Stream Water Quality in a Small Commercial Campground in Colorado

Howard L. Gary

Abstract

Selected physical, chemcial and bacteriological qualities of stream water entering and leaving a campground were examined during the summer of 1978 to investigate the influence of recreational use. Water samples were collected and analyzed at approximately biweekly intervals, and also three times daily before and after the Memorial Day, Fourth of July, and Labor Day weekends. Chemical and physical quality remained unchanged and densities of indicator bacteria in surface water were not significantly increased by recreational use of a campground equipped with modern sanitation facilities.

Public agencies and many recreationists are concerned about health risks, ecological effects of nutrient additions, and site degradation of public lands. More information is needed to help make decisions and plan recreational use of public lands. For these reasons, a study was made in a developed commercial campground to characterize the impacts of concentrated recreational use on the bacteriological, physical, and nutrient quality of stream water on the site.

Natural stream water contains dissolved solids and is affected by geologic conditions, plant materials, and human-caused disturbances. Common ions in solution include carbonates, bicarbonates, chlorides, sulfates, phosphates, and nitrates of calcium, magnesium, sodium, and potassium(13). Total dissolved solids (TDS) of natural waters are usually reduced or diluted by rainfall or snowmelt(21) and increased by the addition of wastewater effluents and runoff from feedlots, fertilized fields, and pastures. Highly productive fishing waters usually have a threshold value of TDS greater than about 400 mg/1(18).

Nitrates are not normally a serious problem in and near mountain campgrounds(8). The primary source of nitrogen pollutants in wastewater are feces, urine, and waste food. Detectable nitrate-nitrogen (NO_3-N) in water usually indicates excessive leaching from faulty disposal systems. Concentration of NO_3-N above about 0.3 mg/1 may stimulate unwanted aquatic plant growth but is not a potential health hazard to humans until concentration exceeds about 10 mg/1(18).

High concentrations of suspended solids (SS) in mountain streams generally indicate active erosion and may be associated with the impact of human activities past and present. SS may also vary with intensity and amount of precipitation, vegetation, season, topography, size of stream, surface soil, stability of channel, and intensity of land use(3). Waters having average SS concentrations greater than about 80 mg/1 generally harm fish and other aquatic life(18).

Other pollution from human sources that may affect mountain streams and lakes is characterized by high densities of coliform bacteria. The common indicator bacteria such as total coliforms, fecal coliforms (FC), and fecal streptococci (FS) are widespread in fecally contaminated environments and originate from diverse sources, including the intestinal tract of humans, other mammals, birds, reptiles, and lower forms of life (15). The presence of coliforms in a stream usually indicates recent fecal pollution and the possible presence of enteric pathogens. The relationship of fecal coliform to fecal streptococcus density (FC/FS) has been used to provide information as to sources of pollution(10, 11). Based on per capita contributions of indicator bacteria from man and domestic livestock, FC/FS ratios greater than about 4:1 are usually indicative of man's body wastes. Ratios less than about 0.7:1 suggests contamination originated from livestock, wildlife, stormwater runoff and other non-human sources.

In one Colorado study, there was no apparent association between increasing levels of bacterial pollution and increasing levels of camper concentrations in developed campgrounds where there were vault-type toilet facilities and trash cans(2). Aukerman and Springer(2) also observed a general inverse relationship

Journal of Environmental Health, V. 45 (1) 5-12.

Howard L. Gary, Principal Hydrologist, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, 240 West Prospect St., Fort Collins, CO 80526.

between cases of bacterial-density increases and low recreational-use periods. They implied less compulsion on the part of campers to properly dispose of wastes in times of low camper-use periods. In Washington, Varness et al.(22) noted somewhat different results in that indicator bacteria densities were significantly increased downstream from heavily used camping areas without sanitary facilities when compared to unused upstream sites. Johnson and Middlebrooks(14) also reported picnicking and campground use resulted in degradation of stream quality in Utah's Wasatch Front. They found that sharp increases of FC counts coincided with peak recreational use, while concentration and mass flow of FC dropped sharply at the end of the recreation season. Surface runoff or "flushing" as a result of rainfall or snowmelt, usually low camper-use periods, may also contribute to bacterial contamination in many Colorado streams(19, 16).

Campground recreation and day-use recreation along mountain streams do not always have a detectable impact on existing water quality. Streams polluted at any given time and at any specific site tend to return to a state similar to that before pollutants were discharged. This process of self-purification at the point of pollution and for an indefinite distance downstream is accomplished by physical, chemical, and biological means, and depends on time, temperature, oxygen supply, and other environmental factors which regulate biological growth(2)).

Study Area

The report study was conducted along a 1-km section of Horse Creek (below confluence of Trout and West Creeks), adjacent to Colorado State Highway 67, about 4 km above the community of Deckers, in central Colorado. The area surrounding the study area is mainly public land. Horse Creek is a major headwaters tributary of the South Fork of the South Platte River. The stream, following spring runoff, is generally less than 3 or 4 m wide and less than 25 cm deep. The small commercial campground located in the study area is isolated from other developed land uses and people activity, except for occasional fishing. The nearest home developments (< 1 home/ha) and domestic livestock were more than 10 km upstream from the study site.

The floodplain in the study area is mainly granitic gravel and rocks washed down from mountain slopes over geologic time. The area was last covered by a new layer of gravel 15 cm or more thick in 1973 as a result of heavy rains and three small dam failures 10 to 13 km upstream on West Creek. The alluvium brought in by the last flood was flushed from the stream channel within a few weeks, returning the amount to pre-flood levels. The streambed is predominantly coarse gravel (32-64 mm) and rubble (64-256 mm) and riffles are common. The streamside willows (*Salix* sp.), generally 3- to 4-m tall, had almost recovered to their former density and height by 1977. There were no beaver ponds in the study area. The steep mountain slopes above the floodplain are decomposed granite, and vegetation cover is mainly ponderosa pine *(Pinus ponderosa)* with some Douglas-fir *(Pseudotsuga menziesii)* on north aspects.

Camping sites within the campground were on both sides of the creek (Fig. 1). The trailer-motor home sites were equipped with individual sewer hookups. The common sewer line drained into a nearby standard concrete septic tank designed to hold wastewater at low velocity under anaerobic conditions and to obtain high removal of settleable solids(20). The final effluent was discharged through perforated pipes into a sub-surface leach field on the south side of Horse Creek. Tent campers were required to use sanitary facilities in the headquarters area which was served by a second septic tank and leach field. The campground generally served as a base camp for nearby recreational activities but also itself provided fishing and various relaxed recreational activities.

Nine water sampling sites 100 m apart were established along an 800-m reach of the Horse Creek study area (Fig. 1). There was little human activity at three sites above the main camping area, because dense willows and old flood debris hindered stream access. Three sites were in the main camping area, and three sites were downstream from the main recreation area, in an area fenced to prevent trespass.

Methods

Stream water level was recorded continuously during the study using a water stage recorder installed in a stilling well, at the side of the stream,

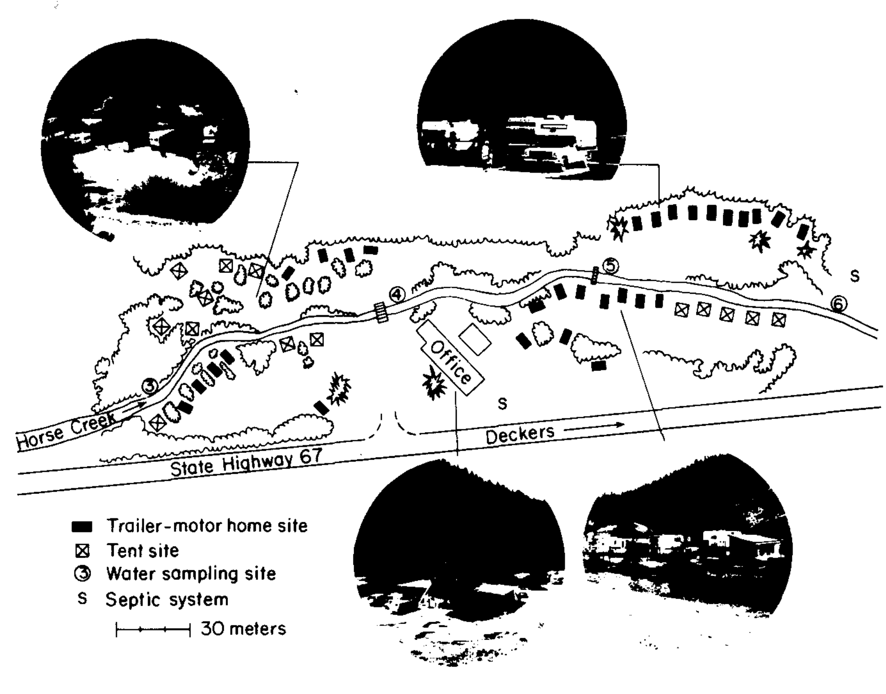


Figure 1
Location of camping units, septic tank systems and four of nine water sampling sites (scale approximate).

near the downstream end of the campground area. Stream discharge at this site was later estimated after developing a discharge-height rating curve based on current velocity meter readings and cross-sectioning techniques(5).

Water samples for routine analysis were collected about mid-morning, at approximately biweekly intervals, from April 20 through October 18, 1978. Additional water samples were taken at sites 1 and 2 above and at sites 6 and 7 below the main recreation area during the Memorial Day, Fourth of July, and Labor Day weekends. Sampling was started the day before (Friday) and ended the day after (Tuesday) each holiday weekend. The daily sampling was at 0600, 1200, and 1800 hours.

Water samples were taken in midstream, were depth integrated and were collected in sterile bottles, stored on ice, and transported to the Manitou Experimental Forest laboratory about 20 km south of the study area. Water samples were also collected using an automatic sampler for SS analysis during the holiday weekends. The automatic water sampler intake hose was placed in the center of the stream, camouflaged with rocks, and located adjacent to the water level recorder. When children and/or adults were in the stream, the float arrangement on the water level recorder bobbed rapidly and registered the time of disturbance. Water collected at specific times by the automatic sampler and analyzed for SS was later verified as to whether local streambed disturbance was caused by recreationists.

In the laboratory, bacteria were plated within two hours after collection, and other physical and chemical analyses were usually completed within six hours. FC and FS were determined using the membrane filter technique (4). Sample size ranged from 1 to 100 ml of stream water. Membrane filters were placed on pads saturated with m-FC broth for FC and on m-enterococcus agar for FS enumeration. FC were incubated in a water bath at 44 $\pm$ 0.2° C for 24 hours and FS in an air incubator at 35 $\pm$ 0.5° C for 48 hours.

SS and TDS were determined gravimetrically by procedures outlined in Standard Methods(1). Sample volume for SS determinations ranged from 250 to 500 ml and 100 ml for TDS determinations.

NO_3-N was determined colormetrically after passing the water through a 0.45 μm filter. This test was determined using a modification of the cadmium reduction method using prepackaged reagent powder pillows along with other reagents(12). Standard additions of NO_3-N were determined each measurement period to check accuracy of test results.

Number of visitors using the campground were determined from daily-use records kept and made available by owners of the campground.

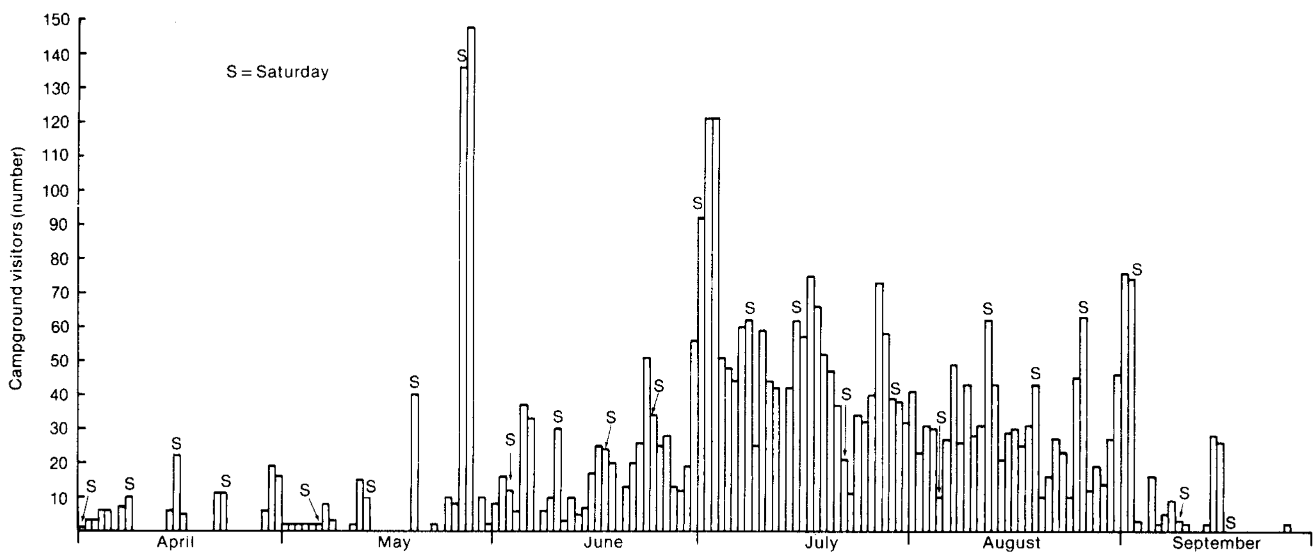
Results and Discussion

Campground Use and Water Regime

Along most of the Front Range in Colorado, heavy use of campgrounds begins on Memorial Day weekend and continues through the Labor Day weekend. Demand for camping and/or campground use peaks on the Memorial Day, Fourth of July, and Labor Day weekends, with secondary weekly peaks on Friday and Saturday nights (Fig. 2). In this study, overnight visitors at the campground ranged from about 150 people the day before Memorial Day 1978 to no overnight visitors on Memorial Day itself. This dramatically illustrated camper mobility. Campground use was relatively greater during July and August than during May and June and dropped rapidly after the Labor Day weekend. The same seasonal pattern of use apparently occurs in most public campgrounds along the Front Range in Colorado and in the Southwest(17).

Peak runoff characteristically occurs in May along the mid-elevations of the Colorado Front Range(9). Stream velocity for Horse Creek ranged from about 0.7 to 0.9 m/second at the time of high flows in May and from 0.2 to 0.4 m/second during low flows in July, August, and September (Fig. 3). The creek running through the study campground is a major attraction of the campground and because most of the

Figure 2
Overnight visitors in the commercial campground.



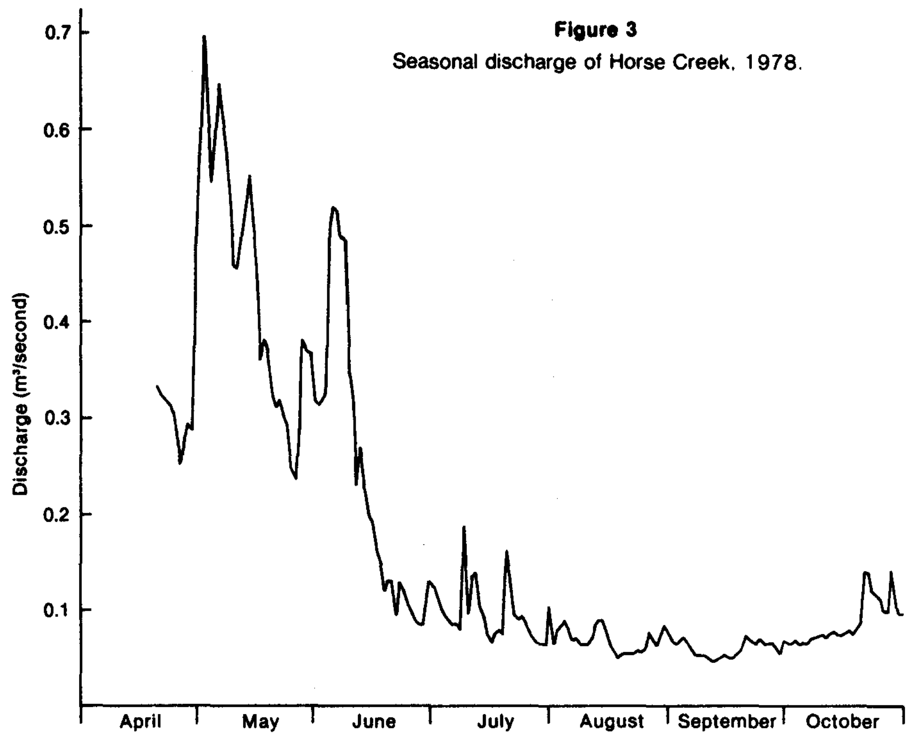


Figure 3
Seasonal discharge of Horse Creek, 1978.

camping use occurred after peak runoff in May, the greatest chance for stream pollution, other than SS, would likely occur during the time of low flows and slower moving water.

Seasonal Water Quality

Analysis of biweekly water samples taken above, in, and below the campground did not indicate any consistent change in water quality or increase in health hazards attributable to use of the campground (Table 1). Good sanitation facilities were readily available at most campsites and/or the camp headquarters, and the sanitation facilities were apparently used for most waste disposal. These results further indicate that septic tanks in use in the campground were apparently providing adequate primary wastewater treatment and that, under

Table 1.
Seasonal pattern of mean water quality upstream, in the campground, and downstream.

Sample date	Sites	Water temperature	Suspended solids	Total dissolved solids	Nitrate nitrogen (NO_3-N)	Fecal coliforms (FC)	Fecal streptococci (FS)	Ratio FC/FS
		°C	-concentration mg/1-		-μg/1-	-colonies/100 ml-		
	U[1]	9.7[4]	0.4	164	430	0	1	—
4-20-78	C[2]	8.3	0.5	114	530	0	2	—
	D[3]	7.3	1.0	124	820	0	2	—
	U	9.3	0.5	127	590	2	3	0.7
4-26-78	C	8.2	0.9	125	750	1	3	0.3
	D	7.2	< 0.1	128	670	92	6	15.3
	U	9.0	1.1	114	550	1	4	0.3
5-11-78	C	8.0	1.1	111	550	1	5	0.2
	D	7.5	0.8	124	400	67	7	9.6
	U	11.0	3.3	79	200	13	240	< 0.1
6- 8-78	C	10.5	3.3	87	210	12	220	< 0.1
	D	9.7	2.3	75	370	12	227	< 0.1
	U	18.2	0.3	130	160	38	243	0.2
6-20-78	C	16.3	<0.1	140	650	35	83	0.4
	D	15.8	<0.1	133	330	36	76	0.5
	U	15.8	2.1	152	350	101	1820	0.1
7-11-78	C	15.3	2.4	154	390	73	1600	< 0.1
	D	15.0	2.9	153	350	74	1340	0.1
	U	14.5	1.7	166	320	64	2230	< 0.1
7-25-78	C	14.0	1.9	169	460	58	1890	< 0.1
	D	13.2	2.1	164	450	54	2270	< 0.1
	U	13.7	1.0	158	480	95	1260	0.1
8- 8-78	C	13.0	0.4	163	440	97	1160	0.1
	D	12.3	0.6	159	360	61	950	0.1
	U	14.5	<0.1	152	320	46	1340	< 0.1
8-22-78	C	13.8	<0.1	154	360	49	1940	< 0.1
	D	13.3	<0.1	152	330	50	1540	< 0.1
	U	8.2	1.4	202	340	0	30	—
10-18-78	C	7.9	1.2	199	400	0	34	—
	D	7.5	1.2	195	720	0	19	—

[1]Upstream from campground
[2]Campground
[3]Downstream from campground
[4]Measurements taken first downstream, and last upstream

present campground use, any effluent reentering the stream via leach fields is greatly diluted by streamwater, with no measurable deleterious effect on existing water quality.

Low TDS values observed for the study area were apparently a result of extensive granitic formations throughout the entire watershed(13). The lowest TDS (75 to 87 mg/l) were observed in early June and coincided with the period of high streamflow, when TDS falls to a yearly minimum. Except for minor decreases following summer rains in August, TDS gradually increased to a range of 195 to 202 mg/l in mid-October, the usual period of minimum streamflow.

NO_3-N did not exhibit any definite seasonal trend, and concentrations observed at the three study sites were not significantly different ($P=0.05$). The NO_3-N range was 160 to 820 $\mu g/l$, but this relatively low concentration range did not appear to produce excessive algal blooms. Filamentous green algae, mainly *Chlorophyta cladophora,* were present at all study sites but were also observed in "near pristine," first-order tributary streams to Horse Creek.

Except for sample dates April 26 and May 11, 1978, FC and FS indicator bacteria followed the expected seasonal pattern of few colonies during April and early May, when water temperature was relatively low and also when recreational activity was low. The relatively high counts of FC downstream from the campground on April 26 and May 11, 1978 (Table 1) cannot be explained. The FC/FS ratios during these two sample periods were considerably greater than 4.0. Based on the widely accepted FC/FS index (usually computed when FS density > 100 colonies/ 100 ml), contamination by human wastes was indicated. Contamination was perhaps due to unauthorized dumping of wastewater in the stream. FC/FS ratios were 0.7 or less during all other study periods.

Bacterial counts increased rather sharply at all study sites during July and August, when water temperature was high. Bacterial counts were greatly reduced by mid-October, when water temperature became seasonally lower. High counts of FS apparently were caused by insect activity and other nonhuman sources. In another study conducted about 25 km upstream from the present study area, FS isolates were found to consist mainly of *Streptococcus faecalis*(7). The relatively high counts of FC at all sites during July and August indicated diffuse sources of upstream pollution, apparently from warm-blooded animals including man, but also indicated no distinguishable input from recreation use of the campground.

Under the bacteriological standards adopted by the Colorado Water Quality Control Commission(6), the stream water above, in, and below the campground was unacceptable for potable water unless disinfected. However, the water was acceptable as Recreation-Class I (primary contact) water. According to this classification, < 200 FC/100 ml of water indicates that water is suitable for prolonged and intimate contact with the body or general recreational and/or swimming enjoyment where small quantities of water may be ingested. Based on observed water temperatures (consistently less than 20° C) and low SS, the state water classification criteria indicated stream water in the study area was also suitable for the protection and maintenance of a wide variety of cold water biota, including trout.

Bacteriological Density During Weekends

The indicator bacteria densities on the Memorial Day, Fourth of July and Labor Day weekends were relatively similar above and below the campground during all sampling times (Fig. 4). The most dramatic increase in FC density was observed at 6 a.m. on Monday of the Memorial Day weekend. For nine sampling times prior to the 6 a.m. reading, FC densities were less than 50, but increased to 250, or fivefold, in a 12-hour period both above and below the campground. No evidence was found to link the FC increase to recreationists or domestic livestock, but the sharp increase of FC densities both above and below the campground indicated these sites were equally responsive to the bacterial inputs into the stream above the study area. This finding also provided general evidence that, had strong bacterial pollution originated in the campground, it probably would be detected at one or more of the downstream sampling sites.

The FC densities observed during the Fourth of July and Labor Day weekends were generally highest during the morning and evening sampling times and lowest during mid-day. The apparent drop during the mid-day was probably more closely related to greater ultraviolet light over the relatively open stream rather than activities of recreationists(20).

The FS densities followed about the same trend observed during routine sampling. FS densities, above and below the campground, were lowest during the Memorial Day weekend and averaged 54 colonies/ 100 ml of water. Water temperature ranged from 9° to 18° C. FS densities were highest during the Fourth of July weekend and averaged 2,290 colonies/100 ml of water and water temperature ranged from 13° to 23°C. The high densities during the Fourth of July weekend were apparently influenced by greater recreationist, animal, and insect activities and by summer rain showers that may flush bacteria directly into the stream (19,16).

During the Labor Day weekend, FS densitites were seasonally lower than during the Fourth of July weekend. Water temperature range was 12° to 21°C. FS densities averaged about 1,400 colonies/100 ml of water upstream from the campground, and about 1,590 colonies/100 ml below the campground. Higher counts below the campground may have been related to disturbances of the streambed by people playing in the stream.

Suspended Solids Fourth of July

Many children and a few adults were personally observed on most days (when taking water samples) playing in the stream within the campground, mainly after mid-day, during the three holiday weekends (Fig. 5). During the Memorial Day and Labor Day weekends, no recreationists were observed near the automatic water sampler, and the trace on the water level recorder also indicated the streambed was not disturbed. The line trace made by the water level recorder indicated people were in the stream near the water sampler on the Fourth of July weekend, and a measure of streambed disturbance was obtained (Fig. 6). The automatic sampler was set to collect water

Figure 4

Mean bacteriological profiles upstream and downstream from the campground during holiday weekends, 1978.

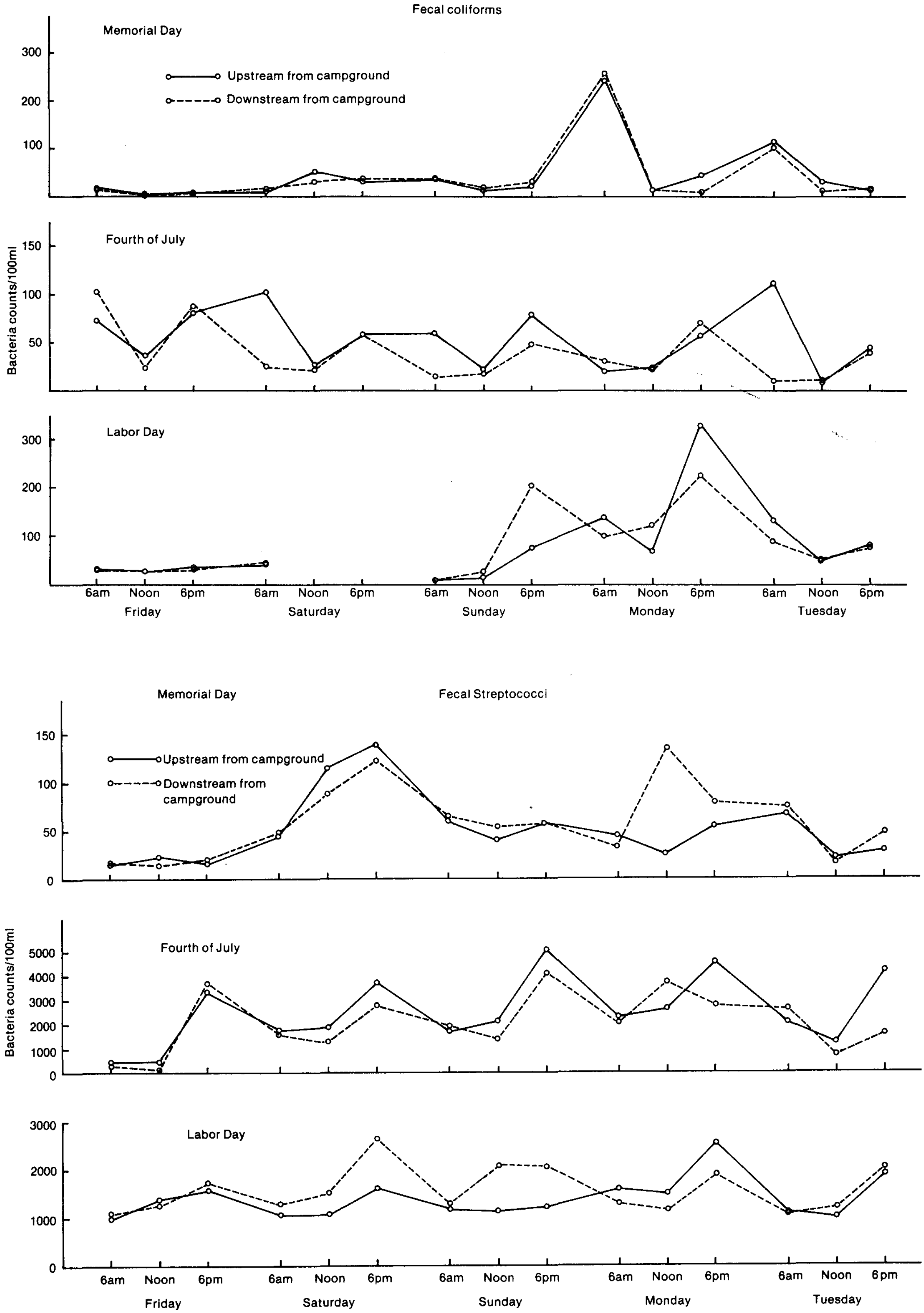


Figure 5

Horse Creek was a major attraction for children.

samples every 30 minutes, so that maximum SS levels may not have been sampled.

However, the observed increases in SS were dramatic during the periods of known human disturbance on Sunday and for two periods on Tuesday. As soon as recreationists moved from the sample area, SS levels fell to almost predisturbance levels. Because the streambed is composed mainly of coarse-textured rock and soil material with little silt and clay fractions, the short-lasting disturbance caused by recreationists in and around the campground probably had little net effect on erosion or sedimentation of the stream. In flood stage, Horse Creek in the local area carries up to 300 mg/l SS for days (unpublished data collected by the author), and thus the reoccurring flood events far outweigh any small periodic degradation caused by the few recreationists either in or out of the campground.

Conclusions

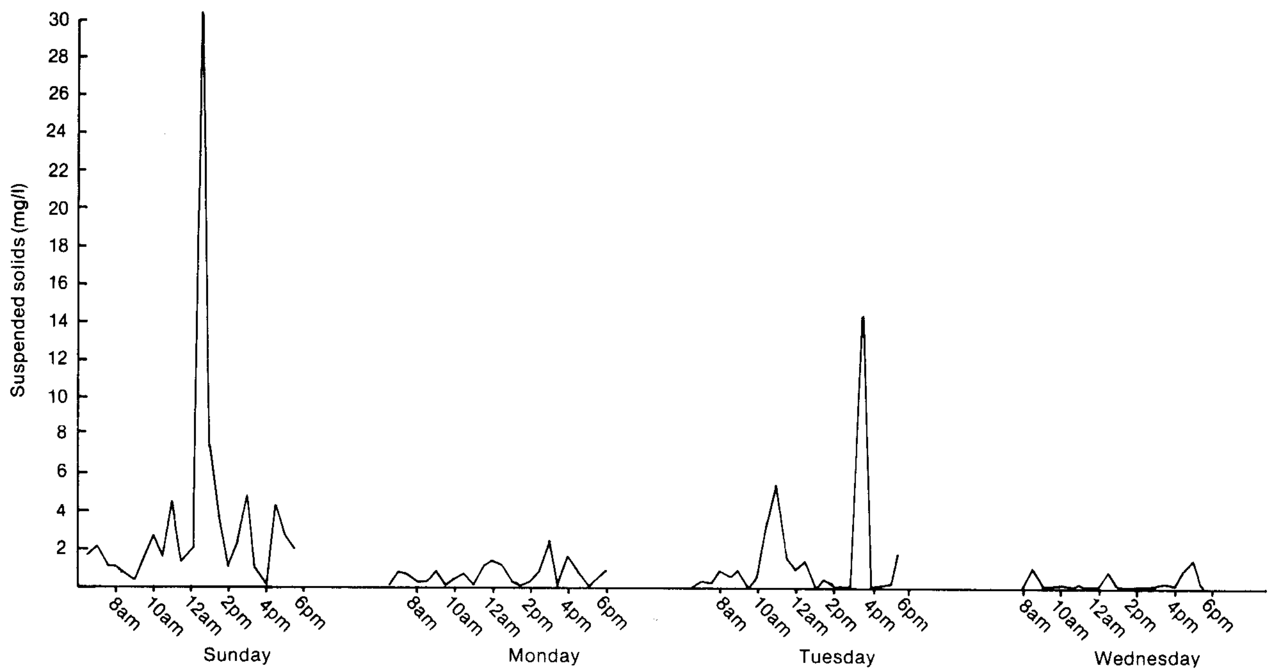
Recreational use in a commercially developed campground equipped with good sanitation facilities did not influence or impair existing chemical and bacteriological properties of the passing stream waters. Properly sited campgrounds, whether commercial or public, equipped with approved wastewater disposal systems and potable water supply, may not further pollute recreational streams and can provide excellent base camps for nearby recreational opportunities. Results of this study indicate that upgrading wastewater treatment at remotely located and undeveloped recreation areas of the West can reduce the potential health hazards.

References

1. American Public Health Association, Inc. (1975) *Standard Methods for the Analysis of Water and Wastewater,* 14th edition. 1193 p. American Public Health Assoc. Inc. Washington, D.C.
2. Aukerman, R. and W.T. Springer. (1976) Effects of recreation on water quality in wildlands, Eisenhower Consortium Bull. 2, 25 p. USDA For. Serv., Rocky Mtn. For. and Range Exp. Stn., Fort Collins, Colo.
3. Barton, M. (1969) Water pollution in remote recreation areas. *J. Soil and Water Conserv.* 24:132-134.

Figure 6

Fluctuation of suspended solids as affected by unknown numbers of recreationists walking or playing in the stream on the July Fourth weekend.



4. Bordner, R.H., J.A. Winter, and P. Scarpino. (1978) *Microbiological Methods for Monitoring the Environment,* EPA-600/8-78-017, 338 pp. U.S. Environ. Prot. Agency, Off. of Res. and Dev., Cincinnati, Ohio.

5. Buchanan, T.J. and W.P. Somers. (1969) Discharge measurements at gauging stations, 65 p. *In* Techniques of water resource investigations of the United States Geological Survey Book 3, Chapter A-8, U.S. Dept. Inter., Washington, D.C.

6. Colorado Water Quality Control Commission. (1978) Water quality standards for Colorado, 27 p. plus 17 p. Appendix. Colo. Dept. of Health, Denver.

7. Erickson, D.C., H.L. Gary, S.M. Morrison, and G. Sanford. (1981) Pollution indicator bacteria in stream and potable water supply of the Manitou Experimental Forest, Colorado, USDA For. Serv. Res. Note RM-414, 7 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo. (In Press)

8. Flack, J.E. (1976) *Design of Water and Wastewater Systems for Rapid Growth Areas,* 149 p. Environ. Resour. Cent., Colo. State Univ., Fort Collins.

9. Gary, H.L. (1975) Watershed management problems and opportunities for the Colorado Front Range ponderosa pine zone: The status of our knowledge. USDA For. Serv. Res. Pap. RM-139, 32 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

10. Geldreich, E.E., H.F. Clark and C.B. Huff. (1964) A study of pollution indicators in a waste stabilization pond. *Jrl. Water Pol. Cont. Fed.* 36:1372.

11. Geldreich, E.E. (1976) Fecal coliform and fecal streptococcus density relationships in waste discharge and receiving waters. *CRC Critical Reviews in Environmental Control* 6:349-369. CRC Press, Inc., Cleveland, Ohio.

12. Hach Chemical Company. (1975) *Hach Water and Wastewater Analysis Procedures Manual,* 128 p. Hach Chemical Co., Loveland, Colo.

13. Hem, J.D. (1959) *Study and Interpretation of the Chemical Characteristics of Natural Water,* Geol. Surv. Water-Supply Pap. 1473. 269 p. Geol. Surv., U.S. Dept. of Interior, Washington, D.C.

14. Johnson, B.A. and E.J. Middlebrooks. (1975) Water quality as an approach to managing recreational use and development on a mountain watershed South Fork of the Odgen River-Ogden Valley area, PRWA21-1, 84 p. Utah Water Res. Lab., Coll. Engr., Utah State Univ., Logan.

15. Kabler, P.W. and H.F. Clarke. (1960) Coliform group and fecal coliform group organisms as indicators of pollution in drinking waters, *J. Amer. Water Works Assoc.* 52:1577-79.

16. Kunkle, S.H. and J.R. Meiman. (1967) Water quality of mountain watersheds, Colo. State Univ. Hydrol. Pap. No. 21, 53 p. Colo. State Univ. Fort Collins.

17. Love, L.D. (1964) Summer recreational use of selected National Forest campgrounds in the central Rocky Mountains, U.S. For. Serv. Res. Pap. RM-5, 23 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

18. McKee, J.W. and H.W. Wolf (eds.) (1963) *Water Quality Criteria,* Calif, State Water Resour. Cont. Board, Publ. 3-A (revised), 548 p. Sacramento.

19. Morrison, S.M. and J.F. Fair. (1966) Influence of environment on stream microbial dynamics, Colo. State Univ. Hydrol. Pap. No. 13, 21 p. Colo. State Univ., Fort Collins.

20. New York State Dept. of Environ. Conserv. (1978) *Manual of Instruction for Wastewater Treatment Plant Operators,* Chap. 1, p. 1-24. Health Education Service, Inc., Albany.

21. Tiedemann, R.A. (1974) Stream chemistry following a forest fire and urea fertilization in North Central Washington, USDA For. Serv. Res. Pap. PNW-203, 20 p. Pac. Northwest For. and Range Exp. Stn., Portland, Oreg.

22. Varness, K.J., R.E. Pacha, and R.F. Lapen. (1978) Effects of dispersed recreational activities on the microbiological quality of forest surface water, *Applied and Environ. Microbiol.* 36:95-104.

Acknowledgement

The author gratefully thanks Jim and Carol Downard, former owners of Deckers Campground, for supplying visitor-use information and access to study sites.

Reprinted from the *Journal of Environmental Health*

Vol. 45, No. 1 July/August, 1982

Published by the National Environmental Health Association, 1200 Lincoln St., #704, Denver, CO 80203

Manuscript Approval and Author's Checklist

Title: ~~High Density Camping and~~ Stream Water Quality in a Small Commercial Campground in Colorado

Author(s): Howard L. Gary

Proposed Outlet: Journal of Environmental Health

Intended User Audiences:

• I have organized and written this manuscript as well as I can. I have checked it for accuracy and assume responsibility for the correctness of all original data in the text and illustrations, and for the conclusions and recommendations drawn from the data. I have completed the checklist on the back of this form.

Author(s) Howard L. Gary **Date** 7-31-81

• I have evaluated the statistical and mathematical bases and find they adequately support the conclusions.

Station Biometrician RM King **Date** 10/30/81

• I have reviewed this manuscript and it has my approval. The author has responded adequately to the reviews (enclosed) of reviewers and the Station Biometrician. It is technically sound.

Project Leader R Alexander **Date** 11/20/81

• I have reviewed this manuscript for policy, including Station policies on review and clearance. I concur that it should be published, and that it is ready for editorial processing.

Assistant Director Clyde A Fasick **Date** 11/23/81

• I have edited this manuscript or have reviewed the edited draft and believe it meets Station standards for effectiveness and quality of writing and illustrations. It is in proper form to submit for publication.

Station Editor W Eucken **Date** 12/17/81

• The author(s) and I have reviewed this manuscript in final form and concur with editorial changes. I have checked statistics for accuracy; figures, tables, and text are consistent. Estimate of demand for reprints: ____ high, ____ med., ____ low.

Project Leader R Alexander **Date** 1/4/81

Piedmont, Montane, Edwards Plateau, Sub-alpine, Mogollon Rim, Short grass prairie, High Plains, etc. are accepted as physiographic units. Lets try Colo Front Range HLG

Does everyone know what the "Colorado Front Range" is? CAF

-- of course not!

Do most of the readers of this Journal know? I suppose they could look it up.

What is it?

Retrieval terms:
Research Work Unit No.: 1252-
Coop. Aid or Study Plan No.: 1751.34 - first manuscript

RM 1630-5 (Revised July 1980)

Author's Checklist for Manuscripts

• The attached manuscript consists of 26 pages, 1 tables, and 6 figures. The figures consist of 5 line drawings and 1 photographs.

• The following individuals have reviewed this manuscript:

	Name	Title	Affiliation	Date
1.	Dave Sturges	Hydrologist		7-31-81
2.	Jerry Gottfried	Hydrologist		7-31-81
3.	Wayne T. Swank	Hydrologist	SE Sta.	7-31-81
4.	Charles A Troendle	Hydrologist		11-20-81
5.	Kirke L. Martin	Microbiologist	CSU	8-13-81
6.				

• I have consulted the Manuscript Preparation Handbook (FSH 1609.11), the Station Manuscript Preparation Desk Guide, and/or the style specifications of the intended outlet, and have checked the manuscript to see that:

X 1. Names of plants and other organisms agree with authoritative sources.
X 2. Spelling of personal names, place names, trade names, and unusual terms is correct.
X 3. Affiliation of the authors is accurate.
X 4. Mention of cooperators or special acknowledgments have been included where necessary.
X 5. Abstract or summary, or both, express the main points of the manuscript, including results and conclusions. An abstract not exceeding 50 words has been included for the Station data base.
X 6. Format and style of the manuscript is correct for the intended publication outlet.
X 7. Numbering and sequence of footnotes are correct.
X 8. Disclaimer is included if commercial products or enterprises are mentioned.
X 9. Proper pesticide precautionary statement is needed.
X 10. Tables are numbered and referred to in the proper order in the text.
X 11. Illustrations are numbered and referred to in the proper order in the text.
X 12. Data points are included with graphs or charts, if replotting is necessary.
X 13. Captions adequately describe what is illustrated.
X 14. Literature citations are referred to in the text, and are listed in the prescribed style.
X 15. All references agree with original sources.
X 16. Any earlier publications or computer programs superseded by this manuscript are prominently mentioned.

Author Edward S. Gary **Date** 7-31-81

• I certify that publication of this manuscript in the quantity and form requested is essential to the official business of the USDA Forest Service, and that it has been prepared to meet exacting standards of economy and effectiveness.

I approve printing ________ copies. Ordering 700 reprints.

Publications Control Officer R H Hamre **Date** 1/4/82