the part of the reservoir ecosystem most affected by drawdown. Fish losses from flushing, egg mortality, and winter-kill can be overcome by means other than limiting drawdown, such as not refilling the reservoirs until the eggs have developed, screening the outlets and installation of aeration systems. However, the abundance of benthic invertebrates can only be increased by limiting drawdown. Also increasing fish survival without increasing invertebrate abundance would cause poor growth rates and condition factors in the fish community.

As stated previously, complete stabilization of small mountain reservoirs would most likely produce the best fisheries. With stabilization a littoral flora and fauna would develop and provide a more

abundant and diverse invertebrate community. Drawdown-related fish mortality would be curtailed and maximum fish production could be realized.

Stabilization of many of these reservoirs could easily be achieved without loss to water users. The storage capacity of most mountain reservoirs is less than 5,000 acre feet. This amount of water can easily be stored in existing large downstream reservoirs. For example, in the Cache la Poudre River drainage there are 9 reservoirs in the mountains above 2,000 meters elevation. The total capacity of these reservoirs is 32,591 acre feet (Colorado State Engineer's Office). Stabilizing these reservoirs and transferring the storage to Horsetooth Reservoir (770 ha) west of Fort Collins, would require only a 5.3 m rise of water depth. Small upstream reservoirs have already been stabilized by storage exchange in areas of western Colorado by the Bureau of Reclamation (Crandall, 1971).

Complete stabilization may be impossible to achieve on many reservoirs, particularly the larger reservoirs. On these, drawdown limits should be developed that would maximize the fishery resource while allowing for water use. To determine specific drawdown limits and management strategies, research beyond what has been accomplished is needed. Some of this research is being undertaken in the second phase of this study.

Quantification of drawdown effects at different levels may be almost impossible to achieve due to administrative, logistical, and legalistic obstacles. Originally a study of drawdown effects at differing levels of drawdown was planned for this study but could not be accomplished for lack of adequate control. For meaningful results, fish of the same species and size would have to be stocked at the same

density and evaluated through at least one annual cycle of drawdown. This involves finding reservoirs that are fairly similar in physico-chemical factors and are devoid of other fish either naturally or through eradication. The difficult part of such a study is to obtain the specified drawdowns for each reservoir and to hold them at the proper level to the following spring. Holders of water rights in these reservoirs are reluctant to do so because allocation of water for the following year in Colorado is based on the amount of water remaining at the end of the water year.

One piece of research that could produce fruitful and valuable results would be to perform quantitative studies on reservoirs that are drawn down completely and reservoirs drawn down to conservation pools that contain similar fish species or community. Such a study could concentrate on the mechanisms involved in decreasing the abundance of invertebrates and fish, determine the effectiveness of conservation pools, and provide baseline data for evaluation of possible future changes in drawdown procedures or habitat improvements on these reservoirs.

Another area for further study could be methods of improving invertebrate abundance and manipulation of food chains. Artificial substrates may be a means of providing cover and food for invertebrates and increasing food supplies for fish under existing drawdown practices. Substrates of a type that would provide means of attachment for aquatic vegetation, remain within the photosynthetic zone, and be situated or designed to remain in the water column during and after drawdown could be designed and evaluated. Artificial substrates have been used extensively in marine and warmwater fisheries to provide food and cover for forage fish and to increase game fish.

Manipulation of food chains is a potential method of improving the sport fishery in drawdown reservoirs which could be investigated. Drawdowns in warmwater reservoirs are beneficial because piscivorous game fish are concentrated with forage fish and feeding is intensified which results in higher survival of game fish (Bennett 1970). Piscivorous coldwater species such as brown trout (Salmo trutta) or lake trout (Salvelinus namaycush) could be stocked in drawdown reservoirs to see if they could utilize the rough fishes in these reservoirs thereby producing a better fishery than that which presently exists.

The acquisition of additional fishing waters is perhaps a greater problem than drawdowns. A catchable fishery program can be carried on forever on the existing reservoirs under current drawdowns or a fishery utilizing fingerling trout or natural reproduction could be established with changes in drawdown practices. However, improvements in the fishery would not ease current fishing pressure or make room for future pressure. In fact improvements might detract from the experience of the present average fisherman who values escapism and solitude over catching fish. To provide for fisherman desires and future use presently-closed reservoirs must be opened. To facilitate the opening of closed reservoirs, especially the municipal reservoirs, a more detailed survey should be conducted by an individual trained in political science and economics. Such a survey could concentrate on the costs of opening reservoirs and could identify the best approach to follow in attempting to open these reservoirs.

Summary

Small high-country reservoirs are a valuable part of the fishery and general recreation resource of Colorado. They have a great deal of potential for providing recreational fishing for residents and non-resident tourists. These reservoirs are all capable of supporting trout populations based on a survey of physical, chemical, and biological parameters. However, the mountain reservoirs are generally infertile and fish production is limited. Water drawdowns decrease the fishery potential of these waters even further causing reduced fish populations and poor growth where fish survival exceeds the invertebrate community which is also reduced by drawdown.

Reservoirs closed to fishing and other recreational activities make up a large part of the resource. Opening these reservoirs would decrease use on presently overused reservoirs and provide for future expected increases in fishing pressure. Openings would also help provide for user demands of uncrowded surroundings. However, there appears little chance at present of opening many closed reservoirs. To effectively manage presently open reservoirs for maximum recreational values, drawdowns should be curtailed. The capacity of most of these reservoirs is small. The volume of several of these reservoirs can easily be stored in existing large downstream reservoirs. Storage in these large reservoirs would result in better management and control of stored water as well as increased recreational values of upstream reservoirs.

If fisheries are to be continued or developed under conditions of drawdown, further research is needed to find drawdown effects at specific levels, methods of improving the invertebrate food base, and evaluation of different fish species in drawdown reservoirs.

SUMMARY OF FINDINGS

Introduction

The Front Range of the Colorado Rockies is one of the most beautiful scenic regions in the country. Its recreational areas are overused, however, and overuse leads to degradation of a satisfying recreation experience. One of the major factors in the recreation experience in the Rockies is the water resource. It provides opportunity for fishing as well as enhancing the scenic beauty. Much of the water resource of the Eastern Slope is contained in high-country reservoirs, some of which are open to the public for recreational purposes...but most, unfortunately, are closed.

This research project has addressed itself to the two-fold problem: (1) to find additional water resources; and (2) to help high-country reservoir managers to make decisions that will lead to the optimum use of the reservoirs.

Objective A

To describe the existing water reservoir situation and its potential for recreation

Description of the reservoir situation has been limited because, prior to this present investigation, little information existed on the high-country reservoirs in the Front Range of Colorado's Rockies.

The completion of Phase I of this project has, on the other hand, generated such a mass of information that the concentrated study had to be limited to 36 high-country reservoirs that constitute a representative sample of the 153 reservoirs in the study area. The reservoirs selected for concentrated study are all presently open to the public.

1. Number of reservoirs: There are 153 high-country reservoirs in the study area. Thirty-six were selected for intensive study because they had existing recreation use.
2. Where located: All are located on the Front Range of the Rockies east of the Continental Divide and within the Colorado boundaries at elevations ranging from 6,000 feet to 12,000 feet.
3. Ownership: Sixty-seven reservoirs are private; 86 are public, of which 31 are open to the public.
4. Reservoir description: Most high-country reservoirs in the study range in area from 10 acres to 150 acres, with a few as large as 300 acres. Twenty-eight are on-stream, and eight are off-stream. Thirty-one of the 36 reservoirs are in scenic areas judged to be "good" to "excellent."
5. Present access: Driving time to 33% of the reservoirs is one-hour or less; 32% may be reached in from one to two hours, and eight require hikes from one to ten miles in length. Fourteen are reached by paved roads and 41 by unpaved roads.
6. Management: There are 13 separate public and private agencies managing the 36 high-country reservoirs in this study. The United States Forest Service manages 14; the Colorado Division of Game and Fish manages four; the National Park Service, four; the cities of Greeley, Idaho Springs, and Estes Park manage one each; and the remainder are each managed by various agencies and private companies either separately or cooperatively.
7. Existing facilities: Eleven of the 36 reservoirs have no facilities. The remainder have facilities ranging from camps, picnic grounds, toilets, grills, boat ramps, water taps, to one that even has ice-skating facilities.

Objective B

To identify the management practices necessary to meet the recreation user desires on high-country reservoirs

This objective is the main thrust of this research. To reach the objective an intensive study was conducted during the summer recreation seasons of 1973 and 1974, with special attention to actual on-site user behavior patterns, expectations, satisfactions, interests, attitudes, and beliefs. The data obtained by the investigators were combined to provide a profile of the on-site recreation users at the 36 high-country reservoirs.

Sub-objective 1. Behavior--To identify the management implications based upon the actual behavior patterns of users and the related physical characteristics of high-country reservoirs

1. Effect of access on use: Reservoirs accessible by paved roads are heavily used; those reached only by hiking trails are "low-use" reservoirs. Most reservoir users spend less than two-hours' driving time to reach the sites, with an average of 1 3/4 hours.
2. Use: Eleven of the 36 reservoirs are most popular, accounting for 61% of the total use of all reservoirs in the study.
3. Area: The size of the reservoir has no significant effect on intensity of use.
4. On-site facilities: Those having the most developed facilities attract the highest number of users, most of whom are day-users. Most users of hike-in sites require no facilities. Two-thirds of the "low-use" reservoirs have no facilities.
5. Location: "High-use" reservoirs are closer to major urban areas. A few "high-use" reservoirs that are at greater distances have superior facilities that attract larger numbers of users. These

isolated sites that achieved "high use" are in areas where few recreation alternatives exist.

6. Scenic quality: Reservoirs having the highest scenic ratings tend to be located in remote areas, thus accounting for their low use.
7. Fishing quality: The larger the number of users, the lower the quality of fishing; and, conversely, the highest fishing quality is found at sites of low use.
8. Drawdown: Inasmuch as water area of a reservoir has no significant effect upon use, drawdown, apparently, had little effect upon use. Only 5% of the users reported that they abandoned a reservoir site because of the effect of drawdown on them.
9. Activities of users: Fishing and camping are the prime activities (and in that order of importance) of users of high-country reservoir sites.
10. Types of camping: "High-use" reservoirs have the largest number of trailer campers and the remote hike-in sites have tent camping almost exclusively. Very little camping occurs at "moderate-use" reservoirs.
11. Equipment: Fishing gear is universally brought to all reservoir sites.
12. Length of stay: About half of the reservoir users stay only the one day, and half are there for longer visitations. Overnight stays are most common at the isolated hike-in sites, and one-day stays are most common at "moderate-use" reservoirs.
13. Incidence of returns: Users of remote, hike-in sites usually do not return, whereas two-thirds of the users at "high-use" and

"moderate-use" sites reported that they were returnees to those same reservoirs.

14. Use fees: Half of the users of high-country reservoirs would be willing to pay an average use fee of $2.00 for the privilege of enjoying the recreation experience at the reservoir.

Management Implications

1. Inasmuch as size has no significant effect on use, managers should disregard size when considering which reservoirs to manage for recreation.
2. Managers who provide day-use facilities will greatly increase reservoir use at their sites.
3. Paved access roads will greatly increase use.
4. Facilities are not necessary--in fact, are discouraged by users--at remote hike-in reservoirs.
5. Improved facilities will not generate increased fees.

Sub-objective 2. Social-psychological--To identify the management practices at high-country reservoirs which reflect a social-psychological profile of recreation users

In this section of the study, an investigation was undertaken to assess the anticipations and expectations of users prior to arrival at the reservoir sites; their satisfactions and attitudes when on-site; and their expressed desires for changes, if any.

1. Anticipations: Prior to visiting the reservoirs, most users anticipated a high-quality fishing experience as their first priority. When on site, most users become overwhelmingly scenic oriented.
2. Desires of users: Half of the users expressed no dislikes. Most who expressed wishes for changes wanted only minor improvements

such as improved sanitation and trash removal, control of bugs, and better weather.

3. Types of reservoir users: Four social-psychological types utilize the reservoirs: Those oriented primarily toward good facilities and easy access; those oriented toward good fishing and good facilities; those oriented toward solitude; and those oriented toward hiking and scenics.
4. Expectations and approval: Three-fourths of users had good expectations, and their approval increased as they experienced recreation on site. The high-country reservoirs, as is, are now providing an excellent recreational experience for a very large proportion of users.

Sub-objective 3. To identify the management practices necessary to meet the fishermen's desires at high-country reservoirs

In this section three groups of fishermen with significantly different desires are identified, profiles developed on them, and management practices recommended.

1. Groups of fishermen: Consumptive fishermen are those who believe it is important that each catches his limit of fish. Avid, non-consumptive fishermen are those who believe that fishing is the most important activity at the site but it is not necessary that each catch the limit. Casual, non-consumptive fishermen are those who believe that fishing is not the most important activity and also that it is not important to catch the limit.
2. Percentages: Only 14% of fishermen are consumptive; 52% avid; and 34% casual.
3. Ages: Casual fishermen are considerably younger than those in

the other two groups. Students comprise a good percentage of the casual group.

4. Length of use: Avid fishermen account for the largest day use, and casual fishermen spend the longest time at the reservoir.
5. Driving times: Casual fishermen spend the longest time driving to the sites--often over four hours.
6. Attitude toward catching fish: The majority of fishermen do not care if they catch a single fish. They are "non-consumptive." Consumptive fishermen are much more concerned about catching fish than those in other groups.
7. Expectations: Consumptive fishermen have much greater fishing expectations than the other two groups.
8. Aesthetic expectations: Non-consumptive fishermen had much higher aesthetic expectations than did consumptive fishermen.
9. Aesthetic realities on-site. Fishing likes drop while aesthetic likes drastically increase when the fishermen reach the reservoirs.
10. Relationships of expectations to fishing quality. Lowest expectations at best fishing reservoirs; highest expectations at poorest fishing reservoirs.
11. Expectations and types of reservoirs: Highest expectations at hike-in reservoirs.
12. Expectations of casual fishermen: Very low expectations.
13. Return visitation: Consumptive and avid--high incidence of return; casual--low incidence of return; consumptive--highest return rate at best fishing sites; casual--highest return at poor fishing reservoirs; avid--highest return at drive-in reservoirs.

14. Desired improvements: Most fishermen, regardless of group, desired no improvements. Consumptive wanted more stocking of fish. Only 4% of fishermen were willing to pay for improvements. Consumptive fishermen were most willing to pay; casual least willing to pay.
15. Size of fish: Fish size is important to all fishermen--most important to the consumptive group.
16. Stocking: The majority of all fishermen, regardless of group, favor yearly stocking.
17. Pay-fishing lakes: Less than one-third of all fishermen using the reservoirs are willing to use pay-fishing lakes.
18. Size of catch: Consumptive fishermen are most interested in number of fish caught.
19. Attitudes toward management practices: Casual fishermen are least interested in management practices.
20. Effect of drawdown: Fishermen, regardless of group, are generally unaffected by drawdown.

Management Recommendations

1. More easily accessible areas with excellent quality fishing should be made available to consumptive fishermen.
2. More sites with improved facilities and excellent fishing should be made available to consumptive fishermen. A few such sites would suffice, inasmuch as consumptive fishermen comprise only 14% of the total. These should be close to population centers, with driving times limited to two hours or less.
3. Day-use reservoirs with good fishing quality should be opened near centers of population to satisfy the needs of avid, non-consumptive fishermen.

4. Casual fishermen are in the majority at hike-in reservoirs. Inasmuch as they are primarily interested in aesthetics, those reservoirs do not need to be stocked. It is not worth managing any fishery for casual fishermen, and very little for avid fishermen.

Objective C

To study the actual potential of the reservoirs to provide a recreation fishery resource

In this section special attention has been placed upon water drawdowns as a determinant of fishery potential. The potential productivity and suitability of habitat for fisheries has been studied.

1. Suitability of habitat: All high-country reservoirs in this study are suitable habitat for game fish.
2. Limitations of production: Production limited by low fertility, short growing seasons, and water drawdown.
3. Drawdown effects: Drawdown results in low survival of spawn, less through flushing, increased winter kill, less and/or destruction of invertebrates. Size of fish populations is most affected be drawdown. Rates of growth and condition factors are not affected. Invertebrates are most affected. Abundance of benthic invertebrates can only be increased by limiting drawdown.
4. Proposed management practices: Best fishery most likely from stabilized reservoirs. Stabilization can easily be achieved on many reservoirs without loss to water users. Drawdown limits should be imposed where complete stabilization is impossible. Under present drawdown practices, a catchable fishery program is possible only through continued restocking.

5. Private owners' attitudes: There is little chance of increasing the fishery resource through opening closed reservoirs unless the objections of the owners can be overcome.
6. Reasons for closed reservoirs: Reasons cited by owners: major reason--safety hazards and liability; vandalism and littering in presently open reservoirs are causing moves to close them. Municipalities hold the greatest percentage of closed reservoirs and appear to be the best possibility for opening closed reservoirs.
7. Alternatives: (1) Alter the habitat; (2) Provide artificial fish-feeding program.

CONCLUSIONS

This research was undertaken to meet three major objectives:

Objective A--The description of the existing water reservoir situation and its potential for recreation was undertaken for two purposes: (1) to provide the background data needed to accomplish the other two objectives and Phase II; and (2) to make a data bank available to water resource managers for making informed decisions for recreation planning. The background data is complete and has already served its purpose in meeting Objectives B and C. Most data are now available to pursue Phase II of the research. The data base for management decisions is not yet complete. However, much of the inventory is completed and all available data will be reported in a few months in a special limited edition report through the Environmental Resources Center, Colorado State University.

Objective B--The identification of management practices necessary to meet the recreation user desires on high-country reservoirs was undertaken to develop a user profile which could be used to predict just what managers need to provide at reservoirs to meet the desires of the recreating public. The findings from this objective do, in fact, identify several sub-groups of recreation reservoir users who constitute the recreation user public at the high-country reservoirs.

Although much more analysis of these data will follow, and much greater details will be published in theses and journals, the original objective has already been met. The basic information on user behavior, expectations, satisfactions, and desires has been identified, and a definite set of management implications has been presented. From this, managers should be able to determine what facilities to provide, where to provide them, which reservoirs to open for various users, what use might be expected

if management practices are implemented, what type of access they need to provide, what users will pay for the recreation experience, and what type of fishery is needed.

Objective C--A study of the actual potential of the reservoirs to provide a recreation fishery resource was undertaken to: (1) provide specific physical, biological, and chemical data necessary to improve the recreation fishery on high-country reservoirs, thus meeting anticipated increased recreation fishing demand; and (2) demonstrate a case study for planning other resource studies of the reservoirs for further research.

The surprising finding from the fisherman profile indicating that most fishermen do not care if they catch a single fish definitely make the value of studying the reservoirs for an improved fishery questionable. However, since the fisherman profile data was not analyzed until after the fisheries data were collected, a full-scale analysis of the fishery was made.

This analysis was successful in providing pioneer data on reservoir fisheries at high-country reservoirs. Information is now available on just what fish exist in the reservoirs, which are surviving best, which are being affected by drawdown, how they are being affected, and many other questions important in sports fishery management. This information does provide new data for management and a base for further research in Phase II on ways of improving the fishery.

Overall, this research project has not only met its original objectives but has also pursued research questions well beyond its original scope. As is the case in most research, many questions have arisen from the findings which need further investigation. However, at this time a much better picture of high-country reservoir users and their desires for recreation is available. What is needed now is practical data on how close managers can come to meeting the user desires. This is being studied in Phase II of the

research which is evaluating the physical, legal, environmental, and political limitations and potentials for meeting the recreation user desires identified in Phase I.

The findings of this study have value for future research, some of which is already being pursued. Furthermore, new research ideas and proposals based on these findings are being generated in several disciplines.

Hopefully, managers will find the data equally as valuable. This project was undertaken with the manager in mind. The questions and objectives were generated with the help of managers, and the findings and implications are aimed at management practices. How close the project has come to providing practical answers for management decisions can only be seen in the future availability and development of high-country reservoirs for recreation.

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APPENDIX A

THESES AND REPORTS EMANATING FROM RESEARCH

Published:

Aukerman, Robert and William J. McLaughlin. 1974. Potential Water Recreation Opportunities at Municipal and Private Forest Mountain Reservoirs. Paper presented at 1974 Society of American Foresters National Convention at New York City, September, 1974.

Being Prepared for Publication:

Brad Buchner -- Perception

Scott Forssell -- Fisherman Profile

Peter Humm -- User Profile

Neal Lewis -- Behavior

Wespestad, Vidar. 1975. Effects of Water Drawdown on Fish in Mountain Reservoirs. Masters Thesis, Dept. of Fishery and Wildlife Biology, Colorado State University. (Presently being printed)

APPENDIX B

SURVEY QUESTIONNAIRE

INSTRUCTIONS

(1) Remember--it is important to be as fast and efficient as possible when you are surveying.

(2) Remember--0 = Refuse to Answer; 9 = Not Applicable

(3) Section II - Pink

The following questionnaire items have a negative loading: Developed resort facilities; camps for organizations; gravel roads; equipped bathing beaches, powerboating; private cottages; camping (with car); cutting Christmas tree; purchasing souvenirs; automobile touring; and campsites with plumbing.

All other items have a positive loading. The following scale represents the key to the numbers that should be placed in the boxes on the survey form.

Negative loaders	9	8	7	6	5	4	3	2	1
Survey scale	-4	-3	-2	-1	0	1	2	3	4
Positive loaders	1	2	3	4	5	6	7	8	9

Example: If a person being surveyed circles -1 of a negative loading item then a 6 is placed in the box to the left of the item on the survey form.

Note: If a person does not answer an item we assume he or she has neutral (0) feeling about that item.

(4) FOR QUESTION 51

Abbreviations for States

Alabama	AL	Kentucky	KY	Ohio	OH
Alaska	AK	Louisiana	LA	Oklahoma	OK
Arizona	AZ	Maine	ME	Oregon	OR
Arkansas	AR	Maryland	MD	Pennsylvania	PN
California	CA	Massachusetts	MA	Rhode Island	RI
Colorado	CO	Michigan	MI	South Carolina	SC
Connecticut	CT	Minnesota	MN	South Dakota	SD
Delaware	DE	Mississippi	MS	Tennessee	TN
District of Columbia	DC	Missouri	MO	Texas	TX
Florida	FL	Montana	MT	Utah	UT
Georgia	GA	Nebraska	NE	Vermont	VT
Hawaii	HI	Nevada	NV	Virginia	VA
Idaho	ID	New Hampshire	NH	Washington	WA
Illinois	IL	New Jersey	NJ	West Virginia	WV
Indiana	IN	New Mexico	NM	Wisconsin	WI
Iowa	IA	New York	NY	Wyoming	WY
Kansas	KS	North Carolina	NC		
		North Dakota	ND		

SECTION I

Code Column	Data	Information Section
1-3		1.) Case-Number between (001-999) fill in when key punching.
4	1	2.) Number of computer card (1,2,3,4,5) fill in when key punching.
5-6		3.) Reservoir--put corresponding number below in columns

Bellaire Lake	- 01	Bluebird Lake	- 14	Chicago Creek	- 27
Parvin Lake	- 02	Lawn Lake	- 15	Chinns	- 28
Dowdy Lake	- 03	Mary's Lake	- 16	Evergreen	- 29
West Lake	- 04	Lake Estes	- 17	Jefferson Lake	- 30
Chambers Lake	- 05	Brainard Lake	- 18	Manitou Park	- 31
Peterson Lake	- 06	Left Hand Park	- 19	Mt. Pisgah	- 32
Zimmerman Lake	- 07	Long Lake	- 20	(Wrights)	- 33
Pinewood Lake	- 88	Isabelle Lake	- 21	Skagway	- 34
Comanche	- 99	Barker Meadow	- 22	Deweese	- 35
Twin Lake	- 10	Jasper Lake	- 23	Lake Isabel	- 36
Red Deer Lake	- 11	Skyscraper	- 24	North Lake	- 37
Pear	- 12	Lower Urad	- 25	Monument	- 38
Sand Beach	- 13	Clear Creek	- 26		

		4.) Date:
7-8		Month - 2 - (NU)
9-10		Day - 2 - (NU)
11		Year - 1 - (NU) 1973 = 3, 1974 = 4
12		5.) Day Sunday = 1, Monday = 2, Tuesday = 3, Wednesday = 4, Thursday = 5, Friday = 6, Saturday = 7
13-15		6.) Average Men
16-18		7.) Average Women
19-21		8.) Average Child-under 16 } Average data collected at different times during one day
22		9.) Condition 1 Weather: Clear = 1, Cloudy = 2, Rain = 3, Snow = 4, Hot = 5, Warm = 6, Cold = 7, Windy = 8
23		Condition 2
24		Condition 3
		(place numbers best describing the weather conditions in columns; if only two conditions apply, place 9 in third box)
25-27		10.) No. Parties
28-30		11.) No. People Fishing - Women
31-33		12.) No. People Fishing - Men } Average data collected at different times during one day.
34-36		13.) No. People Fishing - Children (below 16)
37-40		14.) Time
41-42		15.) Inverviewer - your identification number

1	Art	5	Sharon	9	13
2	Chris R.	6	Garth	10	14
3	Judy	7	Deb	11	15
4	Diane	8	Bill	12	

SECTION II - 1

PLEASE GIVE YOUR IMMEDIATE REACTION TO THE FOLLOWING QUESTIONNAIRE ITEMS BY CIRCLING THE NUMBER THAT BEST DESCRIBES YOUR ATTITUDES.

Code Column	Data	Questionnaire Item	Strongly Dislike			Neutral			Strongly Favor		
43		Absence of people	-4	-3	-2	-1	0	1	2	3	4
44		Talking with tourists	-4	-3	-2	-1	0	1	2	3	4
45		Alpine meadows	-4	-3	-2	-1	0	1	2	3	4
46		Solitude	-4	-3	-2	-1	0	1	2	3	4
47		Awareness of beauty	-4	-3	-2	-1	0	1	2	3	4
48		Developed resort facilities	-4	-3	-2	-1	0	1	2	3	4
49		Sleeping outdoors	-4	-3	-2	-1	0	1	2	3	4
50		Lakes (natural)	-4	-3	-2	-1	0	1	2	3	4
51		Drinking mountain water	-4	-3	-2	-1	0	1	2	3	4
52		Vast area and enormous vistas	-4	-3	-2	-1	0	1	2	3	4
53		Virgin forest	-4	-3	-2	-1	0	1	2	3	4
54		Native wild animals	-4	-3	-2	-1	0	1	2	3	4
55		Hiking	-4	-3	-2	-1	0	1	2	3	4
56		Looking at scenery	-4	-3	-2	-1	0	1	2	3	4
57		Camps for organizations	-4	-3	-2	-1	0	1	2	3	4
58		Absence of manmade features	-4	-3	-2	-1	0	1	2	3	4
59		Gravel roads	-4	-3	-2	-1	0	1	2	3	4
60		Equipped bathing beaches	-4	-3	-2	-1	0	1	2	3	4
61		Timberline vegetation	-4	-3	-2	-1	0	1	2	3	4
62		Enjoyment of nature	-4	-3	-2	-1	0	1	2	3	4
63		Powerboating	-4	-3	-2	-1	0	1	2	3	4
64		Emotional satisfaction	-4	-3	-2	-1	0	1	2	3	4
65		Private cottages	-4	-3	-2	-1	0	1	2	3	4
66		Rugged topography	-4	-3	-2	-1	0	1	2	3	4
67		Camping (with car)	-4	-3	-2	-1	0	1	2	3	4
68		Cutting Christmas tree	-4	-3	-2	-1	0	1	2	3	4
69		Purchasing souvenirs	-4	-3	-2	-1	0	1	2	3	4
70		Physical exercise	-4	-3	-2	-1	0	1	2	3	4
71		Tranquility	-4	-3	-2	-1	0	1	2	3	4
72		Automobile touring	-4	-3	-2	-1	0	1	2	3	4
73		Camping (Backpacking)	-4	-3	-2	-1	0	1	2	3	4
74		Campsites with plumbing	-4	-3	-2	-1	0	1	2	3	4

SECTION II - 2

Code Column	Data	PLEASE CIRCLE THE APPROPRIATE ANSWER.
75		1.) Do you ever fish? Yes - 1 No - 0 If Yes, please answer questions 2 through 20. If No, please start with question 16.
76		2.) Do you tie your own flies? Yes - 1 No - 0
77		3.) Do you purchase a fishing license yearly? Yes - 1 No - 0
78		4.) Do you seek information about where fishing is good in general? Yes - 1 No - 0
79		5.) Did you seek information about fishing at this reservoir? Yes - 1 No - 0
80		6.) How frequently do you fish during the summer? 1 - twice a week or more 2 - once a week 3 - twice a month 4 - once a month 5 - less than once a month
Case 1-3		
Card 4	2	
5		7.) a. Do you fish for particular species? Yes - 1 No - 0
6-7		If Yes b. What species? _____ 01 - Brook Trout 07 - Northern Pike 13 - Largemouth Bass 02 - Brown Trout 88 - Walleye Pike 14 - Smallmouth Bass 03 - Lake Trout 99 - Perch 15 - Other 04 - Native Trout 10 - Crappie 16 - Trout 05 - Rainbow Trout 11 - Channel Catfish 17 - Bass 06 - Kokanee Salmon 12 - White Bass
8		8.) a. Is fish size important to you? Yes - 1 No - 0
9		b. If Yes, what size do you prefer? 1 - Less than 8 inches 4 - 12 to 15 inches 2 - 8 to 10 inches 5 - greater than 15 inches 3 - 10 to 12 inches
10		9.) Is is important that you catch your limit? Yes - 1 No - 0
11		10.) Do you consider a fishing trip a waste of time and/or a big disappointment if you don't catch fish? Yes - 1 No - 0
12		11.) Rate your fishing skill by circling the appropriate number. 5 4 3 2 1 Excellent Average Poor
13		12.) Do you have more than one Rod and Reel for fishing? Yes - 1 No - 0

SECTION II - 3

Code Column	Data	
14		13.) Do you receive or regularly read a magazine or publication of any type about fishing? Yes - 1 No - 0
15		14.) Should all waters be stocked yearly? Yes - 1 No - 0
16		15.) Would you use a pay fishing lake? Yes - 1 No - 0
17		16.) Sex 1 - Male 2 - Female
18-19		17.) What is your age? 01 - 15 to 19 years 02 - 20 to 24 years 03 - 25 to 29 years 04 - 30 to 34 years 05 - 35 to 39 years 06 - 40 to 44 years 07 - 45 to 49 years 33 - 50 to 54 years 99 - 55 to 59 years 10 - 60 to 64 years 11 - 65 and over
20-21		18.) What is your occupation? 01 - Housewife 02 - Student 03 - Unemployed 04 - Retired 05 - Farmer, farm manager, farm labor 06 - Operative and non-skilled laborer (except farm) 07 - Skilled craftsman, foreman 88 - Sales worker 10 - Clerical worker 11 - Manager, official, proprietary 12 - Professional 13 - Disabled or handicapped 14 - Other (specify) _____
22		19.) What is your family income? 1 - under $3,000 2 - $3,000 - $5,999 3 - $6,000 - $9,999 4 - $10,000 - $14,999 5 - $15,000 - $19,999 6 - $20,000 - $24,999 7 - Over $25,000
23		20.) a. Are you here alone or with a group? 1 - Alone 2 - Group (If group, answer b)
24		b. (If Group) 1 - A formal group (Boy Scouts, Hiking Club, etc.) 2 - Family group 3 - Informal group (friends)

SECTION III

Code Column	Data
25	1.) How did you find out about this particular site? 1 - Heard about it from a friend (fill in ques. 2 & 3 Hear About) 2 - Read about it somewhere (fill in questions 2 & 3 Read About) 3 - Random choice (fill in questions 2 & 3 Expect to Find) 4 - Don't know (Skip questions 2, 3, 4, 5, 6) 5 - Other _____
26-27 28-29	2.) What specific things did you _____ that you liked? (list likes and fill them in numbered blanks in question 5 box) 1. 2. OPEN

"Likes"

01 - campsites available at reservoir	21 - natural
02 - fishing*	22 - size
03 - stocked well	23 - clean restrooms
04 - convenient	24 - restrooms
05 - uncrowded	25 - few bugs
06 - quiet, peaceful	26 - drive-in site
07 - solitude, privacy	27 - can use off-road vehicle
88 - scenery*	28 - none
99 - trees	29 - other
10 - lake	30 - mountain air (altitude)
11 - mountains	31 - drinking water (available)
12 - clean area	32 - reservoir water is clean
13 - hiking trails	33 - free
14 - wildlife	34 - boating
15 - swimming	35 - everything
16 - easy access	
17 - remote, wild, wilderness	
18 - easy hike	
19 - grassy shoreline	
20 - family area	

Code Column	Data
30-31 32-33	3.) What specific things did you _____ that you disliked? (list dislikes and fill them in numbered blanks in question 6 box) 1. 2. OPEN

"Dislikes"

01 - no fires	14 - trash
02 - poor fishing	15 - paying a fee to camp
03 - water impure or dirty	16 - poorly marked trail or road
04 - dead trees along edge	17 - man-made objects
05 - no drinking water	18 - dam
06 - terrible road	19 - can't camp at site
07 - weather (windy, rainy, etc.)	20 - could not drive to lake
88 - too many people	21 - poor sanitation facilities
99 - not patrolled, supervised, or managed	22 - none
10 - no swimming	23 - bugs
11 - fishing snags	24 - other
12 - poor facilities	25 - boats
13 - off-road vehicles in area	

SECTION III - 2

Code Column	Data	
34		4.) Overall did you expect to find a place you: 3 - liked a great deal; 2 - liked moderately; 1 - felt neutral about?
35 36 37 38		5.) a. Did you expect the presence/absence of (numbered item in box) at this site to add to your visit and experience: Greatly Moderately Very Little
39 40		b. Does it personally matter to you that site (is/is not, has/does not have) (numbered item in box)? No Yes
		(If yes) c. Do you sometimes decide to go to a similar site or would you return to this one because of (numbered item in box)? No Yes
41 42 43 44		6.) a. Did you expect the presence/absence of (numbered item in box) at this site to subtract from your visit and experience: Greatly Moderately Very Little
45 46		b. Does it personally matter to you that site (is/is not, has/does not have) (numbered item in box)? Yes No
		(If yes) c. Do you sometimes decide not to go to similar site or would not not return to this one because of (numbered item in box)? Yes No
47 48		7.) a. Is this a return visit? 1 = Yes 0 = No (If yes) b. How often do you visit this site during the summer? 1 = 1 or 2 times 2 = 3 or 4 times 3 = more than 4 times
49 50		8.) What special equipment, if any, did you bring? A - Fishing Gear D - Boat G - Camping Gear B - Hiking Boots E - Motorcycle H - Backpacking Gear C - Camera F - Jeep I - None J - Other
51		9.) a. Does this reservoir meet your expectations? 0 = No 1 = Yes

Fill in likes from question #2. 1.____ 2.____	(35)	(38)
Greatly	3	3
Moderately	2	2
Very Little	1	1
	(36)	(39)
No	0	0
Yes	1	1
	(37)	(40)
No	0	0
Yes	1	1

Fill in dislikes from question #5. 1.____ 2.____	(41)	(44)
Greatly	3	3
Moderately	2	2
Very Little	1	1
	(42)	(45)
Yes	0	0
No	1	1
	(43)	(46)
Yes	0	0
No	1	1

SECTION III - 3

Code Column	Data	
52		10.) Are you camping: 1 - under the stars; 2 - in a tent; 3 - in a trailer; 4 - not at all, on this trip?
53		11.) How often during the summer do you visit reservoirs like this one? 1 - once a week 2 - once a month 3 - twice a month 4 - once or twice during the summer 5 - other _____ (Summer defined May-Sept.)
54		12.) How often do you visit these reservoirs during the rest of year? 1 - once a week 2 - once a month 3 - twice a month 4 - once or twice during rest of year 5 - not at all 6 - Other _____ (Rest of year defined Oct.-April)
55-56		13.) What activities did you participate in today? (Can list up to six) 01 - Camping 02 - Fishing 03 - Hiking 04 - Picnicking 05 - Sightseeing 06 - Swimming 07 - Animal Hunting 88 - Boating 10 - Off-road vehicles 11 - Relaxing 12 - Photography 13 - None 14 - Other _____
57-58		
59-60		
61-62		
63-64		
65-66		
67-68		14.) Which of these activities is most important to you? _____ (fill in activity in blank space in question #16)
69-70		15.) Which of these activities is second most important to you? _____
71		16.) What amount of your time other than sleeping and eating will you spend (activity in 14) during this visit? 1 - none of your time 2 - 1/4 of your time 3 - 1/2 of your time 4 - 3/4 of your time 5 - all of your time
72		17.) How long will you spend at this reservoir? 1 - single day 2 - weekend 3 - longer
73		18.) a. Is this the amount of time you usually spend? 1 - yes 0 - no (If no)
74		19.) b. How much time do you usually spend? 1 - single day 2 - weekend 3 - longer
75		
76		
77		
78		
79		
80		
CASE 1-3		
CARD 4	3	
5		
6		
7		

** Are you willing to hike ___ mile(s) into a Reservoir just to ____?

		1 Mile		5 Miles	
Camp	75	1 - Yes 0 - No	76	1 - Yes	0 - No
Fish	77	1 - Yes 0 - No	78	1 - Yes	0 - No
Picnic	79	1 - Yes 0 - No	80	1 - Yes	0 - No
Sightsee	5	1 - Yes 0 - No	6	1 - Yes	0 - No

** (SAMPLE: Are you willing to hike 1 mile to Camp? Are you willing to hike 5 miles to Camp? Are you willing to hike 1 mile to Fish? etc.)

20.) If you could not camp next to the water would you still use this site? 0 - No 1 - Yes

SECTION III - 4

Code Column	Data	
8-9		21.) Now that you are at this reservoir site, what do you specifically like about it? (List likes and fill them in numbers one and two blanks in question #25 box)
10-11		1. 2. OPEN

"Likes"

01 - campsites available at reservoir
02 - fishing
03 - stocked well
04 - convenient
05 - uncrowded
06 - quiet, peaceful
07 - solitude, privacy
88 - scenery
89 - scenery
10 - lake
11 - mountains
12 - clean area
13 - hiking trails
14 - wildlife
15 - swimming
16 - easy access
17 - remote, wild, wilderness
18 - easy hike
19 - grassy shoreline
20 - family area
21 - natural
22 - size
23 - clean restrooms
24 - restrooms
25 - few bugs
26 - drive-in site
27 - can use off-road vehicle
28 - none
29 - other
30 - mountain air (altitude)
31 - drinking water (available)
32 - reservoir water is clean
33 - free
34 - boating
35 - everything

12-13		22.) Now that you are at this reservoir site, what do you specifically dislike about it? (List dislikes and fill them in numbers one and two blanks in question #26 bos)
14-15		1. 2. OPEN

"Dislikes"

01 - no fires
02 - poor fishing
03 - water impore or dirty
04 - dead trees along edge
05 - no drinking water
06 - terrible road
07 - weather (windy, rainy, etc.)
88 - too many people
89 - not patrolled, supervised, or managed
10 - no swimming
11 - fishing snags
12 - poor facilities
13 - off-road vehicles in area
14 - trash
15 - paying a fee to camp
16 - poorly marked trail or road
17 - man-made objects
18 - dam
19 - can't camp at site
20 - could not drive to lake
21 - poor sanitation facilities
22 - none
23 - bugs
24 - other
25 - boats

SECTION III - 5

Code Column	Data	
16		23.) a. Does the presence/absence of (numbered item in box) at this reservoir add to your visit and experience here?
17		
18		Greatly
19		Moderately
		Very Little
20		b. Does it personally matter to you that a reservoir (is/is not, has/
21		does not have) (numbered item in box)?
		No
		Yes
		(If yes)
		c. Do you sometimes decide to go to a similar reservoir or would you return to this one because of (numbered item in box)?
		No
		Yes
22		24.) a. Does the presence/absence of (numbered item in box) at this
23		reservoir subtract from your visit and experience here?
24		Greatly
25		Moderately
		Very Little
26		b. Does it personally matter to you
27		that this reservoir (is/is not, has/does not have) (numbered item in box)?
		No
		Yes
		(If yes)
		c. Do you sometimes decide not to go to a similar reservoir or would you not return to this one because of (numbered item in box)?
		No
		Yes
28		25.) How would you rate this reservoir:
		5 - like it a great deal
		4 - like it moderately
		3 - feel neutral about it
		2 - dislike moderately
		1 - dislike a great deal
29		26.) Which of the following had the most influence upon your decision to come to this reservoir?
		1 - Short travel time to get here
		2 - The fishing
		3 - The scenery you see
		4 - Because it's clean
		5 - Because of the peace and quiet

Fill in likes from Question #21. 1.____ 2.____		
	(16)	(19)
Greatly	3	3
Moderately	2	2
Very Little	1	1
	(17)	(20)
No	0	0
Yes	1	1
	(18)	(21)
No	0	0
Yes	1	1

Fill in dislikes from Question #22. 1.____ 2.____		
	(22)	(25)
Greatly	3	3
Moderately	2	2
Very Little	1	1
	(23)	(26)
No	0	0
Yes	1	1
	(24)	(27)
No	0	0
Yes	1	1

SECTION III - 6

Code Column	Data	
30		27.) Have you ever experienced noticeable changes in the water level at a high mountain reservoir like this one? 0 - No 1 - Yes
		If Yes, Ask questions b and c.
31		b. The time that you experienced drawdoen how did it affect you? 1 - left the site 2 - stayed at the site 3 - no effect
		c. What are the effects of drawdown you noticed most? 1. 2. OPEN
32-33		
34-35		

"Effects of drawdown"

01 - mud on shore	10 - way it looks
02 - fish die	11 - fishing not as good
03 - size of fish	12 - more flies and bugs
04 - lack of water	13 - more snags
05 - better fishing	14 - lack of campers and fishermen
06 - bad smell	15 - none
07 - no area to stand or sit	16 - other
88 - camp close to water	17 - trash
99 - ugly (lack of natural beauty	

(GIVE SCALE CARD)

Please rate the following items as to their importance or unimportance in the scenery that surrounds you. I'll read you the item and you give me the number that corresponds to your feeling about that item.

36		36.) Mountains and ridges
37		37.) Lakes and reservoirs
38		38.) Human impact (roads, trails, campgrounds, summer homes)
39		39.) Open spaces
40		40.) Trees, flowers, and grass
41		41.) Streams and rivers

NO IMPORTANCE	OF LITTLE IMPORTANCE	VERY IMPORTANT	EXTREMELY IMPORTANT
1	2	3	4

SECTION III - 7

de Column	Data	
		Using the same scale: I'll read you some dimensions that might be important to the scenery around you. Give me the number that represents how important or unimportant that dimension is when you look at scenery.
42		42.) Shapes
43		43.) Color
44		44.) Uniqueness to the area
45		45.) Number of different things to look at
46		46.) Edges or layers--Example: where you can draw a line between the sky and a mountain or the sky and trees in a scene.
47		47.) How much time in hours did it take you to get to this reservoir today? 1 - less than 1 hour 2 - 1 - 1 3/4 hours 3 - 2 - 2 3/4 hours 4 - 3 - 3 3/4 hours 5 - greater than 4 hours
48		How much of a user fee would you be willing to pay to use this site as is? 1 - $1 or $2 a day 2 - $3 or $4 a day 3 - $5 or $6 a day 4 - None 5 - Other
		48.) What specific additions or improvements would you like to see at or around this reservoir?
49-50		1. _____ (Fill in the phrase - with your desired improvements - in the blank in questions 49 and 50.)
51-52		2. _____
53		3. None (Fill in question 49 blank with the phrase - like this one - skip question 50 and put number 1 in space 53.)

OPEN

"Improvements"

01 - none (column 53 only)
02 - sanitation improvements
03 - showers
04 - cleaner restrooms
05 - drinking water
06 - picnic tables
07 - wood available
08 - improve road
09 - trash cans
10 - grills for cooking
11 - paved roads
12 - more parking area
13 - level banks
14 - more trees
15 - cleaner water in reservoir
16 - stock more often
17 - stock larger fish
18 - more play area
19 - stock
20 - keep motor vehicles out
21 - more trails for off-road vehicles
22 - boat ramp
23 - keep area clean
24 - better management
25 - better camping facilities
26 - drive-in camping facilities hookups
27 - campsites further apart
28 - other
29 - more campsites
30 - flies and lures only

SECT III - 8

Code Column	Data	
54		49.) If you had the same amount of time to spend as you do on this visit, how much more time in hours would you be willing to travel to a reservoir _____? 1 - 1/2 hour more 2 - 1 hour more 3 - 1 1/2 hours more 4 - 2 hours more 5 - more than 2 hours more 6 - None
55		50.) How much of a user fee would you be willing to pay to use a site where _____ existed? 1 - $1 or $2 a day 2 - $3 or $4 a day 3 - $5 or $6 a day 4 - None 5 - Other
56-63		51.) If they are willing to further participate in this study at a later date, print their name and address below. If they are not interested in participating, get the following data: city, state, and zip code. Name _____ First (M.I.) Last
56-65		Address _____
64-65		_____ City (56-63) State (64-65) Zip
66		52.) Did you leave (City in Question 51) to come to this reservoir? 0 - No 1 - Yes
67-80		(If No) Where were you before you came here?

Code Column	Data	SPECIAL FOR CARD NUMBER FOUR.
5-16		First name
17		Middle Initial
18-32		Last Name
33-51		Street Number and Name
52-56		St., Blvd., R.R., Rd., Pl., Ct., Ave.
57-70		City
71-75		State
76-80		Zip Code

Code Column	Data
SECTION I	
1-3	
4	
5-6	
7-8	
9-10	
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13-15	
16-18	
19-21	
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25-27	
28-30	
31-33	
34-36	
37-40	
41-42	
SECTION II	
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Code Column	Data
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Page 2	
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Case 1-3	
Card 4	2
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6-7	
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Code Column	Data
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Page 3	
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SECTION III	
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32-33	
Page 2	
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Code Column	Data
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Page 3	
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55-56	
57-58	
59-60	
61-62	
63-64	
65-66	
67-68	
69-70	
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Case 1-3	
Card 4	
5	
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Code Column	Data
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Page 4	
8-9	
10-11	
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14-15	
Page 5	
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Page 6	
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32-33	
34-35	
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Code Column	Data
Page 7	
42	
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48	
49-50	
51-52	
53	
Page 8	
54	
55	
56-63	
56-63	
64-65	
66	
67-80	
SPECIAL	
Code Column	Data
5-16	
17	
18-32	
33-51	
52-56	
57-70	
71-75	
76-80	

Name _____
First (M.I.) Last

Address _____

City (56-63) State (64-65) Zip