INSTREAM FLOW EVALUATION FOR SELECTED HEADWATER TRIBUTARIES OF THE UPPER MISSOURI DRAINAGE OF SOUTHWESTERN MONTANA

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INTRODUCTION

This study was initiated to provide the Bureau of Land Management (BLM) of the US Department of Interior with a quantification of the instream flow needs for 15 small headwater tributaries of the upper Missouri River basin of southwestern Montana. Information presented in this report can be used in the implementation of resource management programs on BLM lands within the selected stream drainages and the application of minimum flow recommendations to protect fish and wildlife habitat.

The 15 study streams were selected because of the mutual interest of the BLM and the Montana Department of Fish, Wildlife and Parks (MDFWP) in the high outdoor recreational values of the drainages, their provision of valuable riparian habitat, their contributory flow to downstream fisheries and the known or suspected populations of native westslope cutthroat trout within the streams themselves. The westslope cutthroat trout (*Salmo clarki* lewisi) was once numerous and widely distributed throughout the upper Missouri River drainage, but has largely become restricted to relict populations in a few headwater tributaries (Hanzel 1961, Brown 1971, Roscoe 1974). This restriction has led to the classification of the cutthroat trout as a species of special concern in Montana (Deacon et al. 1979). Streams that still support populations of native cutthroat trout are given a high management priority by the MDFWP and BLM.

Two basic types of instream flow information are provided in this report. They consist of fish population data and a quantification, in cubic feet of water per second, of the instream flows needed to maintain the fishery resource and aquatic habitat during the low flow period (July 1-April 30). Other pertinent descriptive information is provided for the streams of interest. The 15 streams covered in this report are:

Big Hole River drainage
- Bear Creek

Grasshopper Creek-Beaverhead River drainage
- East Fork of Dyce Creek
- West Fork of Dyce Creek

Horse Prairie Creek-Beaverhead River drainage
- Bear Creek
- Black Canyon Creek
- Frying Pan Creek
- Rape Creek
- Shenon Creek
- Trapper Creek

Big Sheep Creek-Red Rock River drainage
- Cabin Creek
- Indian Creek
- Simpson Creek

Red Rock River drainage
- Jones Creek
- Peet Creek

Ruby River drainage
- North Fork of Greenhorn Creek

INSTREAM FLOW METHODOLOGIES

The best and most accurate method for determining the instream flow needs for fish and wildlife purposes is to derive the actual flow and biological relationships from long-term data collected in drought, normal and above normal water years. While this approach has been tried on a few selected waterways in Montana, it is not a practical means of deriving future recommendations due to the excessive time, cost and manpower required to collect field data. Consequently, flow recommendations for most waterways are derived from instream flow methods that are more compatible with existing budget and time constraints, yet provide acceptable and defendable recommendations.

The method of the MDFWP divides the annual flow cycle for the headwater streams and rivers into two separate periods. They consist of a relatively brief snow runoff or high flow period, when a large percentage of the annual water yield is passed through the system, and a nonrunoff or low flow period which is characterized by relatively stable base flows maintained primarily by groundwater outflow. For small headwater streams, the high flow period generally includes the months of May and June while the remaining months (approximately July through April) encompass the low flow period.

Methodology for Low Flow Period - Streams

The methodology chosen for deriving low flow recommendations for headwater trout streams is primarily based on the assumption that the food supply is a major factor influencing a stream's carrying capacity (the numbers and pounds of trout that can be maintained indefinitely by the aquatic habitat). The principal food of both the juvenile and adult trout inhabiting the headwater streams of Montana is aquatic invertebrates whach are primarily produced in the riffle areas of most streams. The methodology assumes that the trout carrying capacity is proportional to food production which in turn is proportional to the wetted perimeter in riffle areas. This method is a slightly modified version of the Washington Method (Collings, 1972 and 1974) which is based on the premise that the rearing of juvenile salmon is proportional to food production which in turn is proportional to the wetted perimeter in riffle areas. The Idaho Method (White and Cochnauer, 1975 and White, 1976) is also based on a similar premise.

Wetted perimeter is the distance along the bottom and sides of a channel cross-section in contact with water (Figure 1). As the flow in the stream channel decreases, the wetted perimeter also decreases, but the rate of loss of wetted perimeter is not constant throughout the entire range of flows. An example of a relationship between wetted perimeter and flow for a riffle cross-section is illustrated in Figure 2. There are generally two points, called inflection points, on the plot of wetted perimeter versus flow at which the rate of loss of wetted perimeter is significantly changed. In the example (Figure 2), these inflection points occur at approximate flows of 8 and 12 cfs. Beyond the upper inflection point, large changes in flow cause only very small changes in wetted perimeter. The area available for food production is considered near optimal beyond this inflection point. Below the upper inflection point, the stream begins to pull away from the riffle bottom. At the lower inflection point, the rate of loss of wetted perimeter begins to rapidly accelerate. Once flows are reduced below the lower inflection point, the riffle bottom is being exposed at an accelerated rate and the area available for food production greatly diminishes.

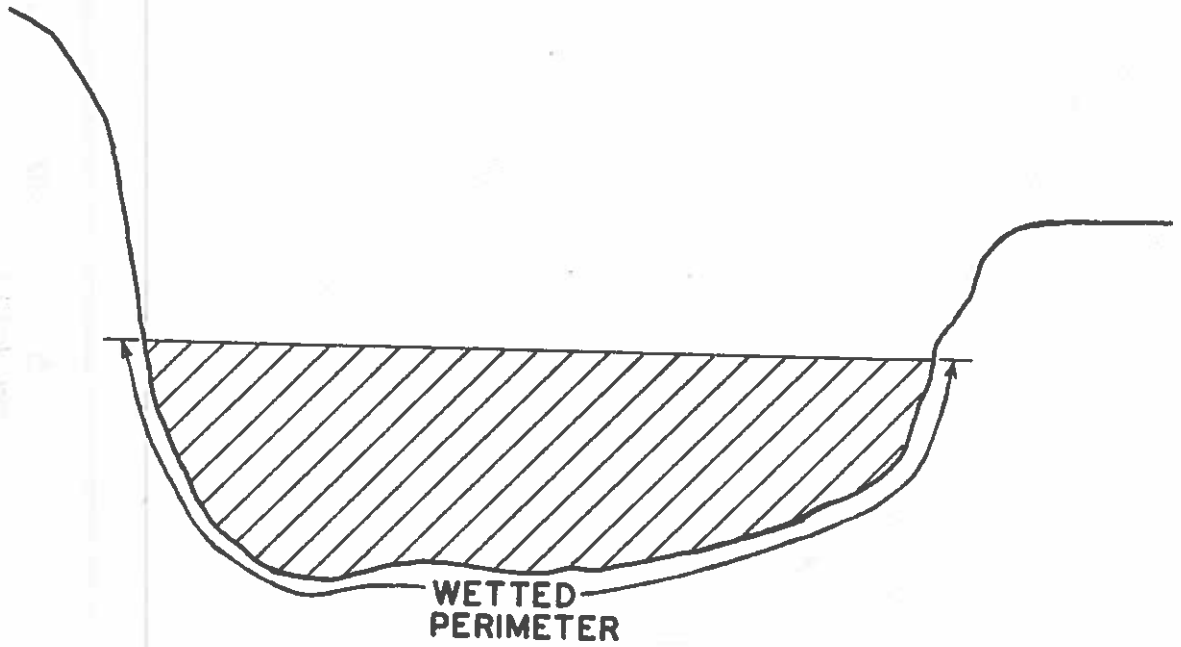


Figure 1. The wetted perimeter in a channel cross-section.

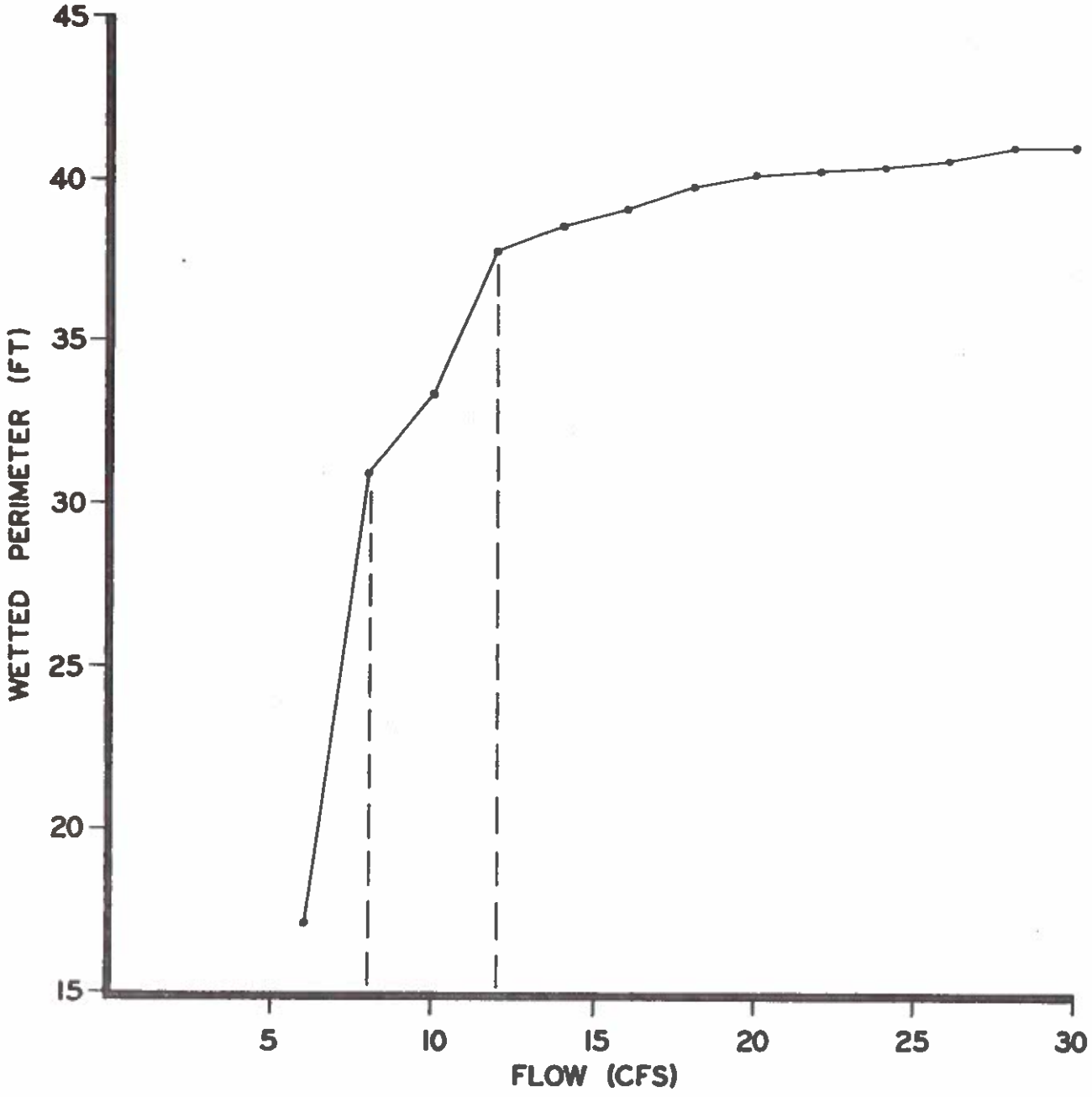


Figure 2. An example of a relationship between wetted perimeter and flow for a riffle cross-section.

The wetted perimeter-flow relationship may also provide an index of other limiting factors that influence a stream's carrying capacity. One such factor is cover. Cover, or shelter, has long been recognized as one of the basic and essential components of fish habitat. Cover serves as a means for avoiding predators and provides areas of moderate current speed used as resting and holding areas by fish. Cover can be significantly influenced by streamflow.

In the headwater streams of Montana, overhanging and submerged bank vegetation is an important component of trout cover. The wetted perimeter-flow relationship for a stream channel may bear some similarity to the relationship between bank cover and flow. At the upper inflection point, the water begins to pull away from the banks, bank cover is lost and the stream's carrying capacity declines. Flows exceeding the upper inflection point are considered to provide near optimal bank cover. At flows below the lower inflection point, the water is sufficiently removed from the bank cover to severely reduce its value as fish shelter. It is reasonable to assume that this premise would be more acceptable if the wetted perimeter-flow relationships were also derived for pools and runs, areas normally inhabited by adult trout. However, cross-sections through pools and runs may not be necessary. When the wetted perimeter-flow relationship for riffles and the composite of all habitat types (pools, runs and riffles) comprising a study section are compared, as illustrated in Figure 3, the shape of the curves and, consequently, the flows at which the inflection points occur, are very similar. This similarity is probably explained by the fact that most headwater streams, due to their high gradients, tend to be mainly comprised of riffle areas. Pools are generally few in number and are poorly developed. A riffle area, therefore, describes the typical habitat type that normally occurs throughout most headwater streams.

It has been demonstrated that riffles are also critical areas for spawning sites of brown trout, and shallow inshore areas are required for the rearing of brown and rainbow trout fry (Sando, 1981). It is, therefore, assumed that in addition to maximizing bank cover and food production, the flows exceeding the upper inflection point would also provide favorable spawning and rearing conditions.

Riffles are the area of a stream most affected by flow reductions (Bovee, 1974 and Nelson, 1977). Consequently, the flows that maintain suitable riffle conditions will also maintain suitable conditions in pools and runs, areas normally inhabited by adult trout. Because riffles are the habitat most affected by flow reductions and are essential for the well-being of both resident and migratory trout populations, they should receive the highest priority for instream protection.

The wetted perimeter/inflection point method provides a range of flows (between the lower and upper inflection points) from which a single instream flow recommendation can be selected. Flows below the lower inflection point are judged undesirable based on their probable impacts on food production, bank cover and spawning and rearing habitat, while flows exceeding the upper inflection point are considered to provide a near optimal habitat for trout. The flows at the lower and upper inflection points are believed to bracket those flows needed to maintain the low and high levels of aquatic habitat potential. These flow levels are defined as follows:

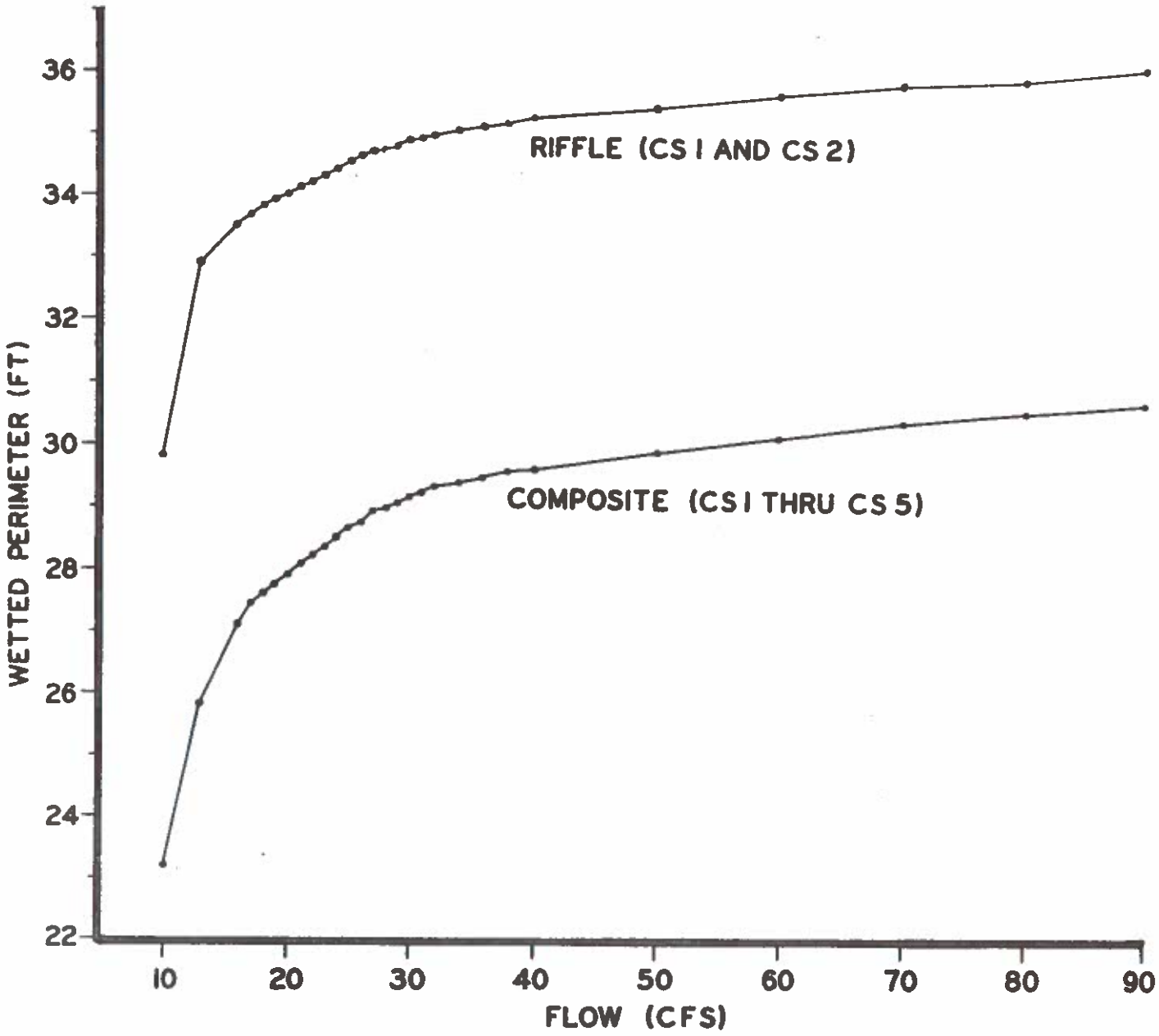


Figure 3. Comparison of the relationships between wetted perimeter and flow for a composite of five cross-sections encompassing various habitat types and a composite of two riffle cross-sections in a subreach of Cherry Creek, Madison River drainage.

1. High Level of Aquatic Habitat Potential - That flow regime which will consistently produce abundant, healthy and thriving aquatic populations. In the case of game fish species, these flows would produce abundant game fish populations capable of sustaining a good to excellent sport fishery for the size of stream involved. For rare, threatened or endangered species, flows to accomplish the high level of aquatic habitat maintenance would: 1) provide the high population levels needed to ensure the continued existence of that species, or 2) provide for flow levels above those which would adversely affect the species.

2. Low Level of Aquatic Habitat Potential - Flows to accomplish a low level of aquatic habitat maintenance would provide for only a low population abundance of the species present. In the case of game fish species, a poor sport fishery could still be provided. For rare, threatened or endangered species, their populations would exist at low or marginal levels. In some cases, this flow level would not be sufficient to maintain certain species.

The final flow recommendation is selected from this range of flows by the fishery biologist who collected, summarized and analyzed all relevant field data for the streams of interest. The biologist's rating of the stream resource forms the basis of the flow selection process. Factors considered in the biologist's evaluation include recreational usage, the existing level of environmental degradation, water availability and the magnitude and composition of existing fish populations. The fish population information, which is essential for all streams, is a major consideration. A nonexistent or poor fishery would likely justify a flow recommendation at or near the lower inflection point unless other considerations, such as the presence of species of special concern (arctic grayling and cutthroat trout), warrant a higher flow. In general, only streams with exceptional resident fish populations or those providing crucial spawning and/or rearing habitat for migratory populations would be considered for a recommendation at or near the upper inflection point. Exceptions are those tributary streams that are an essential source of the water that is needed for maintaining downstream aquatic habitat. In this particular situation, water supply is the overriding consideration.

The process of deriving the flow recommendation for the low flow period thusly combines a field methodology (wetted perimeter/inflection point method) with a thorough evaluation by a field biologist of the existing stream resource.

The wetted perimeter-flow relationships are derived using a wetted perimeter predictive (WETP) computer program developed in 1980 by the Montana Department of Fish, Wildlife and Parks (Nelson, 1980). This program was designed to eliminate the relatively complex data collecting procedures associated with the hydraulic simulation computer models in current use while providing more accurate wetted perimeter predictions.

Description of the WETP Program and Data Collecting Procedures

The WETP program uses at least two sets of stage (water surface elevation) measurements taken at different known discharges (flows) to establish a least-squares fit of log-stage versus log-discharge. Once the stage-discharge rating curve for each cross-section is determined, the stage at a flow of interest can be predicted. This rating curve, when coupled with the cross-sectional profile, is all that is needed to predict the wetted perimeter at most flows of interest.

The program should be run using three sets of stage-discharge data collected at a high, intermediate and low flow. Additional data sets are desirable, but not necessary. The three measurements are made when runoff is receding (high flow), near the end of runoff (intermediate flow) and during late summer-early fall (low flow). The high flow should be considerably less than the bankful flow while the low flow should approximate the lowest flow that normally occurs during the summer-fall field season. Sufficient spread between the highest and lowest calibration flows is needed in order to compute a linear, sloping rating curve (Figure 4).

The WETP program can be run using only two sets of stage-discharge data. This practice is not recommended since substantial "two-point" error can result. However, when only two data sets are obtainable, the higher discharge should be at least twice as high as the lower discharge.

The WETP model is invalidated if channel changes occur in the study area during the data collecting process. For this reason, the collection of the field data needed for calibrating the program should be completed during the period beginning when runoff is receding and ending with the onset of runoff the following year. The stream channel is expected to be stable during this period.

Cross-sections were placed in an area that typified the stream reach for which instream flow recommendations were to be derived. For the headwater streams, this would mean a sequence from the head of a riffle to the head of the next riffle. This sequence was described using from 5 to 10 cross-sections. The cross-sections were placed to describe the typical habitat types in the proportion that they occurred within each sequence. The cross-sections through pools and runs were subsequently eliminated from the analyses since, as previously explained, there appears to be little justification or advantage for their use in the flow recommendation process.

The recommendations were selected solely from the wetted perimeter-flow relationships for riffle areas. If two or more riffle cross-sections were available, the computed wetted perimeters for all riffle cross-sections at each flow of interest were averaged and the recommendation selected from the wetted perimeter-flow relationship for the composite of all riffle cross-sections.

The limitations and advantages of the WETP program, as well as field data requirements and surveying techniques, are discussed by Nelson (1980).

Methodology for High Flow Period

Several major components of aquatic habitat in river and stream systems are related to the physical features and form of the channel itself. Over time, aquatic populations have adapted and thrived within the physical constraints of channel configuration and flow. Basic to the maintenance of the existing aquatic populations is the maintenance of the existing habitat that has historically sustained them.

It is generally accepted that the major force in the establishment and maintenance of a particular channel form in view of its bed and bank material is the annual high flow characteristics. It is the high spring flows that determine the shape of the channel rather than the average or low flows.

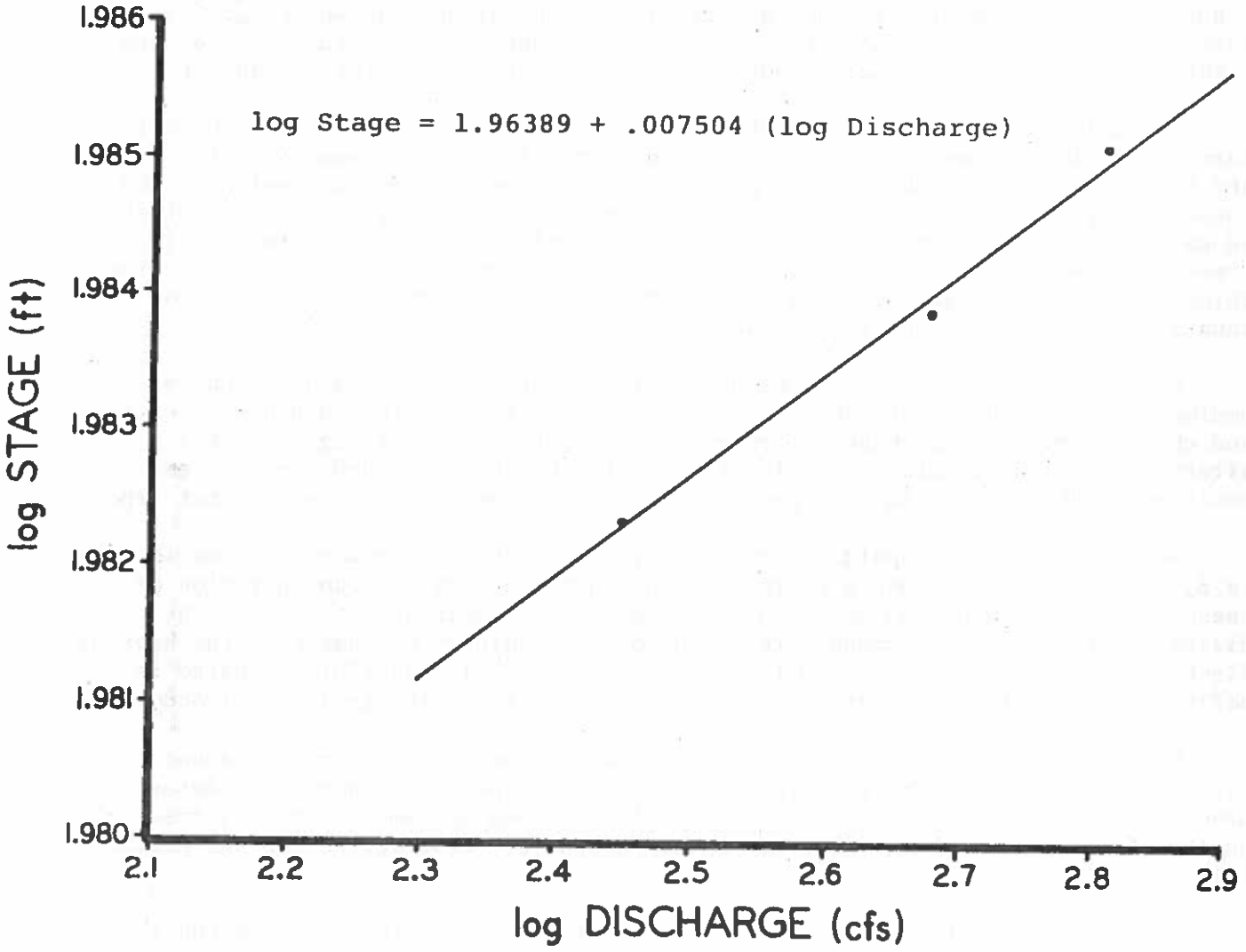


Figure 4. An example of a "three point" stage-discharge rating curve for a riffle cross-section.

Most unregulated headwater streams and rivers in Montana are characterized by an annual spring high water period which normally occurs during May, June and July and results from snowmelt in the mountainous headwaters. Annual spring flow conditions on unregulated streams are heavily dependent upon snowpack and its rate of thawing. On regulated streams, the occurrence and magnitude of the high water period may vary depending upon reservoir operation and storage capacity.

The major functions of the high spring flows in the maintenance of channel form are bedload movement and sediment transport. It is the movement of the bed and bank material and subsequent deposition which forms the mid-channel bars and, subsequently, the islands. High flows are capable of covering already established bars with finer material which leads successively to vegetated islands. Increased discharge associated with spring runoff also results in a flushing action which removes deposited sediments and maintains suitable gravel conditions for aquatic insect production, fish spawning and egg incubation.

Reducing the high spring flows beyond the point where the major amount of bedload and sediment is transported would interrupt the ongoing channel processes and change the existing channel form and bottom substrates. A significantly altered channel configuration would affect both the abundance and species composition of the present aquatic populations by altering the existing habitat types.

Several workers (Leopold, Wolman and Miller 1964, US Bureau of Reclamation 1973, and Emmett 1975) adhere to the concept that the form and configuration of channels are shaped by and designed to accommodate a dominant discharge. The discharge which is most commonly referred to as a dominant discharge is the bankful discharge (Leopold, Wolman and Miller 1964, Emmett 1975). Bankful discharge is defined as that flow when water just begins to overflow onto the active floodplain.

Bankful discharge tends to have a constant frequency of occurrence among rivers (Emmett 1975). The recurrence interval for bankful discharge was determined by Emmett (1975) to be 1.5 years and is in close agreement with the frequency of bankful discharge reported by other studies (Leopold, Wolman and Miller 1964, Emmett 1972).

The bankful discharge for streams and rivers was estimated by using the 1½-year frequency peak flow. The 1½-year frequency peak flow was determined by interpolation between the 1.25 and 2-year frequency peak flows as supplied by the USGS for the streams and rivers in question.

It is not presently known how long the bankful flow must be maintained to accomplish the necessary channel formation processes. Until studies further clarify the necessary duration of the bankful discharge, a duration period of 24 hours is chosen.

A gradual rising and receding of flows should be associated with the dominant discharge, and the shape of the spring hydrograph should resemble that which occurs naturally. USGS flow records were used to determine the time when the high flow period and peak flow normally occur on a given stream. The dominant discharge is requested for that period when it normally occurs. Flows are increased from a base flow level to the dominant discharge in 2-week intervals at the 80th percentile flow level, corresponding to the natural timing of the high flow period.

The 80th percentile is the flow that is exceeded in 8 of 10 years or, in other terms, in 8 years out of 10 there is more water than the 80th percentile flowing in the stream. The 80th percentile was chosed in part because of its compatability with irrigation development. To economically develop efficient, full-service irrigation systems, a good water supply is considered necessary in about 8 years out of 10, on the average (MDNRC, 1976). It is also our belief that the high flow months can withstand substantial withdrawals and not alter the basic functions of channel maintenance. The 80th percentile flows allow for substantial water depletions.

The above instream flow method, which is termed the dominant discharge/channel morphology concept, can only be applied to those streams having at least 9 years of continuous USGS gage records. Consequently, high flow recommendations cannot be derived for the streams considered in this report due to the lack of long-term flow records.

FISH POPULATION ESTIMATES

As previously discussed, an evaluation of existing fish populations is an essential component of the flow recommendation process. In addition to providing a means for partially justifying the selection of a particular flow recommendation, the fish data also serve to document the state of the existing fishery resource.

Electrofishing

Fish populations in the study streams were sampled using a bank electrofishing unit basically consisting of a 110 volt Kawasaki gas generator, a Fisher shocker box, a 500 ft cord, a stationary negative electrode, and a hand-held, mobile positive electrode. A mild electric shock temporarily immobilizes the fish located in the immediate vicinity of the positive electrode, allowing them to be dip netted. The fish capturing efficiency of the units is highly variable since efficiency rates are influenced by stream size, the magnitude of the flow, water clarity, specific conductance, water temperature, cover types and the species and size of fish.

The fish population is enumerated using a mark-recapture method which allows for the estimation of the total numbers and pounds (the standing crops) of fish within a stream section. For most streams, standing crop estimates were obtained for 1,000 ft study sections.

The standing crop estimates require at least two electrofishing runs through each study section. During the first or marking run, all captured fish are anesthetized, marked with a partial caudal fin clip so they can be later identified, then released after individual lengths and weights are recorded. It is desirable to make the second or recapture run at least two weeks after the marking run. This two week period allows the marked fish to randomly redistribute themselves throughout the population. During the recapture run, all captured fish are again anesthetized and released after the lengths and weights of all new (unmarked) fish and the length only of all marked fish are recorded. The population estimate is basically obtained using the formula $P = \frac{MC}{R}$; where P is the estimated

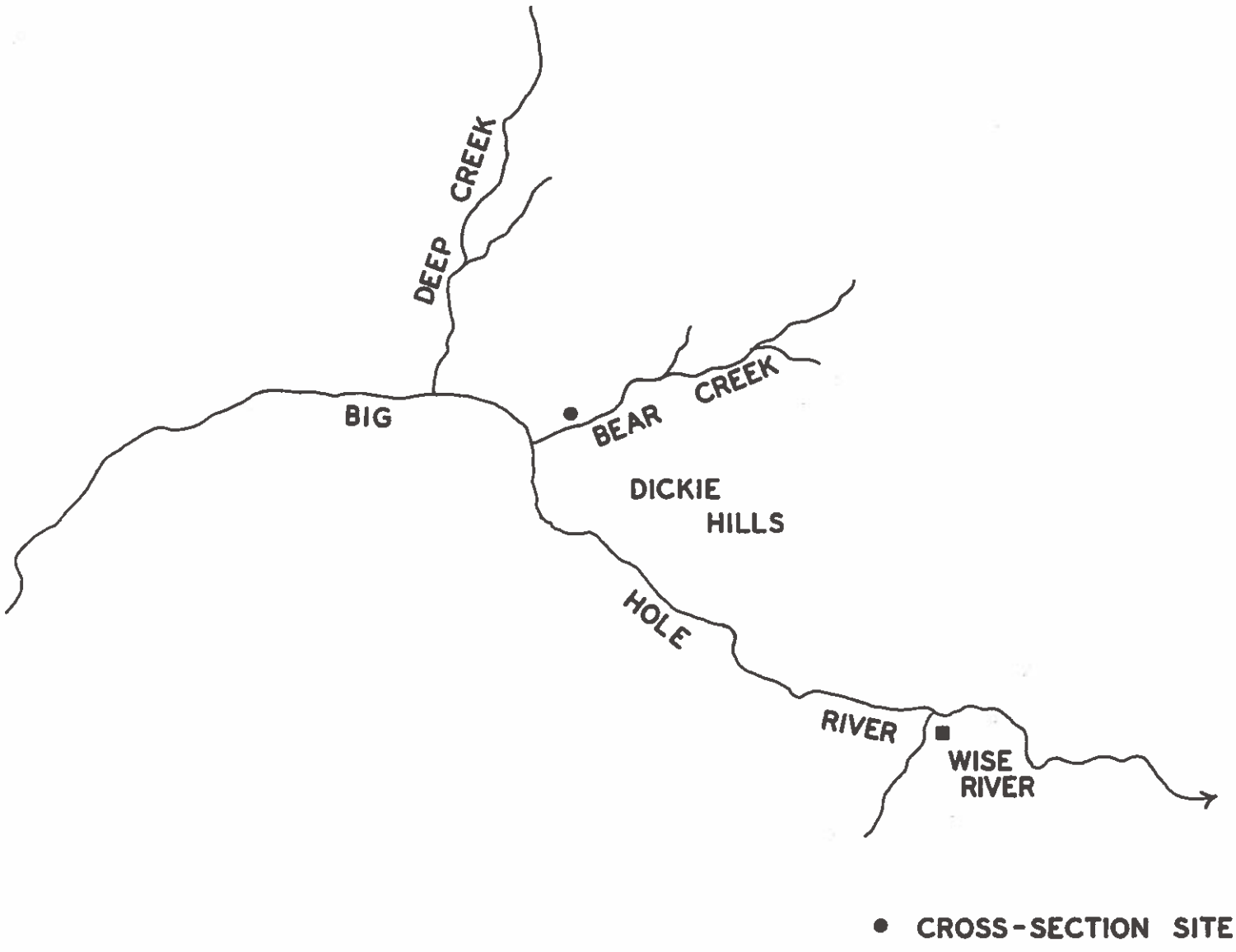
number of fish, M is the number initially marked, C is the number of marked and unmarked fish collected during the recapture run, and R is the number of marked fish collected during the recapture run. This formula, although somewhat modified in its final form for statistical reasons, is the basis of the mark-recapture technique.

The numbers of fish are actually estimated by length groups. Those ½ inch length intervals having similar or equal recapture efficiencies comprise a length group. This grouping is necessary because recapture efficiencies are dependent on fish size. Generally, electrofishing is more effective for capturing larger fish due to their greater surface area and their higher visibility when in the electric field. Because recapture efficiencies are length related, the numbers of fish must be estimated by length groups, then added to obtain the total estimate. Generally, at least seven recaptures are needed per length group in order to obtain a statistically valid estimate.

Pounds of fish are obtained by multiplying the average weight of the fish within each length group by the estimated number, then adding to obtain the total pounds. Estimates can also be obtained for different age-groups of fish. This mark-recapture technique, which is thoroughly discussed by Vincent (1971 and 1974), has been adapted for computer analyses by the MDFWP.

Only electrofishing survey data, consisting of the species, numbers and length ranges of captured fish, are provided for those streams in which fish populations are too sparse to reliably estimate using the mark-recapture method.

BIG HOLE RIVER DRAINAGE



The study area of the Big Hole River drainage.

1. STREAM

Bear Creek

2. DESCRIPTION

Bear Creek originates on the north slope of Dickie Peak at an elevation of approximately 8,200 ft. The stream flows in a soutwesterly direction for 6.3 miles to its confluence with the Big Hole River. The only named tributary of Bear Creek is Johnson Gulch Creek. The 5,504 acre (8.6 mi^2) drainage is characterized by steep, heavily timbered slopes with numerous south-facing clearings. The stream is bordered by a relatively broad riparian zone of willow, alder, birch, aspen, grasses and sedges and is characterized by braided channels and numerous beaver ponds in the lower reaches. The average gradient of the 9.6 ft wide channel is 65.8 ft per 1,000 ft. Ownership of the Bear Creek drainage is controlled by the USFS (67.8%), private individuals (17.9%) and the BLM (14.3%).

Lands within the Bear Creek drainage are used for cattle grazing, timber harvest and recreation in the form of hunting, fishing and winter sports. Access is provided by a gravel road which parallels the stream.

Bear Creek lies within the boundaries of Montana deer and elk hunting district 319 which supported an estimated 23,543 elk hunter-days and 16,127 deer hunter-days in 1981 (MDFWP, 1982). The Bear Creek drainage received an excellent rating for big game hunting quality in a BLM district survey and contains elk winter range at lower elevations (BLM 1980). No estimate of fishing pressure is available for Bear Creek, however, fisherman use of the stream was observed during the summer of 1982.

The BLM controlled portion of the drainage is included in a single grazing allotment which is utilized on a seasonal basis. The allotment was found to be in good condition in terms of range vegetation and erosion in a BLM district survey (BLM 1980). A timber sale is planned for the USFS portion of the Bear Creek drainage in 1983.

A riparian zone survey using the method of Myers (1976) was conducted on Bear Creek. The study reach received an excellent rating. Riparian zone condition is directly related to fish habitat and water quality on small southwestern Montana streams subject to cattle grazing (Myers 1976).

3. FISHERIES

A 1,000 ft section of Bear Creek was electrofished on July 23 and August 9, 1982. Game fish collected, in descending order of abundance, were brook trout and rainbow x cutthroat hybrid trout. Mottled sculpins were the only nongame species collected. The electrofishing survey data are summarized in Table 1.

Table 1. Summary of electrofishing survey data for a 1,000 ft section of Bear Creek (T2N, R12W, SW SE Sec. 34) on July 23 and August 9, 1982.

Species	No. Captured	Length Range (inches)
Brook Trout	344	1.7 - 13.8
Rainbow x Cutthroat Trout	22	1.5 - 10.6
Mottled Sculpin	-	-

Standing crops of brook and rainbow x cutthroat trout within the study section were estimated by using a mark-recapture method (Table 2). The section supported about 501 trout, weighing a total of 34 pounds. Brook trout accounted for 96% of the population and 91% of the biomass. Fish six in and larger accounted for 18% of the estimated population. Brook trout condition (length to weight ratio) was very good and above average when compared to other upper Big Hole River tributaries (Oswald 1980).

Table 2. Estimated standing crops of brook and rainbow x cutthroat hybrid trout in a 1,000 ft section of Bear Creek (T2N, R12W, SW SE Sec. 34) on July 23, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft Number	Per 1,000 ft Pounds
Brook Trout	3.0 - 4.4	335	
	4.5 - 6.4	84	
	6.5 - 13.8	64	
		483(±60)	31(±4)
Rainbow x Cutthroat Trout	3.0 - 10.6	18(±5)	3(±1)

The trout population observed in the study section revealed a good stream fishery. A BLM district fish habitat survey classified Bear Creek as a productive fishery in excellent condition (BLM 1980).

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 122 ft riffle sequence located approximately at stream mile 0.8 (T2N, R12W, SW SE Sec. 34). Approximately 92% of the total drainage area was located above the subreach. Five cross-sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 33.4, 11.3 and 3.8 cfs.

The relationship between wetted perimeter and discharge for a composite of five riffle cross-sections is shown in Figure 5. Lower and upper inflection points occur at 3.5 and 7.0 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 5.0 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Bear Creek.

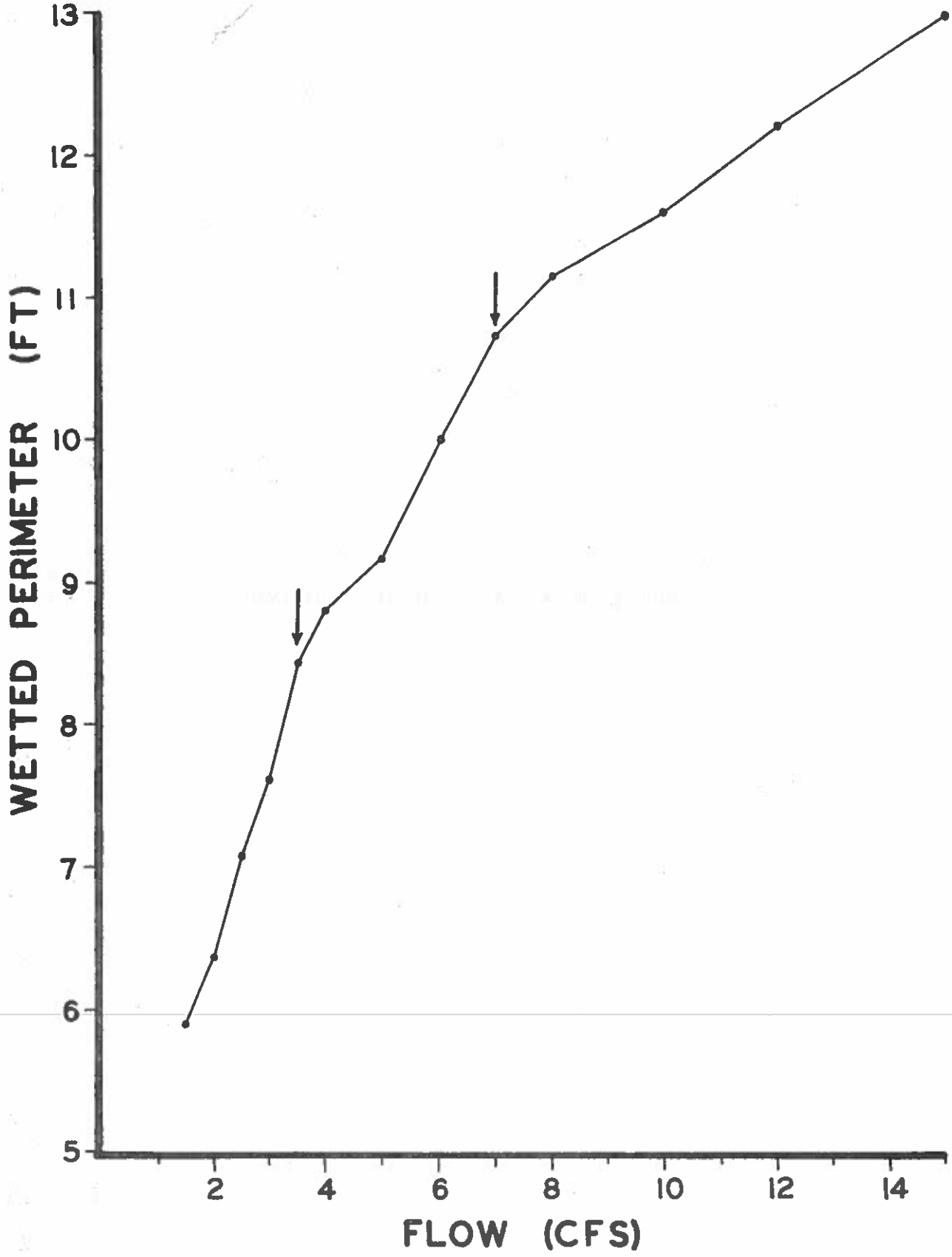
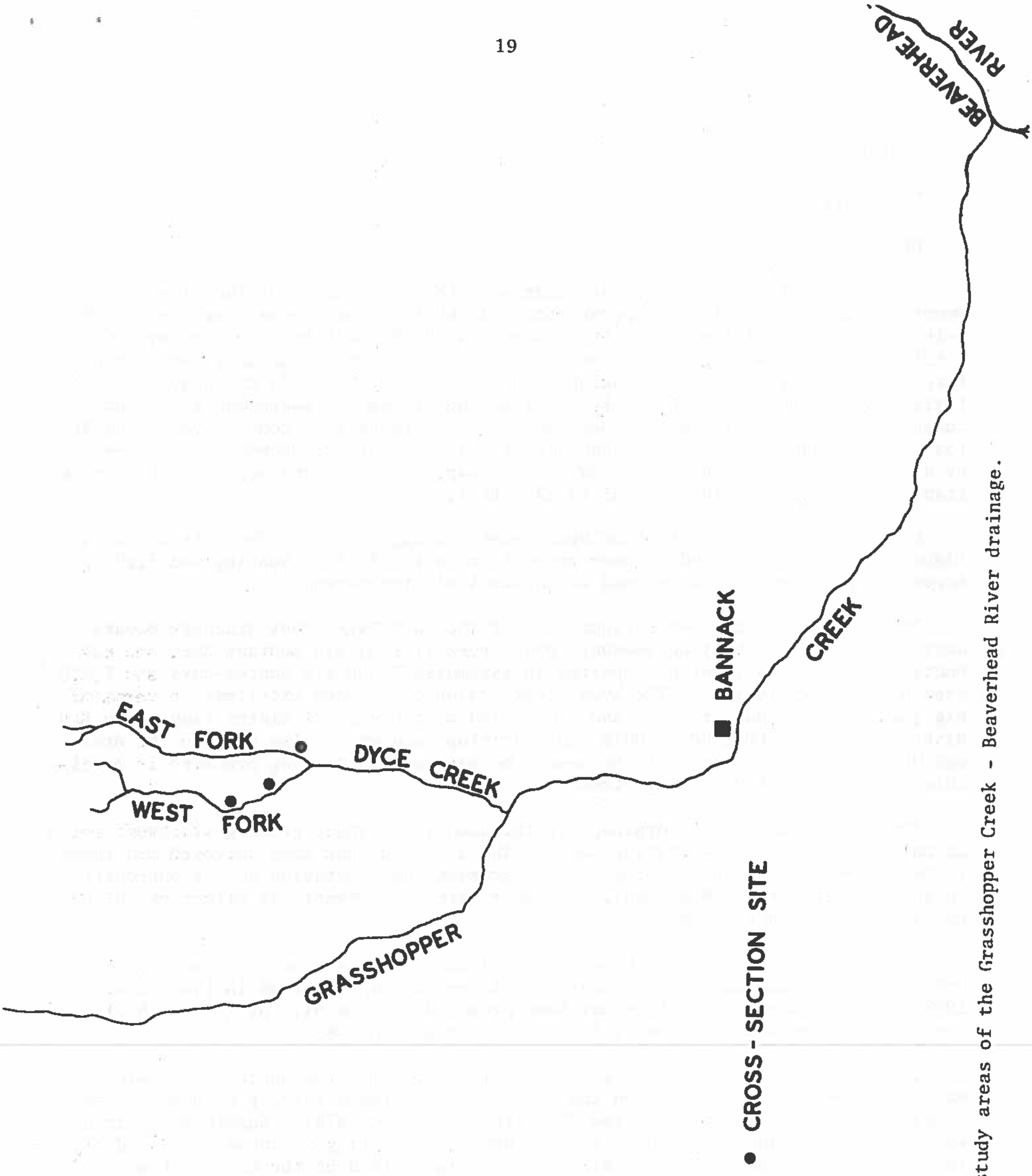


Figure 5. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Bear Creek.

GRASSHOPPER CREEK-BEAVERHEAD RIVER DRAINAGE



The study areas of the Grasshopper Creek - Beaverhead River drainage.

1. STREAM

East Fork of Dyce Creek

2. DESCRIPTION

The East Fork of Dyce Creek originates on the south slope of the Pioneer Mountains at an elevation of approximately 8,560 ft. The stream flows in a southerly direction for 4.7 miles to its juncture with the West Fork to form Dyce Creek, a tributary of Grasshopper Creek and the Beaverhead River. The only named tributary of East Dyce Creek is Dry Gulch. The 3,712 acre (5.8 mi^2) drainage is characterized by coniferous timber on the east facing slopes and sagebrush-grassland communities on the west faces. Ownership of the drainage is controlled by the BLM (38%), USFS (38%) and private landowners (24%). The stream channel is bordered by a narrow riparian zone of willow, alder, aspen, grasses and sedges. The average gradient of the 3 ft wide channel is 83.7 ft/1,000 ft.

Lands within the East Fork of Dyce Creek drainage are used for cattle grazing, timber harvest, mining and outdoor recreation in the form of hunting and fishing. Access is provided by a dirt road which parallels the stream.

The majority of the recreational use of the East Dyce Creek drainage occurs during the big game hunting season. Dyce Creek lies within Montana deer and elk hunting district 331, which supported an estimated 7,660 elk hunter-days and 7,920 deer hunter-days in 1981. The Dyce Creek drainage is rated excellent in terms of big game hunting quality and classified as crucial elk winter range in a BLM district survey (BLM 1980). Mule deer, antelope and moose also utilize the drainage during various seasons of the year. No estimate of fishing pressure is available for the East Fork of Dyce Creek.

The BLM portion of the drainage is included in a single grazing allotment which is maintained on a rest-rotation basis. The allotment has been surveyed and found to be in good condition in terms of soil erosion and vegetation and is currently in an improving trend (BLM 1980). A timber sale is currently in effect on the USFS portion of the upper drainage.

The East Fork of Dyce Creek has had a history of mining activity within the drainage. The maximum recorded year of gold production occurred in 1908 (Lyden 1948). A gold mining operation has been proposed for the site of the old Nick Preen mine. The mining activity is slated to begin in 1983.

The East Fork of Dyce Creek is a calcium-magnesium-bicarbonate stream with a moderately acidic to alkaline pH and specific conductance varying between 76 μ mhos at high flow and 161 μ mhos at low flow (Foggin et al. 1978). Suspended sediment was observed to range between <5 and 776 ppm, representing an annual bed load of 79 tons in 1977 (Foggin et al. 1978). The sediment load of the East Fork was found to be significantly lower than that of the West Fork of Dyce Creek. Stream channel stability after the method of Pfankuch (1975) and riparian zone status (Myers 1976) were both rated good.

3. FISHERIES

A 1,000 ft section of the East Fork of Dyce Creek was electrofished on July 6 and July 14, 1982. Game fish collected in descending order of abundance were rainbow x cutthroat hybrid trout and brook trout. Electrofishing survey data are summarized in Table 3.

Table 3. Summary of electrofishing survey data for a 1,000 ft section of the East Fork of Dyce Creek (T6S, R12W, SE, SE, Sec. 26) on July 6 and July 14, 1982.

Species	No. Captured	Length Range (inches)
Rainbow x cutthroat hybrid trout	49	2.3 - 9.7
Brook Trout	26	1.9 - 8.6

Standing crops of rainbow x cutthroat hybrid and brook trout within the study section were estimated by using a mark-recapture method (Table 4). The section supported 75 trout representing a biomass of 10 pounds. Rainbow x cutthroat hybrid trout accounted for 66% of the population and 70% of the biomass. Trout 6 in and longer accounted for 54% of the total population. Brook trout condition (length to weight ratio) was excellent and well above average when compared with streams in the Big Hole River drainage (Oswald 1981). The fish habitat of Dyce Creek was evaluated as being in very good condition in a BLM district survey (BLM 1980).

Table 4. Estimated standing crops of rainbow x cutthroat hybrid and brook trout in a 1,000 ft section of the East Fork of Dyce Creek (T6S, R12W, SE SE Sec. 26) on July 6, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft Number	Per 1,000 ft Pounds
Rainbow x cutthroat trout	4.5 - 6.9	26	
	7.0 - 9.7	24	
		50(±8)	7(±1)
Brook trout	5.0 - 6.4	15	
	6.5 - 8.6	10	
		25(±5)	3(±1)

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 74 ft riffle sequence located approximately at stream mile 0.2 (T6S, R12W, SE, SE, Sec. 26). Approximately 99% of the total drainage area is located above this subreach. Five cross-sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 4.4, 2.1 and 1.3 cfs.

The relationship between wetted perimeter and discharge for a composite of five riffle cross-sections is given in Figure 6. Lower and upper inflection points occur at 0.7 and 1.5 cfs, respectively. Based on an evaluation of the existing fishery and recreational use of the area, a flow of 1.1 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for the East Fork of Dyce Creek.

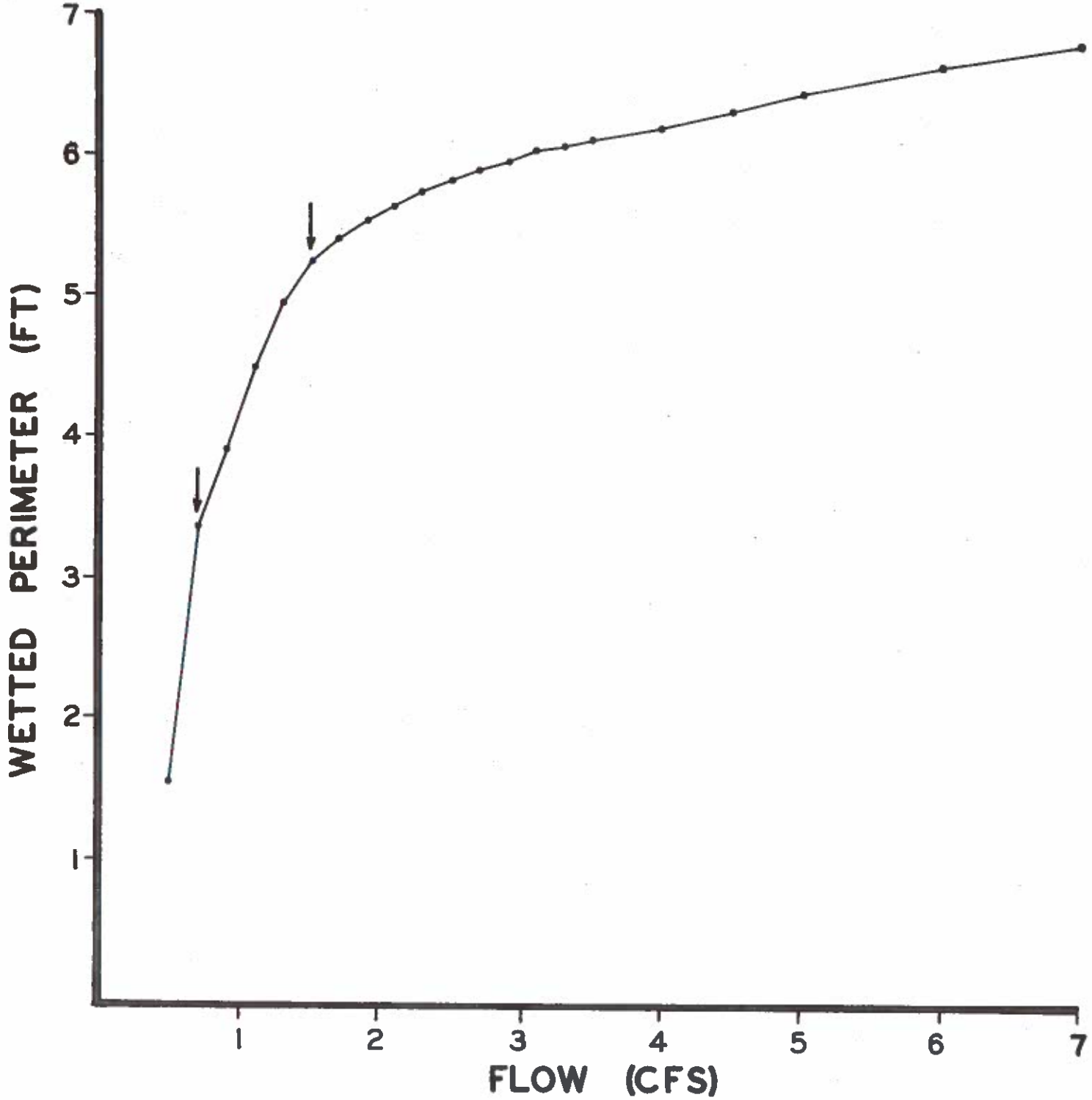


Figure 6. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in the East Fork of Dyce Creek.

1. STREAM

West Fork of Dyce Creek

2. DESCRIPTION

The West Fork of Dyce Creek originates on the south slope of the Pioneer Mountains at an elevation of 7,920 ft. The stream flows in a southerly direction for 4.7 miles to its junction with the East Fork to form Dyce Creek, a tributary of Grasshopper Creek and the Beaverhead River. The 2,368 acre (3.7 mi^2) drainage is characterized by timbered slopes at high elevations and patches of timber and sagebrush steppes in the lower elevations. The stream is bordered by a narrow riparian zone of willow, alder, aspen, grasses and sedges. Two ponds, created by past mining activity, are located on the stream. The average gradient of the 3 ft wide channel is 57.9 ft/1,000 ft. Ownership of the drainage is controlled by the BLM (70.3%) and the USFS (29.7%).

Lands within the West Dyce Creek drainage are used for cattle grazing, mining, timber harvest and recreation in the form of hunting and fishing. Access is provided by a dirt road which parallels the stream.

The majority of the recreational use of the West Dyce Creek drainage occurs during the big game hunting season. The Dyce Creek drainage lies within the boundaries of Montana deer and elk hunting district 331, which supported an estimated 7,660 elk hunter-days and 7,920 deer hunter days in 1981 (MDFWP 1982). The Dyce Creek drainage received an excellent rating for big game hunting quality and is classified as crucial elk winter range in a BLM district survey (BLM 1980). Mule deer, antelope and moose also utilize the drainage during various seasons of the year. Angler use of the West Fork of Dyce Creek has been noted and probably centers around the two ponds. No estimate of fishing pressure is available for Dyce Creek.

The BLM owned portion of the drainage is included in a single grazing allotment which is utilized on a rest-rotation basis. The allotment has been surveyed and found to be in good condition in terms of erosion and vegetation and is currently improving (BLM 1980). A timber sale is currently in effect on the USFS portion of the upper drainage.

The West Fork of Dyce Creek has had a history of mining activity within the drainage. Placer mining for gold occurred in the drainage in the early 1900's (Lyden 1948) and a tungsten mine and mill were located in the upper drainage. Two ongoing placer operations are located on the stream at the present time.

The West Fork of Dyce Creek is a calcium-magnesium-bicarbonate stream with and alkaline pH and specific conductance varying between 187 μ mhos at high flow and 345 μ mhos at low flow (Foggin et al. 1978). Suspended sediment was observed to range between <5 and 3,130 ppm representing an annual bed load of 102 tons in 1977 (Foggin et al. 1978). Stream channel stability after the method of Pfankuch (1975) and riparian zone status after the method of Myers (1976) were both rated good.

3. FISHERIES

An 850 ft section of the West Fork of Dyce Creek was electrofished on July 6 and July 14, 1982. Game fish collected in descending order of abundance were rainbow x cutthroat hybrid trout and brook trout. Electrofishing survey data are summarized in Table 5.

Table 5. Summary of electrofishing survey data for a 850 ft section of the West Fork of Dyce Creek (T6S, R12W, NW, NW Sec. 26) on July 6 and July 14, 1982.

Species	No. Captured	Length Range (inches)
Rainbow x cutthroat hybrid	41	2.4 - 8.6
Brook trout	16	1.0 - 8.2

No estimate of brook or rainbow x cutthroat trout standing crop was calculated due to the heavy riparian canopy that limited electrofishing efficiency in the section.

Three sections of the West Fork of Dyce Creek on the upper (500 ft), middle (400 ft) and lower (700 ft) portions of the stream were electrofished on November 13, 1981 (MDFWP Unpub. data). Rainbow x cutthroat hybrid trout numbers ranged between 10 captured in the upper section and 43 captured in the middle section. The fish ranged between 1.7 and 9.5 inches in length. Brook trout numbers ranged between 0 captured in the upper section and 22 captured in the middle section. The brook trout ranged between 3.1 and 7.6 inches in length. The great majority of the trout captured in the middle section came from a single large pool that had resulted from mining activity. A BLM fish habitat evaluation rated the Dyce Creek drainage as very good (BLM 1980).

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 31 ft riffle sequence located approximately at stream mile 2.0 (T6S, R12W, NE, NE Sec. 22). Approximately 55% of the drainage area was located above the subreach. Five cross-sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 2.0, 1.2 and 0.8 cfs.

The relationship between wetted perimeter and discharge for a composite of three riffle cross-sections is shown in Figure 7. Lower and upper inflection points occur at 0.6 and 1.1 cfs, respectively. Based on an evaluation of the existing fishery, recreational use of the area and mining interest in the drainage, a flow of 0.8 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for the West Fork of Dyce Creek.

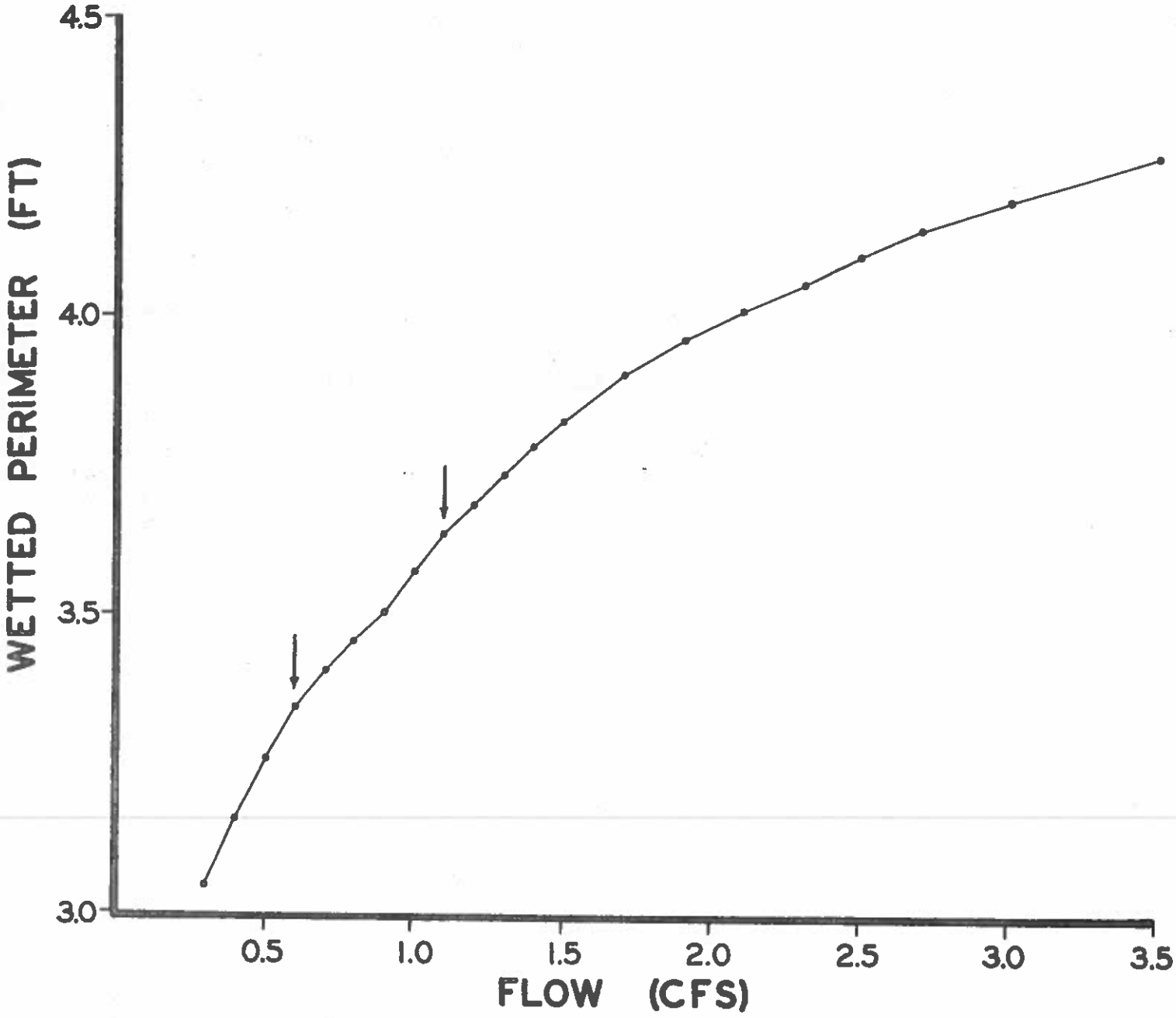
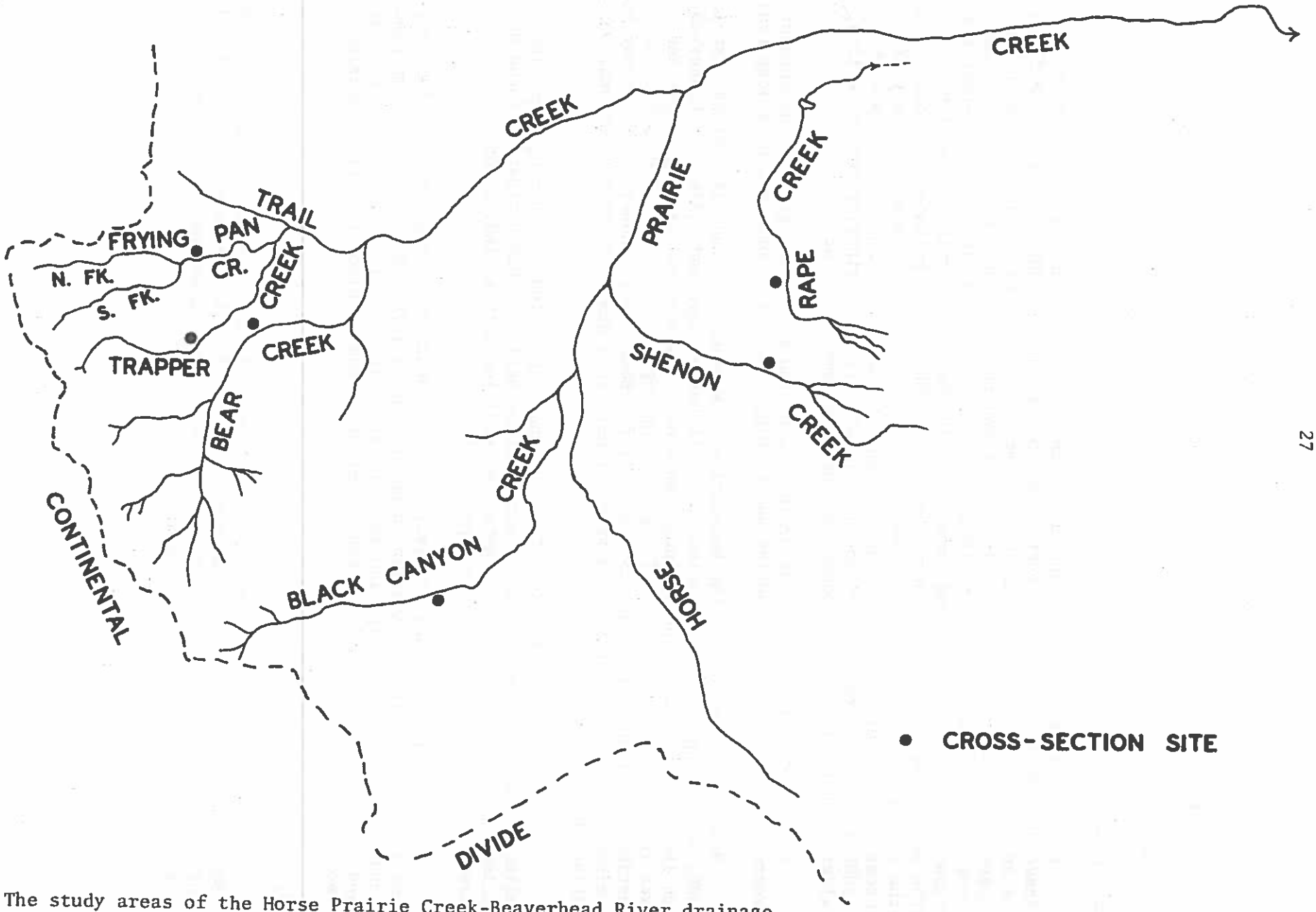


Figure 7. The relationship between wetted perimeter and flow for a composite of three riffle cross-sections in the West Fork of Dyce Creek.

HORSE PRAIRIE CREEK-BEAVERHEAD RIVER DRAINAGE



The study areas of the Horse Prairie Creek-Beaverhead River drainage.

1. STREAM

Bear Creek

2. DESCRIPTION

Bear Creek originates on the east slope of the Continental Divide in the Beaverhead Mountains at an elevation of approximately 8,880 ft. The stream flows in an east-northeasterly direction for about 8.9 miles to its juncture with Trail Creek, a tributary of Horse Prairie Creek and the Beaverhead River. The 12,224 acre (19.1 mi^2) drainage is typified by heavily timbered slopes in the upper elevations and sagebrush-grassland communities in the lower portions. Ownership of the Bear Creek drainage is controlled by the USFS (66%), private individuals (16.2%), the BLM (12.0%) and the state of Montana (5.8%). The only named tributary of Bear Creek is Bear Gulch. The average gradient of the 8.0 ft wide channel is 48.9 ft/1,000 ft. The stream is bordered by a relatively broad riparian zone of willow, alder, aspen, grasses and sedges and supports some beaver activity.

Lands within the Bear Creek drainage are used for cattle grazing and outdoor recreation in the form of hunting and fishing. Access is provided by a Jeep trail.

Bear Creek lies within the boundaries of Montana deer and elk hunting district 328, which supported an estimated 2,522 elk hunter-days and 1,446 deer hunter-days in 1981 (MDFWP 1982). The drainage contains elk winter and calving ranges and was rated excellent in terms of big game hunting quality (BLM 1980). No estimate of fishing pressure is available for Bear Creek. However, the stream received an excellent rating as a sport fishery in a BLM district recreational evaluation (BLM 1980).

The BLM portion of the Bear Creek drainage is included in a single grazing allotment which is managed on a rest-rotation basis. A BLM evaluation found this allotment to be in excellent vegetative condition with no indication of soil erosion and is currently in an improving trend.

A stream channel stability evaluation (Pfankuch 1975) resulted in a fair rating for Bear Creek, while a riparian inventory (Myers 1976) rated the stream in good condition (BLM 1980). Riparian zone condition is directly related to water quality and fish habitat on small southwest Montana streams subject to cattle grazing (Myers 1976).

3. FISHERIES

A 1,000 ft section of Bear Creek was electrofished on August 4 and August 10, 1982. Game fish collected in descending order of abundance were brook trout and cutthroat trout. Mottled sculpins were the only non-game species captured. Electrofishing survey data are summarized in Table 6.

Table 6. Summary of electrofishing survey data for a 1,000 ft section of Bear Creek (T10S, R15W, NW, NW Sec. 35) on August 4 and August 10, 1982.

Species	No. Captured	Length Range (inches)
Brook Trout	73	2.3 - 9.7
Cutthroat Trout	36	2.9 - 8.4
Mottled Sculpin	-	-

The standing crop of brook trout within the study section was estimated using a mark-recapture method (Table 7). No estimate of cutthroat trout standing crop could be derived due to a lack of sufficient numbers of recaptured fish to insure statistical reliability. The section supported 65 brook trout representing a biomass of 7 pounds. Fish 6 in and longer comprised 52% of the estimated population. Brook trout condition (length to weight ratio) was excellent and well above average when compared with brook trout populations in the Big Hole River drainage (Oswald 1981).

Table 7. Estimated standing crop of brook trout in a 1,000 ft section of Bear Creek (T10S, R15W, NW, NW Sec. 35) on August 4, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft	
		Number	Pounds
Brook Trout	5.0 - 9.7	65(±24)	7(±3)

None of the Bear Creek cutthroat trout were collected for meristic determination of strain due to the low numbers of fish collected during the recapture run. Meristic examination of cutthroat trout from Frying Pan and Trapper Creeks, Trail Creek tributaries immediately adjacent to Bear Creek, resulted in their classification as westslope strain (J. Roscoe Unpub. Data 1982). Due to the proximity of Bear Creek to these similar headwater tributaries, it is quite possible that the Bear Creek cutthroat trout represent another westslope population. Future collections are planned to confirm this hypothesis.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 118 ft riffle sequence located approximately at stream mile 4.0 (T10S, R15W, SE, SW Sec. 26). Approximately 67% of the drainage was located above this sequence. The WETP program was calibrated to field data collected at flows of 15.6, 10.5 and 4.8 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 8. Lower and upper inflection points occur at 4.5 and 8.0 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 6.0 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1-June 30) cannot be derived for Bear Creek.

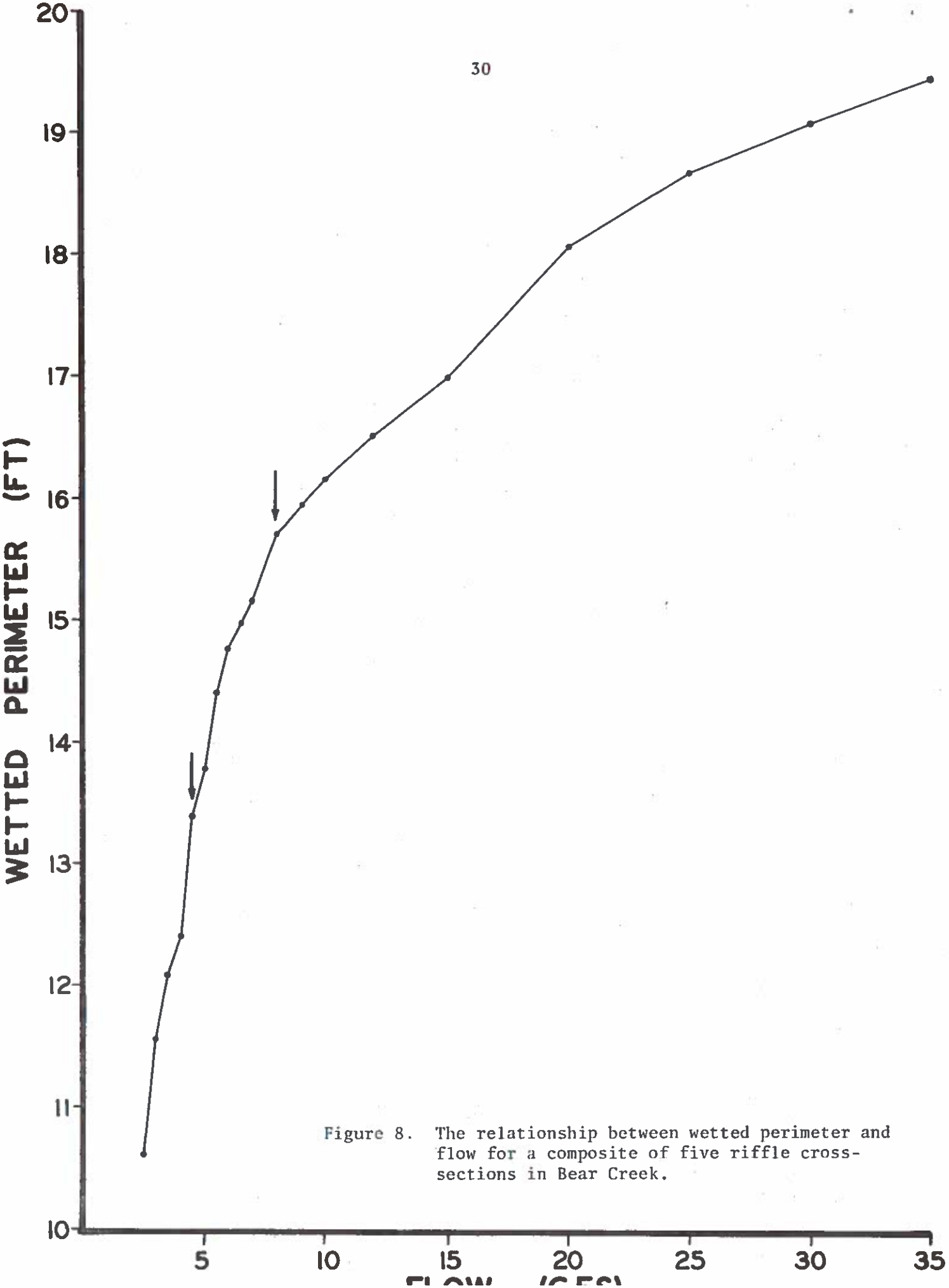


Figure 8. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Bear Creek.

1. STREAM

Black Canyon Creek

2. DESCRIPTION

Black Canyon Creek originates on the east slope of the Continental Divide in the Beaverhead Mountains at an elevation of about 8,880 ft. The stream flows in an east-northeasterly direction for approximately 10.4 miles to its confluence with Everson Creek, a tributary of Horse Prairie Creek and the Beaverhead River. The 10,816 acre (16.9 mi^2) drainage is heavily timbered in the headwater region and characterized by sagebrush-grassland communities in the lower elevations. Ownership of the drainage is controlled by the USFS (49.1%), the BLM (27.3%), private individuals (14.5%) and the state of Montana (9.1%). The stream is bordered by a relatively broad riparian zone of willow, aspen, grasses and sedges and characterized by numerous areas of beaver activity. The average gradient of the 5 ft wide channel is 44.8 ft/1,000 ft.

Lands within the Black Canyon Creek drainage are utilized for cattle grazing and outdoor recreation in the form of hunting and fishing. Access is provided by a dirt road which parallels the stream.

Black Canyon Creek lies within the boundaries of Montana deer and elk hunting district 328, which supported an estimated 2,252 elk hunter-days and 1,446 deer hunter-days in 1981 (MDFWP 1982). The drainage contains elk and moose winter range and is rated excellent in terms of big game hunting quality (BLM 1980). No estimate of fishing pressure is available for Black Canyon Creek. However, angler use of the stream was observed during the 1982 field season.

The BLM segment of the drainage is included in two grazing allotments which are managed on a rest-rotation basis. One of these allotments was evaluated as being in good condition. However, the other was rated as poor and undergoing a declining trend (BLM 1980).

Black Canyon Creek is a calcium-magnesium-bicarbonate stream with a neutral to alkaline pH and specific conductance ranging between 65 and 185 μ mhos (Foggin et al. 1978). Suspended sediment has been observed to range between <5 and 948 ppm. These values represented an annual load of 21 tons in 1977, a low water year, and 172 tons in 1978, which had higher stream flows (Foggin et al. 1978).

A stream channel stability evaluation (Pfankuch 1975) resulted in a fair rating for Black Canyon Creek, while a riparian zone survey (Myers 1976) resulted in a good rating (BLM 1980). Riparian zone condition is related to fish habitat and water quality in small southwest Montana streams subject to cattle grazing.

3. FISHERIES

A 1,000 ft section of Black Canyon Creek was electrofished on August 4 and August 11, 1982. The only game fish collected were brook trout, while mottled sculpins were the only non-game species present. Electrofishing survey data are summarized in Table 8.

Table 8. Summary of electrofishing survey data for a 1,000 ft section of Black Canyon Creek (T11S, R14W, SE, NW Sec. 21) on August 4 and August 11, 1982.

Species	No. Captured	Length Range (inches)
Brook Trout	251	1.6 - 11.1
Mottled Sculpin	-	-

The standing crop of brook trout within the study section was estimated by using a mark-recapture method (Table 9). The section supported an estimated 351 fish representing a biomass of 35 pounds. Fish 6 in and longer amounted to 49% of the population.

Table 9. Estimated standing crop of brook trout in a 1,000 ft section of Black Canyon Creek (T11S, R14W, SE, NW Sec. 21) on August 4, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft Number	Per 1,000 ft Pounds
Brook Trout	3.5 - 4.4	127	
	4.5 - 6.4	95	
	6.5 -11.1	129	
		351 (±46)	35(±4)

The trout population of the study section revealed a good sport fishery of brook trout of a harvestable size.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 146 ft riffle sequence located approximately at stream mile 5.2 (T11S, R14W, SE, NW Sec. 21). Aproximately 65% of the drainage area was located above this sequence. The WETP program was calibrated to field data collected at flows of 17.1, 10.6 and 3.6 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 9. Lower and upper inflection points occur at 2.0 and 7.0 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 3.0 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Black Canyon Creek.

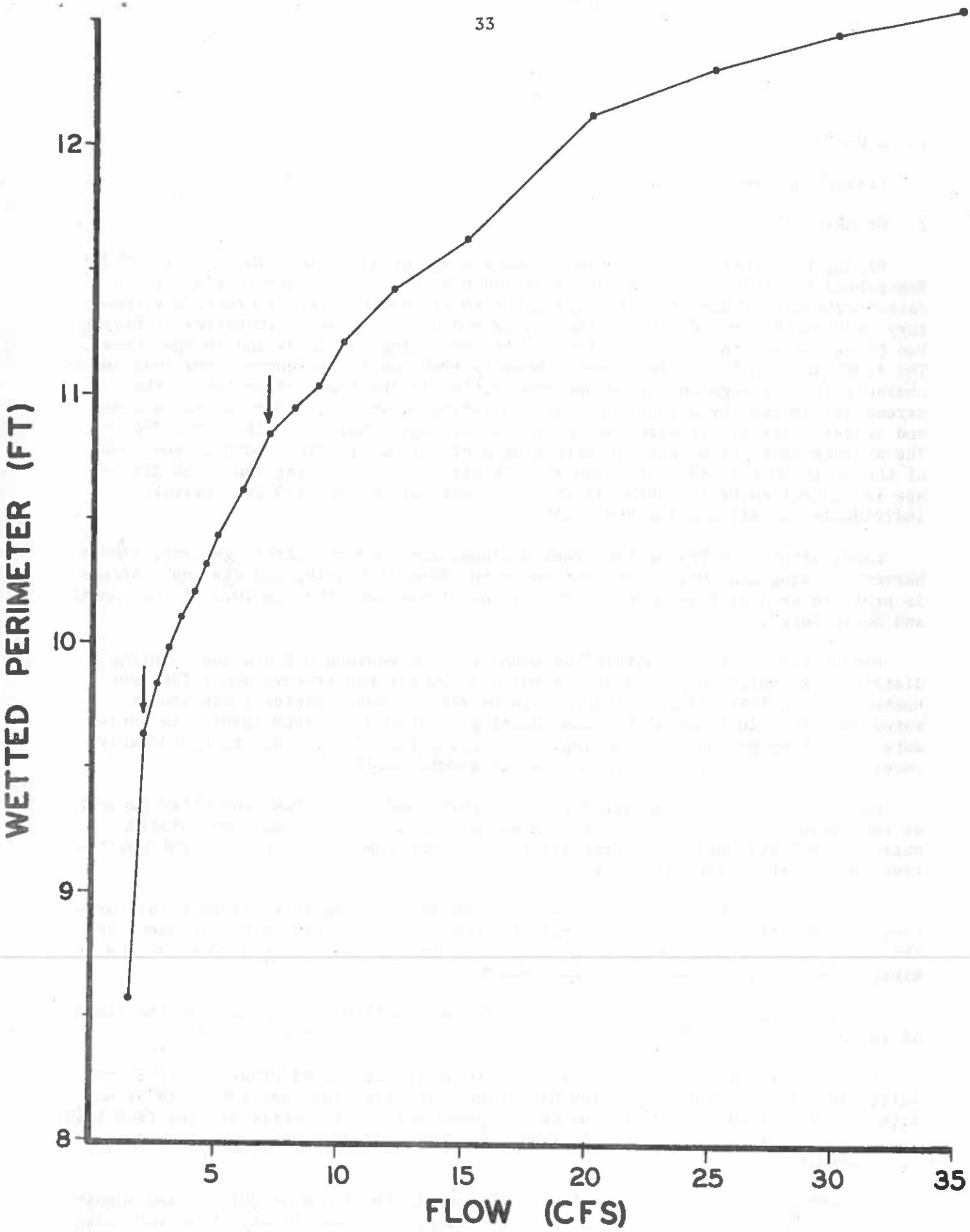


Figure 9. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Black Canyon Creek.

1. STREAM

Frying Pan Creek

2. DESCRIPTION

Frying Pan Creek originates on the east slope of the Continental Divide in the Beaverhead Mountains at an elevation of about 8,400 ft. The stream flows in an east-northeasterly direction for 2.4 miles to its mouth on Trail Creek, a tributary of Horse Prairie Creek and the Beaverhead River. Named tributaries of Frying Pan Creek include the North and South Forks of Frying Pan Creek and Trapper Creek. The 4,352 acre (6.8 mi^2) drainage is heavily timbered in the upper elevations and is characterized by sage and grassland communities in the lower elevations. The stream is bordered by a riparian zone consisting of willow, alder, aspen, grasses and sedges. The 8.5 ft wide channel has an average gradient of 18.9 ft/1,000 ft. The average gradient of the 5.6 mile length of stream from the mouth to the head of the North Fork is 59.5 ft/1,000 ft. Ownership of the Frying Pan Creek drainage is controlled by the USFS (41.7%), the State of Montana (29.2%), private individuals (20.8%) and the BLM (8.3%).

Lands within the Frying Pan Creek drainage are used for cattle grazing, timber harvest, mining and outdoor recreation in the form of hunting and fishing. Access is provided by a dirt road which crosses the stream near the juncture of the North and South Forks.

Frying Pan Creek lies within the boundaries of Montana elk and deer hunting district 328, which supported an estimated 2,522 elk hunter-days and 1,446 deer hunter-days in 1981. The drainage contains elk and moose winter range and is rated excellent in terms of big game hunting quality (BLM 1980). No estimate of fishing pressure is available for Frying Pan Creek. The stream probably receives light fishing pressure due to its remote location.

Portions of two grazing allotments are contained in the BLM controlled segment of the drainage. These allotments are managed on a seasonal and rest-rotation basis. A BLM evaluation of these allotments found them to be in excellent vegetative shape with no indication of soil erosion.

The Frying Pan Creek drainage has had some past mining in the form of exploratory work for the radioactive mineral, thorium. A small abandoned settlement on the South Fork of Frying Pan Creek called Thorium City was erected to house the miners and is still standing at the present.

No timber harvest was in effect on USFS lands within the drainage at the time of the present study. However, a small timber sale is planned for 1984.

A stream channel stability evaluation after the method of Pfankuch (1975) resulted in a fair rating for Frying Pan Creek. The riparian zone (Myers 1975) was rated in good condition but far below its potential due to cattle grazing (BLM 1980).

3. FISHERIES

A 1,000 ft section of Frying Pan Creek was electrofished on July 30 and August 10, 1982. The only fish collected were westslope cutthroat trout. Electrofishing survey data are summarized in Table 10.

Table 10. Summary of electrofishing survey data for a 1,000 ft section of Frying Pan Creek (T10S, R15W, NE, SW Sec. 22) on July 30 and August 10, 1982.

Species	No. Captured	Length Range (inches)
Westslope Cutthroat Trout	115	2.0 - 9.3

The standing crop of westslope cutthroat trout within the study section was estimated by using a mark-recapture method (Table 11). The section supported 474 fish, representing a biomass of 25 pounds. Fish 6 in and larger comprised 17% of the estimated population. The fish condition factor (length to weight ratio) was found to be excellent.

Table 11. Estimated standing crop of westslope cutthroat trout in a 1,000 ft section of Frying Pan Creek (T10S, R15 W, NE SW Sec. 22) on July 30, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft	
		Number	Pounds
Westslope Cutthroat Trout	2.5 - 6.9	447	
	7.0 - 9.3	27	
		474 (±224)	25 (±10)

Meristic examination of representative fish collected from Frying Pan Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpub. Data, 1982). The westslope cutthroat trout, once common throughout the Upper Missouri River drainage, is classified as a species of special concern (Deacon et al. 1979) in Montana. It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce the native cutthroat population of the Upper Missouri drainage.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in an 83 ft riffle sequence located approximately at stream mile 2.0 (T10S, R15W, NE, SW Sec. 22). Approximately 67% of the drainage area is located above the subreach. Five cross-sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 9.8, 4.8 and 2.2 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 10. Lower and upper inflection points occur at 1.8 and 3.0 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 3.0 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Frying Pan Creek.

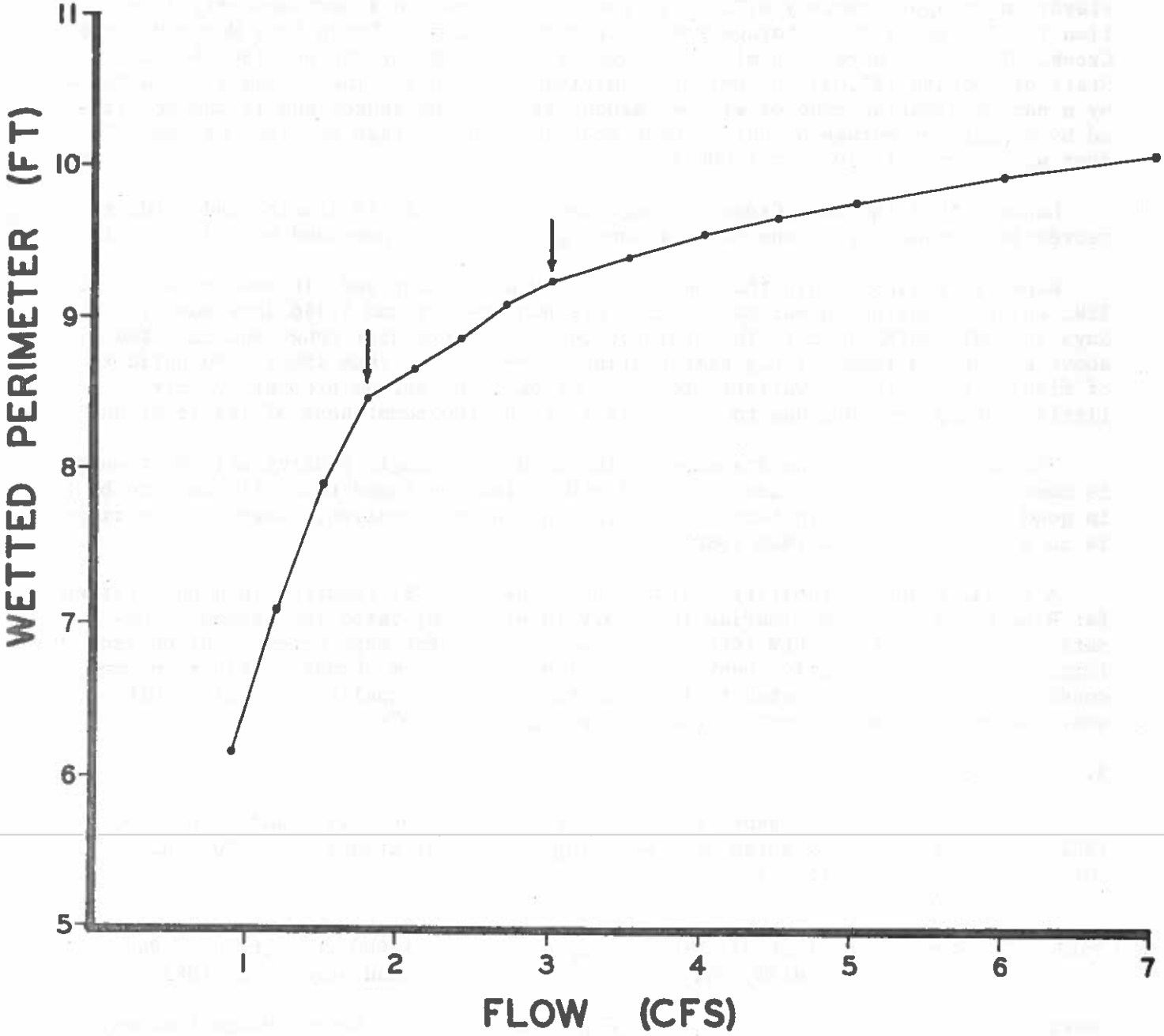


Figure 10. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Frying Pan Creek.

1. STREAM

Rape Creek

2. DESCRIPTION

Rape Creek originates on the east slope of the Beaverhead Mountains at an elevation of approximately 8,720 ft. The stream flows in a northwesterly direction for 7.0 miles to a storage reservoir for the Paiment Ditch from Horse Prairie Creek. The 5,120 acre (8.0 mi^2) drainage is controlled by the BLM (50.0%), the State of Montana (25.0%) and private individuals (25.0%). The stream is bordered by a narrow riparian zone of willow, aspen, grasses and sedges and is characterized by a high percentage of active bank erosion. The average gradient of the 2.5 foot wide stream is 70.3 ft/1,000 ft.

Lands within the Rape Creek drainage are used for cattle grazing and outdoor recreation, primarily in the form of hunting. Access is provided by a Jeep trail.

Rape Creek lies within the boundaries of Montana deer and elk hunting district 328, which supported an estimated 2,522 elk hunter-days and 1,446 deer hunter-days in 1981 (MDFWP 1982). The drainage contains elk winter range and is rated above average in terms of big game hunting quality (BLM 1980). No estimate of fishing pressure is available for Rape Creek. The stream probably receives little fishing pressure due to its small size and the remoteness of its location.

The BLM portion of the drainage is included in a single grazing allotment which is managed on a rest-rotation basis. A BLM evaluation found this allotment to be in good condition both in terms of vegetation and soil erosion. However, the range is in a declining trend (BLM 1980).

A stream channel stability evaluation (Pfankuch 1975) resulted in a poor rating for Rape Creek, while a riparian inventory (Myers 1976) rated the stream in unsatisfactory condition (BLM 1980). The poor ratings for Rape Creek resulted from large percentages of active bank erosion along the stream channel. Riparian zone condition is directly related to fish habitat and water quality on small southwest Montana streams subject to cattle grazing (Myers 1976).

3. FISHERIES

A 1,000 ft section of Rape Creek was electrofished on July 7 and August 19, 1982. The only fish collected were westslope cutthroat trout. Electrofishing survey data are summarized in Table 12.

Table 12. Summary of electrofishing survey data for a 1,000 ft section of Rape Creek (T10S, R13W, NW, SE Sec. 21) on July 7 and August 19, 1982.

Species	No. Captured	Length Range (inches)
Westslope Cutthroat Trout	36	2.3 - 6.3

The standing crop of westslope cutthroat trout within the study section could not be estimated due to a lack of sufficient recaptures to insure statistical reliability of the estimate.

BLM biologists collected fish from Rape Creek in July, 1980. Fish preserved for meristic examination at the time of this collection averaged 8.2 inches in length. Meristic examination of cutthroat trout from Rape Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpub. Data 1980). The westslope cutthroat trout, once common throughout the upper Missouri River drainage, is classified as a species of special concern in Montana (Deacon et al. 1979). It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce and restrict the native cutthroat trout population of the Upper Missouri drainage.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 107 ft riffle sequence located approximately at stream mile 3.7 (T10S, R13W, NW, SE Sec. 21). Approximately 38% of the drainage was located above this sequence. The WETP program was calibrated to field data collected at flows of 1.7, 1.1 and 0.6 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 11. Lower and upper inflection points occur at 0.3 and 0.5 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 0.5 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Rape Creek.

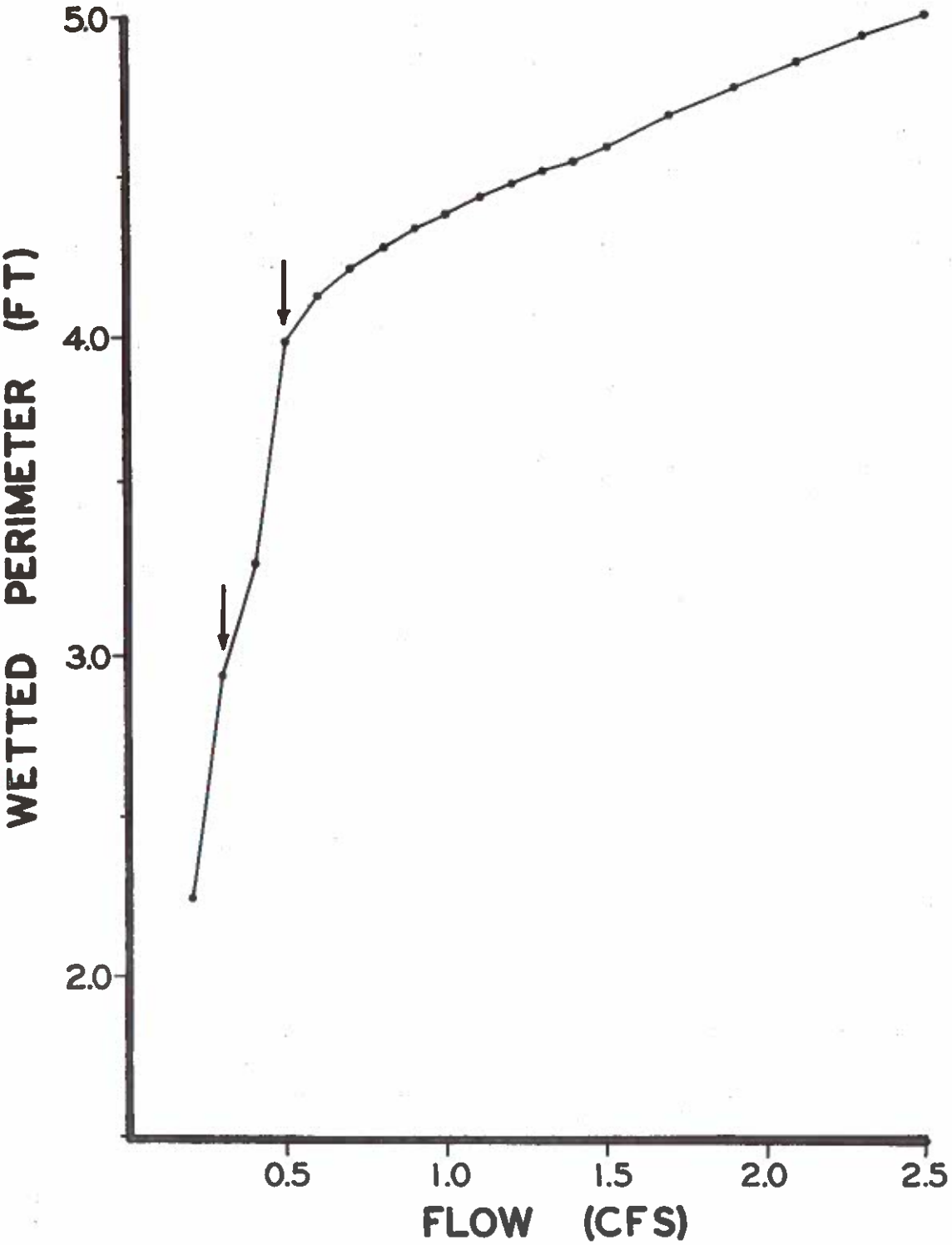


Figure 11. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Rape Creek.

1. STREAM

Shenon Creek

2. DESCRIPTION

Shenon Creek originates on the east slope of the Beaverhead Mountains at an elevation of about 8,760 ft. The stream flows in a northwesterly direction for 6.9 miles to its junction with Horse Prairie Creek, a tributary of the Beaverhead River. The 5,504 acre (8.6 mi^2) drainage is characterized by timbered slopes in the headwater region and sagebrush-grassland communities in the lower elevations. Ownership of the Shenon Creek drainage is controlled by the BLM (60.7%), private individuals (21.4%) and the State of Montana (17.9%). The stream is bordered by a relatively broad riparian zone consisting of willow, birch, aspen, grasses and sedges. The average gradient of the 3.0 ft wide stream is 66.4 ft/1,000 ft.

Lands within the Shenon Creek drainage are used for cattle grazing and outdoor recreation, primarily in the form of hunting. Access is provided by a dirt road which parallels the stream.

Shenon Creek lies within the boundaries of Montana deer and elk hunting district 328 which supported an estimated 2,522 elk hunter-days and 1,446 deer hunter-days in 1981 (MDFWP 1982). The drainage contains elk winter range and is rated excellent in terms of big game hunting quality (BLM 1980). No estimate of fishing pressure is available for Shenon Creek. The stream probably receives little fishing pressure due to its small size.

The BLM portion of the drainage is included in a single grazing allotment which is managed on a rest-rotation basis. A BLM evaluation found the allotment to be in good condition both in terms of vegetation and soil erosion. However, the range was undergoing a declining trend (BLM 1980).

Shenon Creek is a calcium-magnesium-bicarbonate stream with an alkaline pH and specific conductance ranging between 132 μ mhos at high flow and 238 μ mhos at low flow (Foggin et al. 1978). Suspended sediment ranged between <5ppm and 384 ppm, representing an annual bedload of 42 tons in the upper drainage in 1977, while a station in the lower drainage showed higher concentrations (Foggin et al. 1978).

A stream channel stability evaluation (Pfankuch 1975) resulted in a poor rating for Shenon Creek, while a riparian zone inventory (Myers 1976) resulted in an unsatisfactory rating (BLM 1980). The poor ratings for Shenon Creek were due to large percentages of active erosion along the stream banks.

3. FISHERIES

A 1,000 ft section of Shenon Creek was electrofished on July 7 and July 27, 1982. Game fish collected in descending order of abundance were brook trout and cutthroat trout plus rainbow x cutthroat hybrid trout. Mottled sculpins were the only non-game species collected. Electrofishing survey data are summarized in Table 13.

Table 13. Summary of electrofishing survey data for a 1,000 ft section of Shenon Creek (T10S, R13W, NW, NW Sec. 32) on July 7 and July 27, 1982.

Species	No. Captured	Length Range (inches)
Brook Trout	16	4.2 - 7.3
Cutthroat and Rainbow x Cutthroat Hybrid Trout	10	2.9 - 6.8
Mottled Sculpin	-	-

A single electrofishing trip was conducted on a second section of Shenon Creek (T10S, R13W, SE, NW Sec. 33) on July 27, 1982. This upper section was 700 ft in length and yielded 17 cutthroat plus rainbow x cutthroat trout (2.9 - 4.1 in) and 7 brook trout (4.4 - 5.7 in). Mottled sculpins were also present in this upper section.

The standing crop of brook trout within the 1,000 ft study section was estimated by using a mark-recapture method (Table 14). The low estimate of eight fish per 1,000 ft is probably due to the generally poor condition of fish habitat on Shenon Creek, as indicated by the eroding banks and the poor condition of the riparian zone. The poor status of the fish habitat of Shenon Creek has been attributed to cattle grazing practices along the stream (BLM 1980).

Table 14. Estimated standing crop of brook trout in a 1,000 ft section of Shenon Creek (T10S, R13W, NW, NW Sec. 32) on July 7, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft	
		Number	Pounds
Brook Trout	5.0 - 7.3	8(±3)	1(±0)

BLM biologists collected fish from Shenon Creek in July, 1980. Meristic examination of specimens from this collection revealed that some of the fish from Shenon Creek were within the range of characteristics used to describe westslope cutthroat trout (Behnke 1979 and Roscoe 1974), while other specimens had some degree of hybridization with rainbow trout (J. Roscoe Unpub. Data, 1980). The hybridization of native cutthroat trout with introduced rainbow trout is one of the major factors associated with the marked decline of native cutthroat trout populations in Montana (Hanzel 1961).

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 184 ft riffle sequence located approximately at stream mile 2.9 (T10S, R13W, NE, NE Sec. 32). Approximately 47% of the drainage was located above this sequence. The WETP program was calibrated to field data collected at flows of 1.7, 1.0 and 0.7 cfs.

The relationship between wetted perimeter and flow for a composite of four riffle cross-sections is shown in Figure 12. Lower and upper inflection points occur at 0.5 and 1.0 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 0.7 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Shenon Creek.

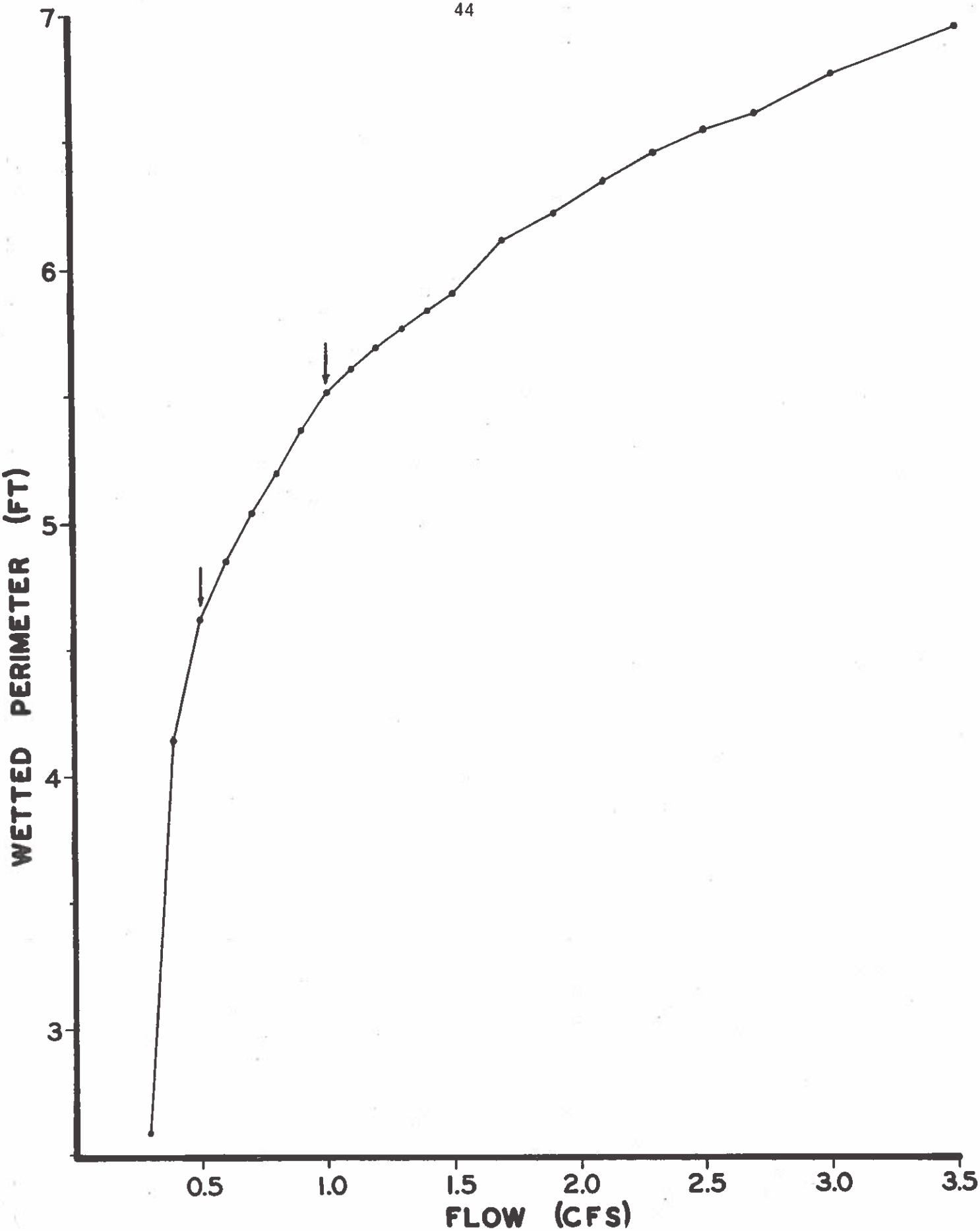


Figure 12. The relationship between wetted perimeter and flow for a composite of four riffle cross-sections in Shenon Creek.

1. STREAM

Trapper Creek

2. DESCRIPTION

Trapper Creek originates on the east slope of the Continental Divide in the Beaverhead Mountains at an elevation of approximately 8,600 ft. The stream flows in an east-northeasterly direction for 4.9 miles to its confluence with Frying Pan Creek. The 3,136 acre (4.9 mi^2) drainage is characterized by heavily timbered slopes in the headwater region and sagebrush-grassland communities in the lower elevations. Ownership of the Trapper Creek drainage is controlled by the USFS (44.9%), private individuals (30.6%), the BLM (14.3%) and the State of Montana (10.2%). The stream is bordered by a narrow riparian zone of willow, aspen, alder, grasses and sedges. The average gradient of the 3.5 ft wide channel is 74.2 ft/1,000 ft.

Lands within the Trapper Creek drainage are used for cattle grazing and outdoor recreation in the form of hunting and fishing. Access is provided by a Jeep trail which crosses the stream.

Trapper Creek lies within the boundaries of Montana deer and elk hunting district 328, which supported an estimated 2,522 elk hunter-days and 1,446 deer hunter-days in 1981 (MDFWP 1982). The drainage contains elk winter range and is rated excellent in terms of big game hunting quality (BLM 1980). No estimate of fishing pressure is available for Trapper Creek. The stream probably receives light fishing pressure due to its remote location and small size.

The BLM portion of the drainage is included in a single grazing allotment which is utilized on a rest-rotation basis. A BLM evaluation found this allotment to be in excellent vegetative condition with no indication of soil erosion and is currently in an improving trend (BLM 1980).

A stream channel stability evaluation after the method of Pfankuch (1975) and a riparian zone evaluation (Myers 1976) resulted in fair ratings for Trapper Creek. Riparian zone condition is directly related to fish habitat and water quality on small southwestern Montana streams subject to cattle grazing (Myers 1976).

3. FISHERIES

A 1,000 ft section of Trapper Creek was electrofished on July 30 and August 10, 1982. Game fish collected in descending order of abundance were westslope cutthroat trout and brook trout. Electrofishing survey data are summarized in Table 15.

Table 15. Summary of electrofishing survey data for a 1,000 ft section of Trapper Creek (T10S, R15W, SE, NW Sec. 34) on July 30 and August 10, 1982.

Species	No. Captured	Length Range (inches)
Westslope Cutthroat Trout	30	2.2 - 7.7
Brook Trout	6	3.0 - 5.3

The standing crop of westslope cutthroat trout within the study section was estimated by using a mark-recapture method (Table 16). The section supported 33 fish representing a biomass of three pounds. Fish condition (length to weight ratio) was excellent.

Table 16. Estimated standing crop of westslope cutthroat trout in a 1,000 ft section of Trapper Creek (T10S, R15W, SE NW Sec. 34) on July 30, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft	
		Number	Pounds
Westslope Cutthroat Trout	4.0 - 7.7	33(±12)	3(±1)

Meristic examination of representative fish collected from Trapper Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpub. Data, 1982). The westslope cutthroat trout, once common throughout the upper Missouri River drainage, is classified as a species of special concern in Montana (Deacon et al. 1979). It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce and restrict the native cutthroat trout population of the upper Missouri drainage.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 224 ft riffle sequence located approximately at stream mile 2.5 (T10S, R15W, SE NW Sec. 34). Approximately 63% of the drainage area was located above this sequence. The WETP program was calibrated to field data collected at flows of 12.1, 3.7 and 0.9 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 13. Lower and upper inflection points occur at 0.6 and 0.9 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 0.9 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Trapper Creek.

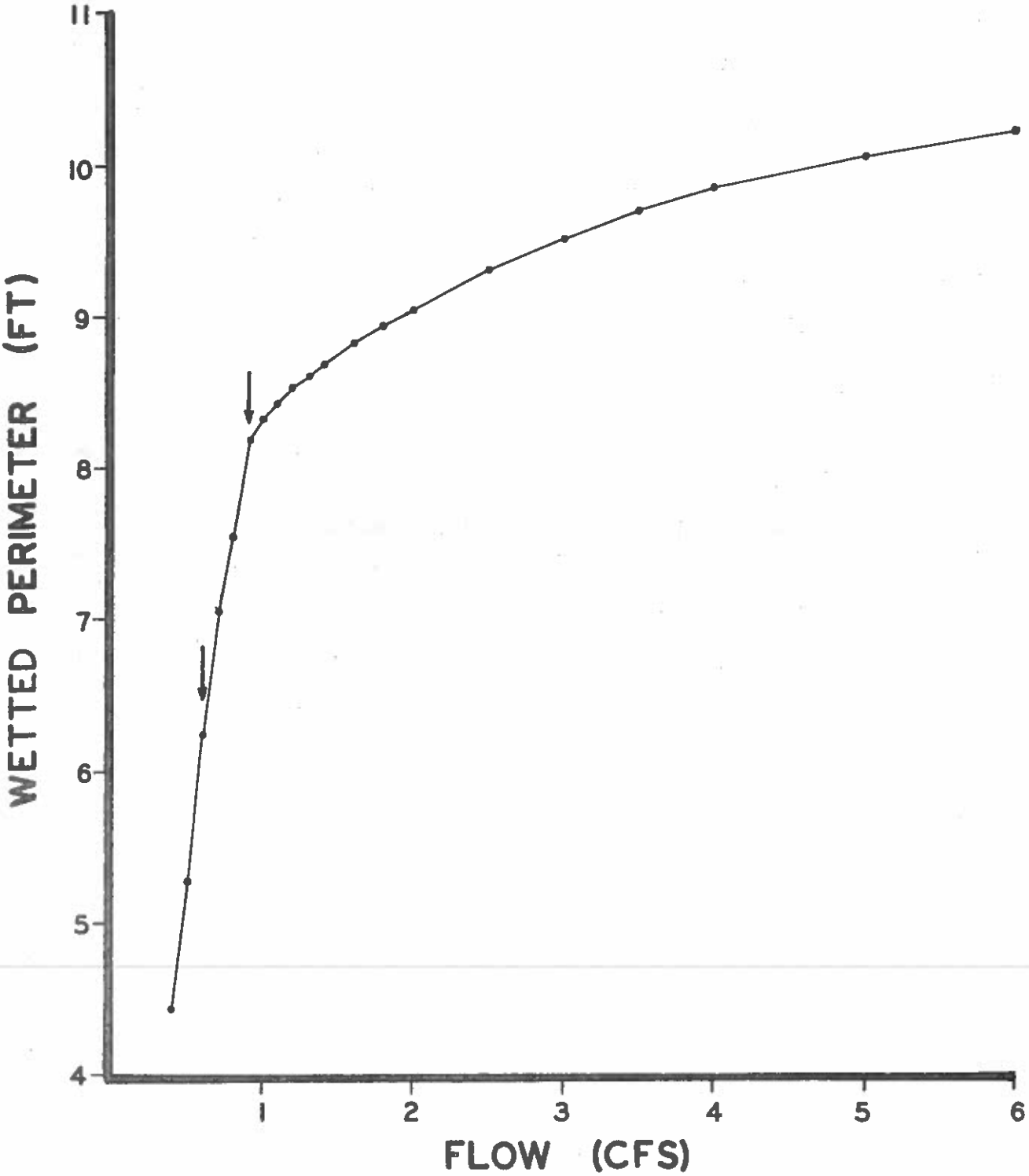
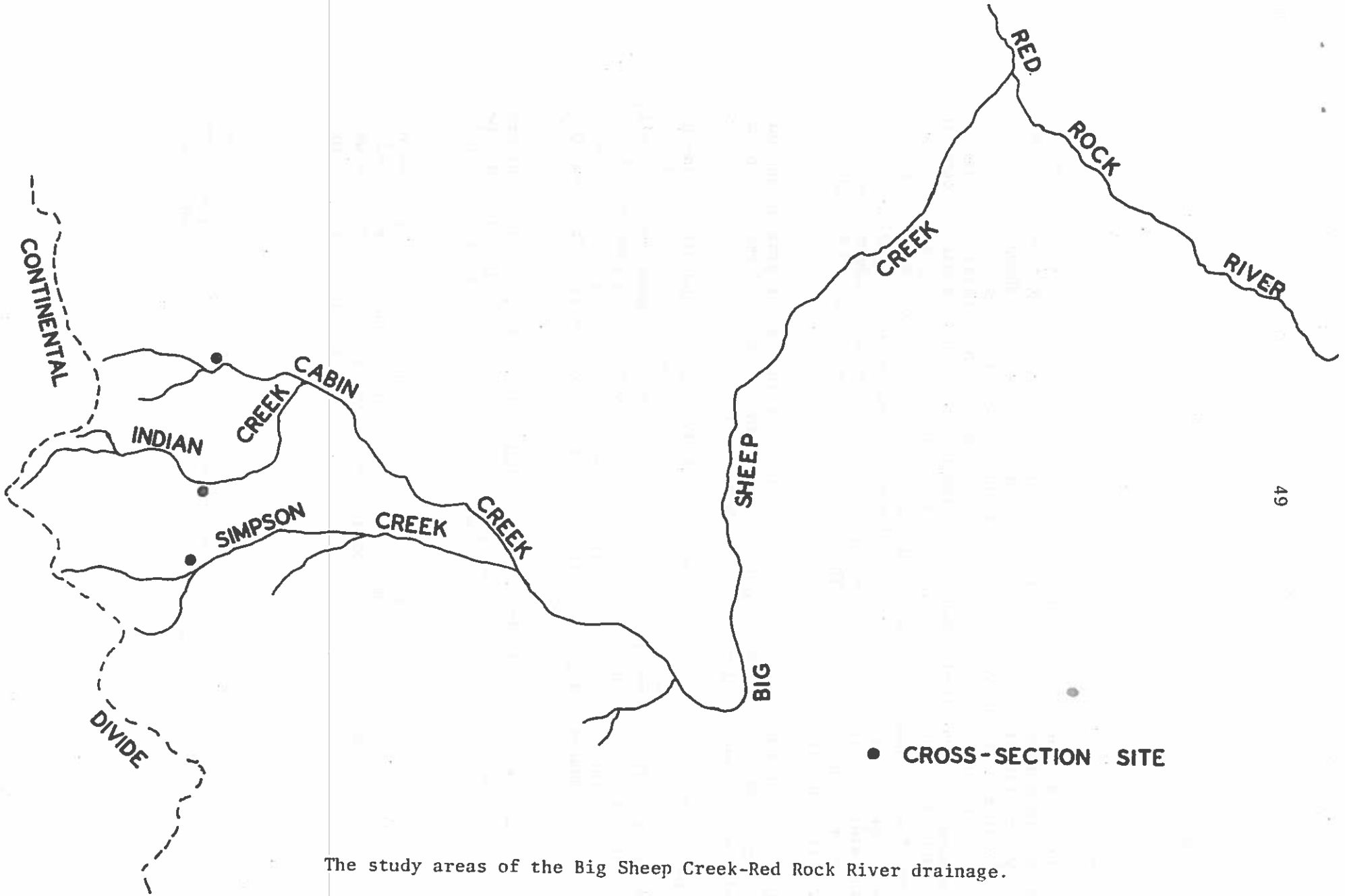


Figure 13. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Trapper Creek.

BIG SHEEP CREEK-RED ROCK RIVER DRAINAGE



The study areas of the Big Sheep Creek-Red Rock River drainage.

1. STREAM

Cabin Creek

2. DESCRIPTION

Cabin Creek originates on the east slope of the Continental Divide in the Beaverhead Mountains at an elevation of 8,400 ft. The stream flows in a southeasterly direction for 13.7 miles to its confluence with Big Sheep Creek, a tributary to the Red Rock River. The 51,200 acre drainage (80 mi^2) is heavily timbered in the extreme upper reaches, but is mainly characterized by high elevation sagebrush-grassland communities. Ownership of the drainage is controlled by the BLM (35%), USFS (34.2%), private individuals (25.4%) and the State of Montana (5.4%). Named tributaries of Cabin Creek include Indian, Cow, Porcupine Canyon, Simpson and Tex creeks. The stream is bordered by a riparian zone of varying width consisting of willow, grasses and sedges and characterized by a high degree of beaver activity. The average gradient of the 5.3 ft wide channel is 22.1 ft/1,000 ft.

Lands within the Cabin Creek drainage are used for cattle grazing and outdoor recreation in the form of hunting and fishing. Access is provided by a gravel road and several dirt roads and Jeep trails.

Cabin Creek lies within the boundaries of Montana deer and elk hunting district 328 which supported an estimated 2,522 elk hunter-days and 1,446 deer hunter-days in 1981 (MDFWP 1982). The drainage provides summer range for elk, mule deer and antelope and is rated excellent in terms of big game hunting quality (BLM 1980). No estimate of fishing pressure is available for Cabin Creek. However, angler use of the lower portions of the stream was observed during the 1982 field season.

Numerous BLM grazing allotments are included in the large Cabin Creek drainage. The headwater region where the present study was undertaken includes portions of two allotments which are managed on a rest-rotation basis. A BLM evaluation of these allotments found them to be in good to excellent condition.

A riparian zone evaluation (Myers 1976) was conducted on an upper reach of Cabin Creek near the present study area. The riparian condition was rated as good (BLM 1980). Riparian zone condition is related to fish habitat and water quality on small southwestern Montana streams subject to cattle grazing (Myers 1976).

3. FISHERIES

A 1,000 ft section of Cabin Creek was electrofished on July 8 and August 3, 1982. The only game fish collected were westslope cutthroat trout, while mottled sculpin were the only non-game species collected. Electrofishing survey data are summarized in Table 17.

Table 17. Summary of electrofishing survey data for a 1,000 ft section of Cabin Creek (T14S, R12W, SE SE Sec. 1, NE NE Sec. 12) on July 8 and August 3, 1982.

Species	No. Captured	Length Range (inches)
Westslope Cutthroat Trout	78	2.5 - 6.8
Mottled Sculpin	-	-

The standing crop of westslope cutthroat trout within the study section was estimated by using a mark-recapture method (Table 18). The section supported 133 smaller (3.0 - 4.9 in) fish representing a biomass of 4 pounds. No estimate of larger fish could be derived due to the low number that was captured.

Table 18. Estimated standing crop of westslope cutthroat trout in a 1,000 ft section of Cabin Creek (T14S, R12W, SE SE Sec. 1, NE NE Sec. 12) on July 8, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft	
		Number	Pounds
Westslope Cutthroat Trout	3.0 - 4.9	133(±56)	4(±2)

BLM biologists collected fish from two 300 ft sections of Cabin Creek in June and July, 1980. Fish preserved for meristic examination during this colleciton averaged 7.3 inches in length. Meristic examination of cutthroat trout from Cabin Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpublished data, 1980). The westslope cutthroat trout, once common throughout the upper Missouri River drainage, is classified as a species of special concern in Montana (Deacon et al., 1979). It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce and restrict the native cutthroat trout population of the upper Missouri drainage.

The population survey of the study section revealed a stream habitat capable of supporting native westslope cutthroat trout. Furthermore, the size composition of the fish captured indicated that the upper reaches of Cabin Creek may represent an important spawning and rearing habitat for the cutthroat population of the drainage.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in an 84 ft riffle sequence located approximately at stream mile 11.9 (T14S, R12W, SE SE Sec. 1). Approximately 3% of the drainage area was located above this sequence. The WETP program was calibrated to field data collected at flows of 4.9, 1.1, and 0.6 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 14. Lower and upper inflection points occur at 0.6 and 0.9 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 0.9 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Cabin Creek.

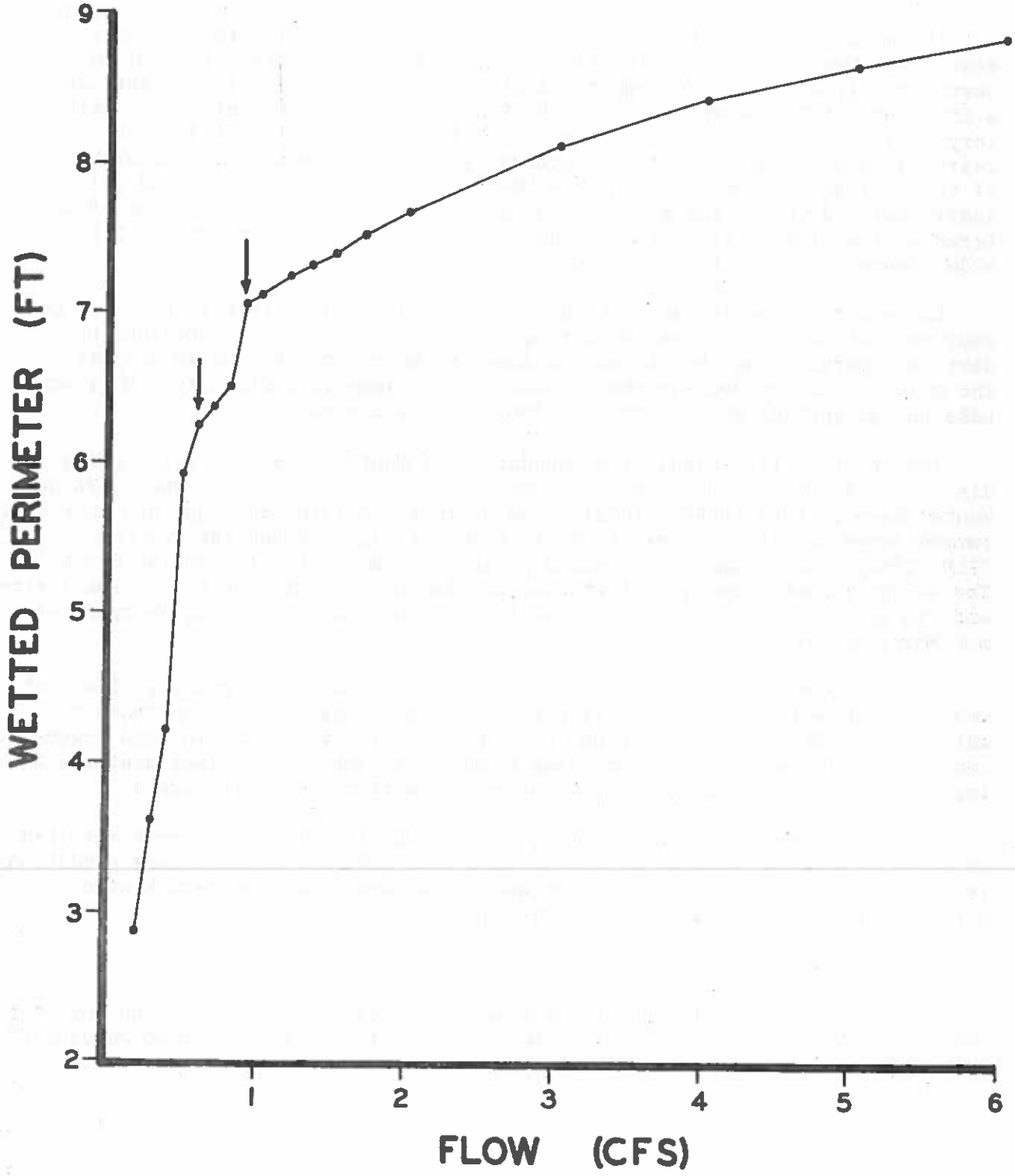


Figure 14. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Cabin Creek.

1. STREAM

Indian Creek

2. DESCRIPTION

Indian Creek originates on the east slope of the Continental Divide in the Beaverhead Mountains at an elevation of 8,320 ft. The stream flows in an east-northeasterly direction for approximately 5.0 miles before joining Cabin Creek, a tributary of Big Sheep Creek and the Red Rock River. The only named tributary to Indian Creek is Sawlog Creek. The 4,928 acre (7.7 mi^2) drainage is characterized by high elevation sagebrush-grassland communities. Ownership of the drainage is controlled by the USFS (48.0%), the BLM (32.0%) and private individuals (20.0%). The stream is bordered by a narrow riparian zone of scattered willow clumps, grasses and sedges. The average gradient of the 2.9 ft wide channel is 33.3 ft/1,000 ft.

Lands within the Indian Creek drainage are used for cattle grazing and outdoor recreation in the form of hunting and fishing. Access is provided by a dirt road paralleling the stream and leads to Morrison Lake, which supports the majority of the recreational fishing in the immediate vicinity. Morrison Lake has no surface outlet into the Indian Creek drainage.

Indian Creek lies within the boundaries of Montana deer and elk hunting district 328, which supported an estimated 2,522 elk hunter-days and 1,446 deer hunter-days in 1981 (MDFWP, 1982). The drainage contains antelope and mule deer summer range and is rated excellent in terms of big game hunting quality (BLM, 1980). No estimate of fishing pressure is available for Indian Creek. The stream probably receives little or no fishing pressure due to its small size and its proximity to major recreational fisheries provided by Big Sheep Creek and Morrison Lake.

The BLM portion of the drainage is contained in a single grazing allotment which is managed on a rest-rotation basis. A BLM range evaluation found this allotment to be in fair condition in terms of soil erosion and in good vegetative condition, but undergoing a declining trend (BLM, 1980). An experimental grazing exclosure is currently being monitored on a reach of Indian Creek.

A riparian zone inventory (Myers, 1976) conducted on Indian Creek resulted in a fair condition rating for the stream (BLM, 1980). Riparian zone condition is related to fish habitat and water quality on small southwestern Montana streams subject to cattle grazing (Myers, 1976).

3. FISHERIES

A 1,000 ft section of Indian Creek was electrofished on July 8 and August 3, 1982. The only fish collected were westslope cutthroat trout. Electrofishing survey data are summarized in Table 19.

Table 19. Summary of electrofishing survey data for a 1,000 ft section of Indian Creek (T14S, R12W, SE NW Sec. 24) on July 8 and August 3, 1982.

Species	No. Captured	Length Range (inches)
Westslope Cutthroat Trout	18	3.8 - 7.7

The standing crop of westslope cutthroat trout within the study section was estimated by using a mark-recapture method (Table 20). The section supported 19 fish representing a biomass of one pound. The low numbers of fish in the study section possibly result from the limited amount of overhanging brush canopy and pool cover, combined with the small size of the stream. Fish captured during the electrofishing survey appeared to be limited to these cover types. A second 1,000 ft section (T14S, R12W, SW NE Sec. 24) located downstream from the study section was electrofished on July 8, 1982. This section, which was virtually lacking in overhanging canopy and had very few pools, yielded a total of four cutthroat trout (5.1 - 6.2 in).

Table 20. Estimated standing crop of westslope cutthroat trout in a 1,000 ft section of Indian Creek (T14S, R12W, SE, NW Sec. 24) on July 8, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft	
		Number	Pounds
Westslope Cutthroat Trout	4.0 - 7.7	19(±7)	1(±0)

BLM biologists collected fish from a 1,100 ft section of Indian Creek in July, 1980. Eight fish, averaging 7.3 inches in length, were preserved for meristic examination from this collection. Meristic examination of cutthroat trout from Indian Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpub. data, 1980). The westslope cutthroat trout, once common throughout the upper Missouri River drainage, is classified as a species of special concern in Montana (Deacon et al., 1979). It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce and restrict the native cutthroat trout population of the Missouri drainage.

The trout population of the study section revealed a stream habitat capable of supporting native westslope cutthroat trout. Instream rock structures were positioned in Indian Creek by BLM volunteers during the summer of 1982. Increased pool habitat resulting from these structures may increase the cutthroat trout population of the stream.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 309 ft riffle sequence located approximately at stream mile 2.7 (T14S, R12W, SW NE Sec. 24). Approximately 44% of the drainage area was located above this sequence. The WETP program was calibrated to field data collected at flows of 2.6, 1.7 and 0.7 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 15. Lower and upper inflection points occur at 0.3 and 0.8 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 0.7 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Indian Creek.

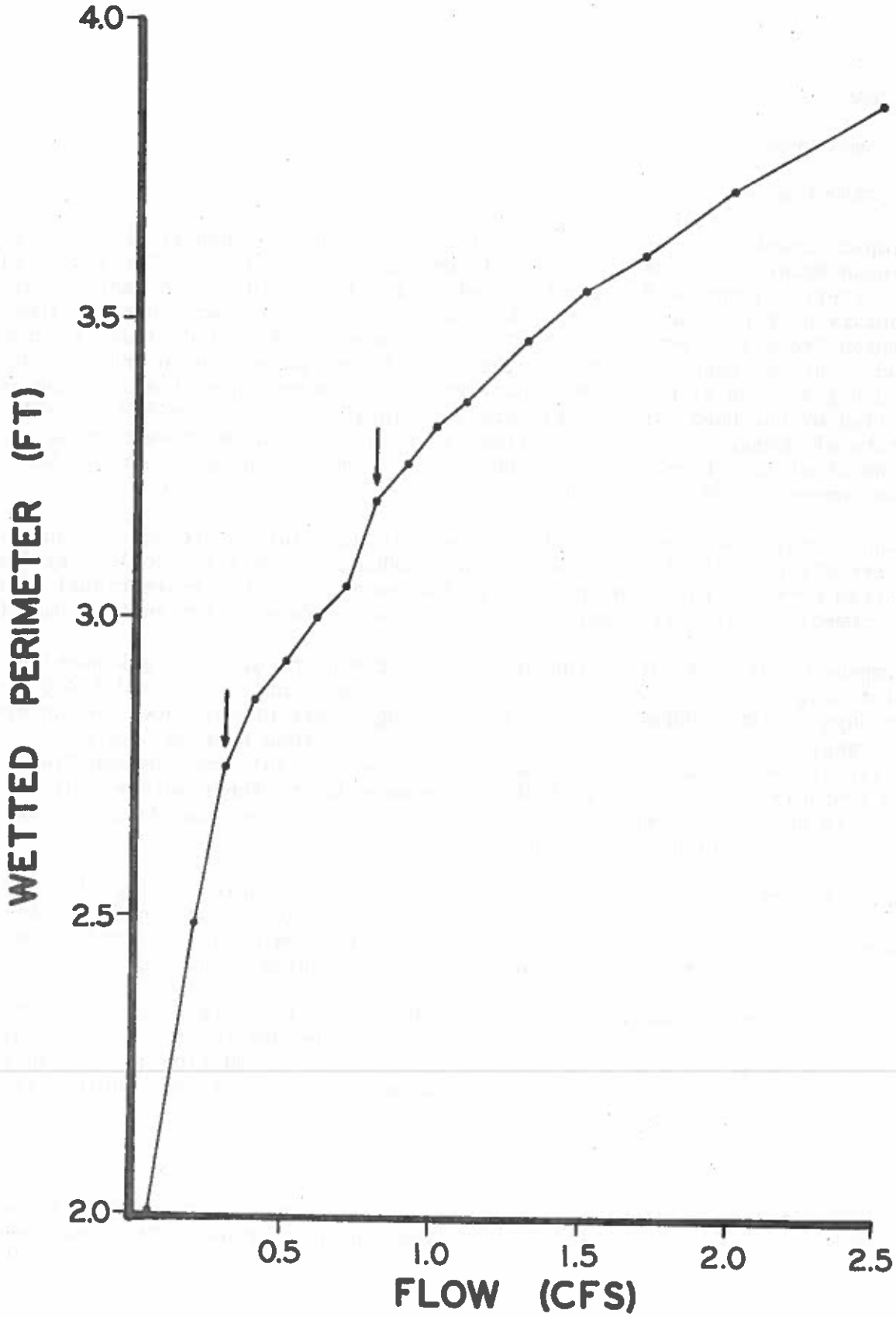


Figure 15. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Indian Creek.

1. STREAM

Simpson Creek

2. DESCRIPTION

Simpson Creek originates on the east slope of the Continental Divide in the Beaverhead Mountains at an elevation of approximately 9,280 ft. The stream flows in an easterly direction for about 8.9 miles to its juncture with Cabin Creek, a tributary of Big Sheep Creek and the Red Rock River. The only named tributary of Simpson Creek is Crystal Creek. The 6,912 acre (10.8 mi^2) drainage is characterized by steep, heavily timbered slopes in the headwater region and rolling, sagebrush-grassland slopes in the lower reaches. Ownership of the drainage is controlled by the USFS (45.7%), private individuals (28.6%), the BLM (24.0%) and the State of Montana (1.7%). The stream is bordered by a relatively broad riparian zone of willow, birch, grasses and sedges. The average gradient of the 5.5 ft wide channel is 48.9 ft/1,000 ft.

Lands within the Simpson Creek drainage are used for cattle grazing and outdoor recreation in the form of hunting and fishing. Access is provided by Jeep trail from Morrison Lake, which supports the majority of the recreational fishing in the immediate vicinity. Morrison Lake has no surface outlet into Simpson Creek.

Simpson Creek lies within the boundaries of Montana deer and elk hunting district 328, which supported an estimated 2,522 elk hunter-days and 1,446 deer hunter-days in 1981 (MDFWP, 1982). The drainage contains mule deer and antelope summer range and is rated excellent in terms of big game hunting quality (BLM, 1980). No estimate of fishing pressure is available for Simpson Creek. The stream probably receives little fishing pressure due to the remoteness of its locale, its small size and its proximity to Big Sheep Creek and Morrison Lake, major recreational fisheries in the area.

The BLM portion of the drainage is contained in a single grazing allotment which is managed on a rest-rotation basis. A BLM range evaluation found this allotment to be in fair condition in terms of soil erosion and in good to excellent vegetative condition, but is undergoing a declining trend (BLM, 1980).

A stream channel stability evaluation (Pfankuch, 1975) resulted in a fair rating for Simpson Creek, while a riparian zone inventory (Myers, 1976) resulted in a good condition rating (BLM, 1980). Riparian zone condition is related to fish habitat and water quality on small southwest Montana streams subject to cattle grazing (Myers, 1976).

3. FISHERIES

A 1,000 ft section of Simpson Creek was electrofished on July 8 and August 3, 1982. The only fish collected were westslope cutthroat trout. Electrofishing survey data are summarized in Table 21.

Table 21. Summary of electrofishing survey data for a 1,000 ft section of Simpson Creek (T14S, R12W, NE, NW, Sec. 36, SE, SW, Sec. 25) on August 3 and August 20, 1982.

Species	No. Captured	Length Range (inches)
Westslope Cutthroat Trout	36	3.0 - 6.5

No estimate of standing crop could be derived for the study section due to a complete lack of recaptured fish. Only seven fish were marked on the August 3 electrofishing run, while 29 were captured on the August 20 recapture run, none of which bore a fin clip mark. Assuming an equal electrofishing efficiency on each run, the data indicate movement of fish through the study section. There is some indication that cutthroat trout of the Cabin Creek drainage, which includes Indian and Simpson creeks, utilize the headwater reaches of the streams on a seasonal basis (Lew Myers, BLM Biologist, Personal Communication).

BLM biologists collected fish from the present study section in July, 1980. Five fish ranging in length from 6.5 - 9.7 inches were preserved for meristic examination. Examination of these cutthroat trout from Simpson Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpub. Data, 1980). The westslope cutthroat trout, once common throughout the upper Missouri drainage, is classified as a species of special concern in Montana (Deacon et al., 1979). It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce and restrict the native cutthroat trout population of the upper Missouri drainage.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 208 ft riffle sequence located approximately at stream mile 6.5 (T14S, R12W, SE SW Sec. 25). Approximately 34% of the drainage area was located above this sequence. The WETP program was calibrated to field data collected at flows of 4.7, 1.6 and 0.6 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 16. Lower and upper inflection points occur at 0.7 and 1.5 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 1.0 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Simpson Creek.

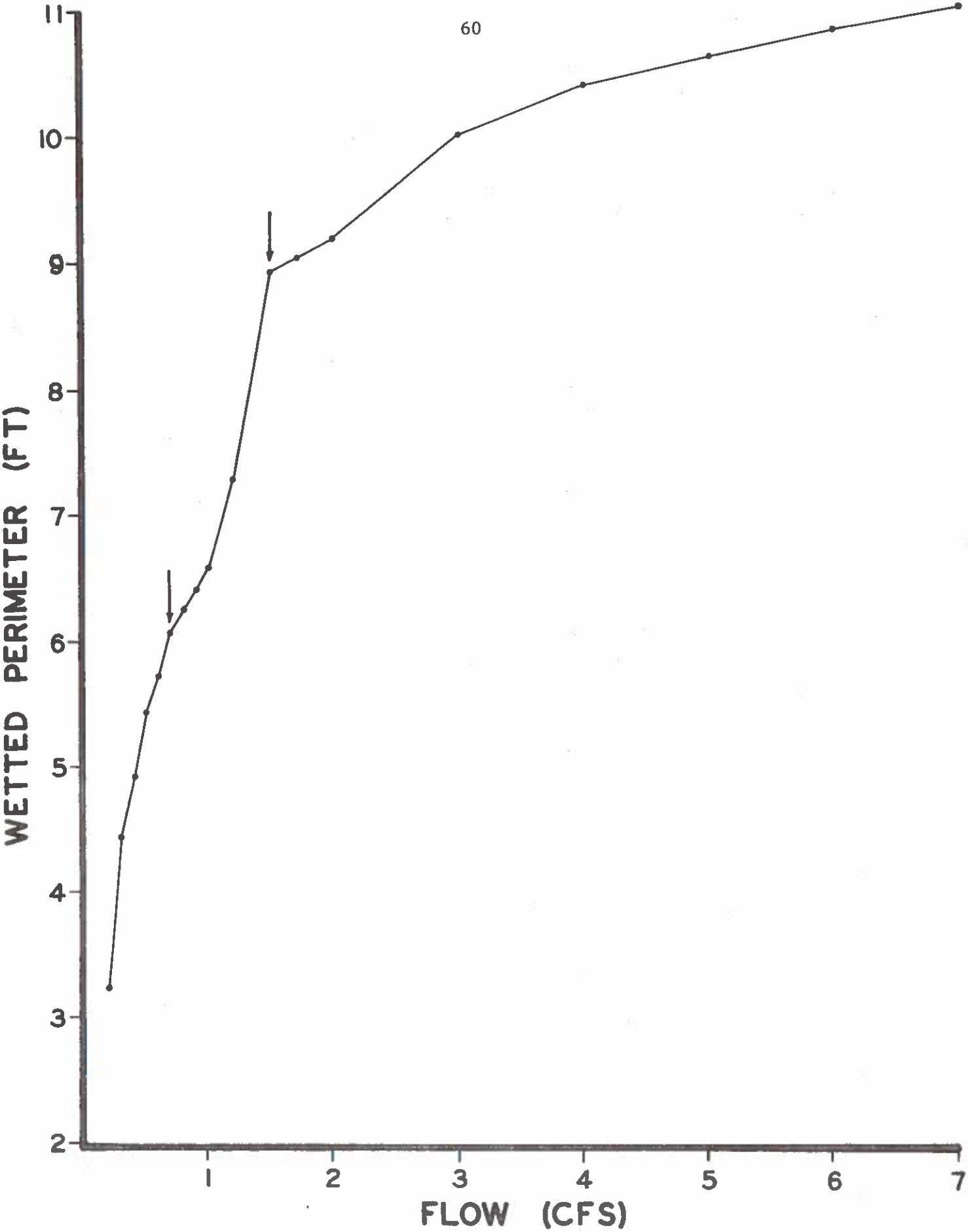
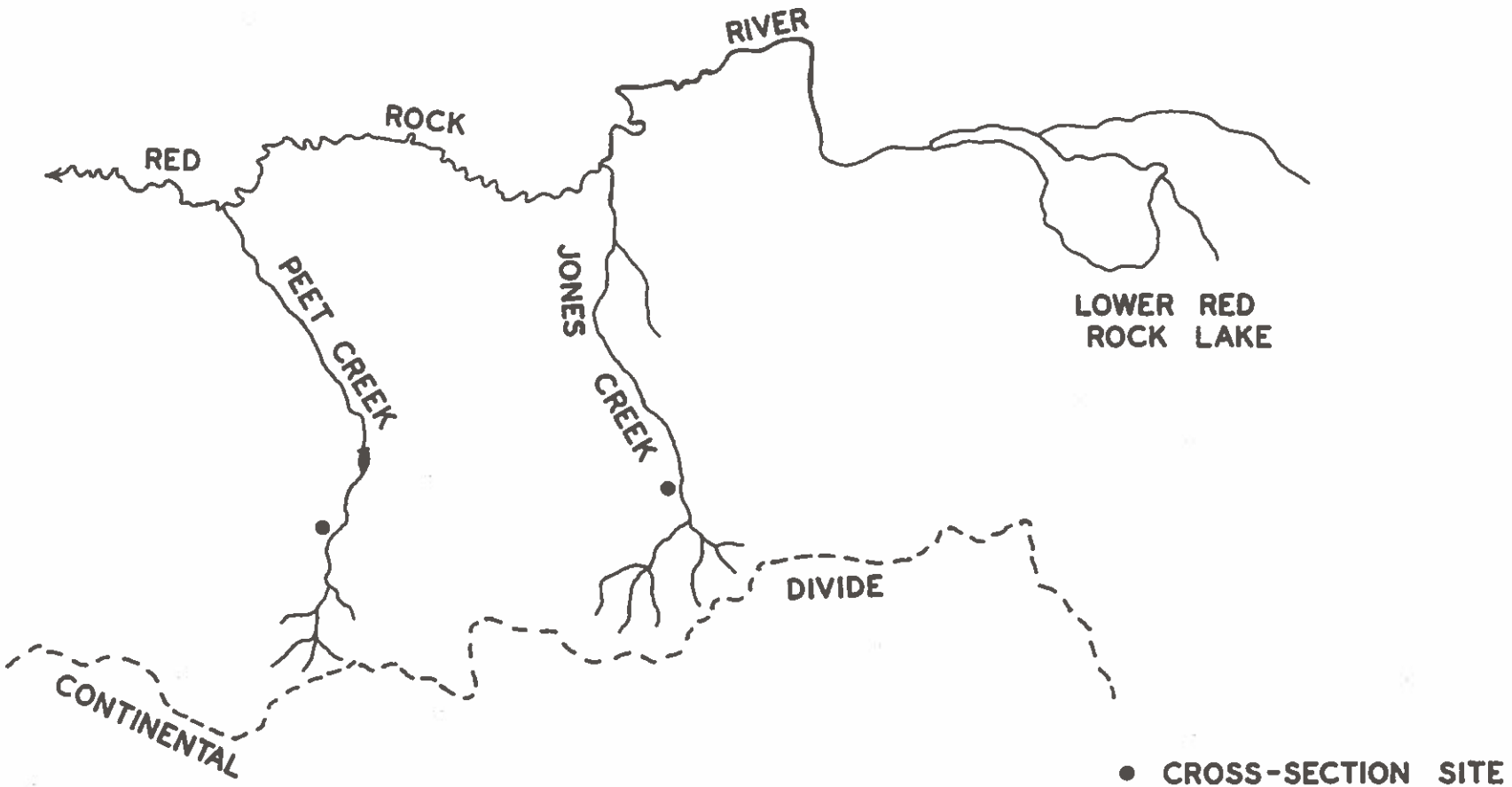


Figure 16. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Simpson Creek.

RED ROCK RIVER DRAINAGE



The study areas of the Red Rock River drainage.

1. STREAM

Jones Creek

2. DESCRIPTION

Jones Creek originates on the north slope of the Centennial Mountains at the Continental Divide at an elevation of 8,400 ft. The stream flows in a north-northwesterly direction for about 7.4 miles to its juncture with Winslow Creek to form Mud Creek, a tributary of the Red Rock River. The 5,317 acre (8.3 mi^2) drainage is heavily timbered in the higher elevations and is characterized by willow bog communities in the lower elevations. Ownership of the drainage is controlled by the BLM (68.7%) and private individuals (31.3%). Most of the BLM segment of the drainage is contained in the Centennial Mountains Primative Area. The stream is bordered by a riparian zone of willow, birch, alder, aspen, grasses and sedges. A large area of abandoned beaver ponds is located below the study section. The average gradient of the 10.4 ft wide channel is 45 ft/1,000 ft.

Lands within the Jones Creek drainage are used for cattle grazing and outdoor recreation in the form of hunting and fishing. Access into the area is restricted by private land ownership in the lower drainage.

Jones Creek lies within the boundaries of Montana deer and elk hunting district 327, which supported an estimated 3,627 elk hunter -days and 1,018 deer hunter-days in 1981(MDFWP, 1982). The drainage contains important grizzly bear, moose, elk and mule deer habitat and is rated excellent in terms of big game hunting quality (BLM, 1980). Fisherman use of Jones Creek has been estimated at 1,884 fisherman-days/year in 1975-76 (MDFWP, 1976). In light of the restricted access to Jones Creek, this estimate is probably inflated due to a small sample size.

The BLM controlled portion of the drainage is included in a single grazing allotment which is managed on a deferred-rotation basis. A BLM range evaluation found this allotment to be in good erosional condition and fair vegetative shape, but undergoing a declining trend (BLM, 1980).

A stream channel stability evaluation (Pfankuch, 1975) resulted in a good rating for Jones Creek. However, a riparian zone inventory (Myers, 1976) resulted in an unsatisfactory rating for the stream. Numerous areas of active bank erosion were observed along the Jones Creek channel, and sedimentation on the cobble substrate was observed to be extreme during the 1982 field season.

3. FISHERIES

A 1,000 ft section of Jones Creek was electrofished on July 29 and August 12, 1982. The only game fish collected were westslope cutthroat trout, while mottled sculpins were the only non-game species present. Electrofishing survey data are summarized in Table 22.

Table 22. Summary of electrofishing survey data for a 1,000 ft section of Jones Creek (T14S, R3W, SE, NE, Sec. 33) on July 29 and August 12, 1982.

Species	No. Captured	Length Range (inches)
Westslope Cutthroat Trout	55	2.0 - 9.0
Mottled Sculpin	-	-

The standing crop of westslope cutthroat trout within the study section was estimated by using a mark-recapture method (Table 23). The section supported 31 fish representing a biomass of four pounds. Fish six inches and longer comprised 39% of the population, and fish condition (length to weight ratio) was excellent.

Table 23. Estimated standing crop of westslope cutthroat trout in a 1,000 ft section of Jones Creek (T14S, R3W, SE NE Sec. 33) on July 29, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft	
		Number	Pounds
Westslope Cutthroat Trout	4.5 - 9.0	31(±8)	4(±1)

Meristic examination of representative fish collected from Jones Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpub. Data, 1982). The westslope cutthroat trout, once common throughout the upper Missouri River drainage, is classified as a species of special concern in Montana (Deacon et al., 1979). It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce and restrict the native cutthroat trout population of the upper Missouri drainage.

The trout population of the study section revealed a stream habitat capable of supporting native westslope cutthroat trout. Trout numbers within the study section may have been limited by the extreme sedimentation that was observed throughout the reach.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 136 ft riffle sequence located approximately at stream mile 4.5 (T14S, R3W, SE, NE Sec. 33). Approximately 48% of the drainage area was located above this sequence. The WETP program was calibrated to field data collected at flows of 7.0, 3.2 and 1.7 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 17. Lower and upper inflection points occur at 1.3 and 3.0 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 2.0 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Jones Creek.

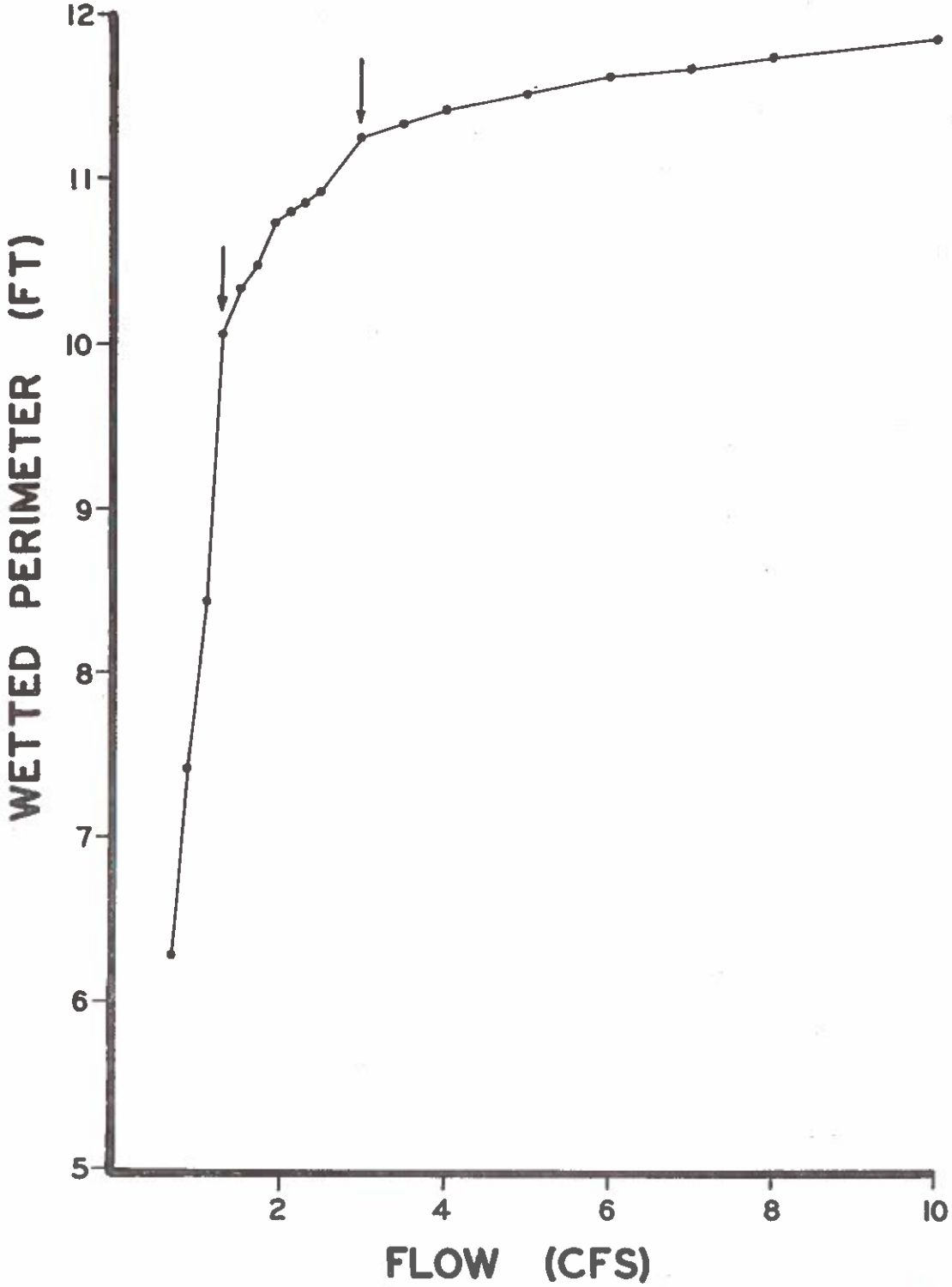


Figure 17. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Jones Creek.

1. STREAM

Peet Creek

2. DESCRIPTION

Peet Creek originates on the north slope of the Centennial Mountains at the Continental Divide at an elevation of approximately 8,600 ft. The stream flows in a north-northwesterly direction for 9.1 miles to its mouth on the Red Rock River. The 13,760 acre (21.5 mi^2) drainage is characterized by heavily timbered slopes in the higher elevations, sagebrush-grassland communities in the mid-elevations and willow bog communities near the stream mouth. Ownership of the drainage is controlled by private individuals (56.7%), the BLM (34.0%) and the State of Montana (9.3%). Several small unnamed lakes are located in the upper drainage, and a small irrigation storage reservoir located on private land below the study area inundates a portion of the drainage. The stream is bordered by a relatively broad riparian zone of willow, birch, alder, aspen, grasses and sedges, and is marked by numerous areas of beaver activity. The only named tributary of Peet Creek is the East Fork of Peet Creek. The average gradient of the 8.1 ft wide channel is 41.6 ft/1,000 ft.

Lands within the Peet Creek drainage are used for cattle grazing and outdoor recreation in the form of hunting and fishing. Access is provided by a gravel road from the Price Creek drainage and a privately controlled dirt road which parallels the stream.

Peet Creek lies within the boundaries of Montana deer and elk hunting district 327, which supported an estimated 3,627 elk hunter-days and 1,018 deer hunter-days in 1981 (MDFWP, 1982). The drainage supports important moose and elk habitat and mule deer summer range and is rated excellent in terms of big game hunting quality. No estimate of fishing pressure is available for Peet Creek. However, fisherman use in the vicinity of the irrigation reservoir was observed during the 1982 field season.

The BLM controlled portion of the drainage is included in a single grazing allotment which is managed on a rest-rotation basis. A BLM range evaluation found this allotment to be in good erosional condition and excellent vegetative shape, but undergoing a declining trend (BLM, 1980).

A stream channel stability evaluation (Pfankuch, 1975) conducted below the storage reservoir resulted in a fair rating for Peet Creek, while riparian zone evaluations (Myers, 1976) conducted in the present study area resulted in poor to fair ratings for the stream (BLM, 1980). Riparian zone condition is related to fish habitat and water quality in small southwest Montana streams subject to cattle grazing (Myers, 1976).

3. FISHERIES

A 1,000 ft section of Peet Creek was electrofished on July 29 and August 12, 1982. The only game fish collected were westslope cutthroat trout, while mottled sculpins were the only non-game species present. Electrofishing survey data are summarized in Table 24.

Table 24. Summary of electrofishing survey data for a 1,000 ft section of Peet Creek (T15S, R4W, NW NE Sec. 3) on July 29 and August 12, 1982.

Species	No. Captured	Length Range (inches)
Westslope Cutthroat Trout	204	2.2 - 8.5
Mottled Sculpin	-	-

The standing crop of westslope cutthroat trout within the study section was estimated using a mark-recapture method (Table 25). The section supported 312 fish representing a biomass of 11 pounds. Only 1% of the fish were six inches or larger, while 78% were between 3.0 and 3.9 inches in length. Fish condition (length to weight ratio) was good in the Peet Creek population.

Table 25. Estimated standing crop of westslope cutthroat trout in a 1,000 ft section of Peet Creek (T15S, R4W, NW, NE, Sec. 3) on July 29, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft Number	Per 1,000 ft Pounds
Westslope Cutthroat Trout	3.0 - 3.9	243	
	4.0 - 5.4	56	
	5.5 - 8.5	13	
		312(±72)	11(±2)

Meristic examination of representative fish collected from Peet Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpub. Data, 1982). The westslope cutthroat trout, once common throughout the upper Missouri River drainage, is classified as a species of special concern in Montana (Deacon et al., 1979). It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce and restrict the native cutthroat trout population of the upper Missouri drainage.

The trout population of the study section revealed a stream habitat capable of supporting native westslope cutthroat trout. Size distributions within the estimated population indicate that Peet Creek provides important spawning and rearing habitat for a population in which many of the larger fish occupy the downstream storage reservoir on a seasonal basis (J. Roscoe, BLM Biologist, Personal Communication).

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 179 ft riffle sequence located approximately at stream mile 6.5 (T15S, R4W, NW NE Sec. 3). Approximately 17% of the drainage area was located above this sequence. The WETP program was calibrated to field data collected at flows of 16.6, 4.3 and 1.3 cfs.

The relationship between wetted perimeter and flow for a composite of five riffle cross-sections is shown in Figure 18. Lower and upper inflection points occur at 0.9 and 1.3 cfs, respectively. Based on an evaluation of the existing fishery, a flow of 1.3 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Peet Creek.

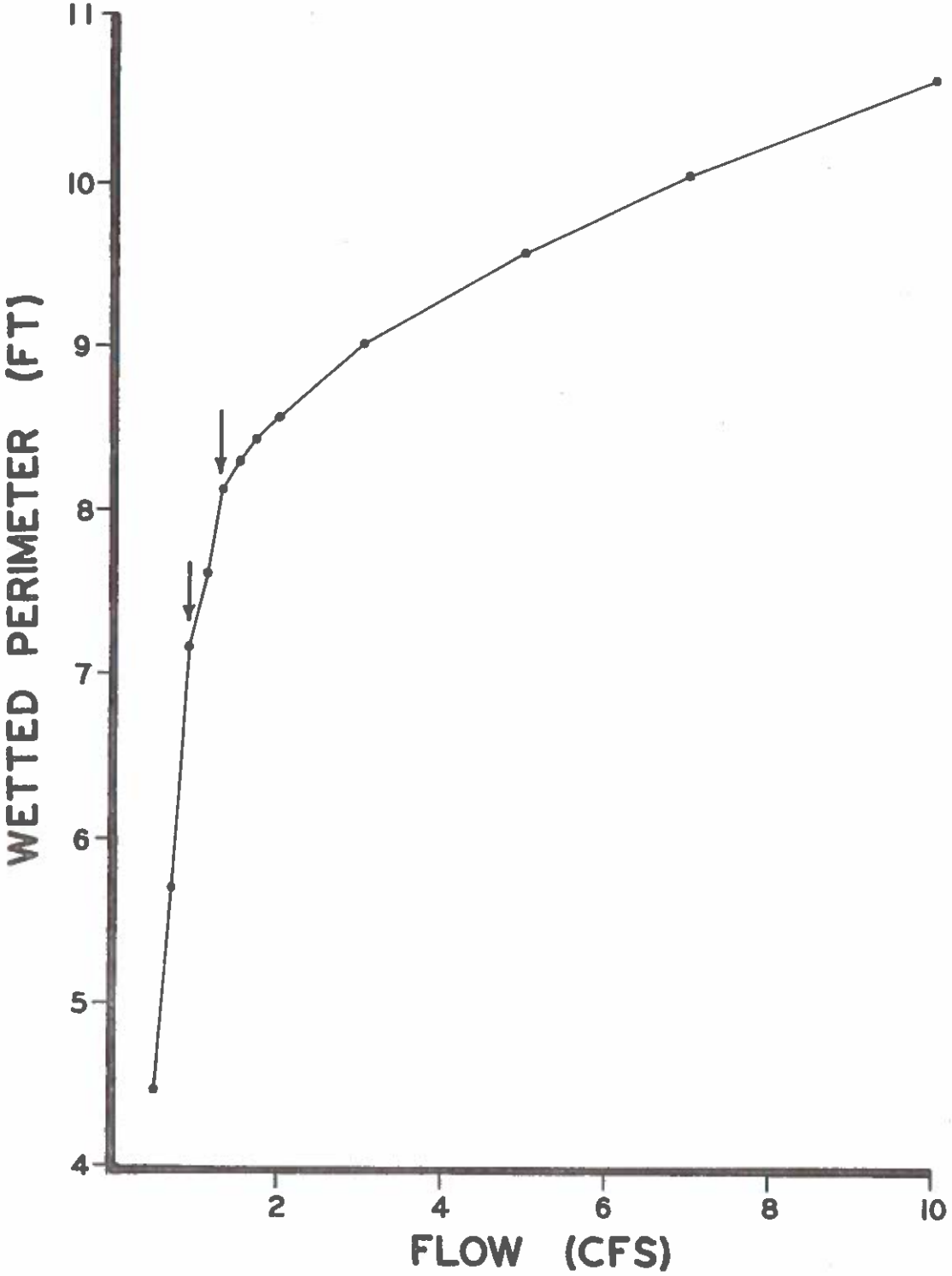
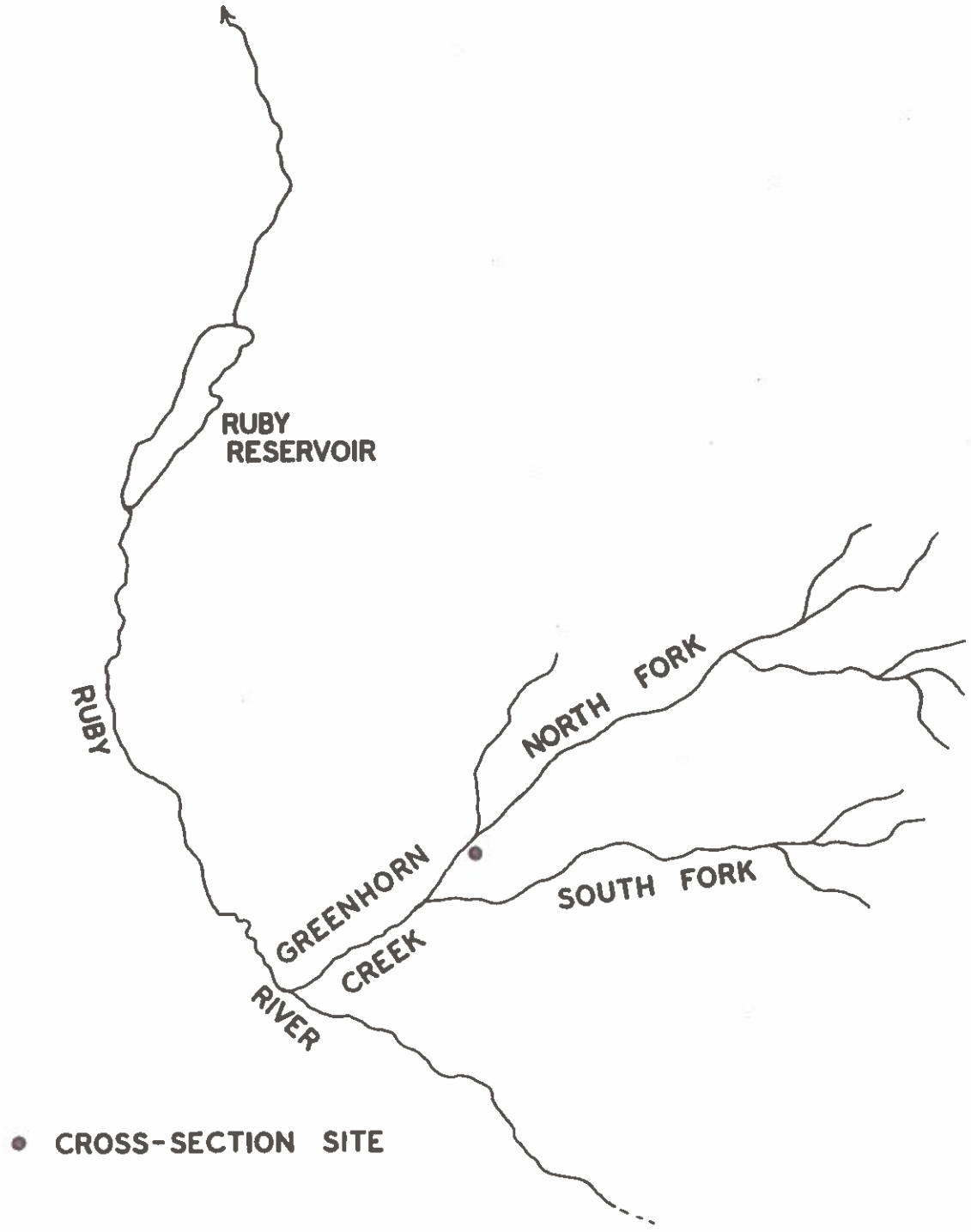


Figure 18. The relationship between wetted perimeter and flow for a composite of five riffle cross-sections in Peet Creek.

RUBY RIVER DRAINAGE



The study area of the Ruby River drainage.

1. STREAM

North Fork of Greenhorn Creek

2. DESCRIPTION

The North Fork of Greenhorn Creek originates on the west slope of the Greenhorn Mountains at an elevation of approximately 9,160 ft. The stream flows in a west-southwesterly direction for 7.4 miles to its juncture with the South Fork to form Greenhorn Creek, a tributary of the Ruby River. The 8,192 acre (12.8 mi^2) drainage is characterized by steep, heavily timbered, north-facing slopes and south-facing slopes bearing numerous clearings. Ownership of the drainage is controlled by the USFS (78.8%), the BLM (19.7%) and private individuals (1.5%). The stream is bordered by a relatively broad riparian zone of willow, alder, birch, dogwood, aspen and grasses. Areas of beaver activity are found in the lower reaches of the stream. Named tributaries of the North Fork include Dark Hollow Creek and the Meadow Fork of Greenhorn Creek. The average gradient of the 9.6 ft wide channel is 81.9 ft/1,000 ft.

Lands within the drainage are used for cattle and sheep grazing and outdoor recreation in the form of hunting and fishing. Access is provided by a dirt road which parallels the stream.

The North Fork of Greenhorn Creek lies within the boundaries of Montana deer and elk hunting district 322, which supported an estimated 7,149 elk hunter-days and 5,372 deer hunter-days in 1981 (MDFWP, 1982). The drainage contains crucial deer and elk winter range and moose winter range and was rated excellent in terms of big game hunting quality (BLM, 1980). No estimate of fishing pressure is available for the stream, however, some fisherman use was observed during the 1982 field season.

The BLM controlled portion of the drainage is included in a single grazing allotment which is managed on a deferred-rotation basis. A BLM range evaluation found the allotment to be in fair condition in terms of soil erosion but in excellent vegetative condition (BLM, 1980).

A riparian zone inventory (Myers, 1976) conducted on the stream resulted in a good condition rating, while a BLM district survey rated the fish habitat as being in excellent condition (BLM, 1980). Riparian zone condition is related to fish habitat and water quality on small southwest Montana streams subject to cattle grazing (Myers, 1976).

The Greenhorn Creek drainage was placer mined for gold in the early 1900's (Lyden, 1948). The exact locations of these placers are not known, and no indications of placer work were observed in the vicinity of the study area.

3. FISHERIES

A 1,000 ft section of the North Fork of Greenhorn Creek was electrofished on August 5, and August 18, 1982. Game fish collected in descending order of abundance were brook trout and westslope cutthroat trout. Electrofishing survey data are summarized in Table 26.

Table 26. Summary of electrofishing survey data for a 1,000 ft section of the North Fork of Greenhorn Creek (T8S, R4W, SE, NW Sec. 24) on August 5, and August 18, 1982.

Species	No. Captured	Length Range (inches)
Brook Trout	47	1.5 - 10.2
Westslope Cutthroat Trout	19	2.8 - 9.9

The standing crop of brook trout within the study section was estimated by using a mark-recapture method (Table 27). No estimate of westslope cutthroat trout could be derived due to a lack of sufficient numbers of recaptured fish to insure statistical reliability. The section supported 33 brook trout representing a biomass of three pounds. Brook trout six inches and longer comprised 28% of the estimated population. Brook trout condition (length to weight ratio) was excellent and far above the average found for populations in Big Hole River tributaries (Oswald, 1981).

Table 27. Estimated standing crop of brook trout in a 1,000 ft section of the North Fork of Greenhorn Creek (T8S, R4W, SE, NW, Sec. 24) on August 5, 1982. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft	
		Number	Pounds
Brook Trout	4.0 - 5.4	21	
	5.5 - 10.2	12	
		33(±8)	3(±1)

Meristic examination of representative cutthroat trout collected from the North Fork of Greenhorn Creek found them to be within the range of characteristics described by Behnke (1979) and Roscoe (1974) as typifying the westslope strain of cutthroat trout (J. Roscoe, Unpub. Data, 1982). The westslope cutthroat trout, once common throughout the upper Missouri River drainage is classified as a species of special concern in Montana (Deacon et al., 1979). It has been documented that cutthroat trout are very intolerant of environmental disturbances and habitat changes, are poor competitors with introduced species, readily hybridize with rainbow trout and are highly susceptible to fishing pressure (Hanzel 1961, Behnke and Zarn 1976, Behnke and Benson 1980). These factors have combined to greatly reduce and restrict the native cutthroat trout population of the upper Missouri drainage.

The trout population of the study section revealed a stream habitat capable of supporting native westslope cutthroat trout and a recreational stream fishery for catchable sized brook and cutthroat trout.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 136 ft riffle sequence located approximately at stream mile 1.2 (T8S, R4W, SE NW Sec. 24). Approximately 93% of the drainage area was located above this sequence. The WETP program was calibrated to field data collected at flows of 49.9, 7.7 and 3.0 cfs.

The relationship between wetted perimeter and flow for a composite of four riffle cross-sections is shown in Figure 19. Lower and upper inflection points occur at 2.0 and 3.5 cfs. Based on an evaluation of the existing fishery, a flow of 3.0 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for the North Fork of Greenhorn Creek.

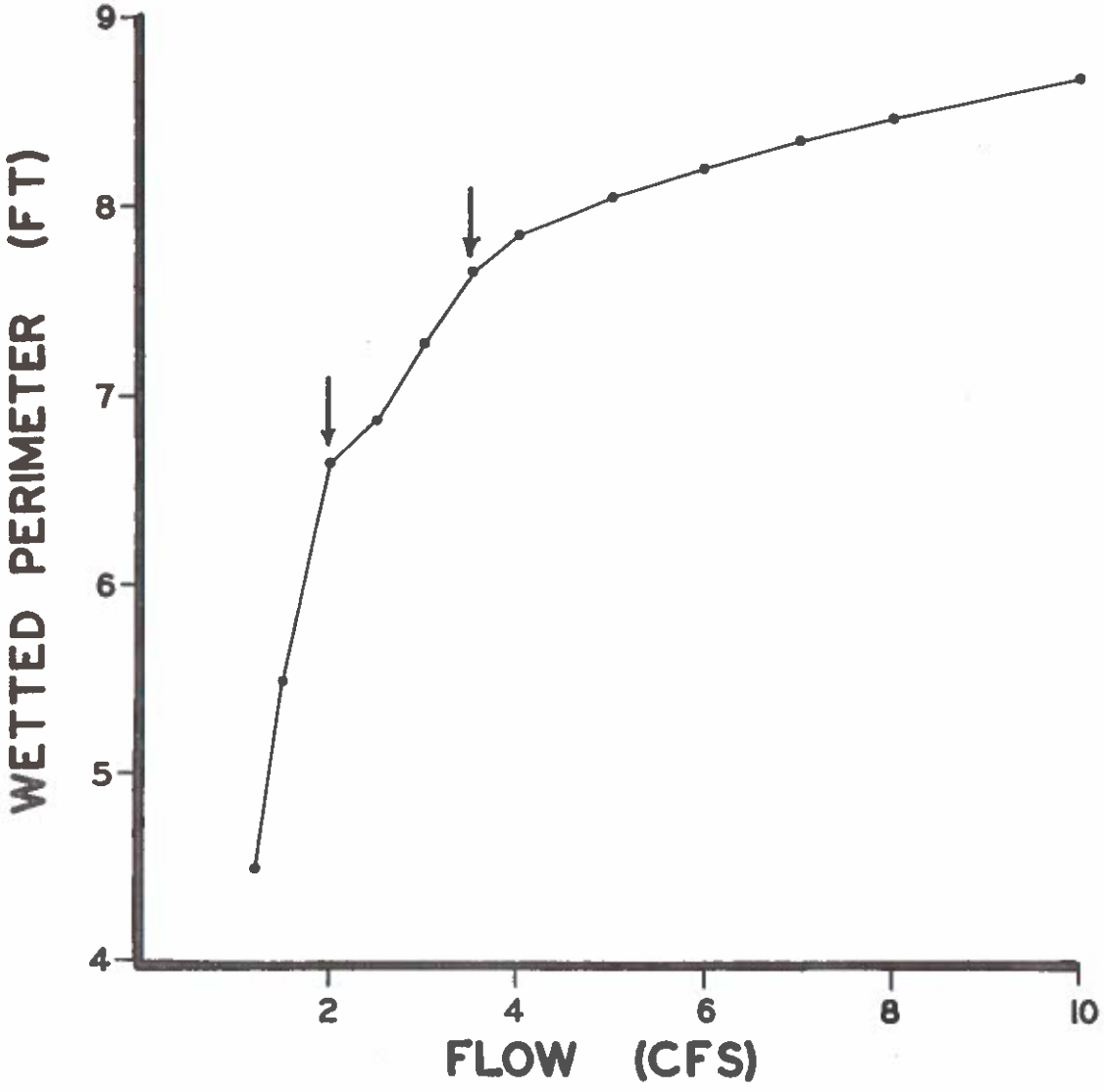


Figure 19. The relationship between wetted perimeter and flow for a composite of four riffle cross-sections in the North Fork of Greenhorn Creek.

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