Ecology and status of a wilderness fishery: Westslope cutthroat trout in the South Fork Flathead River

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Ecology and Status of a Wilderness Fishery: Westslope Cutthroat Trout in the South Fork Flathead River

by

Michael Kenneth Young

B.S., University of Montana, 1982.

Presented in partial fulfillment of the requirements for the degree of Master of Science University of Montana 1986

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Date August 26, 1986
Cutthroat trout have declined throughout the western U.S. To improve the westslope cutthroat trout fishery, the Montana Department of Fish, Wildlife and Parks implemented restrictive angling regulations on the South Fork Flathead River in northwestern Montana. Visual and mark–recapture estimates for the upper 35 km of the river (149 and 242 trout/km, respectively) indicated trout population densities were low. High catch rates demonstrated the vulnerability to angling of this subspecies and particularly of the larger individuals. Anglers tended to support the regulation change and favored continued harvest of some trout. Microhabitat characteristics of cutthroat trout in this study differed greatly from those previously reported for stream–dwelling salmonids. Discriminant analysis could not classify trout size based on microhabitat variables. This supports certain predictions of Fretwell’s models of habitat distribution.
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INTRODUCTION

Cutthroat trout (*Salmo clarki*) are native to the western United States. All interior subspecies of cutthroat trout have suffered drastic declines in abundance and distribution in the past 100 years (Behnke 1979). Much of this decline has been attributed to habitat degradation, hybridization and overfishing (Behnke and Zarn 1976).

The westslope cutthroat trout (*S. c. lewisi*) is the only native trout west of the continental divide in Montana, except in the Kootenai River drainage. This subspecies occupies only 27% of its estimated historical range in Montana (Liknes 1984). Furthermore, genetically pure populations of westslope cutthroat trout are known from only 1% of the streams in its historical range (Liknes 1984). Leary et al. (1984) concluded westslope cutthroat were in danger of extinction due to introgression with rainbow (*S. gairdneri*) and Yellowstone cutthroat trout (*S. c. bouvieri*). Competition with exotic salmonids, such as brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*), may cause cutthroat declines in some areas (Griffith 1972, U.S. Fish and Wildlife Service 1983). Angling can also lead to population decreases. Bjornn et al. (1977) stated that cutthroat trout in Idaho could be fished to extinction under liberal regulations. As a result of these problems, Montana declared the westslope cutthroat trout a Class A Species of Special Concern (Holton 1986).

The South Fork of the Flathead River (SFFR) basin contains the largest remaining population of genetically pure westslope cutthroat trout in Montana
(Liknes 1984). In 1983, outfitters, wilderness users and University of Montana personnel met with biologists from the Montana Department of Fish, Wildlife and Parks (MDFWP) to discuss the status of westslope cutthroat trout in the SFFR (Andrew Sheldon, University of Montana, pers. comm.). The outfitters believed the number and average size of trout had decreased due to overharvest by anglers, and several wilderness visitors supported this view (Chris Coile, Montana Outfitters Association, pers. comm.). The MDFWP responded by creating new regulations for the SFFR in 1984. The previous limit of ten cutthroat trout/d with no size restriction was changed to three fish/d with no trout exceeding 30.5 cm (12 inches).

Salmonids have frequently responded well to reduced harvest. Cutthroat trout in the St. Joe River in Idaho increased 4-fold after restrictive regulations were implemented (Johnson and Bjornn 1978). Catch-and-release regulations on Kelly Creek caused a 13-fold increase in cutthroat trout populations (Bjornn et al. 1977). The no-kill section of the South Platte River in Utah contained greater biomass and more trout > 30 cm than a section with an eight-fish limit (Anderson and Nehring 1984). Gresswell (1982) found that a 33-cm (13 inch) maximum size restriction with a two fish/d limit increased the average size of cutthroat trout in Yellowstone Lake.

The change in regulations provided a unique opportunity to study the response of 'pure' westslope cutthroat trout to changes in fishing regulations. Furthermore, the river has remained essentially free of man-caused disturbance in its upper reaches. After consideration of these two factors, I identified four
objectives for this study: an estimate of the trout population density, an estimate of trout vulnerability to angling, a description of trout microhabitats with an evaluation of the impacts of trout size and population density on microhabitat use, and a survey of anglers to determine their opinions regarding this fishery.

Population Estimation

Baseline data on the cutthroat population were required to evaluate the effect of the regulations. Few such studies had been conducted on the upper portion of the SFFR. The river flows through the Bob Marshall Wilderness Area and federal law prohibits the use of motorized equipment. The ban covers electrofishing which is the most frequently used technique of population estimation in Montana. The uppermost reaches of the SFFR are over 45 km by trail from the nearest road and airstrips within the wilderness are closed to all but emergency traffic (Gordon Ash, wilderness ranger, USFS, pers. comm.). Thus most conventional methods of population estimation were limited by federal regulations and/or the remoteness of the site.

Visual census methods are not affected by these restraints. Underwater observation had been successfully used in similar circumstances on the North and Middle Forks of the Flathead River (Fraley et al. 1981), the St. Joe River (Bjornn 1975) and the Yellowstone River (Schill and Griffith 1984). Furthermore, snorkel censuses have compared favorably with seining (Goldstein 1978), bank, aerial and poisoning counts (Northcote and Wilkie 1963) and electrofishing (Fraley et al. 1981,
Campbell and Neuner 1985). Population estimates by underwater censusing can be obtained rapidly compared to other techniques (Whitworth and Schmidt 1980) and precision can be excellent (Keast and Harker 1977). Therefore, I chose snorkeling to estimate cutthroat trout abundance in the SFFR.

**Vulnerability**

Fishing regulations are effective only if anglers can alter the structure, abundance or distribution of fish populations. A 30.5-cm minimum size limit and eliminating bait fishing and stocking did not increase the abundance of brown and rainbow trout in the Cache la Poudre River in Colorado (Klein 1974). Vincent (1984) felt fluctuations in habitat overwhelmed effects of angling on trout in the upper Gallatin River in Montana. In the same study, however, trout > 33 cm increased 345% on a section of the Madison River after its closure to fishing.

By gauging vulnerability of trout to angling, one may indirectly evaluate the potential impact of the new fishing regulations, e.g. low vulnerability would suggest that the new regulations would have little effect on the trout population. I determined catch rates and catchability of different size classes of westslope cutthroat trout. High values would suggest high vulnerability.

**Microhabitat**

It is reasonable to expect that the type and number of habitats occupied by
fish will vary as the population size varies. Fretwell (1972) defined two types of habitat distributions in dispersive organisms: ideal-free and ideal-despotic. In both cases, the suitability of a habitat decreases as the density of individuals increases, once the animals reach a minimum threshold necessary for successful reproduction. Furthermore, given a choice of habitats, individuals should consistently select the habitat which has the highest average suitability: this satisfies the definition of 'ideal' (Fretwell 1972).

Differences become evident when an individual attempts to enter an occupied habitat. In the ideal-free case, the newcomer will not be prevented from entering the habitat by the residents and its suitability will be equal to the average suitability for all individuals in that habitat. In the ideal-despotic case, the newcomer will have a lower suitability than the average suitability of the residents because it is excluded or subjected to danger by the behavior of the residents. In both cases, however, increased densities lead to use of greater numbers of habitats. Habitat suitability decreases as more individuals enter a habitat. Eventually a poorer, 'empty' habitat will have a suitability equal to that of a better but partially 'filled' habitat. A new individual could select either habitat and expect equal success. Typically these models have been applied to breedings birds (Fretwell 1972, Wittenberger 1981). Fraser and Sise (1980) used stream minnows to test one prediction of the models, i.e. increased population size leads to more uniform use of available habitats. Salmonids in streams may also exhibit this response and behave according to the predictions of Fretwell's models.

If westslope cutthroat trout in the SFFR are at low densities, habitats used by
different size classes of adults and subadults should be similar if the bioenergetic requirements of these size classes are similar. Several authors have suggested larger trout should select faster water velocities and greater depths than smaller fish (Fausch and White 1981, Smith and Li 1983, Fausch 1984) while Bachman (1982) believes larger individuals require lower focal point water velocities. Differences between microhabitats of juvenile and adult salmonids are well documented (Chapman and Bjornn 1969, Everest and Chapman 1972, Symons and Heland 1978, Wankowski and Thorpe 1979, Kennedy and Strange 1982, Baltz and Moyle 1984), but it is not understood whether this segregation is interactive or selective. Unfortunately, some authors have pooled data for all sizes of adult fish when reporting microhabitat characteristics (Baldes and Vincent 1969, Shirvell and Dungey 1983).

Several studies have suggested that preferred microhabitats for various size classes of salmonids are similar. Age 0 brown trout inhabited typical adult habitat when adults were absent (Gosse and Helm 1981). Campbell and Neuner (1985) found little difference between microhabitats of juvenile and adult rainbow trout. Bachman (1984) observed brown trout of different sizes occupying the same foraging site during the summer. These studies and Fretwell’s models suggest the following null hypothesis: westslope cutthroat trout in the SFFR will inhabit similar microhabitats if trout densities are low and the supply of optimal microsites is not limiting.

Fretwell (1972) suggested that dominant individuals may occupy the best habitat and displace subdominant individuals to habitats with lower initial
suitability if the best habitat is in limited supply. The dominance of large trout over smaller trout has been widely reported (Newman 1956, Jenkins 1969, Gibson 1978, Helfrich et al. 1982). Furthermore, trout have been found to defend territories (Miller 1957, Chapman 1966, Edmundson et al. 1968, Slaney and Northcote 1974) or form linear dominance hierarchies (Helfrich et al. 1982, Bachman 1984). Thus, if westslope cutthroat trout behave according to Fretwell's hypotheses, the larger individuals should hold the best microhabitats and displace the smaller fish to less suitable sites. At low fish densities, optimal sites may be available to all individuals, but as the population increases, differences in microhabitats of large and small trout should develop.

Angler Survey

Frequently, management of fisheries is based on the needs of the resource, with little attention devoted to the desires of the public. Nonetheless, awareness of the attitudes and behavior of anglers can determine the success or failure of a management strategy. Voiland and Duttweiler (1984) suggested biologists were failing to take advantage of sociological data. The results of an angler survey in Missouri were used to increase the fishing opportunities of trout anglers (Hicks et al. 1983). Idaho fishermen demonstrated their preference for wild cutthroat trout in the St. Joe River (Johnson and Bjornn 1978).

Information from anglers could be used to evaluate and direct management of cutthroat trout in the study area. Thus a questionnaire was developed to
assess the views of fishermen visiting the SFFR drainage in the Bob Marshall Wilderness Area. I was interested in three subjects: support for the current regulations, for more restrictive regulations and for trout stocking.

METHODS
Study Area

The upper SFFR drainage lies entirely within the boundaries of the Bob Marshall Wilderness Area in northwestern Montana. This portion of the SFFR has been designated a Wild River under the Wild and Scenic Rivers Act. The 1982 estimate of use of the Bob Marshall Wilderness Area was 178,200 visitor-days (Lucas 1985). This use was concentrated along the SFFR and its tributaries.

The study was conducted in July and August of 1984 and 1985 on approximately 35 km of the SFFR from the mouth of Big Salmon Creek to the confluence of Danaher and Youngs Creeks (Figure 1). Elevation at the upper and lower ends was 1436 and 1295 m, respectively. Gradient is 4.03 m/km. The mean of three discharge measurements taken at Big Prairie in early August of 1985 was 7.34 m3/s. Stream width was 10–40 m.

The SFFR in the study area is braided in many sections. The banks frequently lack riparian vegetation. Major floods in 1964 and 1970 may have been responsible for the obvious channel shifts and high (> 50 m) eroding banks (Jim Vashro, MDFWP, pers. comm.). The geology of the upper SFFR drainage was described by Johns (1980). The river valley consists largely of Quarternary Glacial deposits. Formations of the Misoula Group, as well as Cambrian and Devonian
Figure 1. The study area.
undifferentiated materials, occur in the river corridor.

Leathe (1980) stated 5 species of fish occur in the upper Flathead River basin: westslope cutthroat trout, bull trout (*Salvelinus confluentus*), mountain whitefish (*Prosopium williamsoni*), slimy sculpin (*Cottus cognatus*) and shorthead sculpin (*C. confusus*). Neither species of sculpin was observed during this study.

**Population Estimation**

The size of the study area and the lack of field assistance precluded the use of simple random sampling to determine trout abundance. The following technique was devised to minimize costs (sampling time) while still yielding a reasonably precise estimate of trout abundance.

Initially, I mapped the study area using photographs of topographic maps projected through an enlarger. The area was then divided into 35 1-km sections. In the field, I placed these sections in five 7-km clusters. A single kilometer was randomly selected from each cluster. These sections were field-mapped using a meter tape, and the location and size of each pool and riffle were noted. The habitat types were arbitrarily defined, but generally pools had less than average velocity and surface turbulence and greater than average depth while riffles had greater than average velocity and surface turbulence but less than average depth. Since it was felt that pools would contain more westslope cutthroat trout than riffles (Shepard et al. 1982), stratified random sampling was used to select half of the pools and one-third of the riffles for censusing. I randomized the order of
censusing the selected kilometer sections.

The population estimates were based on a simple visual sample and a mark–visual recapture sample. The marking phase consisted of capturing trout using a fly rod and dry fly. Hooking mortality was assumed to be negligible (Dotson 1982, Mongillo 1984). A single pass was made through each selected pool and riffle. Trout were measured (total length), tagged and released. Dangler tags, consisting of a red plastic chip attached to white latex thread, were used in 1984. Dangler tags and cylindrical Floy anchor tags were used in 1985.

Within 24–48 h of hook-and-line sampling, I conducted a visual census in the selected habitats. A snorkel, mask and wetsuit were used to perform the underwater census. I swam upstream from the lower end of each pool or riffle, noting the size class (< 23, 23–30, or > 30 cm) and the presence or absence of a tag for each cutthroat trout. Fish length was assessed by visual estimation and by comparing the fish’s total length to observable characteristics of the substrate and then measuring the distance on the substrate. This information was recorded on sanded white plexiglass sheets.

Underwater observations were made from 1000–1500 hours on cloudless days. The water surface was usually exposed to sunlight due to the lack of riparian vegetation. Generally the entire channel could be observed on a single pass along one bank. If surface turbulence or channel width reduced visibility of the opposite bank, I made a second pass along that bank. Additional passes were also made to census beneath undercut banks, overhanging vegetation and debris jams. Care was taken to avoid disturbing fish to reduce the likelihood duplicate
counts of a single individual.

The population estimate for the simple visual census is derived from Sheldon (1966) (as modified from Cochran 1977):

Kilometers (i) 1...i...M
Sample with equal probability 1......m

Habitat type strata (j) 1...j...S

Habitats (k) 1...k...R_{ij}
Sample 1......r_{ij}

For each r_{ij}, observe:

\[ x_{ijk} \]

where:

\[ x_{ijk} = \text{the number of fish in the } ijk^{th} \text{ habitat} \]

Then the number per large cluster (i) within the jth habitat type stratum is:

\[ x_{ij.} = \frac{\sum_{k=1}^{R_{ij}} x_{ijk}}{r_{ij}} \]

and the number per large cluster over all j is:

\[ x_{i.} = \sum_{j=1}^{S} x_{ij.} \]

and the number for the entire study area over all i and j is:

\[ x_{.} = \sum_{i=0}^{M} \sum_{j=0}^{S} x_{i..} \]

and the average number per kilometer for the entire study area is:
\[ x_{1..} = \frac{X_{...}}{N} \]

Variances:

\[
V(X) = \sum_{i=1}^{m} \sum_{j=1}^{r} \frac{(R_{ij} - r_{ij})R_{ij}}{r_{ij}} S_{b1j}^2 + \frac{M(N-m)}{m^2} S_b^2
\]

and:

\[
V(x_{1..}) = \frac{V(X)}{M^2}
\]

where:

\[
S_{b1j}^2 = \sum_{k=1}^{r} \frac{(x_{ijk} - x_{1..})^2}{r_{ij} - 1}
\]

and:

\[
S_b^2 = \sum_{i=1}^{m} \frac{(X_{i..} - x_{1..})^2}{m-1}
\]

The standard errors of the estimates are the square roots of the corresponding variances.

A mark-recapture estimate of the population was calculated using the Petersen estimate (Ricker 1975):

\[
N = \frac{MC}{R}
\]

where \(N\) = total population size, \(M\) = the number of fish marked, \(C\) = the number of fish observed during the underwater census, and \(R\) = the number of tagged fish observed during the underwater census. \(N\) represents the total population of the sampled reaches. To determine the average number of trout/km, calculate:
An approximation of the variance is:

\[ V(X_p) = \frac{m^2(c)(c-R)}{R^3} \frac{X_{i..}^2}{C^2} \]

The standard error of the estimate is the square root of the variance. A 95% confidence interval using \( \pm 2 \{V(X_p)\}^{.5} \) is biased, but this bias is reduced to an acceptable level if \( MC > 4N \) (Otis et al. 1978).

The precision of each estimate was evaluated by calculating \( cv(X) \) (White et al. 1982), where:

\[ cv(X) = \frac{SE(X)}{X} \times 100 \]

Fish captured in 1985 were weighed to the nearest 5 g on Ohaus spring scales. These data were used to construct the length–weight equation:

\[ W = aL^b \]

where \( W \) is weight (g), \( L \) is length (mm) and \( a \) and \( b \) are constants derived from the data by converting the above equation to:

\[ \log W = \log a + b \log L \]

Least-squares regression was used to calculate the slope (\( b \)) and \( y\)-intercept (\( \log a \)) of this equation.

Biomass per kilometer was estimated by calculating the weight of 15 fish (in .5–cm intervals) in each size class based on the length–weight equation. The mean of these weights was multiplied by the average number of trout in that size class per kilometer, based on the simple visual estimate. The sum of the
expanded weights of the three size classes was used as the biomass estimate.

Vulnerability

The assessment of angling vulnerability of westslope cutthroat trout was conducted simultaneously with the population estimate in 1984 and separately in 1985. Again, I captured, tagged and released trout prior to conducting a visual census. The size class of each trout was noted during the census. The proportion of cutthroat trout in each size class in the visual and rod-caught samples were compared using a chi-square test of homogeneity (Cochran 1977). This test was also used to evaluate differences in the susceptibility of each size class to visual detection. Newman and Waters (1984) used a similar analysis to assess size-selection of *Gammarus* by trout. The three size classes (< 23, 23–30 and > 30 cm) were chosen to help evaluate the new regulations protecting all cutthroat trout greater than 30.5 cm (12 inches).

Additional indicators of catchability included catch rates (trout/h) and of physical evidence of previous capture. Fish lacking one or both maxillae or displaying hook-caused damage to the upper or lower jaw were considered previous captures.

Microhabitat

Microhabitat data were collected in 1985. Three one-kilometer sections were
randomly selected for sampling. I snorkeled from the lower end of each section until a fish was detected. Each trout was observed for 1–3 min to determine its focal point and activity. Each fish was measured using a 1.3-m orange fiberglass rod. A marker was placed below the focal point prior to collecting data on focal point water velocity, surface water velocity, focal point depth, total depth, substrate size, surface turbulence and shade. Water velocity was measured from 0–170 cm/s using midget Bentzel current speed tubes (Everest 1967). Depth was measured with the fiberglass rod. Substrate was placed in one of the following categories: < .25 cm, .25–2.5 cm, 2.5–7.5 cm, 7.5–15 cm, 15–30 cm, 30–60 cm or > 60 cm. A site possessed surface turbulence if I could not clearly detect the substrate from directly above the water surface. Shade was determined by estimating its presence or absence at a site from 1000–1500 hours.

Fausch and White (1981) demonstrated that trout may select focal points in slow water near swifter currents. Such a 'water velocity difference' would maximize the amount of food passing the focal point per unit time but minimize the metabolic costs of swimming. Cutthroat trout were active surface feeders in the SFFR (pers. obs.) and have demonstrated an affinity for surface feeding in laboratory experiments (Schutz and Northcote 1972). Furthermore, water velocities at the surface are close to the maximum velocity in the water column at a given point. The definition of water velocity difference has varied in previous studies, depending upon the author and the species of interest (Fausch and White 1981, Pratt 1984). In this study, the water velocity difference was the difference between surface and focal point velocities. Other variables examined were focal point
distance from the bottom and percentage of total depth of focal points.

Data on habitat availability were collected on four kilometers of stream, three of which were sampled for trout microhabitats. Eight randomly chosen transects were established per kilometer. A rope marked at 2-m intervals was placed across the channel at each transect. I collected information on surface water velocity, total depth, substrate size, surface turbulence and shade. Certain sites with depth > 1.25 m could not be safely sampled and were omitted from the analysis.

I divided the trout sample into two size classes (<=26 cm and > 26 cm). Stepwise discriminant analysis (SPSS Inc. 1983) was used to determine if size class membership could be predicted based on microhabitat characteristics. Discriminant analysis has been widely used in other studies of aquatic environments (Swanston et al. 1977, Green and Vascotto 1978, Tonn et al. 1983, Sheldon 1984). Size class was the dependent variable and surface water velocity, focal point water velocity, water velocity difference, total depth, focal point distance from the substrate, the percentage of total depth of focal points and substrate size were the independent variables. A variable was selected based on its ability to reduce the overall Wilks' lambda and was entered into the analysis if its F-score was greater than 1 (SPSS Inc. 1983). A second discriminant analysis was conducted using the same selection rules with three size classes (< 23 cm, 23–30 cm, > 30 cm).

Simple correlation coefficients were calculated for each independent variable with trout size (SPSS Inc. 1983). Correlation coefficients were also determined for total depth with surface water velocity, focal point water velocity and water
velocity difference.

The use and availability of habitat was analyzed by conducting chi-square tests of homogeneity (Marcum and Loftsgaarden 1980). The variables selected for this analysis were surface water velocity, total depth, substrate size and surface turbulence. Each variable was divided into 3–4 categories and each category contained at least five observations. Electivity values were calculated for these variables using a modified Ivlev's index (Jacobs 1974):

\[ D = \frac{r-p}{r+p-2rp} \]

where \( r \) equals the proportion of a habitat parameter used by trout and \( p \) is the proportion of that parameter available in the stream. Values range from −1 to 0 for avoidance and from 0 to 1 for preference (Jacobs 1974). Values greater than an absolute value of 0.5 may indicate strong positive or negative selection of a habitat (Moyle and Vondracek 1985). Please note that selection usually implies an active choice by the fish. In the present context, however, choice cannot be explicitly demonstrated. Therefore the terms selection, avoidance and preference are used largely for convenience. This does not eliminate the possibility that these terms are being accurately applied.

Angler Survey

Informal interviews of 20 anglers in 1984 demonstrated that most (75%) were not aware of the new regulations and five gave evidence of violating them (pers.
obs.). Glass and Maughan (1984) considered ignorance of new regulations a major problem in gaining compliance with length limits for largemouth bass (*Micropterus salmoides*) in Oklahoma. In 1985, the MDFWP distributed information on the 3-fish limit to increase angler awareness (John Fraley, MDFWP, pers. comm.) and I began a more structured assessment of angler characteristics.

Trail registers were installed on June 29–30, 1985 at 6 trailheads leading into the Bob Marshall Wilderness Area. I selected these trailheads because they probably receive the greatest use by fishermen visiting the SFFR drainage (Robert Lucas, Forestry Sciences Lab, USFS, pers. comm.). Each register displayed two information posters, one requesting help with this study and the other explaining the current fishing regulations in the wilderness area (Appendix A). The registers contained cards requesting the name and address of each visitor 16 years old or older. USFS personnel collected the completed cards approximately every 2 weeks until mid-September, when the trail registers were removed.

I decided to remove the registers at that time due to the reduced numbers of fishermen, the possibility of vandalism to the registers and the loss of Forest Service assistance (most seasonal personnel were laid off). The majority of visitors after September 15 are hunters and they comprise only 16% of all visitors to the wilderness (Lucas 1985). Note that the use of voluntary trail registers may lead to nonrepresentative sampling of anglers. Lucas (1983) demonstrated that registration compliance varied with user type, location and season. Probably not all types of anglers were surveyed and the results should be interpreted with this in mind.
A preliminary list of questions designed to ascertain angler beliefs, attitudes and behavior was submitted for evaluation to University of Montana, MDFWP and Forestry Sciences Laboratory personnel. Their comments were used to create a new set of questions. A pretest using slightly modified questions was conducted on a sample of 20 Rock Creek anglers. I developed a final version of the questionnaire after consideration of the pretest results.

The final questionnaire consisted of 15 questions and was constructed according to Dill (1978). The first question was designed solely to encourage recipients to complete the questionnaire. The remaining questions focused on angler attitudes, beliefs and behavior. The first mailing, composed of a questionnaire, a postage-paid return envelope and a cover letter, was sent March 12. A postcard reminder was sent 1 week later. The final mailing was sent April 2. I sent all mailings to only one person from each address on the registration cards.

SPSSx was used to calculate answer frequencies for each question (SPSS Inc. 1983). Written comments were also categorized and tabulated.

RESULTS
Population Estimation

In 1984, I observed 341 trout during underwater swims (Figure 2). The simple visual census of 19 pools and 12 riffles in five sections yielded an estimate of 5217 (SE = 388) westslope cutthroat trout in the entire study area. The estimated number of trout per kilometer was 149 (SE = 11). The mark–visual recapture estimate for a single kilometer was 242 (SE = 32). Forty-eight of 78
(62%) tagged fish were detected during the census.

The values of $cv(x)$ for the simple and mark-recapture estimates were 7% and 13%, respectively. White et al. (1982) suggested that $cv(X)$ should ideally be < 10%, thus precision was considered good in both cases.

Visual censuses were conducted only during excellent viewing conditions. Underwater visibility always exceeded 5 m and frequently exceeded 10 m. Drifting algae, however, began to reduce visibility during the last census on 17 August 1984.

I attempted to minimize surface splashing during the census because surface disturbance greatly altered trout behavior. Northcote and Wilkie (1963) also reported this reaction. Undisturbed fish generally did not flee forward from me as I approached, but moved to one side until I had passed. Frequently trout swam directly at the diver, then continued downstream. Neither behavior should result in duplicate counts.

Attempts to repeat the census in 1985 failed due to poor weather (which reduced underwater visibility) and restricted trail access. The latter problem resulted from the ca. 3000-hectare Charlotte Peak Fire. Drifting algae obscured the tags on two occasions when censuses were attempted. An extremely long (496 m) pool was also too deep (> 5 m) to census accurately due to a moderate current and light attenuation caused by the algae. Furthermore, similar conditions prevented an assessment of daily movements, which may impact the mark-recapture estimate.

I conducted a fin-clipping experiment to determine tag loss by westslope
Figure 2. The size class distribution of 341 trout observed during visual censuses in 1984.
cutthroat trout and to evaluate the validity of the mark-recapture estimate. I captured ten fish, clipped their adipose fins and released them. A census of these fish was conducted the following day. Unfortunately, the clips were not visible underwater. Slaney and Martin (in press) experienced similar difficulties detecting fin-clipped trout.

An assumption of the visual census was that all size classes were equally susceptible to visual detection. A chi-square test of homogeneity showed no significant difference between the size class distribution of known tagged fish and of tagged fish detected during the visual census (P > 0.6) (Table 1). Thus the null hypothesis of equal detectability was accepted.

The length-weight equation $W = 0.000023323 L^{2.853}$ was calculated using 119 trout captured from mid-July to mid-August 1985 (Figure 3). The biomass estimate was 22.506 kg/km (Table 2).

**Vulnerability**

I caught 92 and 174 cutthroat trout in 1984 and 1985, respectively. A chi-square test of homogeneity showed no difference in the size class distribution between the two years (P > 0.2) (Table 3). The results are comparable to those obtained by Fraley (unpubl. data 1985) in the study area. The mean sizes of trout captured in 1984 and 1985 were 25.7 cm (SD = 5.0) and 26.6 cm (SD = 5.0), respectively.

The 1984 catch rate equaled 4.4 trout/h, but this included travel time.
Table 1. Observed and expected values of known and visually detected tagged trout in 1984. Expected values are given in parentheses.

<table>
<thead>
<tr>
<th>Size Class (cm)</th>
<th>Detected</th>
<th>Known</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 30</td>
<td>6 (7.2)</td>
<td>13 (11.8)</td>
<td>19</td>
</tr>
<tr>
<td>23-30</td>
<td>26 (23.6)</td>
<td>36 (38.4)</td>
<td>62</td>
</tr>
<tr>
<td>&lt; 23</td>
<td>16 (17.1)</td>
<td>29 (27.9)</td>
<td>45</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>78</td>
<td>126</td>
</tr>
</tbody>
</table>

Chi-square = 0.8529 with 2 df. P > 0.6.
Figure 3. The graph of the length:weight equation

\[ W = 0.000023323 \times L^{2.853} \]
Table 2. The biomass estimate for trout in a single kilometer, based on a population estimate of 149 trout/km. Size class is the size class of the trout, No./km is the number in that size class per kilometer, g/indiv is mean grams per individual in that size class, and kg/km is the kilograms per kilometer in that size class.

<table>
<thead>
<tr>
<th>Size Class</th>
<th>No./km</th>
<th>g/indiv</th>
<th>kg/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 23 cm</td>
<td>79</td>
<td>82</td>
<td>6.5</td>
</tr>
<tr>
<td>23-30 cm</td>
<td>57</td>
<td>194</td>
<td>11.1</td>
</tr>
<tr>
<td>&gt; 30 cm</td>
<td>13</td>
<td>377</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>149</td>
<td></td>
<td>22.5</td>
</tr>
</tbody>
</table>
Table 3. Observed and expected values for rod-caught trout in 1984 and 1985. Expected values are in parentheses.

<table>
<thead>
<tr>
<th>Size Class (cm)</th>
<th>1984</th>
<th>1985</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 23</td>
<td>31 (24.9)</td>
<td>41 (47.1)</td>
<td>72</td>
</tr>
<tr>
<td>23-30</td>
<td>44 (48.1)</td>
<td>95 (90.9)</td>
<td>139</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>17 (19.0)</td>
<td>38 (36.0)</td>
<td>55</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>174</td>
<td>266</td>
</tr>
</tbody>
</table>

Chi-square = 3.14 with 2 df. P > 0.2.
between selected pools and riffles. In 1985, the catch rate had climbed to 7.0 trout/h. However, only time actually spent fishing was used in this year, thus the results should represent a better estimate of the true catch rate. Fraley’s (unpubl. data 1985) catch rates support this conclusion.

I compared the size class distributions of the rod-caught and visual samples from 1984 to determine differences in vulnerability to angling of different sizes of westslope cutthroat trout. Highly significant differences exist between these distributions (P < 0.002) (Table 4). I contracted an index of trout vulnerability to angling by dividing the number of tagged trout in each size class by the number of censused trout in each size class. This index suggests that vulnerability increases as size increases (Figure 4).

The number of fish having damaged mouths was also indicative of this species’ susceptibility to capture. Of 109 trout examined in 1985, 32 had some damage (29%).

Microhabitat

I calculated mean values for microhabitat characteristics from 72 focal points of westslope cutthroat trout (Table 5). Distributions of habitat use by westslope cutthroat trout and habitat availability were determined in 1985. These trout did not occupy some portions of their habitat in proportion to the habitat’s availability. Significant differences occurred between focal points and available habitat with respect to surface water velocity, total depth, substrate size and surface turbulence.
Figure 4. Vulnerability index for trout captured and censused in 1984.
Table 4. Observed and expected values of rod-caught and visual trout samples from 1984. Expected values are in parentheses.

<table>
<thead>
<tr>
<th>Size Class (cm)</th>
<th>&lt; 23</th>
<th>23-30</th>
<th>&gt; 30</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rod-caught</td>
<td>31 (45.0)</td>
<td>44 (37.0)</td>
<td>17 (11.0)</td>
<td>92</td>
</tr>
<tr>
<td>Visual</td>
<td>181 (167.0)</td>
<td>130 (137.0)</td>
<td>30 (37.0)</td>
<td>341</td>
</tr>
<tr>
<td>Total</td>
<td>212</td>
<td>174</td>
<td>47</td>
<td>433</td>
</tr>
</tbody>
</table>

Chi-square = 13.51 with 2 df.  P < 0.002.
(Tables 6–9). Shade was inadequately sampled for this analysis. Total depth was the only variable for which trout exhibited strong positive and negative selection (abs. val. $D > 0.5$) for certain values (Table 10).

One (total depth) of seven microhabitat variables was significantly correlated ($P < 0.05$) with trout size, but all the $r^2$ values of these correlations were less than 0.01, suggesting that little of the variation in the data was explained by the relationships. It is reasonable to assume that depth and velocity should be related (Vogel 1983), so I calculated correlation coefficients for three velocity variables with total depth. Focal point velocity was significantly correlated with total depth ($P < 0.001$). These two variables were multiplied to create a new variable, but this variable was not correlated with trout size ($P > 0.22$).

Discriminant analysis performed poorly in identifying trout size based on microhabitat characteristics. The discriminant function for two groups was nonsignificant ($P = 0.113$) and was unable to consistently classify group membership (Table 11). In the three-group case, the first discriminant function was significant ($P=0.021$) but very little of the variation in the data was explained by the groups (canonical correlation coefficient $= 0.377$) (Table 12). Even though the classification rate was relatively high in this case, the use of the same data to construct and test the discriminant functions probably lead to a positive bias (Hair et al. 1979). Group centroids for each case tended to cluster (Figures 5–6).

Angler Survey
Table 5. Mean values of microhabitat parameters for 72 trout in 1985. Standard deviations are given in parentheses.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface Water Velocity</td>
<td>92 (36)</td>
</tr>
<tr>
<td>Focal Point Water Velocity</td>
<td>44 (16)</td>
</tr>
<tr>
<td>Water Velocity Difference</td>
<td>48 (27)</td>
</tr>
<tr>
<td>Total Depth</td>
<td>81 (25)</td>
</tr>
<tr>
<td>Focal Point Dist. From Bottom</td>
<td>9 (4)</td>
</tr>
<tr>
<td>% Total Depth of Focal Point</td>
<td>89 (5)</td>
</tr>
<tr>
<td>Substrate Size</td>
<td>12 (9)</td>
</tr>
</tbody>
</table>
Table 6. Observed and expected frequencies of surface water velocity above trout focal points and at points on availability transects. F. P. is focal point and Avail. is availability. Expected values are in parentheses.

<table>
<thead>
<tr>
<th>Surface Water Velocity (cm/s)</th>
<th>0-60</th>
<th>61-120</th>
<th>&gt; 120</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. P.</td>
<td>14 (26.0)</td>
<td>40 (30.0)</td>
<td>18 (16.0)</td>
<td>72</td>
</tr>
<tr>
<td>Avail.</td>
<td>111 (99.0)</td>
<td>104 (114.0)</td>
<td>59 (61.0)</td>
<td>274</td>
</tr>
<tr>
<td>Total</td>
<td>125</td>
<td>144</td>
<td>77</td>
<td>346</td>
</tr>
</tbody>
</table>

Chi-square = 11.52 with 2 df. P < 0.004.
Table 7. Observed and expected frequencies of total depth at trout focal points and at points on availability transects. F. P. is focal point and Avail. is availability. Expected values are in parentheses.

<table>
<thead>
<tr>
<th>Total Depth (cm)</th>
<th>0-60</th>
<th>61-90</th>
<th>&gt; 90</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. P.</td>
<td>17 (47.7)</td>
<td>26 (15.2)</td>
<td>29 (9.2)</td>
<td>72</td>
</tr>
<tr>
<td>Avail.</td>
<td>212 (181.3)</td>
<td>47 (58.7)</td>
<td>15 (34.8)</td>
<td>274</td>
</tr>
<tr>
<td>Total</td>
<td>229</td>
<td>73</td>
<td>44</td>
<td>346</td>
</tr>
</tbody>
</table>

Chi-square = 88.88 with 2 df. P << 0.001.
Table 8. Observed and expected frequencies of substrate size beneath trout focal points and at points on availability transects. F. P. is focal point and Avail. is availability. Expected values are given in parentheses.

<table>
<thead>
<tr>
<th>Substrate Size (cm)</th>
<th>&lt; 2.5</th>
<th>2.5-7.5</th>
<th>7.5-15</th>
<th>&gt; 15</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. P.</td>
<td>5 (7.5)</td>
<td>18 (18.7)</td>
<td>31 (20.0)</td>
<td>18 (25.8)</td>
<td>72</td>
</tr>
<tr>
<td>Avail.</td>
<td>31 (28.5)</td>
<td>72 (71.3)</td>
<td>65 (76.0)</td>
<td>106 (98.2)</td>
<td>274</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>90</td>
<td>96</td>
<td>124</td>
<td>346</td>
</tr>
</tbody>
</table>

Chi-square = 11.76 with 3 df. P < 0.009.
Table 9. Observed and expected frequencies of surface turbulence above trout focal points and at points on availability transects. F. P. is focal point and Avail. is availability. Expected values are in parentheses.

<table>
<thead>
<tr>
<th>Turbulence</th>
<th>Present</th>
<th>Absent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>F. P.</td>
<td>57 (44.5)</td>
<td>15 (27.5)</td>
<td>72</td>
</tr>
<tr>
<td>Avail.</td>
<td>157 (169.5)</td>
<td>117 (104.5)</td>
<td>274</td>
</tr>
<tr>
<td>Total</td>
<td>214</td>
<td>132</td>
<td>364</td>
</tr>
</tbody>
</table>

Chi-square = 11.61 with 1 df. P < 0.001.
Table 10. Electivity values of total depth. Absolute values of $D > 0.5$ indicate strong selection.

<table>
<thead>
<tr>
<th>Total Depth (cm)</th>
<th>0-60</th>
<th>61-120</th>
<th>&gt; 120</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D$</td>
<td>-0.83</td>
<td>0.46</td>
<td>0.84</td>
</tr>
</tbody>
</table>
Figure 5. The distribution of observations in the two-group discriminant analysis. The characters on the DF I axis are the group centroids.
Figure 6. The distribution of observations in the three-group discriminant analysis. The filled characters are the group centroids.
Table 11. Classification table and statistics for the two-group discriminant analysis. DF is the discriminant function, P is the significance level, and C. C. is the canonical correlation coefficient.

<table>
<thead>
<tr>
<th>Predicted Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual Group</td>
</tr>
<tr>
<td>16-26 cm (1)</td>
</tr>
<tr>
<td>27-36 cm (2)</td>
</tr>
</tbody>
</table>

Cases correctly classified: 56%

<table>
<thead>
<tr>
<th>Variables</th>
<th>Wilks'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used</td>
<td>DF</td>
</tr>
<tr>
<td>Total Depth</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 12. Classification table and statistics for the three-group discriminant analysis. SWV is surface water velocity, WVD is water velocity difference, PD is focal point percentage of total depth, DF is discriminant function, P is the significance level, and CC is the canonical correlation coefficient.

<table>
<thead>
<tr>
<th>Predicted Membership</th>
<th>Actual Group</th>
<th>No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 23 cm (1)</td>
<td>22</td>
<td>8</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>23-30 cm (2)</td>
<td>36</td>
<td>2</td>
<td>34</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>&gt; 30 cm (3)</td>
<td>14</td>
<td>4</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

Cases correctly classified: 63%

<table>
<thead>
<tr>
<th>Variables Used</th>
<th>Wilks' DF</th>
<th>Wilks' lambda</th>
<th>P</th>
<th>CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWV, WVD, PD</td>
<td>1</td>
<td>0.803</td>
<td>0.021</td>
<td>0.377</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.936</td>
<td>0.106</td>
<td>0.253</td>
</tr>
</tbody>
</table>
Fifty-four completed registration cards contained the names of 42 Montana residents and 57 nonresidents. Seventy-six questionnaires were mailed to selected visitors. The US Postal Service returned three surveys because the addressees could not be located. One person could not respond because he was outside the country and two apparent recipients failed to return completed questionnaires. The remaining 69 questionnaires (91%) were completed and returned by April 16, 1986.

Respondents answered most questions (Table 13). Mean nonresponse per question was 4% (SD = 2.3) and this was primarily by participants that had not fished in the area in 1985. Written comments were also summarized (Table 14).

**DISCUSSION**

**Population Estimation**

The visual census indicates a reduced population of westslope cutthroat trout in the upper SFFR. The catch-and-release section of Rattlesnake Creek (closed to angling until 1985) in Montana contained 247 cutthroat trout/km, but its discharge was only 0.95 m³/s (Wilson and Blount 1986). Furthermore, the study area averaged 13.1 trout > 30 cm/km, whereas the mean in Rattlesnake Creek was 63.6 trout > 30 cm/km (Wilson and Blount 1986). One section of Rock Creek in Montana averaged over 800 rainbow trout/km, and this does not include the number of three other salmonids in this reach (Peters 1981). The upper Clark Fork River (5.01 m³/s) averaged 430 brown trout/km (Vashro and Peters 1977). Differences in trout densities between the SFFR and these streams may be related to two factors: stream productivity and trout vulnerability to angling. Vulnerability
Table 13. Answer frequencies to selected questions from the angler survey. Inc is increase, Dec is decrease, NE is no effect and Oth is the sum of other responses and missing answers.

Do you believe the current fishing regulations for cutthroat trout will increase, decrease or have no effect on the number of trout in the SFFR?

Inc 71% Dec 4% NE 12% Oth 13%

Do you believe the current fishing regulations for cutthroat trout will increase, decrease or have no effect on the average size of trout in the SFFR?

Inc 69% Dec 6% NE 9% Oth 16%

Do you believe the current fishing regulations for cutthroat trout will increase, decrease or have no effect on the quality of fishing in the SFFR?

Inc 71% Dec 0% NE 15% Oth 14%

Do you believe the catch and release regulations would increase, decrease or have no effect on the quality of fishing in the SFFR?

Inc 52% Dec 12% NE 20% Oth 16%

If the current fishing regulations were changed to catch and release regulations, would you fish the SFFR?

Yes 49% No 38% Oth 13%

If you have fished in the SFFR before 1985, how would you rate the quality of fishing now compared to your previous experience?

Better 7% Worse 16% Same 23% Oth 54%
Table 13 continued.

Would you support the stocking of trout in the SFFR?  
Yes 38%  No 41%  Oth 21%

Would you support the stocking of trout in lakes draining into the SFFR?  
Yes 54%  No 25%  Oth 21%

Did you keep and eat any trout from the SFFR drainage in 1985?  
Yes 72%  No 22%  Oth 6%

How important was fishing as a reason for visiting the SFFR drainage in 1985?  
Most 29%  Very 35%  Fairly 16%  Not 14%  Oth 6%

What types of water did you fish in the SFFR drainage in 1985?  
Only Running Water 55%  Only Lakes 4%  
Combinations 27%  Oth 13%

How many years have you fished in the SFFR drainage, including 1985?  
None 7%  1 35%  2-5 25%  6+ 29%  Oth 4%
Table 14. A compilation of written comments from the angler survey. C&R is catch and release, inc. is increase, dec. is decrease, tribs. is tributaries, and exp. is experience.

<table>
<thead>
<tr>
<th>Would like to:</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep one fish &gt; 30 cm</td>
<td>6</td>
</tr>
<tr>
<td>Keep fish for meals</td>
<td>16</td>
</tr>
<tr>
<td>Keep at least one fish/d</td>
<td>3</td>
</tr>
<tr>
<td>Keep all injured fish</td>
<td>2</td>
</tr>
<tr>
<td>Avoid C&amp;R due in inc. in # but dec. in fish size</td>
<td>4</td>
</tr>
<tr>
<td>Avoid C&amp;R due to handling stress to fish</td>
<td>3</td>
</tr>
<tr>
<td>Have C&amp;R only on portions of the river or tribs.</td>
<td>5</td>
</tr>
<tr>
<td>Have C&amp;R in entire area</td>
<td>1</td>
</tr>
<tr>
<td>Avoid stocking to protect native trout</td>
<td>7</td>
</tr>
<tr>
<td>Avoid stocking to maintain wilderness exp.</td>
<td>4</td>
</tr>
<tr>
<td>Have stocking only if no natural spawning</td>
<td>2</td>
</tr>
<tr>
<td>Have stocking only as a last resort from overuse</td>
<td>3</td>
</tr>
<tr>
<td>Have stocking increased</td>
<td>3</td>
</tr>
</tbody>
</table>

Other comments

| Support any action to protect fishery                                         | 3   |
| Habitat degradation from commercial use (horses)                             | 4   |
| Fishery degradation from commercial use (rafts)                              | 1   |
| Found fishing excellent                                                      | 4   |
will be addressed in a later section. Productivity of the SFFR was assumed to be low. It appears high flows each spring prevent establishment of vegetation on the lower banks and cause scouring of the stream substrate. Unfortunately, limited information is available on water chemistry or discharge in the study area.

The population estimates in this study are much larger than previous estimates for this stream. Shepard et al. (1982) reported densities of 54 and 84 trout/km for two locations within the study area. Even though pools contained the highest trout densities, Shepard et al. (1982) sampled other habitat types more intensively. In this study, pools were sampled with greater frequency than riffles because the former should provide greater information and more accurate counts (Scheaffer et al. 1979). If both censuses were correct, then westslope cutthroat trout increased substantially from 1981 to 1984. The 1981 census was conducted roughly 2 weeks later in August during much lower flows (2.7 m$^3$/s). This may have caused migration of trout out of the study area and produced lower counts. Kraft (1972) found that trout did not leave a reach until it had been severely dewatered, but he studied brook trout in a small stream.

The results of the simple and mark-recapture censuses differ considerably. Approximately 60% of the known tagged fish were detected during underwater observation. Nonetheless, the viewing conditions were excellent and I feel it is unlikely that a third of all fish escaped detection. Two factors may have contributed to an artificially high mark-recapture estimate. First, tags could have been lost due to poor tag insertion, tangling of the tag in drifting algae or other fish striking the tag. One fish in 1985 possessed an obvious scar near the dorsal
fin where a tag had apparently been dislodged. Rawstron (1973) reported high initial losses of tags by salmonids. Drifting algae, a severe problem in 1985, was noticeable on the final census of 1984 and may have caused tag loss as well as reducing tag visibility. Second, daily movements may have caused certain tagged individuals to escape detection if they entered an unsampled habitat. Edmundson et al. (1968) found 14% of juvenile steelhead moved > 6 m from their original station within 1 day. Bjornn and Mallet (1964) documented extensive movements in cutthroat trout, but these tended to be seasonal. Ted Bjornn (University of Idaho, pers. comm.) suggested cutthroat trout may be largely nonmigratory from late July to late August. Nonetheless, on several occasions readily observed habitats lacked any trout despite the recent (within 24 h) capture of an individual at that site. Furthermore, in one riffle I observed two tagged fish though I had not marked any fish in that habitat. The best estimate of westslope cutthroat trout abundance in the upper SFFR is probably between the two suggested values.

The length-weight equation for cutthroat trout in the study area was similar to that of cutthroat trout throughout the upper Flathead River basin (Fraley et al. 1981). Biomass was difficult to compare due to the use of different units (m in this study, m² in Fraley et al. 1981). The biomass of cutthroat trout in much smaller Rattlesnake Creek was 97.2 kg/km, over 4 times the biomass in the study area.

The pool:riffle ratio for the SFFR in the study was 50.9:49.1. This nearly equals the ideal ratio of 1:1 (Duff and Cooper 1976). Hickman and Raleigh (1982) stated that this balance provided abundant food-producing water (riffles) and
rearing habitat. Ray Zubik (MDFWP, pers. comm.) has suggested that the number of pools and riffles per kilometer may help explain cutthroat densities. The data demonstrate trout were more abundant in pools than in riffles. Pools held approximately 24 trout/100 m while riffles contained seven trout/100 m.

Vulnerability

Cutthroat trout are generally considered extremely vulnerable to angling. Over 30% of the cutthroat in an Idaho stream were removed in 32 h of angling, while only 7% of the brook trout were captured (MacPhee 1966). The results of this study tend to confirm this belief.

Catch rates in this study are quite high when compared to rates for other species in other streams (Table 15). Based on the simple visual population estimate in the study area, theoretically one could capture all the westslope cutthroat trout in 1 km in less than 22 h. Admittedly, much of the published data on catch rates has been of angling by the public, who tend to be less efficient than researchers. Furthermore, I have had extensive angling experience in western Montana. Nonetheless, anglers fishing Rattlesnake Creek in Montana captured an average of 3.6 cutthroat trout/h, which climbed to 7.3 trout/h in one section (Wilson and Blount 1986).

Certain individuals are extremely susceptible to capture by rod and line. A 29-cm trout was tagged and recaptured within 3 h in this study. A 44-cm cutthroat trout was caught 9 times in 7 months in Rattlesnake Creek (Wilson and
Table 15. Catch rates (fish/h) for several studies. WCT is westslope cutthroat trout, YCT is Yellowstone cutthroat trout, CT is unspecified cutthroat trout, BK is brook trout, R is rainbow trout, BR is brown trout, and BT is bull trout.

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<th>Rate</th>
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<td>WCT</td>
<td>M. Fk. Flathead R. tribs., MT Shepard et al. 1982</td>
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<tr>
<td>8.7</td>
<td>BK, CT</td>
<td>Rochat Creek, ID MacPhee 1966</td>
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<td>7.4</td>
<td>WCT</td>
<td>South Fk. Flathead R., MT Fraley unpubl. data 1985</td>
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<td>7.0</td>
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<td>South Fk. Flathead R., MT This study (1985)</td>
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<td>4.4</td>
<td>WCT</td>
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<td>3.6</td>
<td>CT</td>
<td>Rattlesnake Creek, MT Wilson and Blount 1986</td>
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<td>2.5</td>
<td>CT</td>
<td>St. Joe R., ID Johnson and Bjornn 1978</td>
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<td>1.8</td>
<td>BK</td>
<td>Lawrence Creek, WI Hunt 1970</td>
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<td>1.2</td>
<td>R, BR, BT, CT</td>
<td>Rock Creek, MT Peters 1983</td>
</tr>
<tr>
<td>1.1</td>
<td>YCT</td>
<td>Yellowstone River, WY Jones et al. 1984</td>
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</tbody>
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Blount 1986). Greer and Griffith (1985) estimated that each cutthroat trout in one section of the Yellowstone River in Yellowstone National Park was captured 9.2 times/year.

Slaney and Martin (in press) found similar proportions of cutthroat in their visual and rod-caught samples. In this study, the size of fish was positively related to an increase in vulnerability. Fish > 30 cm were more than twice as vulnerable as fish < 23 cm. Wilson and Blount (1986) reported recapture rates of 41% and 7% for cutthroat trout > 40 cm and < 20 cm, respectively. MacPhee (1966) captured 31% of all sizes of cutthroat trout in Rochat Creek but caught 50% of all cutthroat trout over 15 cm. Pollard and Bjornn (1973) caught only 4–12% of juvenile steelhead < 11.5 cm but nearly all of the juvenile steelhead > 11.5 cm in certain sections of an Idaho stream. The probability of recapture of brown trout increased as their size increased (Favro et al. 1986).

Griffith (1972) suggested that cutthroat trout were more vulnerable to fishermen because they occupied habitats easily approached by anglers. Cutthroat trout tend to occur at the heads of pools (Pratt 1984). This location would provide individuals with the first opportunity to capture food produced in the riffle immediately upstream. The production of aquatic invertebrates tends to be greater in riffles than in pools (Hynes 1970). This does not explain the size class differences in vulnerability. One hypothesis is larger westslope cutthroat trout are more active feeders than smaller individuals and thus have a greater probability of being caught. Elliot (1975) demonstrated that larger fish must feed longer to reach satiation. Another possibility is that in a low-productivity stream, the most
aggressively feeding individuals grow the fastest and attain the largest sizes.

The new regulations are designed to increase the total number and the average size of westslope cutthroat trout by reducing harvest of fish > 30 cm, which should also increase the number of sexually mature fish and thus increase recruitment. Shepard et al. (1984) suggested adfluvial westslope cutthroat trout mature at 34.9 cm after 6–7 years of growth. If harvest of subadult cutthroat trout is high, it is possible that no increase in average size will occur. Under these circumstances, few fish would survive to pass the regulation 'bottleneck' of 30.5 cm (12 in) (Andrew Sheldon, University of Montana, pers. comm.). Intense cropping of cutthroat trout over 33 cm has been reported on the St. Joe River, which has a 33-cm minimum size limit (Johnson and Bjornn 1978). If a bottleneck does develop on the SFFR, a combination of a lower maximum size and bag limit might increase the number of trout escaping to the larger size refuge.

Microhabitat

Several studies (Fausch and White 1981, Gosse and Helm 1981, Shirvell and Dungey 1983) have associated different daytime activities with certain focal points, e.g. resting, feeding and hiding. In this study, all microhabitats were assumed to be feeding sites. The majority of fish were observed making foraging trips before returning to a focal point, and no fish held positions that could be ascribed to other activities.

The mean water velocity of focal points of westslope cutthroat trout in this
study (44.5 cm/s) was much higher than previously reported for cutthroat trout. Focal point velocities of cutthroat trout in three Idaho streams averaged 7.8–13.7 cm/s and ranged as high as 29.3 cm/s, but few fish exceeded 16 cm and the author did not report the range of available water velocities (Griffith 1972). Pratt (1984) reported focal point velocities of 24 cm/s for individuals > 100 mm. Bovee (1978) listed the highest probability-of-use of water velocity by cutthroat trout from 35–52 cm/s, but these values are mean water column velocities. Such readings are generally taken at 0.6 of total depth from the surface (Platts et al. 1983). Focal points in this study averaged 0.89 of total depth. The drag of the substrate creates a velocity gradient with slower flows near the bottom (Vogel 1983). The mean focal point velocities reported here are generally much higher than those of other salmonids (Baldes and Vincent 1969, Everest and Chapman 1972, Fausch and White 1981, Shirvell and Dungey 1983, Smith and Li 1983, Baltz and Moyle 1984) with the following exception: adult rainbow trout (mean size 18.9 cm) in a California stream held focal points averaging 45 cm/s (Alley 1977 from Smith and Li 1983).

A possible explanation for the occupation of the swift microhabitats is related to food availability. The number of drifting invertebrates passing a given point more than tripled as velocity increased from 20 to 40 cm/s in three California streams (Smith and Li 1983). If the SFFR has low densities of invertebrates, westslope cutthroat trout may have to utilize sites with high water velocity to obtain adequate food. A possible consequence would be slow growth due to the relatively large metabolic costs of swimming. This argument is
supported by examining the mean water velocity difference in this study (47.6 cm/s). Theoretically, the larger the difference the greater the foraging advantage conveyed to the fish. This difference is at least 20 cm/s greater than previously reported in other studies of salmonids (Wickham 1967, Fausch and White 1981, Pratt 1984).

Mean total depth of focal points of cutthroat trout (80.9 cm) is also deeper than previously noted. Bovee (1978) reported the preferred depths of cutthroat trout were 46–55 cm. Depth and velocity, however, tend to be positively correlated (this relationship was found for total depth and focal point water velocity in this study), which helps explain why both of Bovee’s (1978) values should be lower.

Morantz et al. (1986) have seriously questioned the validity of water velocity measurements taken close (10–20 cm) to an underwater observer. Their results indicated that diver position may increase or decrease velocity readings, especially for midget Bentzel speed tubes. Such effects were not considered in this study, but should have been minimized. Readings were taken ca. 45 cm downstream and to the side of the speed tubes.

Wilzbach (1985) suggested food availability takes precedence over cover in site selection by cutthroat trout. Nonetheless, the importance of cover to trout is well documented (Boussu 1954, Baldes and Vincent 1969, Lewis 1969, Hickman and Raleigh 1982, Pratt 1984), yet its definition is subject to varying interpretation. Wesche (1980) defined cover for adult trout as being obscure substrate $\geq 15$ cm deep with water velocity $\geq 15$ cm/s. Pratt (1984) listed 19 habitat combinations
she considered cover. Giger (1973) associated cover in an area with one or more of the following: overhanging or submerged vegetation, undercut banks, debris jams, logs, boulders, deep water or turbulent water.

The definition of cover should probably be species- and site-specific. Shade produced by artificial cover was occupied more frequently by brown trout than by brook or rainbow trout (Butler and Hawthorne 1968). Griffith (1972) found brook trout in deep, slow water close to overhead cover, while cutthroat trout occurred in faster, shallower water almost twice as far from overhead cover. Based on previous studies and the current habitat availability in the SFFR, an appropriate definition of cover for westslope cutthroat trout in the study area might be an area with deep and/or turbulent water, overhanging vegetation or debris jams.

Westslope cutthroat trout were most often found in the vicinity of surface turbulence or in water > 30 cm deep. Overhanging riparian vegetation was rare, except in the uppermost sites. Trout of all sizes occurred beneath this vegetation. I encountered debris jams pools infrequently in the study area (6 were censused in 1984) but trout were also associated with these habitat features. In 4 of 6 sites, however, only trout < 23 cm were found there and generally at high densities, e.g. 72 were found in a 50-m pool. Interestingly, these fish had probably moved into the river during that summer (Shepard et al. 1984). I could not describe focal point characteristics for these fish because they tended to wander throughout the water column. Frequently they failed to positively orient themselves with respect to the current. The low water velocities may have contributed to this behavior. In other habitats, trout < 23 cm occupied fixed microsites and faced upstream.
Hickman and Raleigh (1982) suggested large adult trout would hold feeding focal points with overhead cover and subdominant adults and juveniles would occupy sites lacking such cover. The absence of large (> 30 cm) trout near or beneath debris jams in this study may be attributable to a lack of light which may be necessary for effective feeding (Schutz and Northcote 1972), but this is purely speculative. Gibson and Power (1975), however, found that brook trout used shade in shallow (< 50 cm) water, but moved into open areas when depth exceeded 50 cm. Juvenile Atlantic salmon (Salmo salar) chose turbulent shallow water over shaded shallow water (Gibson 1978).

The mean distance of focal points above the substrate (8.8 cm) was typical of values for many salmonids. Pratt (1984) reported a mean distance of 13 cm. Values for other species include 10–18 cm for adult rainbow trout (Baltz and Moyle 1983, Campbell and Neuner 1985), 2–7 cm for adult brook trout (Fausch and White 1981), 2–9 cm for juvenile bull trout (Pratt 1984) and 2–5 cm for juvenile and adult brown trout (Moyle and Vondracek 1985).

Substrate size was not considered representative of trout microhabitats due to its large coefficient of variation (70%). Substrate size has, however, been widely used to describe trout microsites (Gorman and Karr 1978, Binns and Eiserman 1979, Hickman and Raleigh 1982).

My inability to obtain microhabitat information in certain areas should not substantially alter interpretation of these results. I usually censused deep locations (> 1.25 m) without difficulty and relatively few trout occupied these sites, but these trout were generally > 30 cm. The use–availability analysis suggests that
deep areas were utilized in much greater proportion than their availability. Less than 5% of the availability transect points, however, were unreadable. Of these less than half were unreadable due to depth. The points unreadable due to high velocity (> 170 cm/s) were probably not used by trout, based on the low occupancy of those sites during censuses in this study.

Obviously, not every microhabitat parameter could be measured during the field season. It is possible that microhabitats could be separated by trout size based on unsampled variables to which the trout react. One observation, that cutthroat trout typically occupy the upper third of a pool, was not quantified or entered into the analysis, but this pattern has been previously documented (Griffith 1972, Pratt 1984). In addition, competition for microhabitats could develop during different seasons as flows and food availability shift, e.g. in winter when many trout enter the substrate (Bjornn 1971) or during spawning (Shirvell and Dungey 1983). Nonetheless, several authors were able to distinguish microhabitat differences among different size classes of trout based on the variables used in this study (Fausch and White 1981, Smith and Li 1983, Baltz and Moyle 1984).

The inability of the discriminant analysis to separate size groups supports the assumption that no differences in microhabitats exist among different size classes of westslope cutthroat trout. This is further substantiated by the lack of substantive correlations between trout size and the individual microhabitat parameters. These results agree with the prediction of Fretwell’s model that at low densities only a single habitat will be occupied. Fraser and Sise (1980) found that *Rhinichthys atratulus* occupied few habitats at low densities. Bohlin (1977)
reported juvenile sea trout behaved similarly in a laboratory stream. Additional microhabitat research is planned for 1990. Of particular interest will be the habitat distribution of trout if they increase in abundance. The model predicts a more uniform use of all available habitats with the optimal sites held by large individuals (Fretwell 1972).

Note that the discriminant analysis using three groups did result in a high classification rate for the 23–30 cm class (94%). It was assumed that most fish in the study area were residents during the field season. If this was false, then the largest size class could be composed of fluvial or adfluvial trout migrating downstream after spawning. These fish might not occupy optimal microsites during their migration. Furthermore, the residents might be separated based on microhabitat characteristics. An intensive study of movements is necessary to resolve this problem.

Angler Survey

Over half the visitors volunteering their names on registration cards were not Montana residents. Lucas (1985) estimated 39% of all visitors to the Bob Marshall Wilderness complex were nonresidents. This area has received national publicity (Edwards 1985) and USFS officials had noted an increase in out-of-state visitors in 1985 (Gordon Ash, wilderness ranger, USFS, pers. comm.).

Response to the questionnaire was excellent. Only two of 76 questionnaires were apparent nonreturns. Dill (1978) stated that the average return rate for
surveys conducted using the 'total design method' was 73% for the general public and 81% for special interest groups. Furthermore, he suggested question nonresponse rarely exceeded 4%.

Nearly 80% of anglers that responded to this survey fished in the SFFR. About 5% exclusively fished lakes and would not come under the jurisdiction of the regulations protecting westslope cutthroat trout in streams of the SFFR drainage. Strong support apparently exists for the current regulations. The majority of anglers felt the regulations would lead to increases in the average size and abundance of trout and quality of fishing. A number of anglers mentioned that they would like the opportunity to harvest one fish > 30.5 cm. Managers will have to determine whether the trout population could sustain a harvest of large trout.

The appeal of catch-and-release regulations was less certain. Though most felt angling quality would improve in the SFFR, only slightly more than 50% stated they would continue to fish there under those regulations. Several wrote comments relating the wilderness experience to the opportunity to capture and consume fish. Over 75% of those responding indicated they kept fish during their stay in 1985. The apparent dislike of no-kill regulations supports the hypothesis that anglers prefer restrictions that will not affect their fishing behavior (Renyard and Hilborn 1986). A few anglers did suggest that catch-and-release regulations would be acceptable on portions of the river or tributaries.

The majority of anglers had fished the SFFR more than 1 year and more than 1 day in 1985. Most considered fishing an important part of their wilderness visit. Responses of anglers visiting the Uinta Primitive Area in Utah were very similar
(Kennedy and Brown 1976).

Recall the justification for the new regulations was a perceived decline in the abundance and mean size of cutthroat trout. Only 34% of those expressing an opinion, however, felt the fishery was in worse shape in 1985 than in previous years. This proportion also holds for long-term (6+ years) users, who would have the best opportunity to evaluate quality changes. This may reflect a possible improvement of angling if the recent population estimates are correct. Alternatively, the greatest decline in the fishery may have occurred prior to the visits of long-time visitors.

State policy dictates that the SFFR will not be stocked, but that lakes in the drainage may be stocked to genetically ‘swamp’ nonnative salmonids or to create fisheries where no natural spawning occurs (James Vashro, MDFWP, pers. comm.). Most anglers favored stocking lakes, but I noted more resistance to stocking the river. Seven anglers wrote that native cutthroat trout deserved protection. Johnson and Bjornn (1978) found that 88% of fishermen using the St. Joe River wished to preserve the native cutthroat fishery even if the bag limit was reduced to 0.

**SUMMARY**

The SFFR in the study area contains relatively low numbers of westslope cutthroat trout, based on visual and mark-recapture population estimates. The new regulations protecting trout > 30.5 cm may cause an increase in trout
abundance, due to the sensitivity of this subspecies to angling. Trout > 30 cm were most susceptible to capture by hook and line. Microhabitats of all fish were similar, again suggesting the availability of optimal sites for all sizes of trout, and that the fish are behaving ideally with respect to certain predictions made by Fretwell's models of habitat distribution. Anglers supported the new regulations and felt fishing quality would improve, but wished to continue harvesting some trout.

Previous studies (Bjornn et al. 1977, Jones et al. 1984) have documented large increases in cutthroat trout populations in response to the implementation of restrictive angling regulations. Should the number of trout in the SFFR increase, several other changes may also take place in the fishery. Biomass, catch rates and/or mean size of trout should increase. Trout may use all microhabitats more uniformly and theoretically the largest individuals should hold the best sites. Differences in the microhabitats of large and small trout may become evident. Biologists may wish to consider altering the regulations to satisfy fishermen, e.g. to allow the occasional harvest of larger fish.

Follow-up studies are planned for 1990. In the interim, I recommend a study of daily and seasonal movements. The potential impact of daily movements on the mark-recapture estimate has been noted. If movements occur throughout the summer by one, a few or all size classes, the interpretation of other results in this study could change dramatically. Furthermore, such behavior would make a future evaluation of the success of the fishing regulations more difficult.
APPENDIX A

Materials Developed for Use in the Angler Survey
Biologists have several options when it comes to managing trout streams in wilderness areas. These options include such techniques as catch regulations and stocking. The key to effective management depends upon knowing the aspects of wilderness fishing important to anglers.

You are one of a number of people being asked to give an opinion on these matters. Your name was drawn from a survey card you completed before entering the Bob Marshall Wilderness Area. In order to have representative results, it is important that each questionnaire be completed and returned. It is also important that the questionnaire be completed by the person named on the front envelope. If this person is no longer at this address, please print the correct address on the return envelope and mail it to me. I will see that this person receives a questionnaire.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This enables us to check off your name when the questionnaire is returned. Your name will never be placed on the questionnaire.

The results of this survey will be presented to the Montana Department of Fish, Wildlife and Parks, the University of Montana and all interested citizens. To receive a copy, please print your name, address and "Results Requested" on the back of the return envelope. Please do not put this information on the questionnaire.

If you have any questions, feel free to write or call. The number is (406) 243-6749. Thank you for your assistance.

Sincerely,

Michael K. Young
Project Director

A-1. Cover letter for the initial mailing.
Three weeks ago we wrote to you seeking your opinions on wilderness trout management. As of today we have not received your completed questionnaire.

Your input is important. This information will be examined by Montana Fish, Wildlife and Parks personnel to help guide future management of wilderness fisheries. Only about one of every 200 fishermen visiting the Bob Marshall Wilderness Area in 1985 has been asked to complete this questionnaire. Therefore, it is essential that each person return a questionnaire to truly represent the opinions of wilderness fishermen.

As mentioned in the previous letter, it is important that the person named on the envelope completes the questionnaire. Furthermore, you may be assured of complete confidentiality. You can obtain the results of this study by printing your address on the back of the return envelope.

Should the previous questionnaire have been misplaced, please use the replacement we have enclosed.

Your cooperation is greatly appreciated.

Sincerely,

Michael K. Young
Project Director

A-2. Cover letter for the second mailing.
Last week a questionnaire seeking your opinion about wilderness trout management was mailed to you. Your name was selected from a trail registration card.

If you have already completed and returned it to us please accept our sincere thanks. If not, please do so today. Because it has been sent to a small sample of wilderness fishermen, it is very important that your thoughts be included if the results are to accurately reflect the opinions of wilderness fishermen.

If by some chance you did not receive a questionnaire, or it has gotten misplaced, call me now at (406) 243-6749 and I will place one in the mail to you today.

Sincerely,

Michael K. Young
Project Director
WILDERNESS AREA FISHERY STUDY
SPECIAL REGISTRATION CARD
Please print the complete name and mailing address of each person in your party who is 16 years old or older and plans to fish in the South Fork of the Flathead River, its tributaries, or lakes draining into it. (Guides, packers, work crews, etc. should not register.)

Please Print

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Today's date: _______________   THANK YOU!
WILDERNESS FISHERY STUDY

ALL FISHERMEN PLEASE REGISTER

A study is being conducted on the South Fork of the Flathead River drainage.

We need to know more about your opinions to manage this fishery, so some of you will be mailed a questionnaire.

THANK YOU

University of Montana
Montana Dept. of Fish, Wildlife and Parks

A-5. Survey information poster.
FISHERMAN

TAGGED FISH HAVE BEEN PLACED IN THESE WATERS

YOUR CONTRIBUTION TO BETTER FISHING IS APPRECIATED. Please RETURN TAGS to the Montana Fish & Game Dept.

P.O. BOX 67 KALISPELL, MT. 59901
PHONE 755-5505

A-6. MDFWP information poster.
We would like to know how you feel about issues involving management of trout in the Bob Marshall Wilderness Area.

Please answer all of the questions. If you wish to comment on any questions or qualify your answers, feel free to use the margins or the back of this form. Your comments are appreciated.

Return to:

Trout Survey Director
Department of Zoology
University of Montana
Missoula, Montana 59812

A-7. Page 1 of the questionnaire.
If you fished in the South Fork of the Flathead River drainage, which areas did you fish? (Circle all that apply)

1. AREA 1 (FROM THE MEADOW CREEK BRIDGE TO BIG SALMON CREEK)
2. AREA 2 (FROM BIG SALMON CREEK TO THE MOUTH OF DAIHAER AND YOUNGS CREEKS)
3. AREA 3 (FROM THE MOUTH OF DAIHAER AND YOUNGS CREEKS TO THE SOUTHERN WILDERNESS BOUNDARY)
4. NONE OF THE ABOVE
5. DID NOT FISH IN 1985
In 1984, the fishing regulations for cutthroat trout were changed from 10 fish per day to 3 fish per day. Furthermore, only fish less than 12 inches may be kept. We would like your opinions on how the regulations will affect the trout and the fishing.

Do you believe the current fishing regulations for cutthroat trout will increase, decrease or have no effect on the number of trout in the South Fork of the Flathead River? (circle answer)

(1) INCREASE
(2) DECREASE
(3) NO EFFECT
(4) UNDECIDED

Do you believe the current fishing regulations for cutthroat trout will increase, decrease or have no effect on the average size of trout in the South Fork of the Flathead River? (circle answer)

(1) INCREASE
(2) DECREASE
(3) NO EFFECT
(4) UNDECIDED

If the current fishing regulations were changed to catch and release (no-kill) regulations, would you fish the South Fork of the Flathead River? (circle answer)

(1) YES
(2) NO
(3) UNDECIDED

Next, we would like to know your feelings about the quality of fishing in the South Fork of the Flathead River.

How would you rate the quality of fishing in the South Fork of the Flathead River in 1985? (circle answer)

(1) GOOD
(2) FAIR
(3) POOR
(4) DID NOT FISH HERE IN 1985

If you have fished in the South Fork of the Flathead River before 1985, how would you rate the quality of the fishing now compared to your previous experience? (circle answer)

(1) BETTER
(2) WORSE
(3) ABOUT THE SAME
(4) UNDECIDED
(5) DID NOT FISH HERE BEFORE 1985

Do you feel the current regulations will increase, decrease or have no effect on the quality of the fishing in the South Fork of the Flathead River? (circle answer)

(1) INCREASE
(2) DECREASE
(3) NO EFFECT
(4) UNDECIDED

Do you believe catch and release (no-kill) regulations would increase, decrease or have no effect on the quality of the fishing in the South Fork of the Flathead River? (circle answer)

(1) INCREASE
(2) DECREASE
(3) NO EFFECT
(4) UNDECIDED

Stocking is one way of managing a fishery. We would like to know your feelings about trout stocking.

Would you support the stocking of trout in the South Fork of the Flathead River? (circle answer)

(1) YES
(2) NO
(3) UNDECIDED

Would you support the stocking of trout in lakes draining into the South Fork of the Flathead River? (circle answer)

(1) YES
(2) NO
(3) UNDECIDED

Finally, we would like to know about your fishing experiences in the South Fork of the Flathead River drainage. We respect your privacy; this information will be kept strictly confidential.

How important was fishing as a reason for visiting the South Fork of the Flathead River drainage in 1985? (circle answer)

(1) THE MOST IMPORTANT REASON
(2) A VERY IMPORTANT REASON
(3) A FAIRLY IMPORTANT REASON
(4) NOT VERY IMPORTANT

Which types of water did you fish in the South Fork of the Flathead River drainage in 1985? (circle all that apply)

(1) THE SOUTH FORK OF THE FLATHEAD RIVER
(2) TRIBUTARIES TO THE SOUTH FORK OF THE FLATHEAD RIVER
(3) LAKES DRAINING INTO THE SOUTH FORK OF THE FLATHEAD RIVER
(4) FISHED IN OTHER WATERS
(5) DID NOT FISH IN 1985
Did you keep and eat any trout from the South Fork of the Flathead River drainage in 1985? (circle answer)

(1) YES
(2) NO
(3) DO NOT REMEMBER

How many days did you fish in the South Fork of the Flathead River drainage in 1985? (circle answer)

(1) NONE
(2) ONE DAY
(3) 2-5 DAYS
(4) 6 OR MORE DAYS

How many years have you fished in the South Fork of the Flathead River drainage, including 1985? (circle answer)

(1) NONE
(2) ONE YEAR
(3) 2-5 YEARS
(4) 6 OR MORE YEARS

If you have any other comments on trout management in this wilderness please write them here.

Thank you for your time and cooperation. If you would like a summary of the results please print your name and address on the back of the return envelope (not on the questionnaire) and we will see that you get it.

APPENDIX B

Data From the 1984 Census
B-1. Data from the 1984 census. Sampled sections were selected from 35 available kilometers. The section number increases from upstream to downstream. The habitat types (pool and riffle) are numbered within each sample section. The total number of each habitat type within a section is given in parentheses. M is the number of fish marked in each habitat type, C is the number of fish observed in each habitat type during the visual census, and R is the number of marked fish observed in each habitat type during the visual census.

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<th>R</th>
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