

**ECONOMIC VALUE OF BENEFITS
FROM RECREATION AT
HIGH MOUNTAIN RESERVOIRS**

by

**Richard G. Walsh
Robert Aukerman
Dean Rud**

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SUMMARY REPORT

ECONOMIC VALUE OF BENEFITS FROM RECREATION
AT HIGH MOUNTAIN RESERVOIRS

By

Richard G. Walsh, Professor of Economics
Colorado State University

Robert Aukerman, Professor of Recreation Resources
Colorado State University

Dean Rud, Graduate Assistant, Economics
Colorado State University

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Colorado State University
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ECONOMIC VALUE OF BENEFITS FROM RECREATION
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Richard G. Walsh, Robert Aukerman, and Dean Rud^{1/}

Rapid population growth along the Front Range of Colorado exerts increased pressure on the state's natural resources, degrading existing water recreation areas and diminishing the value of water recreation activities. Economic information is needed to assess the feasibility of expanding recreation opportunities on high mountain reservoirs which are now closed to public use. Until recently, more than 100 reservoirs were closed, with 3,500 surface acres representing 40 percent of the total surface area of reservoirs at 6,000 to 11,000 feet elevation on the Front Range of Colorado (Auckerman, Springer and Judge, 1977). In the future, these small reservoirs of 10 to 400 acres in size may be able to satisfy uses for water-based recreation while continuing to serve other uses, such as storage for irrigation and domestic water supply.

The recreation benefits found in this study can be compared to the costs of developing and managing recreation facilities along with legal, environmental and institutional considerations to assess the feasibility of expanding recreation opportunities on high mountain reservoirs. Results may be useful to the state legislature when it makes appropriation decisions, such as whether to lease or buy access and minimum pools in high mountain reservoirs. Results may be useful

^{1/}Dr. Walsh is Professor of Economics, Dr. Aukerman is Associate Professor of Recreation Resources and Mr. Rud is a graduate research assistant in the Department of Economics, Colorado State University, Fort Collins.

to state and local agencies having responsibility for water resource management under existing legislation. Ditch and reservoir owners may find the information useful in deciding whether to open reservoirs for public use.

Research Procedure

This study developed and applied a procedure for measuring recreation benefits of high mountain reservoirs. Two hundred people were interviewed at 12 high mountain reservoir sites on the Front Range of Colorado during the summer of 1978. The 12 study sites represented the range in size from 10 to 400 acres and other characteristics such as road or trail access and facilities, typical of reservoirs located at 6,000 to 11,000 feet elevation along the Front Range of Colorado. For comparison, 40 boaters were interviewed at two reservoirs located in the foothills of the Front Range at 5,000 to 6,000 feet elevation. Study sites are shown on Figure 1 and their characteristics in Table 1.

Each recreation participant was asked for an estimate of his or her direct out-of-pocket costs in making the trip. Direct costs associated with the activities were identified easily. This was followed by a surplus value question, which asked respondents to consider the maximum worth of their recreation experience, defined as the increase in total trip expenses above which they would decide not to participate, given water level and crowding level as they existed on the day of the interview.

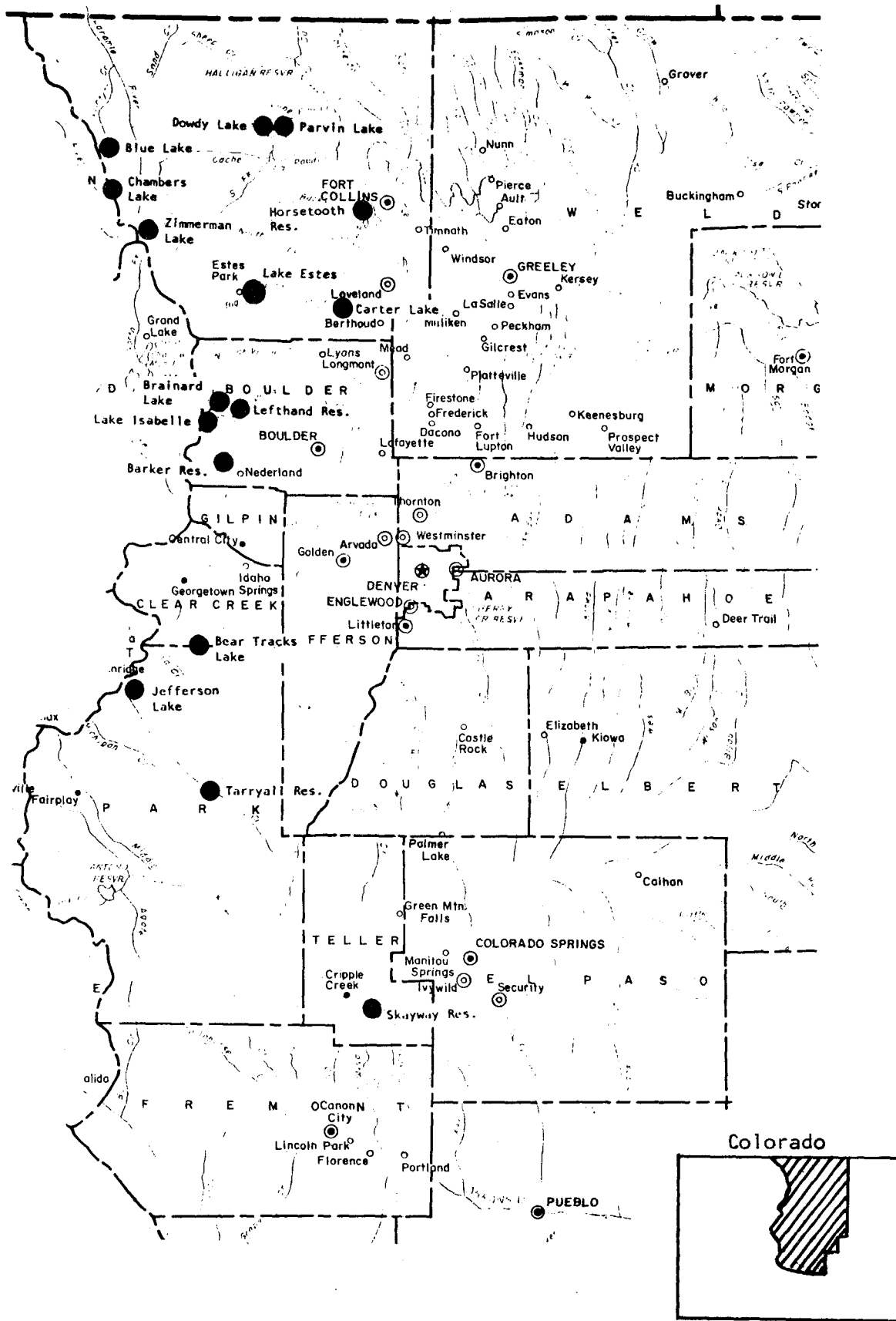


Figure 1 . Location of the Study Sites, High Mountain Reservoirs, Colorado, Summer, 1978.

Table 1. Number of Persons Interviewed, Size, Storage Capacity, Shoreline Miles, and Annual Recreation Use, 12 High Mountain Reservoirs, Colorado, 1978.

Recreation Site	Number of Interviews	Surface Acres	Storage Capacity, Acre Feet	Shoreline Miles	Annual Number of User Days, 1976
High Mountain Reservoirs					
Small, 1-50 acres					
Bear Tracks Lake	4	15			
Blue Lake	13	17			
Brainaird Lake	7	16			
Lake Isabelle	10	36	594		
Zimmerman Lake	5	19	193		
Medium, 51-150 acres					
Dowdy Lake	18	115	13,222		
Jefferson Lake	18	115	1,720		
Lefthand Reservoir	38	101	1,534		
Parvin Lake	14	64	900		
Skagway Reservoir	17	115	3,678		
Large, 151-400 acres					
Barker Reservoir	15	380	12,125		
Chambers Lake	26	282	8,824		
Lake Estes	14	185	3,000		
Tarryall Reservoir	14	175	13,135		
Low Mountain Reservoirs					
Over 400 acres					
Carter Lake	22		133,500		266,995
Horsetooth Reservoir	18	1,899	143,500		214,730

Maximum reservoir water level was determined by clearly observed water lines showing maximum bankful conditions. Interviewers estimated, in percentage terms, how water level the day of the interview compared to maximum bankful conditions. Then, respondents were asked to estimate how their participation and value would change with changes in the current water level to five threshold levels: 100, 75, 50, 25 and zero percent of maximum bankful. Thus, respondents were asked to consider each of these water levels as unique recreation resources, with the expectation that each would have a distinct demand.

Types of Recreation Activities

Table 2 shows the types of recreation activities at high mountain reservoirs. The primary activity during the summer of 1978 was fishing, which accounted for two-thirds of total time at the reservoir sites. This was particularly true for medium-sized and large-sized reservoirs with road access. Fishing accounted for 36 percent of total time at small reservoirs with trail access only. Fishermen reported that 7.2 percent of their time at the study sites was devoted to recreation vehicle camping and 6.9 percent to tent camping. On large-sized reservoirs, RV camping was more important where it accounted for 11.5 percent of total time. Tent camping was more important on small walk-in reservoirs where it accounted for 18.2 percent of total time. Backpacking was also an important activity at small reservoirs where it accounted for 17.9 percent of total time. Hiking accounted for 8.1 percent of total time at small reservoirs but represented only about 3 percent of total time at all high mountain reservoirs. Inactivity accounted for 5.4 percent of the

Table 2 . Types of Recreation Activities Reported at High Mountain Reservoirs, Colorado, 1978.

Recreation Site	Sample Size	Percent of Time at This Site															
		Camp- ing (RV)	Camp- ing (Tent)	Fish- ing	Hiking	Back- pack- ing	Sight- seeing	Picnick- ing	Swim- ing	Canoe- ing, Rafting	Off- Road Vehicle	Relax- ing	Photo- graphy	Hunt- ing	Power Boat- ing	Sail- Boating	Other
High Mountain Reservoirs																	
Small, 1-50 acres	37	2.11	18.16	36.24	8.05	17.89	1.89	.27	.27	0.00	.41	5.68	5.35	1.08	0.00	0.00	2.30
Medium, 51-150 acres	101	6.54	5.50	76.44	1.83	.15	1.29	.50	.35	.80	0.00	5.15	.45	0.00	.50	.30	0.00
Large, 151-400 acres	62	11.45	2.50	69.44	1.69	1.21	1.58	2.15	0.00	.57	0.00	5.55	.48	0.00	2.58	.81	0.00
TOTAL	200	7.24	6.91	66.83	2.94	3.79	1.49	.97	.23	.58	.08	5.37	1.36	.20	1.05	.40	.43
Low Mountain Reservoirs																	
Over 400 acres	39	4.90	.77	6.28	.26	0.00	0.00	2.77	2.39	0.00	.56	10.87	2.08	0.00	38.18	7.80	22.87

total time at high mountain reservoirs. Photography accounted for about 5.4 percent of the total time at small high mountain reservoirs but accounted for one-tenth that (0.5 percent) on medium-sized and large-sized reservoirs. Power boating was limited to large high mountain reservoirs where it accounted for only 2.6 percent of total time. Sailing, canoeing and rafting were unimportant, accounting for about 0.5 percent of total time. Sightseeing accounted for 1.5 percent of the time at study sites, but driving off-road vehicles accounted for less than 0.1 percent of total time. Picnicking was important at the larger reservoirs where it accounted for 2.2 percent of total time.

Economic Value of Recreation Benefits

Table 3 shows that the value per day of recreation at high mountain reservoirs would increase by \$0.34 for each 1 percent increase in water level and peak at \$34 with 100 percent bankfull. Participation in recreation activities at the study sites would increase by .067 days per participant for each 1 percent increase in water level and peak at 6.65 days annually with 100 percent bankfull.

Table 4 shows that the average price of recreation at high mountain reservoirs was \$15 per day. This is the direct out-of-pocket cost of round trip mileage of 326 miles, equivalent to 4.6 cents per mile. This was considerably less than the price of fishing on West Slope streams where the average price was \$25 per day in 1978 (Walsh, Ericson and Arosteguy, 1978). It is comparable to the average direct costs of \$10 per day reported by resident Colorado fishermen

Table 3 . Effect of Water Level on Willingness to Pay to Participate in Recreation Activities at High Mountain Reservoirs, Colorado, 1978.

Recreation Site	Sample Size	Percent of Maximum Bankful Water Level				
		100	75	50	25	00
- - - - Dollars per Day - - - - -						
High Mountain Reservoirs						
Small, 1-50 acres	37	\$33.54	\$35.05	\$22.24	\$9.46	\$1.54
Medium, 51-150 acres	101	27.61	22.59	12.47	2.54	.16
Large, 151-400 acres	62	44.83	38.88	29.37	7.98	.03
TOTAL	200	34.05	29.95	19.52	5.51	.19
Low Mountain Reservoirs						
Over 400 acres	39	69.46	57.54	43.24	13.41	0

Table 4 . Miles Traveled, Direct Cost per Trip and Per Day at Site, with Consumer Surplus per Day of Participation in Recreation Activities at High Mountain Reservoirs, Colorado, 1978.

Recreation Site	Sample Size	Average One-Way Miles Traveled on This Trip	Average Direct Out-of-Pocket Cost for This Trip		Average Consumer Surplus Above Trip Cost per Day	Average Total Willingness to Pay per Day	Consumer Benefit/ Cost Ratio
			Total Cost of Trip	Cost Per Day			
High Mountain Reservoirs							
Small, 1-50 acres	37	254.04	\$56.35	\$14.85	\$17.34	\$32.19	2.17
Medium, 51-150 acres	101	145.68	28.98	14.05	10.60	24.65	1.75
Large, 151-400 acres	62	136.15	43.98	17.14	20.73	37.87	2.21
TOTAL	200	162.77	38.69	15.16	14.99	30.15	1.99
Low Mountain Reservoirs							
Over 400 acres	39	48.15	62.18	37.04	15.88	52.92	1.43

in 1973, with inflation averaging about 10 percent annually over the past five years (Ross, Blood and Nobe, 1975).

Total benefits include both the price actually paid plus willingness to pay, which is the area under the demand curve for the activity. This consumer surplus of fishing at high mountain reservoirs averaged \$15 per day. When added to direct costs of \$15 per day, total benefits were \$30 per day. The consumer benefit/cost ratio for fishing at high mountain reservoirs was 2.0 ($= \$30/\15) compared to stream fishing with a ratio of 1.6 ($= \$40/\25). Boating on low mountain reservoirs was more expensive with a B/C ratio of 1.4 ($= \$53/\37). These B/C ratios were calculated with total benefits as the numerator and direct trip cost as the denominator.

Optimum Capacity of Reservoir Recreation

Indications are that high mountain reservoirs are used to capacity. Reserve recreation capacity of only about one person per activity day existed at the study sites in the summer of 1978. Table 5 shows this as the difference between optimum number of encounters (An encounter was defined as one person within 50 yards of the respondent.) calculated as 15.0 persons and the 13.9 persons encountered on the day of the interview. Optimum capacity was defined as the number of parties encountered which would maximize the total value of recreation activity on the reservoir. This occurs at the point where the added costs of congestion to existing users just equals the benefits gained by the additional user. This was calculated from the value data shown on Tables 5 and 6.

Table 5 . Hours on the Reservoir and Number of Other Parties Encountered Per Activity Day, With Optimum Capacity for Maximum Total Value, the Number Preferred for Maximum Enjoyment, and the Maximum Number Tolerated Before Discontinuing Participation in Recreation Activities at High Mountain Reservoirs, Colorado, 1978.

Recreation Site	Sample Size	Hours on Reservoir Per Activity Day	Number of Other Parties Encountered Per Activity Day at this Site				Optimum Capacity for Maximum Total Value
			The Day of Interview	Most Preferred For Maximum Enjoyment of Activity	Maximum Tolerated Before Discontinuing Activity	Optimum Capacity for Maximum Total Value	
High Mountain Reservoirs							
Small, 1-50 acres	37	5.35	8.00	3.36	17.11	9.0	
Medium, 51-150 acres	101	6.19	15.93	7.24	28.39	12.0	
Large, 151-400 acres	62	6.26	14.19	12.13	31.37	19.0	
TOTAL	200	6.06	13.92	8.04	27.23	15.0	
Low Mountain Reservoirs							
Over 400 acres	39	9.33	46.64	35.74	61.13	23.0	

Table 6 . Effect of Number of Other Parties Encountered Per Activity Day on Willingness to Pay to Participate in Recreation Activities at High Mountain Reservoirs, Colorado, 1978.

Recreation Site	Sample Size	Number of Other Parties Encountered per Activity Day														
		0	5	10	15	20	25	30	35	40	45	50	55	60	65	
----- Dollars per Day -----																
High Mountain Reservoirs																
Small, 1-50 acres	37	\$48.82	\$40.04	\$29.73	\$11.79	0	0	0	0	0	0	0	0	0	0	0
Medium, 51-150 acres	101	35.98	33.44	29.08	23.39	\$17.70	\$7.75	0	0	0	0	0	0	0	0	0
Large, 151-400 acres	62	56.54	55.06	52.29	47.93	40.78	28.72	\$6.30	0	0	0	0	0	0	0	0
TOTAL	200	44.73	41.87	39.50	35.07	24.49	7.78	0	0	0	0	0	0	0	0	0
Low Mountain Reservoirs																
Over 400 acres	39	66.71	63.98	61.26	58.54	55.09	51.60	48.11	\$43.80	\$39.40	\$35.00	\$24.95	\$13.74	\$2.53	0	0

Reservoir users reported they would prefer to encounter 8.0 persons on the reservoir during an activity day, or 5.9 persons fewer than the 13.9 persons encountered on the day of the interview. The maximum number they would tolerate before discontinuing the activity was 27.2 persons. Optimum carrying capacity which would maximize the total value of the recreation activity at the reservoirs was calculated as 15 persons per day, or nearly double the most preferred number of encounters. However, optimum carrying capacity was about one-half of the maximum number of encounters users would tolerate before discontinuing the activity at the study sites.

Characteristics of Recreation Users

Table 7 shows some of the characteristics of participants in recreation activities at high mountain reservoirs. Average annual income was reported as about \$19,000, compared to average income of households in the state of \$13,600 in 1976, the latest year available. This finding is consistent with other studies of outdoor recreation which show that participants tend to be in the middle and upper-middle income groups. Fishermen at high mountain reservoirs have considerably less income than fishermen on West Slope streams, who reported average incomes of \$26,000 (Walsh, Ericson and Arosteguy, 1978). Average incomes of fishermen at high mountain reservoirs were identical to boaters on low mountain reservoirs. Recreation users of high mountain reservoirs with trail access only had average incomes of \$21,600, or slightly more than users of high mountain reservoirs with road access.

Table 7 . Socioeconomic Characteristics, Income, Education, Age, Sex and Number of Years Participated in Primary Recreation Activity at High Mountain Reservoirs, Colorado, 1978.

Recreation Site	Sample Size	Average Income	Average Years of Education	Average Age of Respondent	Average Age of Head of Household	Percent Male	Years Participated in Primary Activity
High Mountain Reservoirs							
Small, 1-50 acres	37	\$21,568	14.95	31.19	31.87	89%	13.41
Medium, 51-150 acres	101	17,158	13.27	41.01	44.88	86%	18.93
Large, 151-400 acres	62	20,258	12.61	47.21	48.42	84%	25.48
TOTAL	200	18,935	13.38	41.12	43.57	86%	19.94
Low Mountain Reservoirs							
Over 400 acres	39	19,000	13.90	33.03	34.36	69%	8.13

Average number of years education was reported as 13.4 years, which was one year more than the average education of the adult population of the state reported as 12.4 years. This finding is consistent with national surveys of outdoor recreation which show that participants tend to be somewhat more educated than the national average. Boaters at low mountain reservoirs reported one-half year more education than fishermen at high mountain reservoirs.

The average age of participants in recreation activities at high mountain reservoirs was 41.1 years, only slightly less than the average age of adults in the U.S. of 41.5 years. Recreation users of high mountain reservoirs with trail access only averaged 31.2 years of age, or 10 years less than users of all mountain reservoirs, which have road access for the most part.

Fishermen on high mountain reservoirs reported 20 years' experience in the activity, compared to only eight years for boaters on low mountain reservoirs. This fishing and boating experience of reservoir users was consistent with that of stream users on the West Slope where fishermen reported 22 years' experience compared to six years for kayakers and five years for rafters.

Alternative Management Practices

Table 8 shows the effect of alternative management practices on the value of recreation at high mountain reservoirs. Toilet facilities, campsites, picnic tables and fire rings contributed to the value of recreation at medium-sized and large-sized reservoirs

Table 8 . Effect of Alternative Management Practices on Willingness to Pay to Participate in Recreation Activities at High Mountain Reservoirs, Colorado, 1978.

Alternate Management Practices	High Mountain Reservoirs			TOTAL	Low Mountain Reservoirs
	Small, 0-50 acres	Medium, 51-150 acres	Large, 151-400 acres		
Average Total Willingness to Pay per Day	\$32.19	\$24.65	\$37.87	\$30.15	\$52.92
Reservoir Water Dirty, Polluted	10.03	6.57	8.56	7.83	31.05
User Fee Imposed of \$2 per Day or \$10 per Year	17.28	17.50	19.64	18.11	49.46
Sanitation Facilities Did Not Exist	31.14	18.61	19.79	21.29	39.12
Road Access Poor	32.99	19.21	30.04	25.12	19.41
Hike Trail Only Access to Reservoir (1+ mile)	32.62	19.46	16.64	21.02	1.14
No Off-Road Vehicles Allowed	34.49	29.74	44.73	35.27	49.42
No Motor Boats Allowed	35.26	29.49	42.52	34.60	6.54
No Campsites, Picnic Tables or Fire Rings	34.24	17.93	20.67	21.79	22.73
Shoreline Too Steep and Rocky	25.59	13.82	17.50	17.14	9.24
Reservoir Not Stocked Well With Fish	21.65	8.13	10.94	11.50	35.75
No Swimming Allowed	34.55	29.22	42.36	34.28	30.10

but were unimportant to users of small reservoirs. The quality of the access road also contributed to the value of recreation at medium-sized and large-sized reservoirs but was unimportant to users of small reservoirs. If hiking trails were the only access to reservoir recreation, the value of recreation at medium-sized, and in particular large-sized reservoirs, would be reduced substantially, but values to users of small reservoirs would be unaffected.

Fish stocking programs make a substantial contribution to the value of recreation at high mountain reservoirs. The same can be said for regulations which prohibit the use of motor boats and swimming. Prohibition of off-road vehicles also contributes to the value of recreation at high mountain reservoirs. Imposing a recreation fee of \$2 per day or \$10 per year would substantially reduce the value of recreation at high mountain reservoirs by considerably more than the out-of-pocket costs to the user.

Quality of the environment contributes to the value of recreation at high mountain reservoirs. A steep and rocky shoreline reduces recreation values by a substantial amount. Dirty or polluted water reduces recreation use values more than any other single thing.

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