Recommended Stream Resource Maintenance Flows on Seven Southern Idaho Streams

COOPERATIVE INSTREAM FLOW SERVICE GROUP

INSTREAM FLOW INFORMATION PAPER: NO. 8

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Cooperating Agencies:

Fish and Wildlife Service
Environmental Protection Agency
Heritage Conservation and Recreation Service
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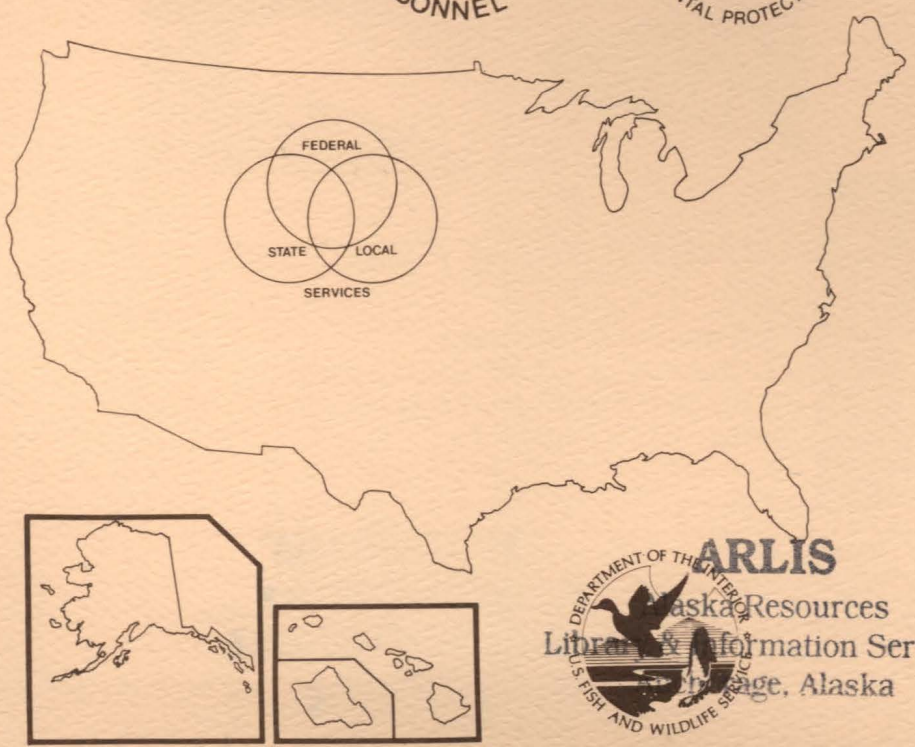

COOPERATIVE INSTREAM FLOW SERVICE GROUP

The Cooperative Instream Flow Service Group was formed in 1976 under the sponsorship of the U.S. Fish and Wildlife Service. Primary funding was provided by the U.S. Environmental Protection Agency. The group operates as a satellite of the Western Energy and Land Use Team. It is a part of the Western Water Allocation Project, Office of Biological Services.

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While the Fish and Wildlife Service is providing the initiative and leadership, the IFG is conceived as a multi-agency, multi-disciplinary program which is to become a "center of activity," providing a focus for the increasing importance of instream flow assessments.

The multi-agency, multi-disciplinary nature of the group is provided through the Intergovernmental Personnel Act transfer of state personnel, and details from other Federal agencies.

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RECOMMENDED STREAM RESOURCE MAINTENANCE FLOWS ON SEVEN SOUTHERN IDAHO STREAMS

Instream Flow Information Paper No. 8

by

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ABSTRACT

This paper documents the results of instream flow investigations conducted on seven south Idaho streams by the Boise Ecological Services Field Office during 1972 to 1975. The results were reanalyzed by the Cooperative Instream Flow Service Group using the concept of probability-of-use curves which are based on weighted criteria for depth and velocity. Recommended stream resource maintenance flows by month are presented.

INTRODUCTION

Coordinated comprehensive planning for the wise use and management of Idaho's water and related lands has been in progress since 1966. Since 1972, these efforts have been led by the Idaho Department of Water Resources (formerly the Idaho Water Resources Board) with participation from other State and Federal agencies represented on the Pacific Northwest River Basins Commission.

Such planning efforts have led to the recognition that a major step leading to proper water management is the determination of the quantity of water which should remain in the stream to support fish and wildlife resources and other public values.

Accordingly, in June 1972 the U.S. Fish and Wildlife Service (USFWS), Boise Office, initiated field studies to gather instream flow information, utilizing funds from the U.S. Department of Interior's Western U.S. Water Plan (Westwide) Study. Because of curtailment of Westwide funds, these instream flow investigations were continued with funding from the Pacific Northwest River Basin Commission's Comprehensive Coordinated Joint Plan (CCJP) Study, the U. S. Army Corps of Engineers, and U. S. Bureau of Reclamation.

This report presents stream resource maintenance flow recommendations for those stream reaches on which sufficient data were collected during these studies. The study waters include Little Weiser, Deadwood, North Fork Payette, South Fork Boise, Boise, Blackfoot rivers and Willow Creek. Stream resource maintenance flows are defined as the range of flows within which fish, wildlife, other aquatic organisms, and related recreational activities (fishing, hunting, boating, etc.) are maintained or protected.

GENERAL METHOD

The method employed for determining all stream resource maintenance flow recommendations is based on criteria reflecting depth and velocity requirements of fish, and expressing flow requirements in terms of one or more of the following four biological activities: passage, spawning, incubation, and rearing. Fish and wildlife resources for each study stream are presented in Table 1.

Basic procedures used in collecting flow data required the following equipment: (1) Price type AA current meter; (2) headset for use with current meter; (3) stopwatch; (4) current meter rating chart; (5) beaded steel tagline; (6) permanent transect marking materials; (7) data collection sheets; (8) cameras and film (color, black and white); and (9) hip boots.

Table 1. Important fish and wildlife resources in study streams.

Study Streams	Rainbow Trout	Cutthroat Trout	Brown Trout	Brook Trout	Dolly Varden	Mountain Whitefish	Kokanee Salmon	Smallmouth Bass
Little Weiser River	X					X		
Deadwood River	X	X		X	X	X		
North Fork Payette River	X		X	X	X	X	X	
South Fork Boise River	X			X	X	X	X	
Boise River	X		X			X		X
Blackfoot River	X	X	X	X				
Willow Creek	X	X	X					

In order to conduct instream flow studies on most study streams, controlled releases from upstream structures were requested for a given period of time. Generally, a given flow was released for a minimum of 24 hours to allow for stabilization of water levels throughout the study reach.

During preliminary investigations of most streams or stream reaches, three spawning and three passage transects were selected for study. Orange-painted stakes were placed in each stream bank at natural high watermark to identify all transects. A beaded tagline was extended across the stream between the markers. A Price Type AA current meter, mounted on a standard top-setting wading rod, was used to measure depth and velocity parameters on the transect.

At least one discharge transect was established at each study site. Procedures for determining stream flows at these transects were in accordance with U.S. Geological Survey methods (USGS 1969). Velocities were taken at 0.6 of the water depth from the water surface in water less than 2.5 feet deep, and at 0.8 and 0.2 of depth from water surface over 2.5 feet in depth.

Passage transects were established on the shallow gravel bars most critical to passage of adult fish, with a linear transect following the shallowest course from bank to bank. The transects were divided into segments based on the consistency of bottom elevations so as to obtain as accurate a channel configuration as possible. Velocities were measured at 0.6 of the water depth from the water surface.

At each of several flows, the total width and longest continuous portion meeting minimum depth (0.4 feet) and maximum velocity (4.0 fps) criteria for passage are recorded and graphed against discharge. Graphs for each transect, with velocity plotted against percent usable stream width, were used to select the flow which meets the criteria on at least 25% of the total transect width and a continuous portion equaling at least 10% of its total width (Thompson 1972). The usable widths (considering both depth and velocity) of all transects for each stream reach are plotted and averaged, and the results provide a minimum flow recommendation for passage.

Spawning transect sites were established by selecting an area that was determined to be representative of the stream as a spawning area, usually at the head of a riffle. The transect was divided into 10 equal segments with a measuring station at the midpoint of each segment. At each station the current meter was positioned at a depth of 0.4 feet above the bottom.

Spawning flow recommendations are based on a concept presented by the Cooperative Instream Flow Service Group, Fort Collins, Colorado.

These recommendations are based on the concept of probability-of-use curves which are based on weighted criteria developed for depth and velocity parameters. The

> ". . .curves are based on the assumption that individuals of a species will tend to select areas within the stream having the most favorable combinations of hydraulic conditions. It is further assumed that they will also utilize less favorable conditions, with the probability-of-use decreasing with diminishing favorability of one or several hydraulic conditions. Finally, it is assumed that individuals will elect to leave an area before conditions become lethal. The weighted criteria are presented in the form of probability-of-use curves, the peak of which represents optimum conditions for a given hydraulic parameter." (Bovee and Cochnauer 1978:iii).

Each spawning transect was segmented into at least 10 sections. The weighted value of each segment was determined by multiplying the width of the segment by the weighted value for depth and velocity. The total weighted value for the transect is the total of the transect segments. Each total weighted value was then plotted against the corresponding discharge resulting in a curve such as depicted in Figure 3.

Starting at zero discharge, the weighted value of the study site increases rapidly for small increases in discharge up to a point where the weighted spawning value increases slowly while discharge increases rapidly. At this inflection point, the greatest amount of spawning habitat is available for the least amount of flow, and is selected as the spawning maintenance flow. In cases where more than one spawning transect was measured, the weighted values for all transects were averaged, and the average was plotted against corresponding discharge.

Egg incubation and fry emergence flow recommendations are 66% of the recommended spawning flow if a velocity of at least 1 foot/sec is maintained. This flow provides enough shear force to adequately oxygenate the spawning gravels through the incubation period.

The period of year when fish are not migrating, spawning, or when eggs or fry are not in gravel is loosely defined as the rearing period. This period is probably most criticial for survival, and is the life history phase for which the least amount of information is available with respect to physical flow requirements. Since this period encompasses many activities whose relationships with the stream are highly complex, a combination of measurements and judgements were employed to determine rearing flow recommendations.

No measurements were made specifically for rearing because at the time of the studies, little or no information was available relating fish rearing to stream flows. Collings (1974) recommended that rearing flows for Pacific salmon species be based on the assumption that rearing is proportional to food production, which in turn is assumed to be proportional to wetted perimeter. Since data were collected on riffle areas, the wetted perimeter concept was applied to the study streams. In determining rearing discharge, a representative riffle transect was selected and wetted perimeter calculated and plotted against discharge to produce a curve such as depicted in Figure 10.

Starting at zero discharge, wetted perimeter increases rapidly for small increases in discharge, up to the point where the river channel nears its maximum width. Beyond this inflection point, wetted perimeter increases slowly with increasing discharge. The desired quantity of water for rearing (food production) is selected near this inflection point where the greatest amount of wetted perimeter is available for the least amount of flow. On streams where adequate data were not collected, visual judgement of the field team was relied on to determine a rearing flow.

Photo points were established at each transect to record visual changes in stream characteristics by various flow stages. These photos are on file at the Boise office, USFWS.

To assimilate flow recommendations for the four biological activities of all important fish species, a periodicity chart was compiled for each study stream. The flow requirement determined for each life history phase, for each species inhabiting the stream reach of concern, is arrayed according to the applicable period. The stream resource maintenance flow selected for any month is the highest flow required to accommodate all biological activities within that month.

The recommended flow reflects only the quantitative requirements for fish and does not compensate for quality deficiencies. Comprehensive investigations of water quality were beyond the scope of these field studies and flows recommended herein are presented under the assumption that State and Federal water quality standards are met.

LITTLE WEISER RIVER

The headwaters of Little Weiser River originate about 20 air miles south of the town of McCall, Idaho (Figure 1). A long narrow ridge of peaks, called the West Mountains, form a divide between the Payette and Weiser River drainages of western Idaho. The Little Weiser River flows south and west from West Mountains to its confluence with Weiser River near Cambridge, Idaho at river mile 45.0. Major tributaries to the Little Weiser River are Anderson, Four-bit and, Gray's Creeks, which combine to give the Little Weiser River a drainage area of approximately 195 square miles. The study area is in the Gladhart section, approximately 8 miles upstream of the mouth.

Water is diverted at river mile 20.0 for filling of C. Ben Ross Reservoir, an off-stream impoundment used primarily for irrigation water storage. Additional irrigation water is withdrawn directly from the stream throughout most of its length.

The stream elevation of the Little Weiser River at the C. Ben Ross Diversion is approximately 3,220 feet. Through the 20.0 mile study area the river drops 590 feet to an elevation of 2,630 feet. The average gradient through the area is 0.558% or 29.5 feet per mile. Average annual discharge of Little Weiser River at the Indian Valley gage station just above the study area is 102 cfs (USGS 1960). Records are not available for discharge throughout the study area.

Game fish species include rainbow trout (Salmo gairdneri) and mountain whitefish (Prosopium williamsoni). Three spawning and three passage transects were established for the study, and physical parameters were measured at each of five flows.

The recommended passage flow for rainbow trout is 42 cfs (Figure 2) and the spawning flow recommendation for rainbow trout is 40 cfs (Figure 3). The rearing flow recommendation, based on the wetted perimeter curve (Figure 4), is 70 cfs. Flows for angling were not considered in the study, but in most cases the suggested flows are adequate for that purpose.

The recommendations are for continuous flows from Gray's Creek to the mouth. The recommended flow regime in cfs, based on fish species periodicity flows, is shown on page 8.

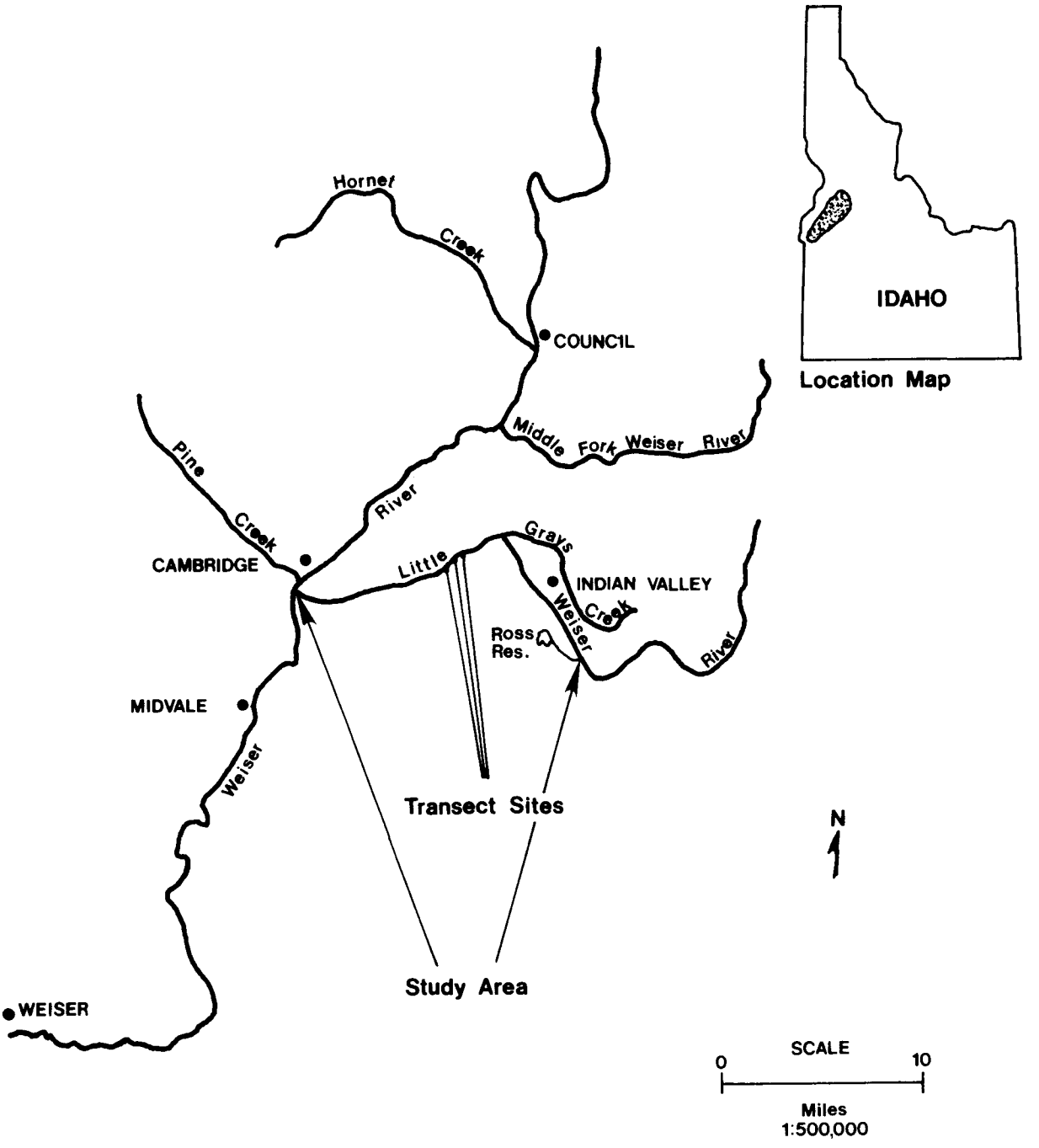


Figure 1. Study area on Little Weiser River below C. Ben Ross Diversion

Species/Life Stage	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout												
Spawning				40	40							
Incubation				27	27	27	27					
Passage			42	42	42							
Rearing - All Species	70	70	70	70	70	70	70	70	70	70	70	70
Recommended Flow Regime	70	70	70	70	70	70	70	70	70	70	70	70

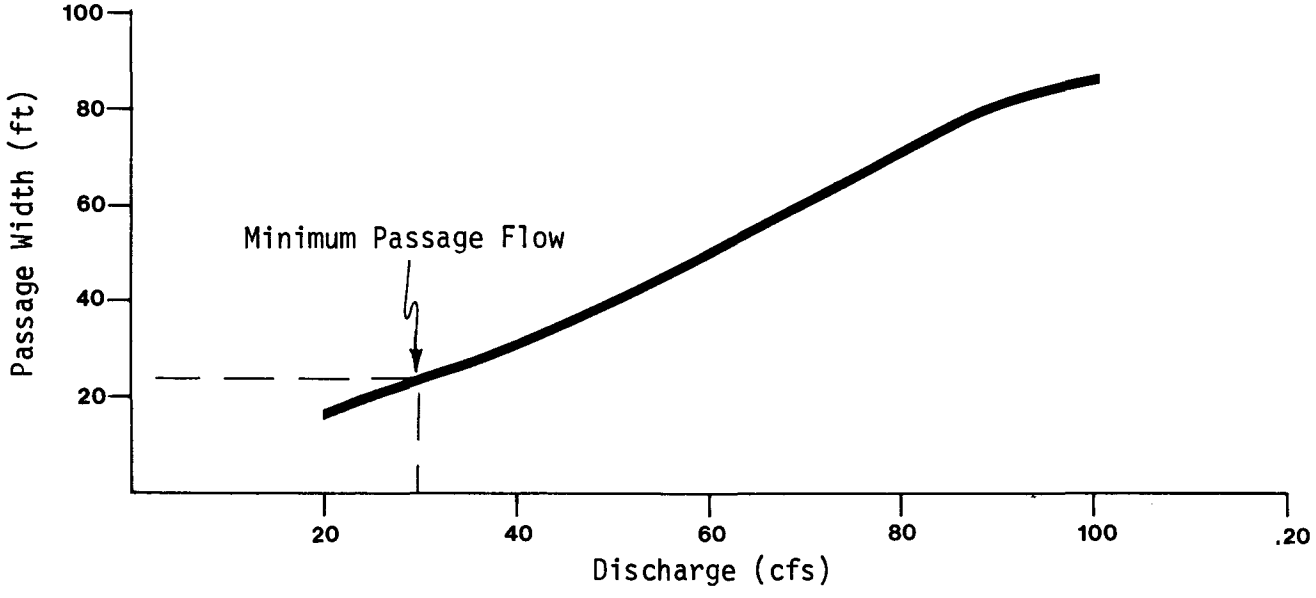


Figure 2. Trout passage curve for Little Weiser River below C. Ben Ross Diversion.

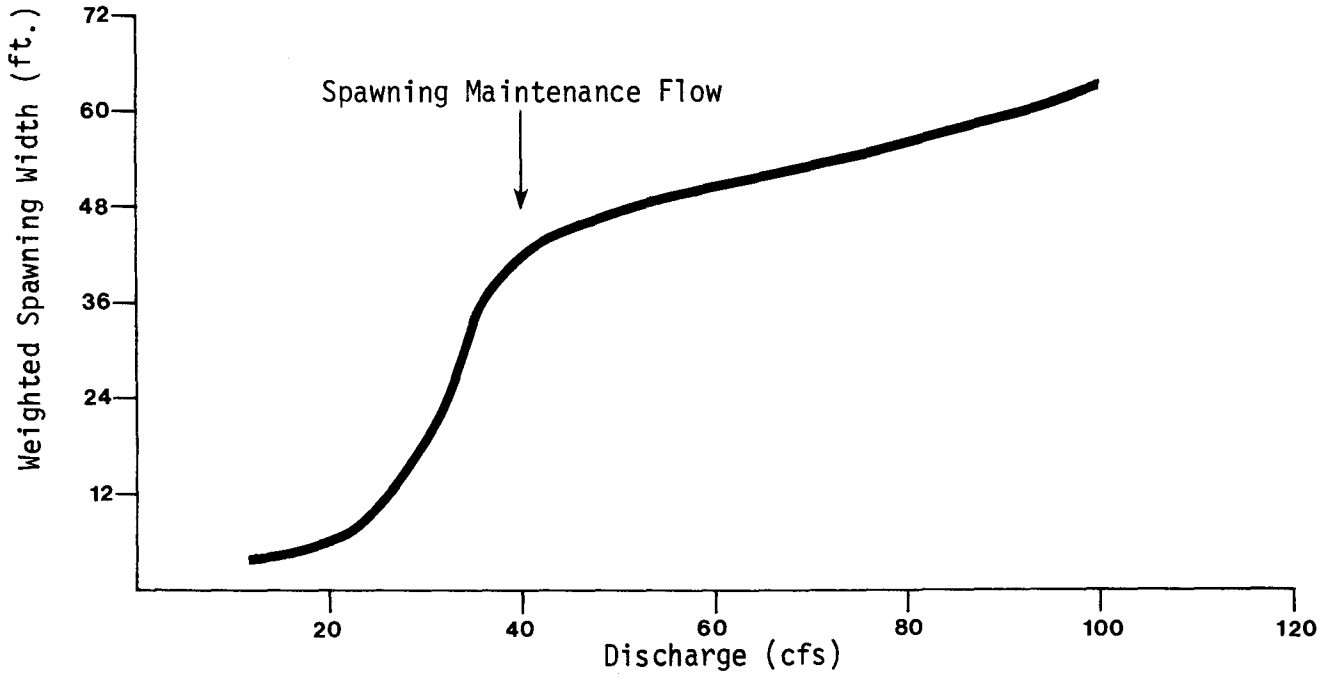


Figure 3. Rainbow trout spawning curves for Little Weiser River at C. Ben Ross Diversion.

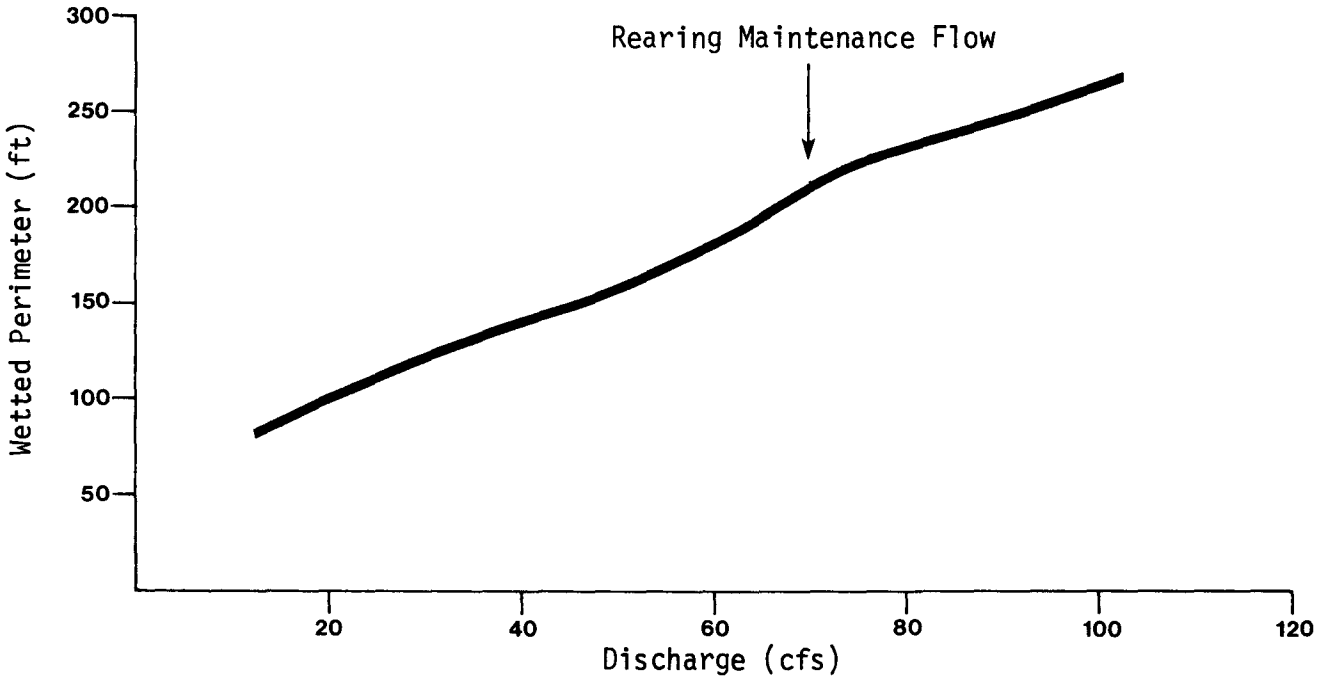


Figure 4. Wetted perimeter curve for Little Weiser River below C. Ben Ross Diversion.

DEADWOOD RIVER

The Deadwood River is located in the mountainous region of south central Idaho in the Boise National Forest (Figure 5). The headwaters of Deadwood River originate approximately 27 air miles east of Cascade, Idaho, and about 75 miles north of the city of Boise. The river flows mainly in a southerly direction to its confluence with South Fork Payette River at river mile 105.0, and drains an area of approximately 224 square miles. The major tributaries to the Deadwood River are Deer Creek above Deadwood Dam and Warm Springs, Whitehawk, and Lorenzo Creeks below the dam.

Deadwood Dam at river mile 24.4 is the only major impoundment on the Deadwood River. Built and operated by the Bureau of Reclamation, it is a concrete arch structure that was completed in 1930. The reservoir has a reported capacity of 160,400 acre-feet between the elevations of 5,230 feet and 5,334 feet. A recent report reveals that there is 108,000 acre-feet of "unutilized storage"[1] for instream purposes. Water is used to augment flow of the Payette River at Black Canyon power plant near Emmett, and since 1952 as supplemental irrigation supply for Emmett Irrigation District and other users in the Lower Payette River Valley. A small transbasin diversion is maintained from a tributary of Johnson Creek, in the Salmon River Basin, to the Deadwood River for supplemental storage in Deadwood Reservoir.

The study encompassed that part of the Deadwood River from Deadwood Dam to the mouth.

The Deadwood River drains a portion of the exposed Idaho Batholith. The soil composition is highly granitic, allowing for rapid changes in stream channel configuration during the large spring runoff.

The stream elevation of the Deadwood River below Deadwood Dam is 5,200 feet. In the 24.4 mile reach to the mouth the river drops 1,510 feet to an elevation of 3,690 feet. The average gradient through the area is 1.172% or 61.88 feet per mile.

Maximum recorded discharge, 2,580 cfs, occurred July 14, 1953. Essentially no flow was recorded for long periods in 1934-1937, when the gates in the dam were closed. The U.S. Geological Survey has maintained a gage at river mile 23.4 since October 1926. Mean annual discharge near the mouth is 349 cfs (USGS 1952).

[1] "...portion of conservation storage which is contractually obligated for future use and potentially available for interim use." (Nelson et al., 1977).

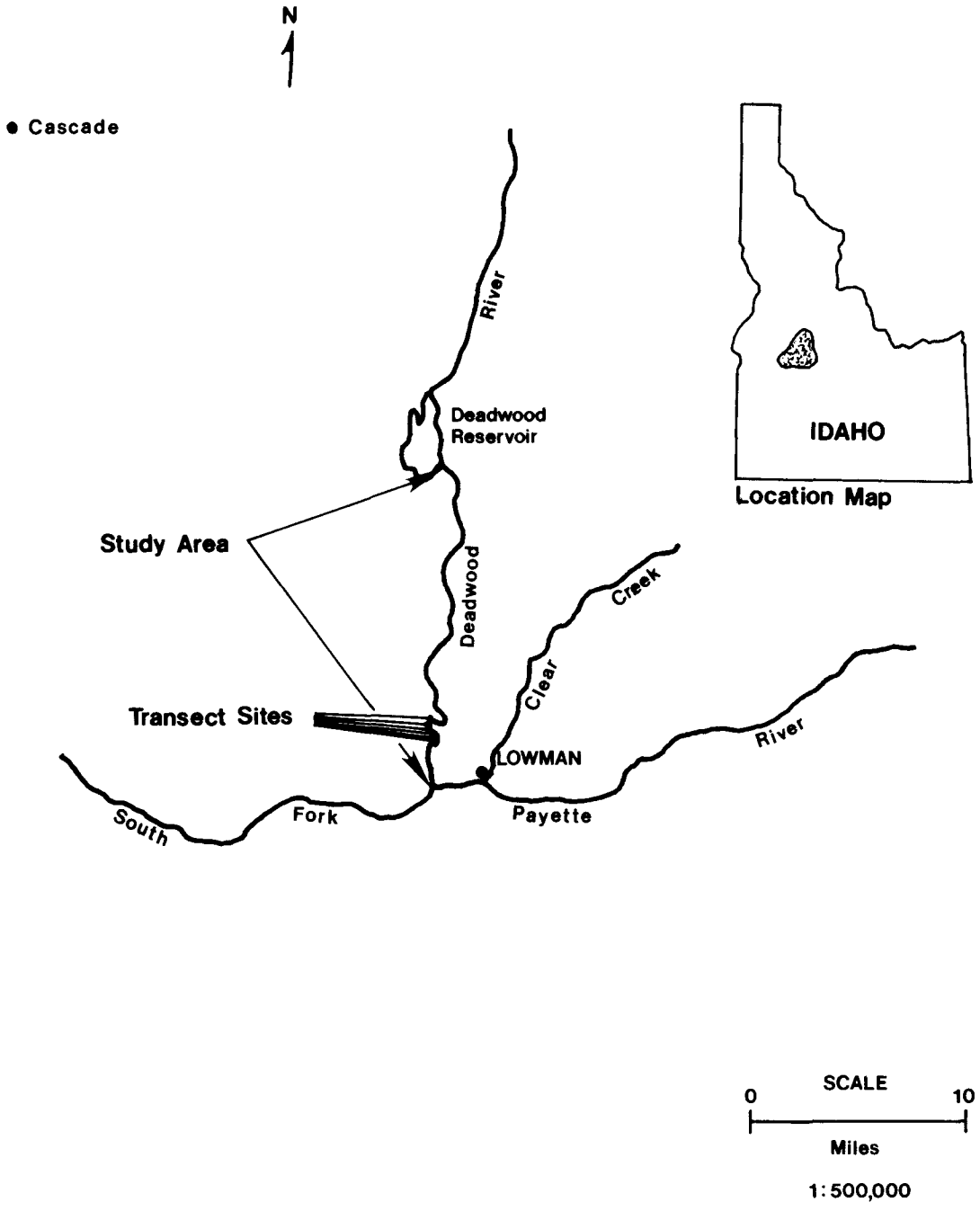


Figure 5. Study area on Deadwood River below Deadwood Dam.

Game fish populations include rainbow trout, cutthroat trout (Salmo clarki), Dolly Varden (Salvelinus malma), brook trout (Salvelinus fontinalis), and mountain whitefish. Rainbow and cutthroat trout are spring spawners; while Dolly Varden, brook trout, and whitefish spawn in the fall.

In order to accomplish the study, the Bureau of Reclamation made a series of controlled releases so data could be collected over a range of flows. The flow releases from the dam compared to those measured at the study site are set forth below.

Released Flows At Dam (cfs)	Measured Flow at Study Site
250	333
150	230
112	183
75	137
50	107
25	75

On September 26, 1972, 7 hours of rain increased the amount of inflow from the tributaries approximately 34 cfs. By the time the flow from the dam had been reduced to the point where it was becoming critical to spawning and passage of fish, the total additional inflow from the rainstorm has fallen to about 10 cfs. At the end of the study (October 5, 1972), the inflow had dropped below the normal base flows for that time of year. Thus, it is not felt that these inflows from the rain had a significant effect on habitat conditions recorded at the beginning and end of the study.

The recommended trout passage flow at the study site was determined to be 50 cfs (Figure 6). The flow recommendations for spawning at the study site were determined to be 125 cfs for rainbow trout, 90 cfs for cutthroat trout, and 120 cfs for Dolly Varden (Figures 7, 8, and 9). Using the wetted perimeter curve, the rearing flow recommendation at the study site was determined to be 125 cfs (Figure 10). Flows for angling were not considered in the study but, in most cases, the suggested flows are probably adequate for that purpose.

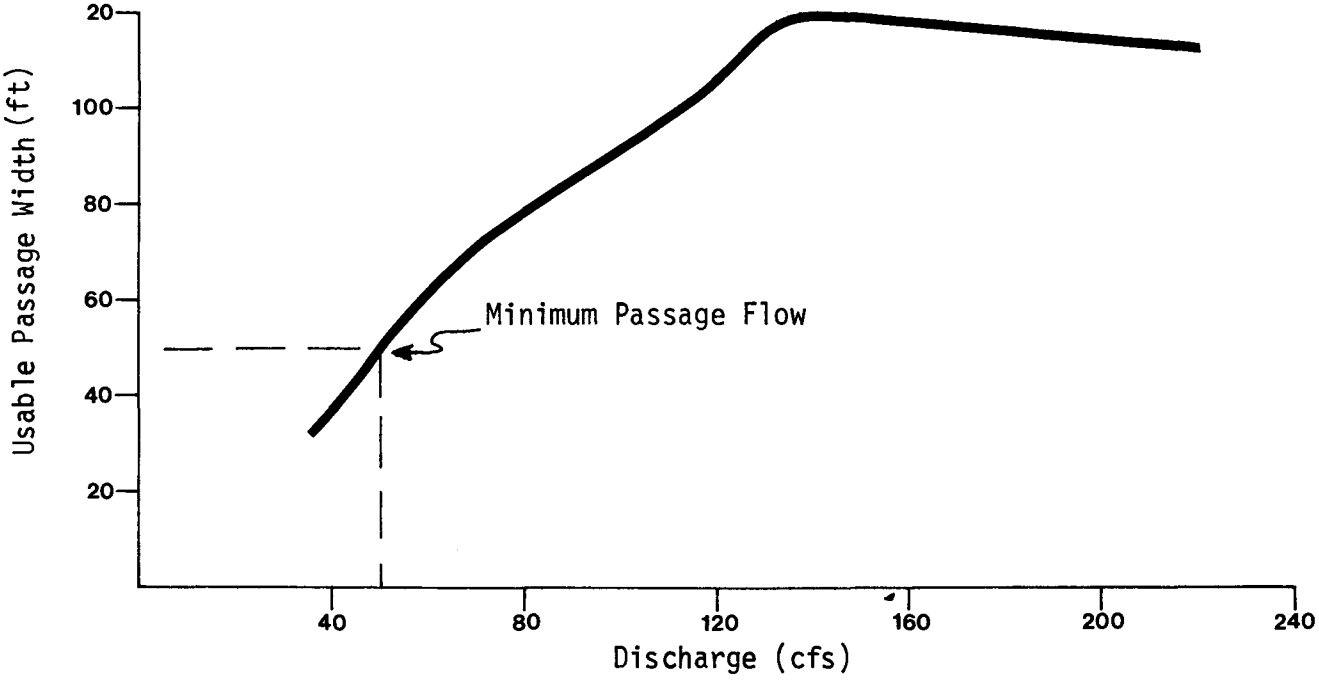


Figure 6. Trout passage curve for Deadwood River below Deadwood Dam

The recommended flow regime encompasses that section of river from Deadwood Reservoir Dam to the South Fork of the Payette River. The recommended low flow regime in cfs released from Deadwood Reservoir, based on species periodicity flows, is as follows:

Species/Life Stage	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout												
Spawning					125	125						
Incubation					85	85	85	85				
Passage				50	50	50						
Cutthroat Trout												
Spawning					90	90						
Incubation					60	60	60	60				
Passage				50	50	50						
Dolly Varden												
Spawning										120	120	
Incubation	80	80								80	80	80
Passage									50	50	50	
Rearing - All Species	125	125	125	125	125	125	125	125	125	125	125	125
Recommended Flow Regime	125	125	125	125	125	125	125	125	125	125	125	125

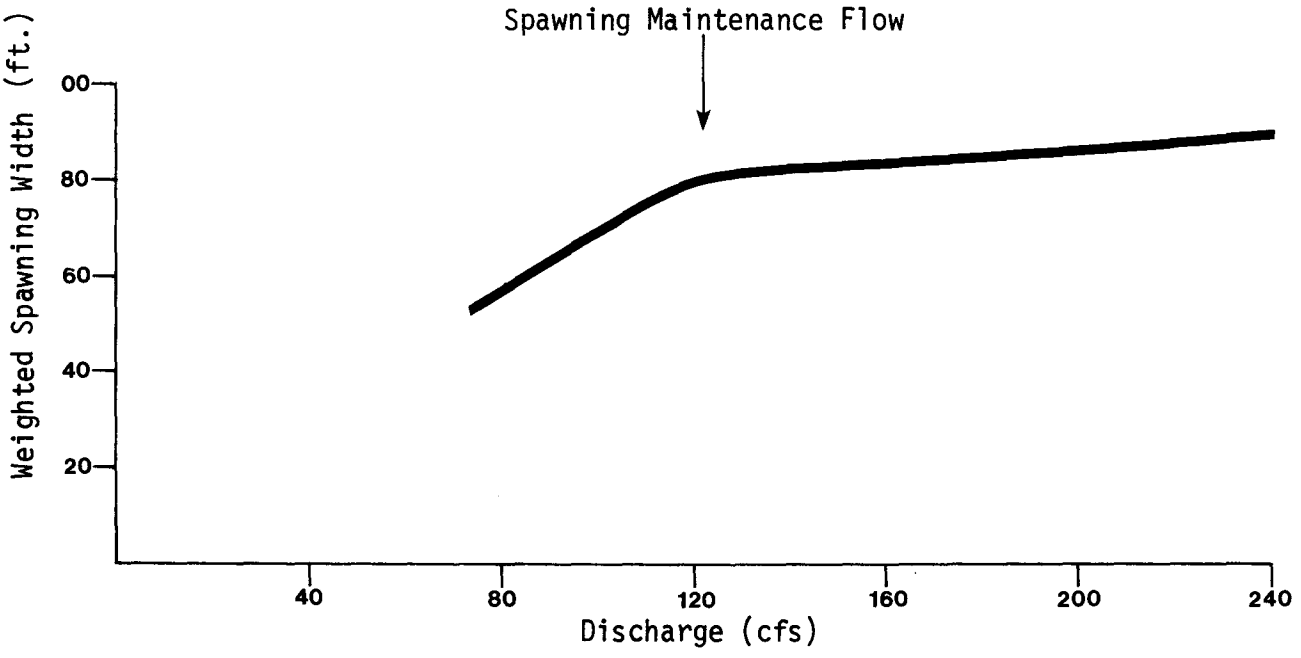


Figure 7. Rainbow trout spawning curve for Deadwood River below Deadwood Dam.

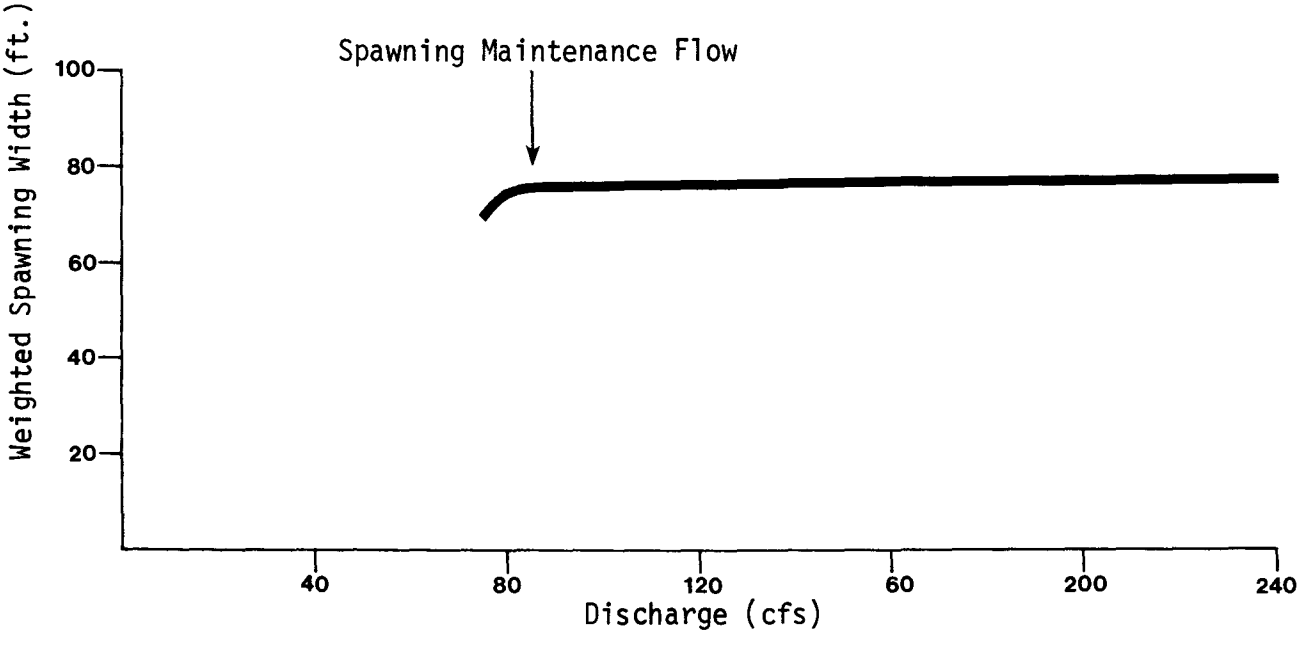


Figure 8. Cutthroat trout spawning curve for Deadwood River below Deadwood Dam.

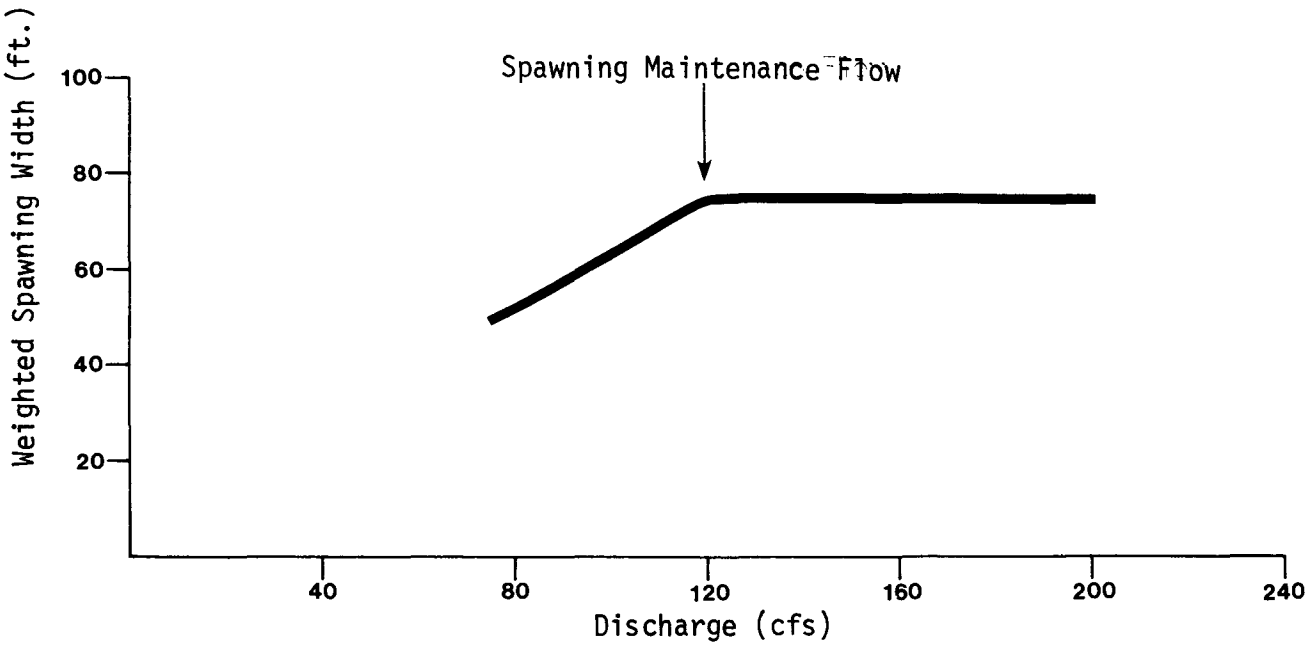


Figure 9. Dolly Varden spawning curve for Deadwood River below Deadwood Dam.

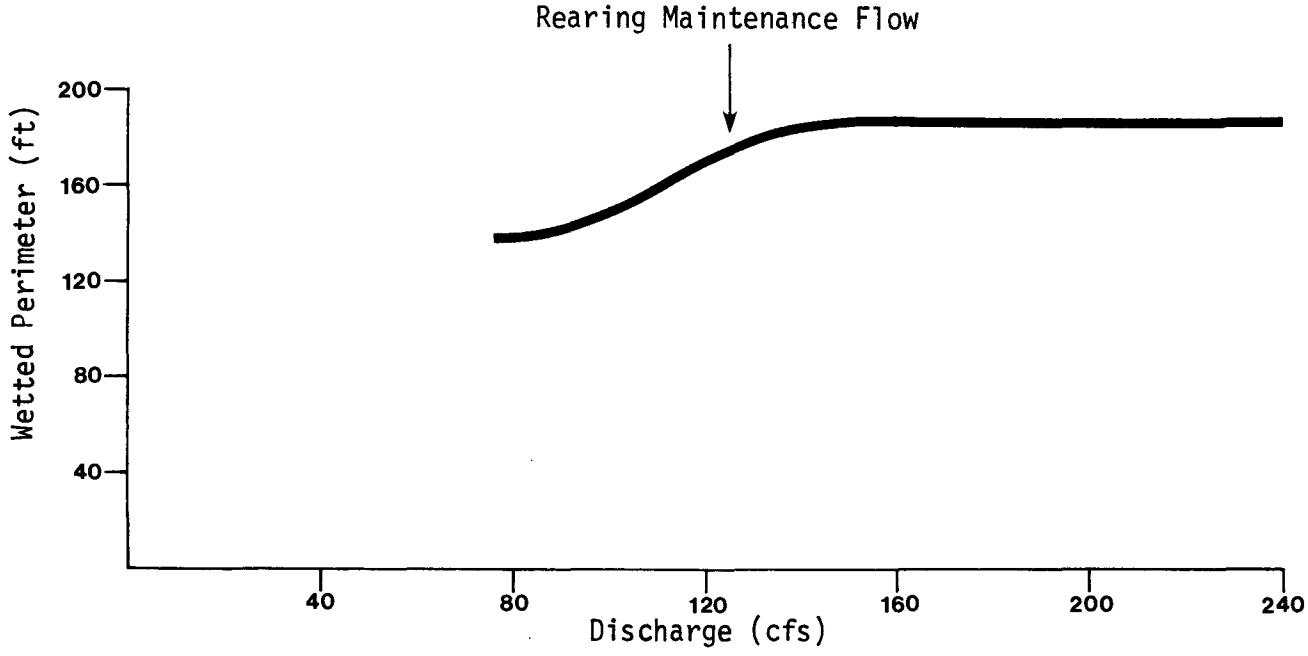


Figure 10. Wetted perimeter curve for Deadwood River below Deadwood Dam.

NORTH FORK PAYETTE RIVER

The North Fork of the Payette River is located in the mountainous region of south central Idaho. It is situated geologically in the Idaho Batholith of the Northern Rocky Mountain Province. The headwaters of the North Fork Payette River originate approximately 19 air miles north of McCall, Idaho, along the western margin of the Salmon River Mountains.

From Payette Lake's outlet at river mile 75.4, the North Fork Payette River flows south into Cascade Reservoir (river mile 53.9) near the mouth of Lake Fork Creek (Figure 11).

The North Fork of the Payette River, at its mouth near Banks, drains approximately 1,260 square miles and drops to a water elevation of 2,790 feet. Extremes in elevations in the drainage vary from 2,790 feet near Banks to mountain peaks in excess of 9,000 feet. The mean altitude for the Payette Lake drainage is 6,520 feet.

The study site for this instream flow study is located approximately 2 river miles downstream from Lardo Dam on McCall's Payette Lake. All of the study transects are located within a 1 mile length of river beginning 200 yards downstream from an iron bridge adjacent to McCall's sanitary landfill. The upper transect is located approximately at river mile 73.5, the lowest transect located near river mile 72.5.

The volumes of discharges released from the outlet of Payette Lake were measured and recorded by means of a USGS water-stage recording gage 0.2 miles downstream from Payette Lake's outlet at river mile 75.2. (The period of record for this water gage is from September 1908 to June 1917, and from May 1919 to 1972.) The average annual discharge from Lardo Dam for the period of 61 years was 369 cfs or 267,300 acre-feet per year. During a 15-year base period (1952 to 1967) the average annual discharge was 377 cfs. Maximum and minimum discharges on record with the USGS range from 4,260 cfs on June 4, 1948, to no flow on more than one occassion, most recently from October 22 to November 11, 1938 (USGS 1976).

The water released annually from Payette Lake contributes approximately 10% of the total discharge from Black Canyon Reservoir on the Lower Payette system. A single irrigation diversion was located within the study area approximately midway between transect locations, but at no time was the gate observed to be open to allow water to be diverted from the river. The observations were made primarily during the months of July and August when irrigation demands are normally at their highest. It was concluded from these observations that this diversion posed no immediate threat to the aquatic biota of the North Fork Payette River.

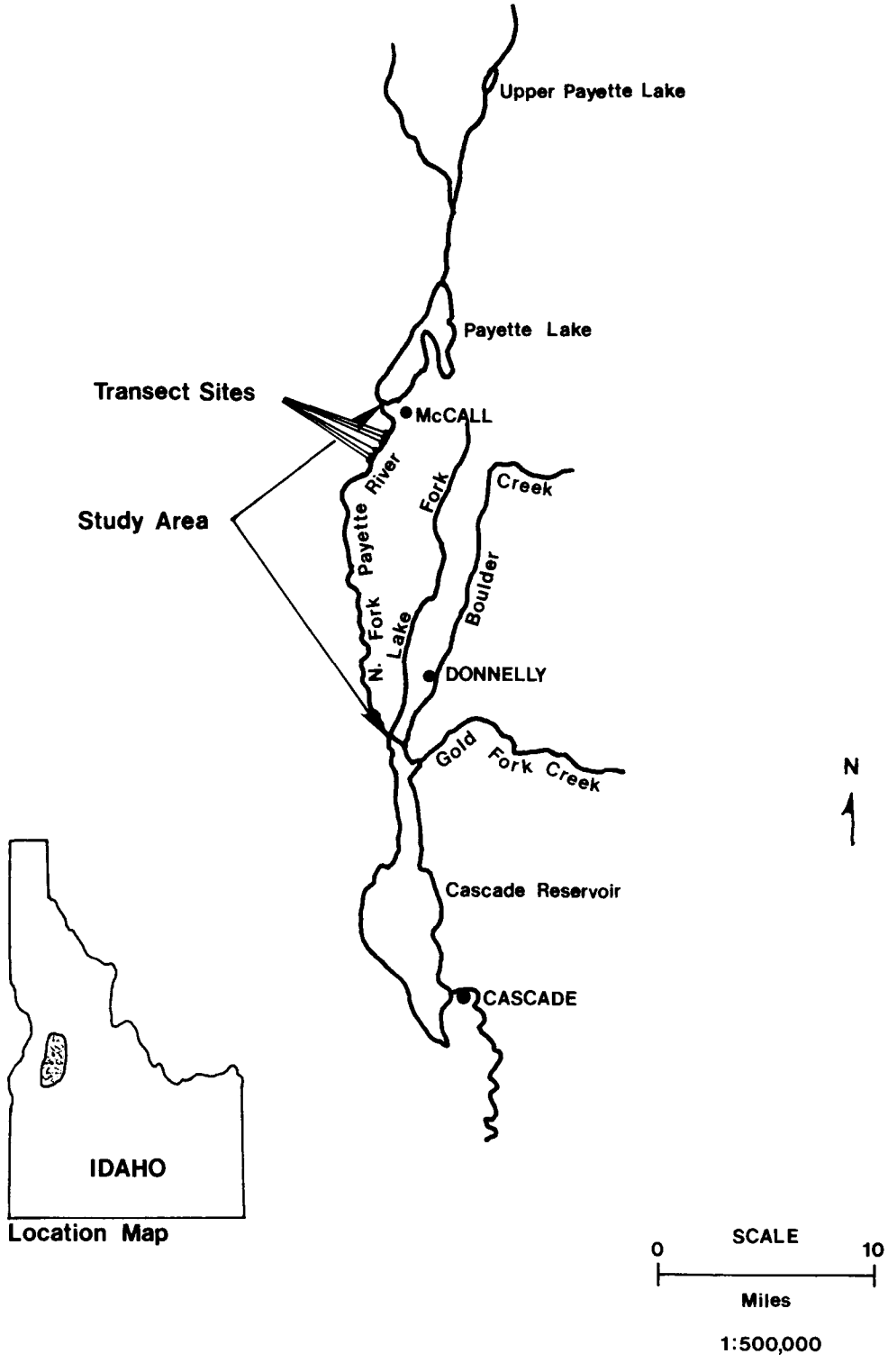


Figure 11. Study area on North Fork Payette River below Payette Lake.

Fish species known to inhabit the study area, at least part of the year, include: kokanee salmon (Onchorynchus nerka), rainbow trout, brown trout (Salmo trutta), brook trout, Dolly Varden, mountain whitefish, and miscellaneous rough fish species.

Because of recreational demands, flow releases from Lardo Dam are regulated to allow the water level in Payette Lake to remain at a relatively high level throughout the summer months until near mid-September. This stabilized water level enables swimmers, boaters, and water-skiers to gain full benefit from use of docks and beaches. Water released from Payette Lake for irrigation purposes appears to be of a lower priority than that which is retained for recreational use. As a result of stabilizing the lake level, flows below the dam are severely depleted, particularly during dry periods in late summer.

The spawning flow recommendations are: rainbow trout, 100 cfs; brook trout, 90 cfs; brown trout, 125 cfs; Dolly Varden, 80 cfs; kokanee salmon, 75 cfs (Figures 12, 13, 14, 15, and 16). The recommended rearing flow, which would give the greatest amount of wetted perimeter for the least flow over riffles, is 140 cfs (Figure 17). Flows for angling were not considered in the study; however, the recommended flows are believed to be adequate for that purpose.

The recommended low flow regime in cfs for the stretch of stream from Payette Lake to Cascade Reservoir, based on fish species periodicity flows, is as follows:

Species/Life Stage	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout												
Spawning				100	100							
Incubation				67	67	67	67					
Brown Trout												
Spawning										125	125	125
Incubation	83	83								83	83	83
Brook Trout												
Spawning										90	90	
Incubation	60	60								60	60	60
Dolly Varden												
Spawning										80	80	
Incubation	53	53								53	53	53
Kokanee Salmon												
Spawning									75	75		
Incubation	50								50	50	50	50
Rearing - All Species	140	140	140	140	140	140	140	140	140	140	140	140
Recommended Flow Regime	140	140	140	140	140	140	140	140	140	140	140	140

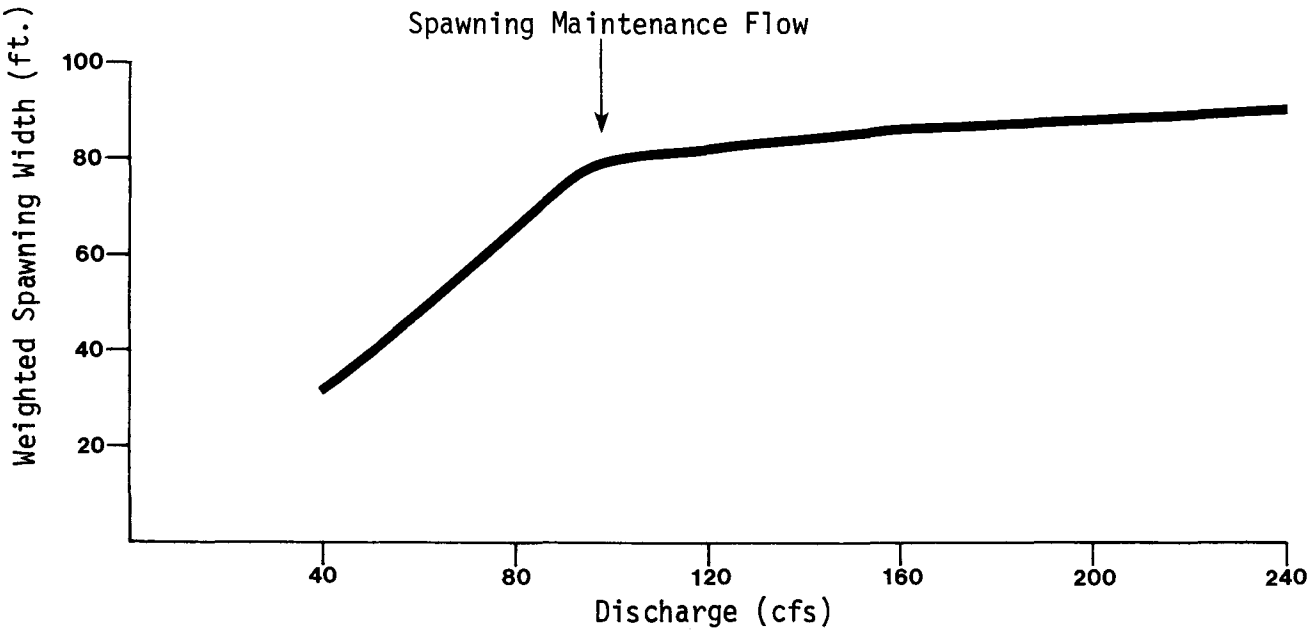


Figure 12. Rainbow trout spawning curve for North Fork Payette River below Payette Lake.

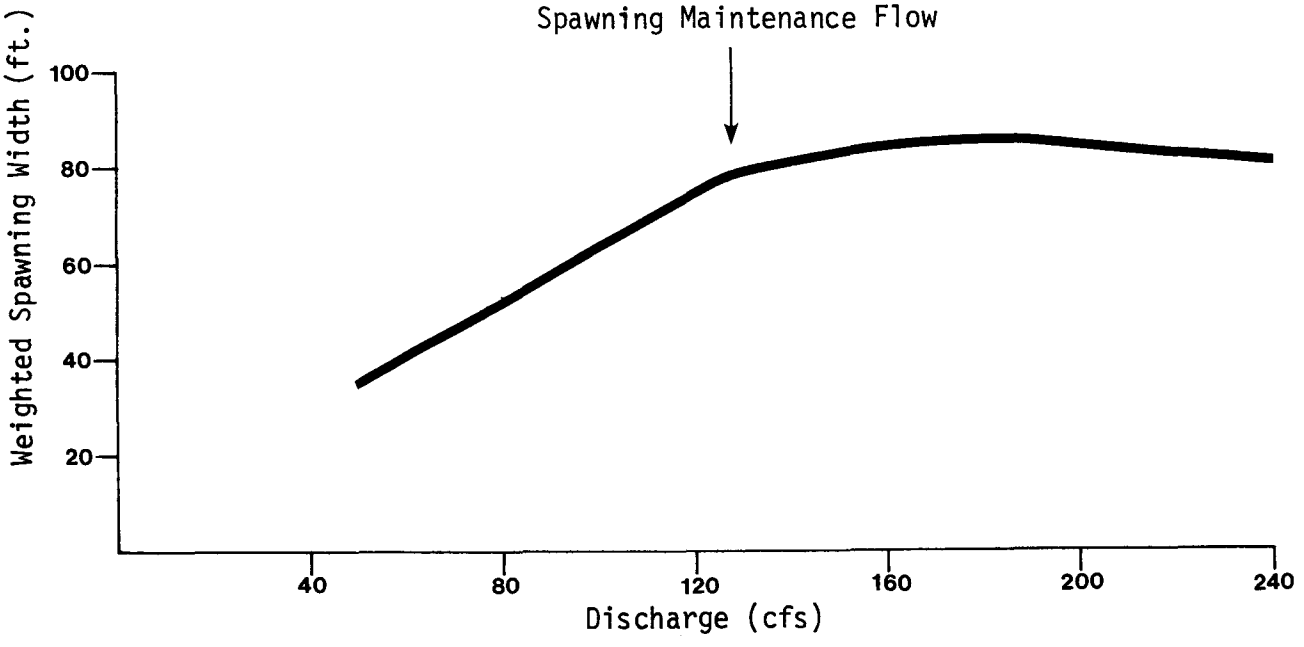


Figure 13. Brown trout spawning curve for North Fork Payette River below Payette Lake.

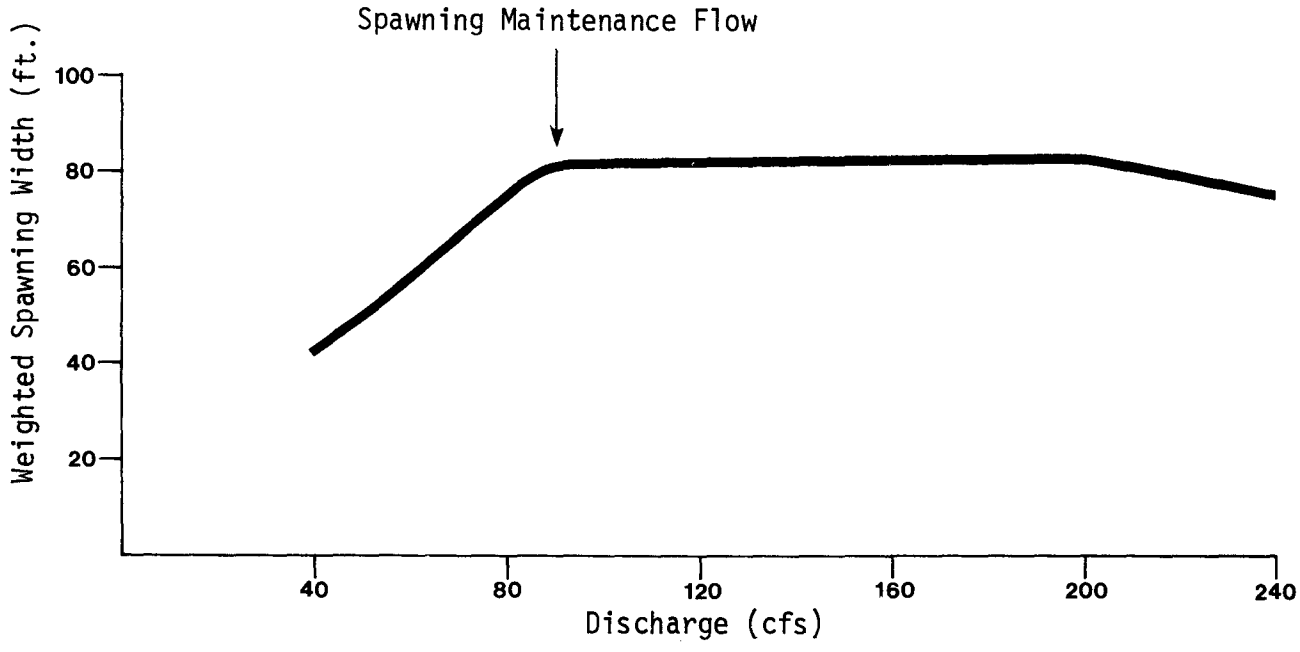


Figure 14. Brook trout spawning curve for North Fork Payette River below Payette Lake.

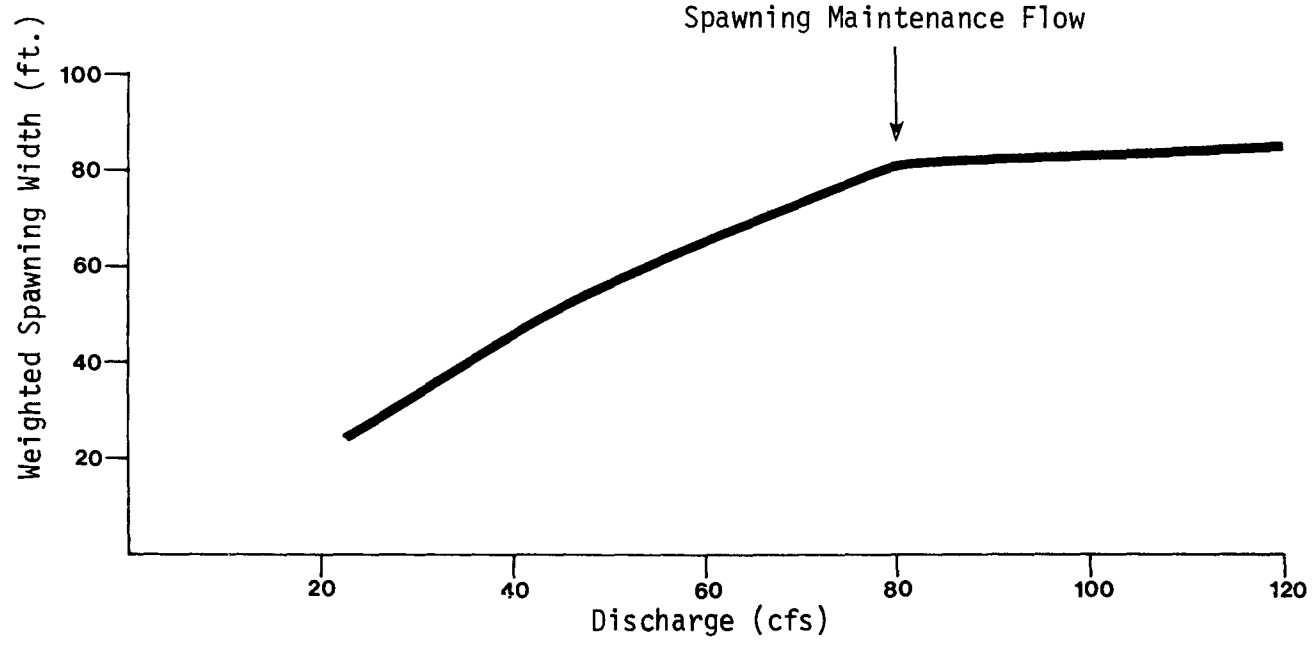


Figure 15. Dolly Varden spawning curve for North Fork Payette River below Payette Lake.

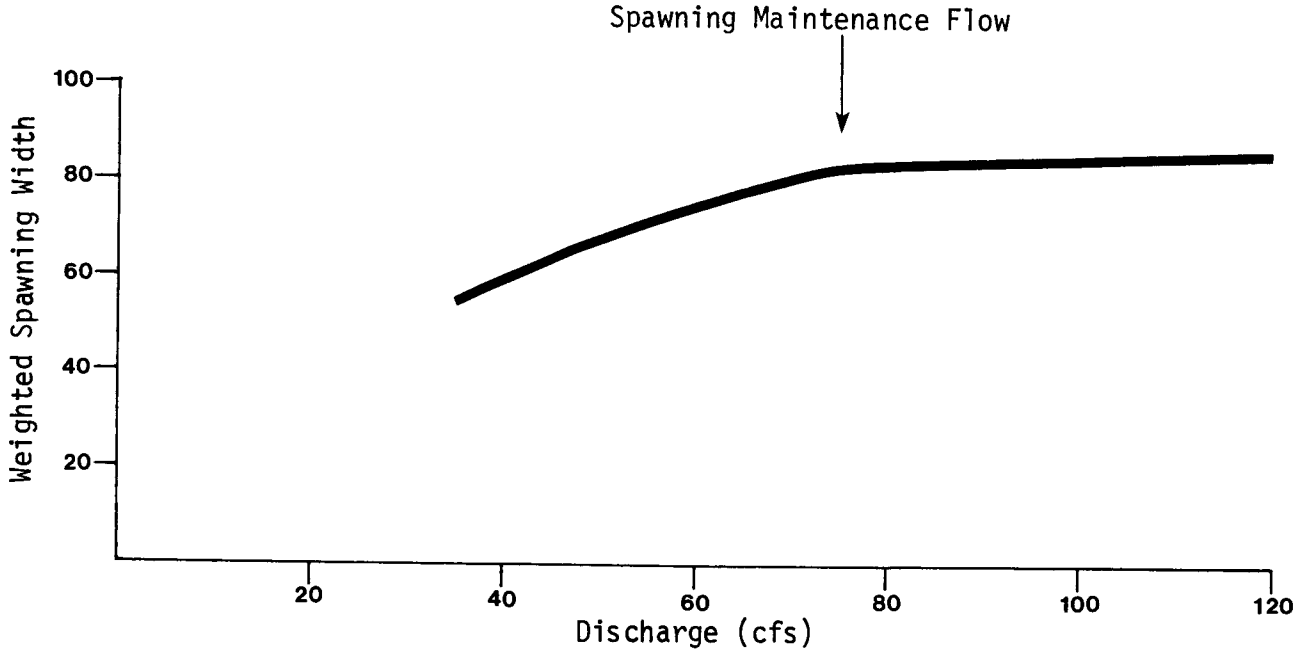


Figure 16. Kokanee salmon spawning curve for North Fork Payette River below Payette Lake.

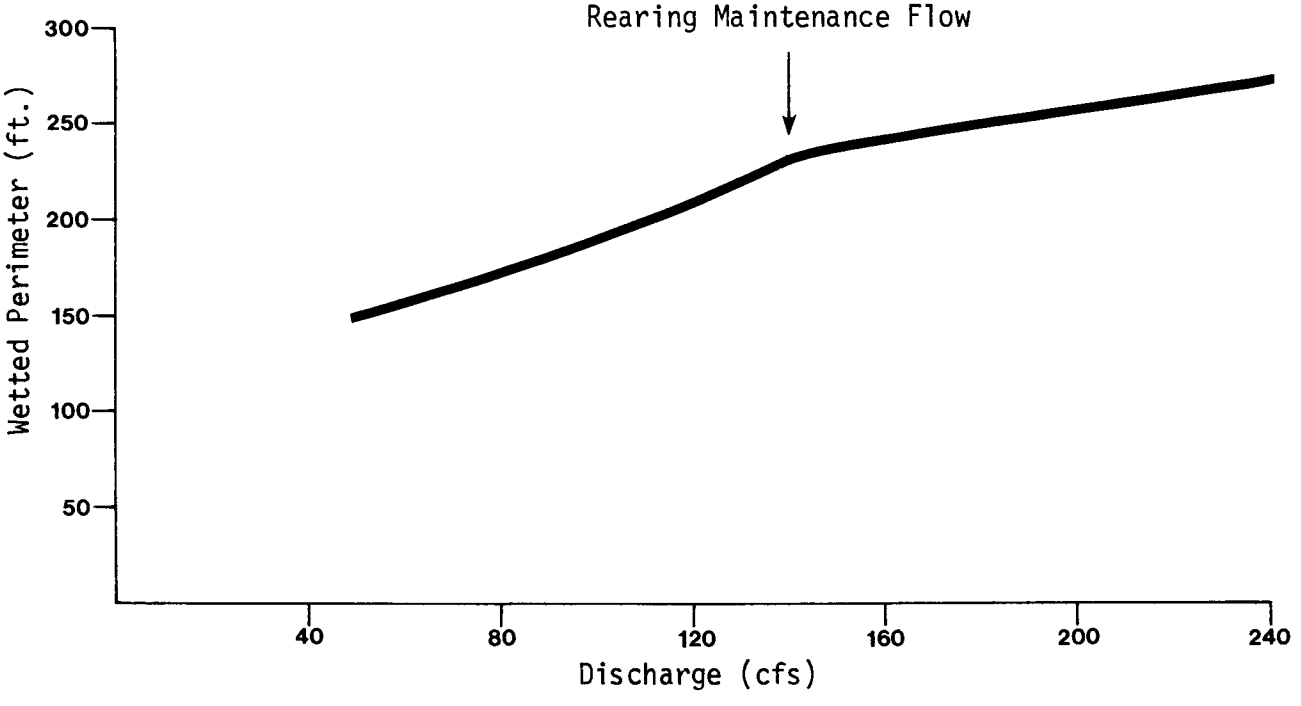


Figure 17. Wetted perimeter curve for North Fork Payette River below Payette Dam.

SOUTH FORK BOISE RIVER

The South Fork of the Boise River is located in southwestern Idaho (Figure 18). From its sources in the Smokey Mountains, it flows south and west to its confluence with the Middle Fork of the Boise to form the main Boise River at River mile 79.0. The main part of the drainage is located approximately 60 air miles east of Boise, and drains approximately 1,304 square miles. Since Arrowrock Dam was built in 1915, the South Fork of the Boise no longer drains directly into the Middle Fork of the Boise River, but flows into Arrowrock Reservoir, 11.2 river miles upstream from the original mouth. The major impoundment on the South Fork of the Boise is Anderson Ranch Dam, built in 1945, which has a capacity of 502,700 acre-feet of storage. The major tributaries to the South Fork of the Boise River below Anderson Ranch Dam are Rattlesnake Creek, Smith Creek, and Cow Creek.

Our study encompassed that part of the South Fork of the Boise River from Anderson Ranch Dam to Neal Bridge, a section 32.3 miles long from river mile 11.2 to river mile 43.5.

The South Fork of the Boise River drainage lies mainly in the northern Rocky Mountain Physiographic province, in the region of the Idaho Batholith.

The stream elevation of the South Fork of the Boise River at Anderson Ranch Dam is 3,970 feet. In the 32.3 miles through the study area, the river drops 760 feet by the time it reaches the mouth. The average gradient through the study area is 0.445% or 23.5 feet per mile.

The USGS has maintained a stream discharge gage station on the South Fork of the Boise River, 1.8 miles downstream from Anderson Ranch Dam since April 1943, with continuous records to the present year.

Average annual runoff for the South Fork of the Boise River below Anderson Ranch Dam is 1,028 cfs, or 744,800 acre-feet per year, about one-third of the usable water for the Lower Boise system. Maximum recorded discharge, 9,850 cubic feet per second, occurred on May 25, 1956. Minimum discharge of record is 0.1 cfs on November 13, 1959, when the dam was closed (USGS 1976).

The overhanging cliffs, the foothills, and the lower slopes enveloping the South Fork of the Boise River support a sagebrush-grass vegetative association. Coniferous forest and aspen groves occur at the higher elevations in the headwaters of the South Fork.

Game fish populations include rainbow trout, Dolly Varden, mountain whitefish, brook trout, and smallmouth bass (Micropterus dolomieui). The

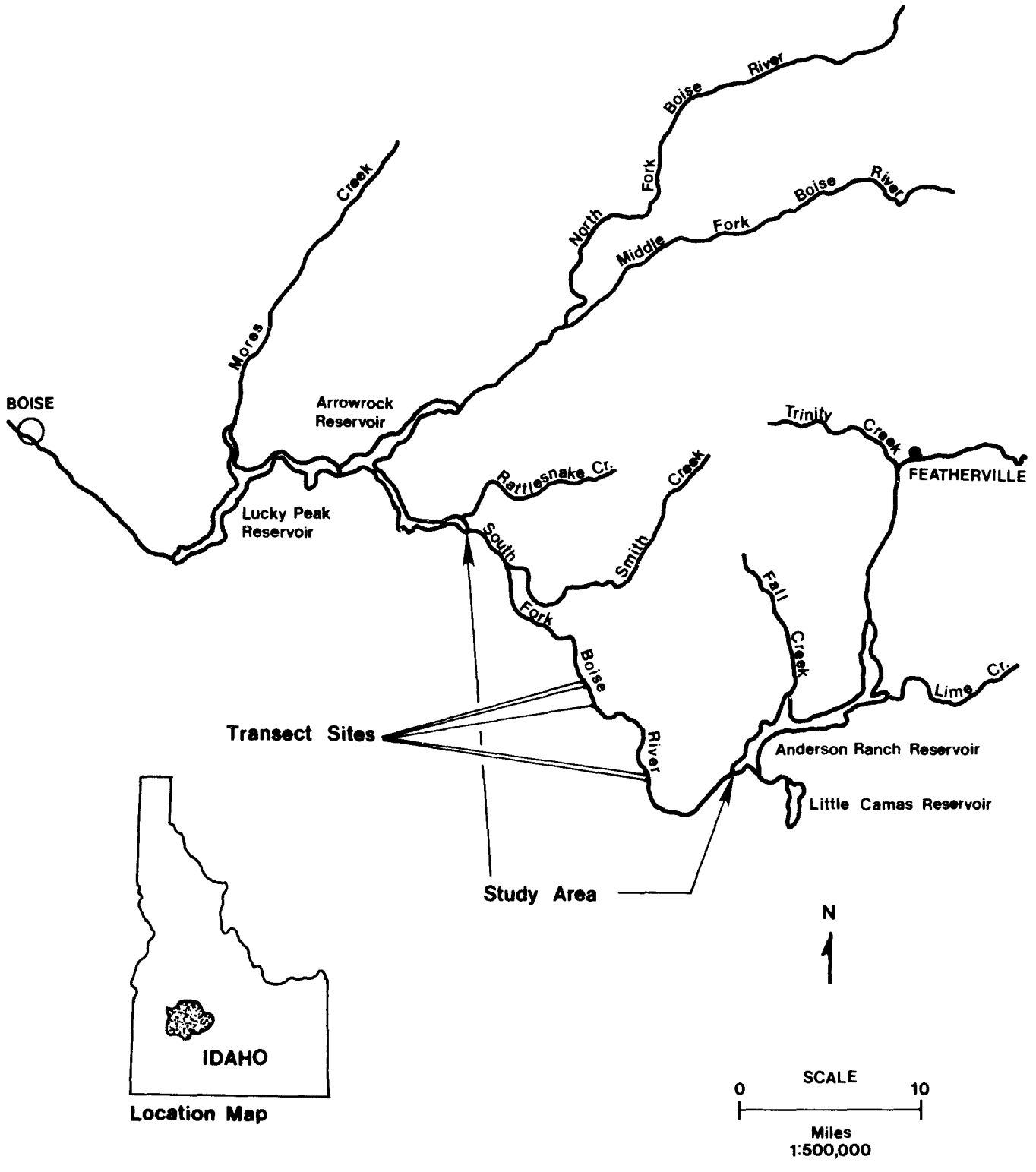


Figure 18. Study area on South Fork Boise River below Anderson Ranch Dam.

rainbow trout is the highest valued fish species below Anderson Ranch Dam. The stream is presently being managed as a wild trout stream with tackle restrictions allowing only artificial lures and flies.

An Idaho Fish and Game Department study during 1973 and 1974 indicated that anglers spent 28,914 hours to catch 25,258 game fish in the river from the dam downstream to Danskin Bridge (Beach, 1975). During the 1974 general trout season (June-November), anglers spent 26,443 hours to harvest 22,025 game fish. In 1976 tackle restrictions (artificial lures and flies only) and a minimum length requirement for rainbow trout were imposed. During the general trout season, anglers fished an estimated 14,960 hours to harvest 11,076 rainbow trout, with 9,525 of these fish released back into the stream (Steve Mate, personal communications). Mountain whitefish are abundant through the study areas, and produce a good fishery through the winter months when the trout season is closed.

The majority of the rainbow trout spawning takes place in late April and May. The whitefish, kokanee, and Dolly Varden spawn from September through November.

To assist our instream flow studies the Bureau of Reclamation made a series of controlled releases from Anderson Ranch Dam. The flows released from the Dam were approximately those requested.

Flow (cfs)	Date
1,000	Monday, November 13, 1972
600	Tuesday, November 14, 1972
500	Saturday, March 23, 1974
400	Sunday, March 31, 1974
300	Thursday, November 16, 1972
200	Friday, November 17, 1972
100	Tuesday, May 1, 1973

It was found that most of the river posed no problem to fish passage and only one passage transect was utilized to represent potential passage blocks in the stream. The recommended passage flow to allow fish movement throughout the study area is 130 cfs.

The spawning flow recommendation for rainbow trout is 280 cfs; brook trout, 170 cfs; and Dolly Varden, 200 cfs (Figures 19, 20, 21).

It should be recognized that the spawning flow recommendations are for main channel spawning. The amount of suitable substrate is limited in the main channel, and most spawning apparently occurs in the smaller side channels where more suitable spawning substrate exists.

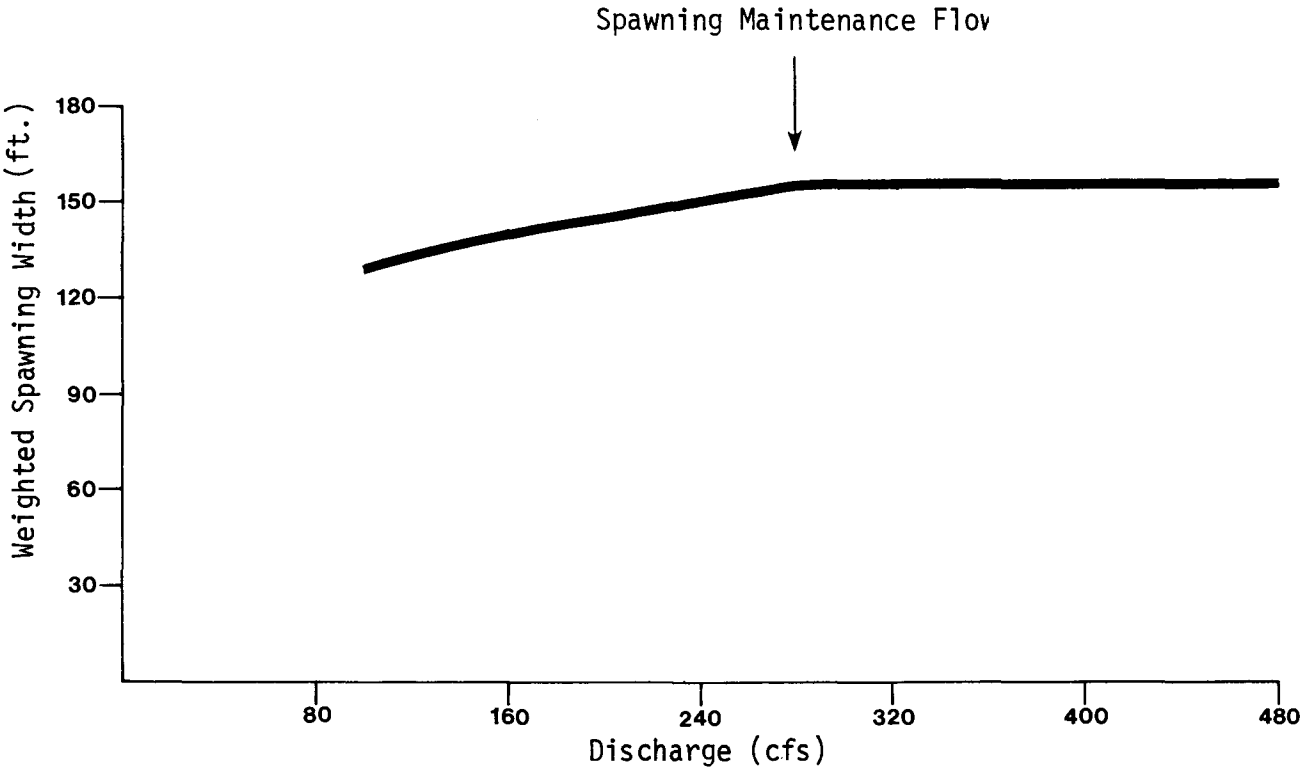


Figure 19. Rainbow trout spawning curve for South Fork Boise River below Anderson Ranch Dam.

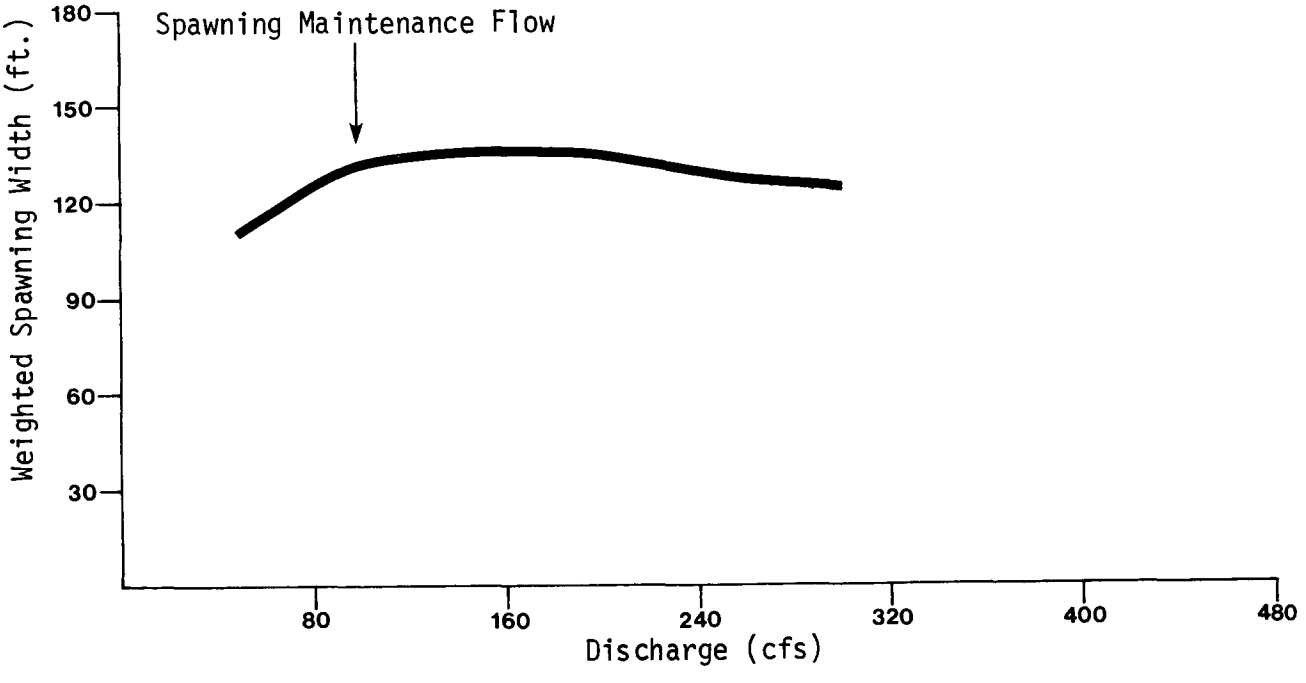


Figure 20. Brook trout spawning curve for South Fork Boise River below Anderson Ranch Dam.

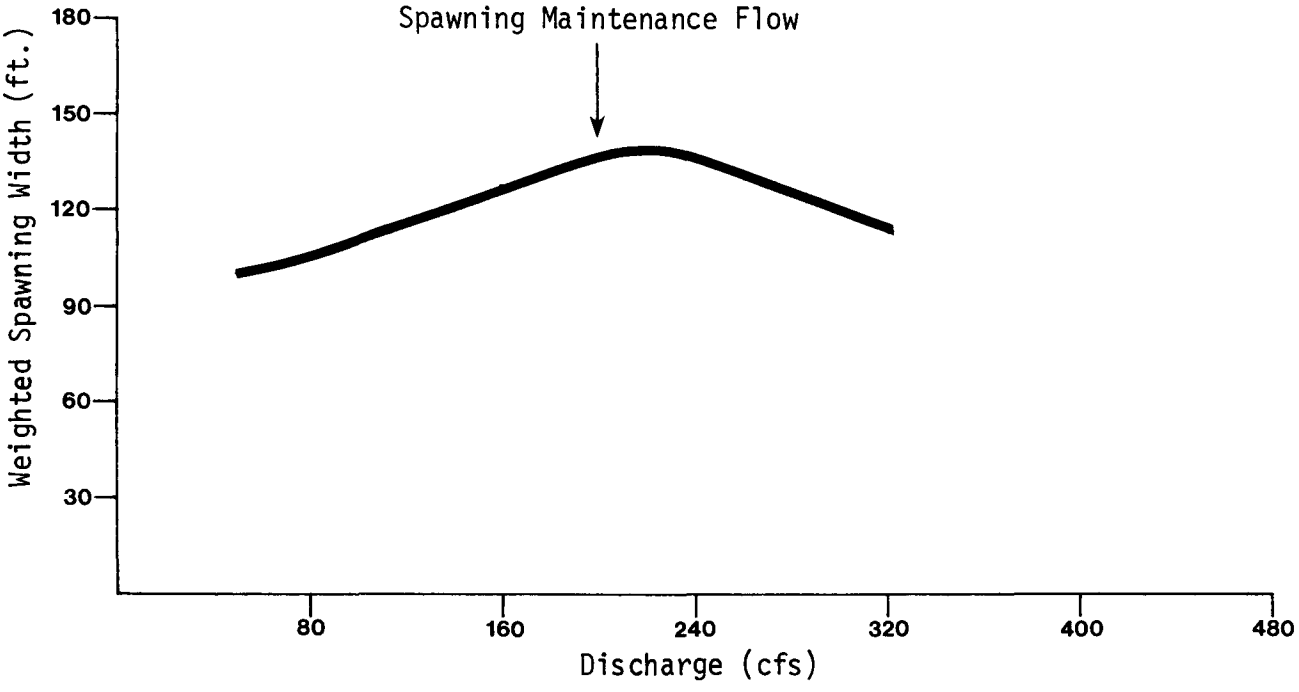


Figure 21. Dolly Varden spawning curve for South Fork Boise River below Anderson Ranch Dam.

The rearing flow recommendation is based on subjective evaluation of the habitat loss at each flow, and 200 cfs is suggested as the minimum rearing flow for all activities other than spawning, incubation, and passage.

Flows for angling were not considered in the study, but in most cases, the suggested levels are probably adequate for the purpose. Beach (1974) recommends that during the whitefish season (December through March), maximum flow of 700 cfs be maintained to optimize the fishability of the stream.

The recommended low flow regime in cfs, from Anderson Ranch Dam to Arrowrock Reservoir, based on species periodicity flows, is as follows:

Species/Life Stage	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout												
Spawning				280	280	280						
Incubation				187	187	187	187	187				
Brook Trout												
Spawning									100	100	100	100
Incubation	67	67	67	67					67	67	67	67
Dolly Varden												
Spawning										200	200	
Incubation	120	120	120							120	120	120
Rearing - All Species	200	200	200	200	200	200	200	200	200	200	200	200
Recommended Flow Regime	200	200	200	280	280	200	200	200	200	200	200	200

Editor's Note: Since these data were collected in the early 1970's, the Idaho Department of Fish and Game has conducted instream flow studies on South Fork Boise River and has made a rearing flow recommendation of 279 cfs based on wetted perimeter/discharge relationship (Cochnauer 1977). The department is presently evaluating greater flows to allow for spawning in the smaller side channels.

BOISE RIVER

The lower Boise River includes that portion of the river from Lucky Peak Dam downstream to the mouth (Figure 22). The stream channel through the study area averages between 105 feet and 200 feet in width; in some places it splits into two or more channels where the river becomes intricately braided. Some sections of the river have been channelized, leveed, and riprapped to the point where it is no longer in a natural condition.

The gradient through the study area is from an elevation of 2,827 feet at Lucky Peak Dam to 2,177 feet at the Snake River, for a drop of 10.2 feet per mile through the 63.8-mile reach.

Major tributaries which contribute to the Lower Boise River are North Fork, Middle Fork, and South Fork of the Boise River, and Mores Creek, all of which are located above the study area.

Average annual discharge for the Boise River near Boise is 3.023 cfs or 2,190,000 acre-feet per year (USGS 1976). The flow is regulated by three reservoirs on the river and one off-stream reservoir, with a combined usable storage capacity of 1,165,150 acre-feet. Anderson Ranch Dam, on the South Fork of the Boise River, built in 1945 by Bureau of Reclamation, has an active storage capacity of 423,000 acre-feet. Arrowrock Dam, on the main Boise River, built by Bureau of Reclamation in 1915, has an active storage capacity of 286,000 acre-feet. Lucky Peak Dam, on the main Boise River, built by the Corps of Engineers in 1954, has an active storage capacity of 278,200 acre-feet. Nelson et. al. (1977) reports, "Lucky Peak Reservoir has 116,000 acre-feet of unobligated storage[2] which could be renegotiated to provide the needed instream flows. Lake Lowell is an off-stream reservoir built in 1915 along with Diversion Dam below Lucky Peak Dam. The diversions and return from groundwater and canals along the Lower Boise River combined to produce a complicated hydrologic system.

Maximum recorded discharge for the Boise River was 35,500 cfs on June 14, 1896. There has been zero discharge on many occasions when the gates at Lucky Peak Dam were closed. Minimum recorded discharge for Boise River near Boise prior to the construction of the major storage dams upstream, was 432 cfs on November 14, 1915.

[2] "...portion of conservation storage which is not contractually obligated to water users although bound by legislative intent for particular reimbursable purposes..." (Nelson et al., 1977)

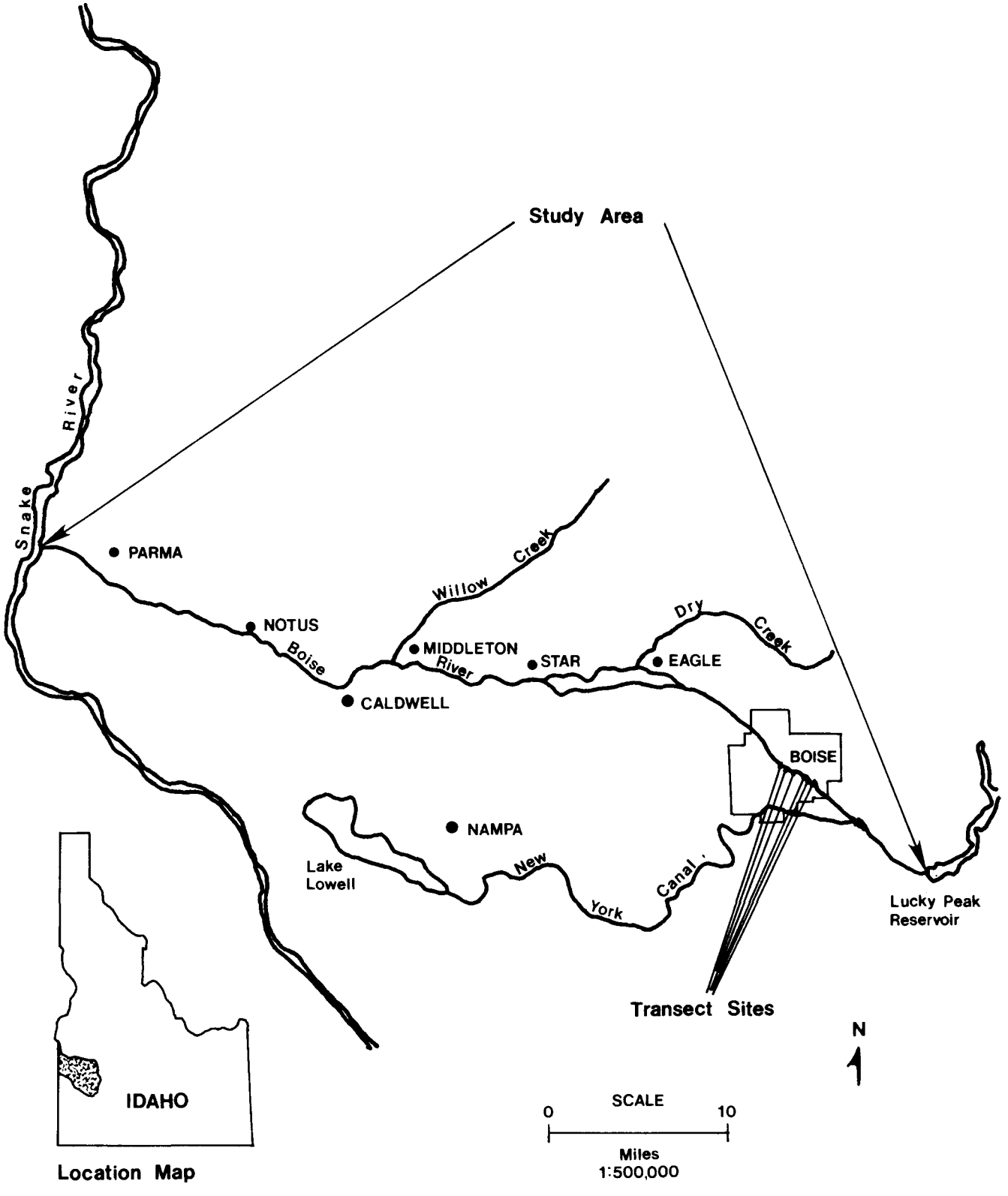


Figure 22. Study area on Boise River below Lucky Peak Reservoir.

Runoff characteristics follow a basic pattern which does not vary significantly from one year to the next. Natural runoff is characterisized by low flows from late July through February, increased flows during March, and high flows during April through June. Flows below Diversion Dam are normally high just prior to the irrigation season for flood control, during irrigation season, and are very low during the late fall and early winter months.

The U.S. Geological Survey has maintained stream discharge gages on the Lower Boise River since 1895. Gages have been added and discontinued at several locations since this time. The following is a list of the gage stations that were used for this study:

Gage Title	Location	Landmark
Boise R. near Boise	River Mile 63.8	At Lucky Peak Dam
Boise R. at Boise	River Mile 52.8	Capital Blvd. Bridge
Boise R. near Middleton (new)	River Mile 29.2	Lansing Lane
Boise R. at Notus (discontinued)	River Mile 13.8	At Notus
Boise R. near Parma (new)	River Mile 3.6	County Road Bridge

Diversions and inflows from Lucky Peak Dam to the mouth are very numerous. The total capacity of the more than 40 canals which divert water from the Boise River is approximately 6,700 cfs. Normal maximum diversion rates during the irrigation season are 600 cfs from Diversion Dam to Boise, 1,400 cfs from Boise to Star, 850 cfs from Star to Notus, and 175 cfs from Notus to Parma. Boise River flows exhibit wide fluctuations, particularly from Diversion Dam to Star, where diversions can range from 0 to 2,000 cfs. Diversions and inflows on the Boise River have a major impact on the existing fisheries. Diversions often limit flows in the Boise River to less than 5 cfs in the Star to Middleton area, and to less than 100 cfs in the Notus area.

The most significant low flow conditions above Eagle, Idaho, occur from the end of the irrigation season (October 15) to whenever flood control or irrigation releases are resumed the next year. From Eagle, downstream low flow conditions are generally associated with irrigation diversions.

The Boise River provides water for irrigation of about 347,000 acres of cropland. Most of this is in the Boise Valley, but some water is diverted for irrigation of land out of the drainage near Mountain Home. Water for municipal and industrial use is also provided by the Boise River by recharging the ground water in some areas.

The US Bureau of Reclamation's Boise Project is the largest user of Boise River water, and can be divided into an upper and lower system. The upper system, 116,300 acres, includes the area served directly from

In order to conduct instream flow studies on the Lower Boise River, the U.S. Army Corps of Engineers made a series of controlled flow releases from Lucky Peak Dam as follows:

Flow	Time Flow Changed	Date
500 cfs	4:00 pm	Monday, Feb 10, 1975
400 cfs	4:00 pm	Wednesday, Feb 12, 1975
300 cfs	4:00 pm	Friday, February 14, 1975
250 cfs	4:00 pm	Sunday, Feb 16, 1975
150 cfs	4:00 pm	Tuesday, Feb 18, 1975
100 cfs	4:00 pm	Thursday, Feb 20, 1975
Return to Normal Operations	4:00 pm	Saturday, Feb 22, 1975

Individual transects have been coded for convenience with respect to its type (spawning or passage), location (river reach), and order of occurrence (numbered downstream). PT-LBR-1 refers to the farthest upstream (-1) passage transect (PT-) on the Lower Boise River (LBR-).

Transect	River Mile	Major Landmark
PT-LBR-1	53.9	Broadway Bridge (downstream) (RM 53.7)
ST-LBR-1	53.6	Broadway Bridge (upstream)
PT-LBR-2	53.6	Broadway Bridge (upstream)
PT-LBR-3	53.0	Capital Bridge (downstream) (RM 52.8)
ST-LBR-2	52.3	Americana Blvd. Bridge (upstream) (RM 52.0)
ST-LBR-3	52.2	Americana Blvd. Bridge (upstream)

Various side channels and slough areas were monitored for loss of depth and wetted bottom as these areas provided habitat which is typical for warm water fish. These slough areas were characterized by sand, mud, or gravel bottoms, adjacent brush on either or both banks, and generally slow velocities. Water depths in these various channels or sloughs are directly influenced by Boise River flows or indirectly by seepage.

Slough Locations:

Study Site	River Mile	Major Landmark
SL #1 (left bank)	39.2	North Channel, Linear Rd., 100 yds. upstream
SL #2 (right bank)	30.2	Lansing Lane, @ 1 mile upstream
SL #3 (right bank)	29.1	Lansing Lane, at road end
SL #4 (right bank)	14.3	0.5 mile upstream from Notus Gage
SL #5 (right bank)	14.0	0.2 mile upstream from Notus Gage

the Boise River, mostly by the Main (New York) and Ridenbaugh Canals. The lower system, 50,600 acres, includes the area that receives water after it has first been stored in Lake Lowell. The remainder of the canals on the Lower Boise River supply approximately 160,000 acres of land.

Releases from Lucky Peak Dam to the Boise River are regulated by the Corps of Engineers, Bureau of Reclamation, Boise Project Board of Control, and the Boise River Watermaster. At present, the Idaho Department of Fish and Game Department owns approximately 50,000 acre-feet of storage in Lucky Peak Reservoir which is used for releases during the winter months to maintain fish populations.

Waste loads that accumulate during these low flow periods, in addition to the large fluctuations in flows that occur on a predictable annual schedule, provide for a poor habitat and a limited carryover population of game fish.

Wildlife along the Lower Boise River originally was very abundant, but has decreased with the loss of natural cover caused by man's encroachment into the area. Deer are still found along the river in reduced numbers. Muskrat, mink, and a few beaver are found along the Lower Boise River, and are the mammals most affected by reduced flows in the river.

The habitat along the Boise River holds a diversity of birds, including song birds, raptors, upland game birds, waterfowl, and shore birds. Waterfowl and shore birds are most affected by reduced or excessive flows in the Boise River during nesting seasons. Low flows during the winter have an adverse affect on the river's waterfowl carrying capacity.

Game fish populations in the Boise River above Star include rainbow trout, brown trout, mountain whitefish, and Dolly Varden. Game fish species below Star include largemouth bass (Micropterus salmoides), smallmouth bass, and channel catfish (Ictalurus punctatus). Rainbow trout is the species of highest value to the sportsman above Star. Brown trout fry have been planted in the stream and natural reproduction has been documented (Will Reid, personal communications). Brown trout up to 2 pounds have been harvested in this river stretch. Mountain whitefish make up approximately 46% of the game fish population in the study area and are the second most sought after species. The river below Star is generally a low-quality fishery due to returned irrigation water, effluent from waste water treatment plants and food process plants, and an inconsistent flow regime.

The Boise River through Boise has a high recreational potential due to its proximity to 25% of the State's population.

The spawning flow recommendations are: rainbow trout, 255 cfs; brown trout, 225 cfs; and Dolly Varden, 150 cfs (Figures 23, 24, and 25). The majority of the stream bottom in the study reach consists of unsuitable spawning substrate, and large rocks 6 to 10 inches in diameter. Gravels suitable for spawning have been removed from the main river channel by high spring flows and deposited either in higher side channels or in downstream locations. Because of the dams constructed above the study area, the bedload, which would have replaced the removed gravel, is not available.

By observing the Boise River throughout the study area at high flows, it was found that a flow of 1,100 cfs or greater is needed to provide suitable water depths and velocities in the side channels where more suitable spawning gravel now exists. For incubation, a flow of 900 cfs is needed. The higher spawning flow recommendation is suggested as an optimum spawning flow and should be maintained as much as possible through the spawning and incubation periods.

The rearing flow recommendation is that flow which provides for the greatest wetted perimeter on riffles for the least amount of discharge. For the study reach, a rearing flow of 220 cfs is recommended (Figure 26).

Flows for angling were not considered for this study reach; however, the suggested discharge levels are probably adequate for angling.

No conclusive recommendations could be made from the data collected in the slough areas in the lower section of the river; therefore, it is recommended that the flow recommendations above Star be maintained to the mouth.

The recommended low flow regime in cfs, for the Boise River from Lucky Peak Dam to Snake River, based on species periodicity flows, is as follows:

Species/Life Stage	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout												
Spawning				225	225	225						
Incubation				151	151	151	151	151				
Brown Trout												
Spawning										225	225	
Incubation	151	151								151	151	151
Dolly Varden												
Spawning										150	150	
Incubation	100	100								100	100	100
Rearing - All Species	150	150	150	150	150	150	150	150	150	150	150	150
Recommended Flow Regime	150	150	150	225	225	225	150	150	150	225	225	150

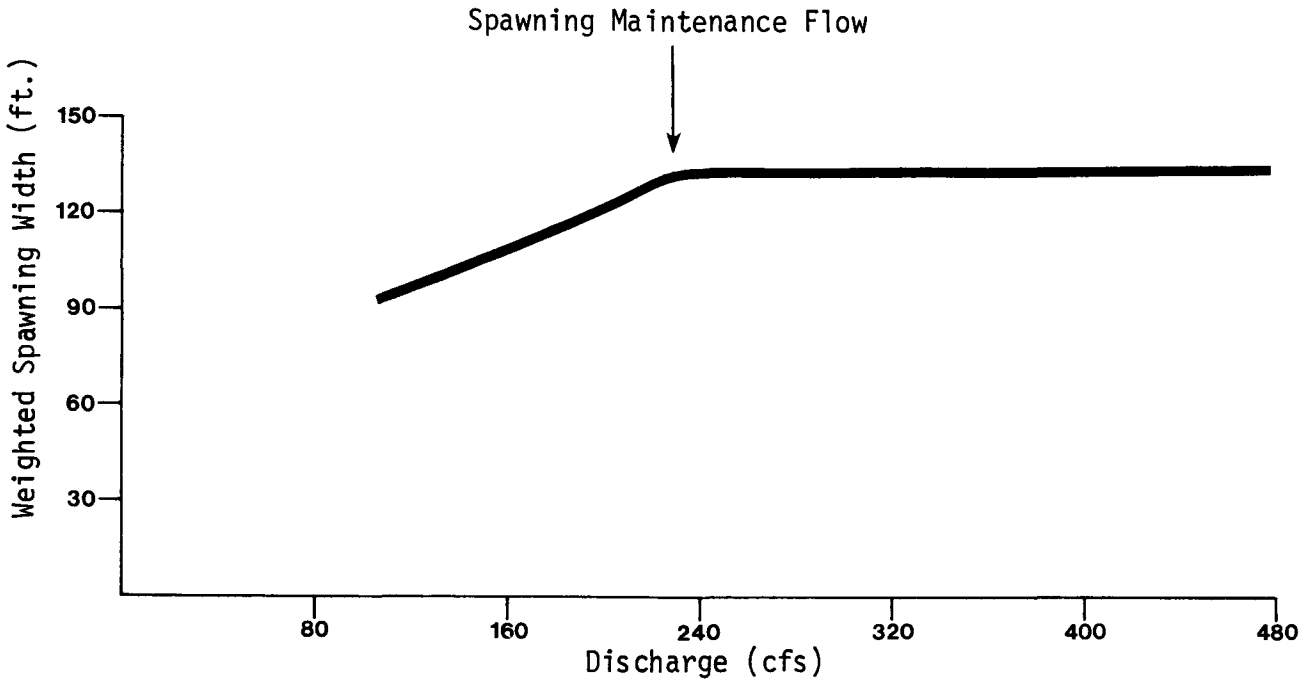


Figure 23. Rainbow trout spawning curve for Boise River below Lucky Peak Dam.

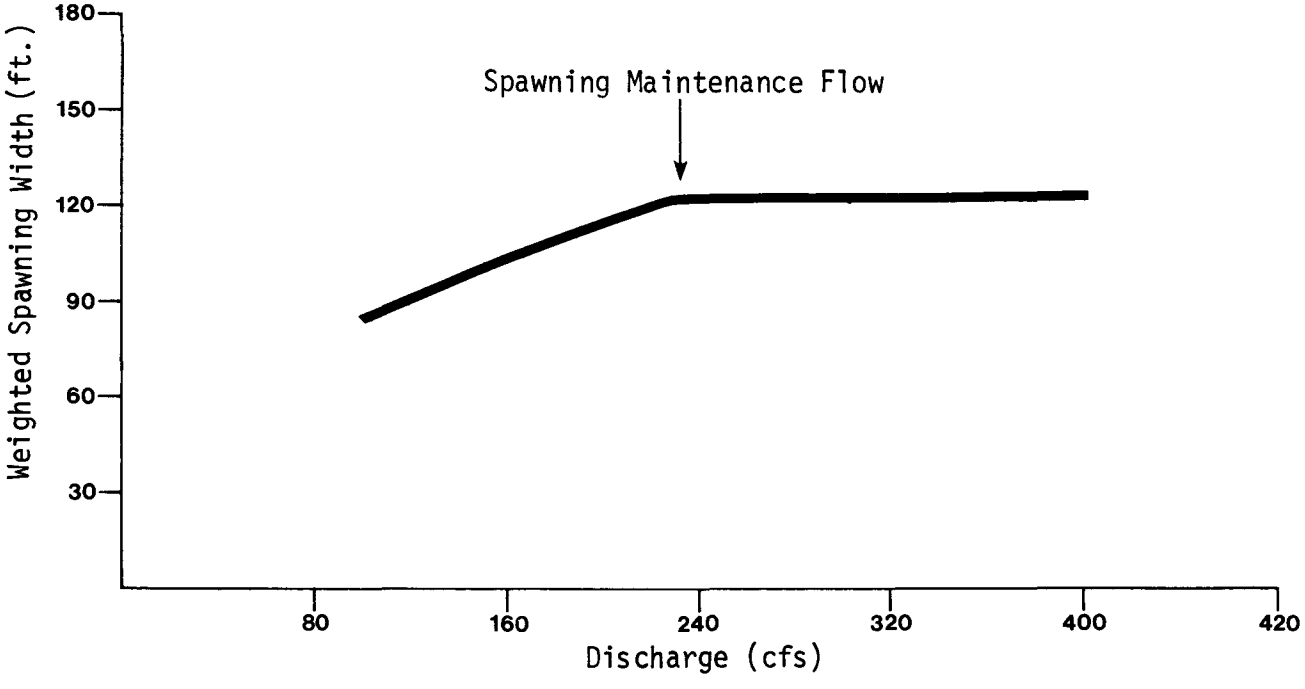


Figure 24. Brown trout spawning curve for Boise River below Lucky Peak Dam.

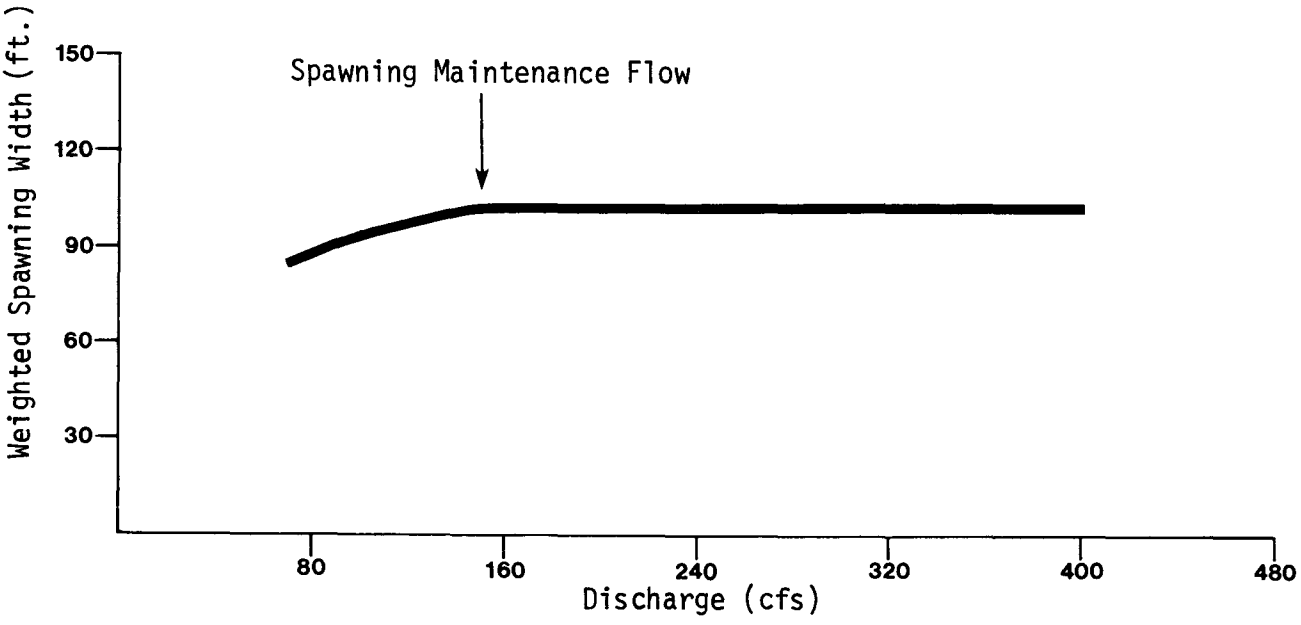


Figure 25. Dolly Varden spawning curve for Boise River below Lucky Peak Dam.

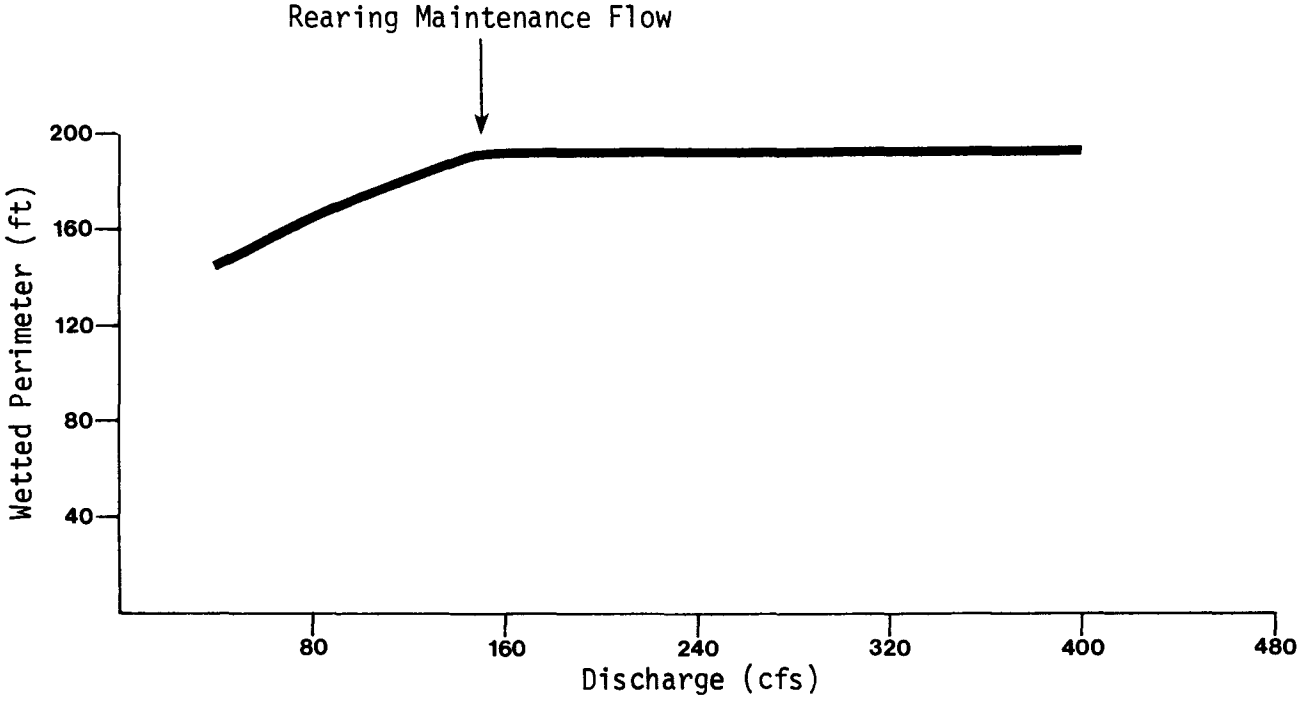


Figure 26. Wetted perimeter curve for Boise River below Lucky Peak Dam.

BLACKFOOT RIVER

The Blackfoot River is located in the highly productive southeastern Idaho area (Figure 27). From its sources in the Caribou Range, the river flows north and west to its confluence with the Snake River at river mile 751.2. The drainage is located approximately 30 air miles southeast of the city of Idaho Falls and 40 air miles northeast of Pocatello and drains almost 1,295 square miles. The major tributaries to the Blackfoot River are Lanes Creek, Diamond Creek, and Slug Creek above Blackfoot Dam; and Corral Creek, Brush Creek, and Wolverine Creek below the dam. Most of the water of Sand Creek, small drainage north of the Blackfoot River, is diverted into the Blackfoot River through the Idaho Canal at river mile 31.3.

Blackfoot Dam at river mile 78.0 is the major impoundment structure on the Blackfoot River. Built by Corps of Engineers in 1909 and operated by the Fort Hall Irrigation District, it is a 50-foot high rockfill structure with a concrete core. The reservoir has a usable storage capacity of 413,000 acre-feet between the elevations of 6,086 feet and 6,124 feet. Water in Blackfoot Reservoir is held in storage to be diverted for irrigation of about 50,000 acres near Pocatello and on the Fort Hall Indian Reservation. Inflows to Blackfoot Reservoir have been augmented by seasonal diversions from Grays Lake through Clark's Cut since 1924. Depending on the runoff situation, up to 20,000 acre-feet a year are obtained from this source for use on Fort Hall Indian Reservation lands with control in Blackfoot Reservoir.

Our study encompassed that part of the Blackfoot River below Blackfoot Dam at the mouth of Wolverine Creek, a section 38.3 miles long from river mile 39.7 to river mile 78.0.

The Blackfoot River drainage lies mainly in the Middle Rocky Mountain physiographic area. The rocks of this section are largely sedimentaries such as limestones, sandstones, shales, etc. The phosphoria formation is only a few hundred feet in thickness, but holds the rich phosphate deposits.

The stream elevation of the Blackfoot River at Blackfoot Dam is 6,100 feet. Through the 38.3 mile study area, the river drops 1,415 feet to an elevation of 4,685 feet at the mouth of Wolverine Creek. The average gradient through the area is 0.699% or 36.9 feet per mile. Draney Peak at 9.737 feet is the highest point in the Blackfoot drainage, which drops to 4,400 feet at the confluence with the Snake River. As the elevation drops from 9,000 feet, the vegetation changes from coniferous-aspen type to a drier sagebrush zone with a few straggling conifers. The area encompassing the Blackfoot Reservoir still shows some evidence of marsh vegetation, but the lower watershed elevations below the dam support semidesert vegetation where sagebrush, tall grasses, and

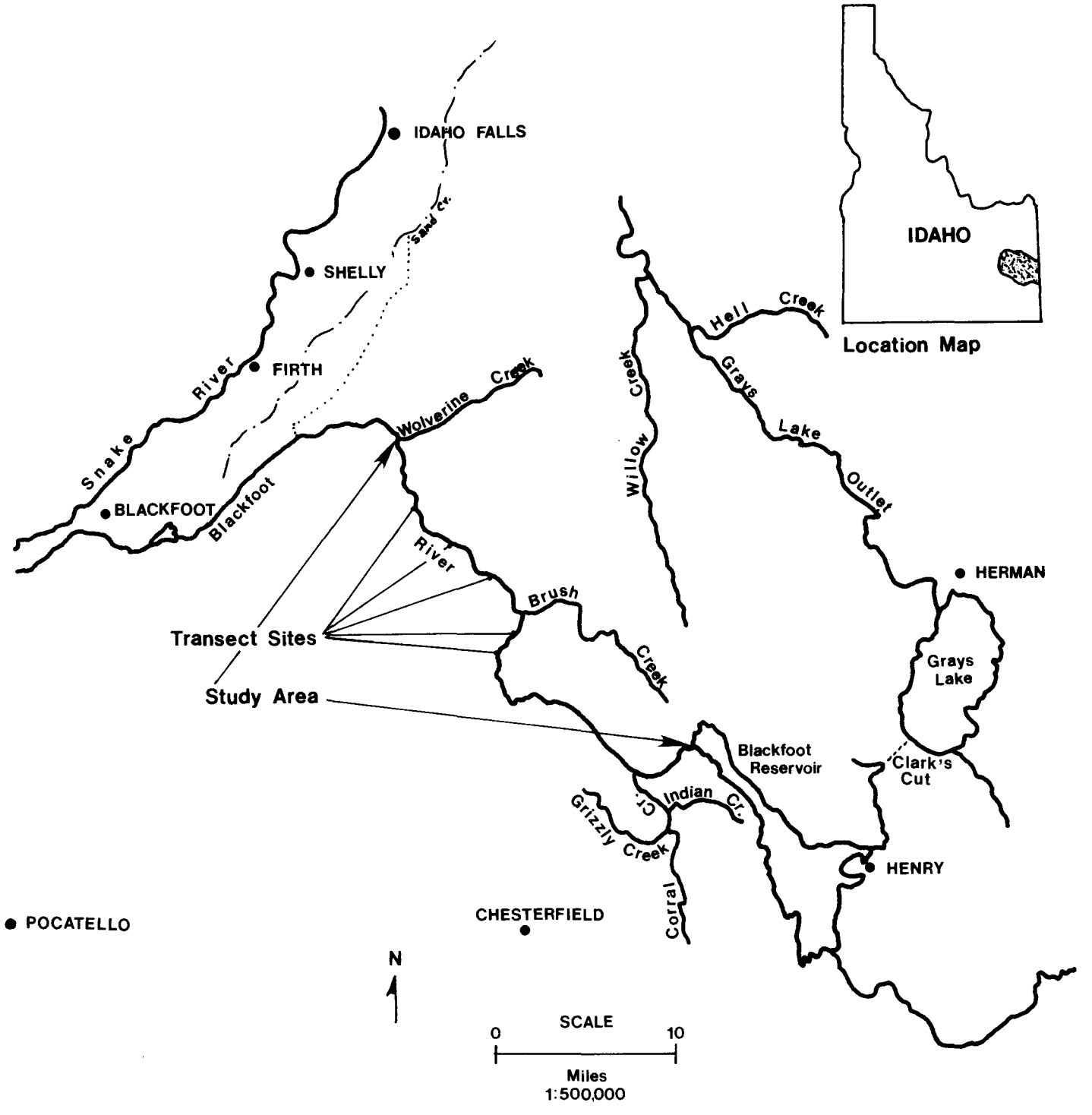


Figure 27. Study area on Blackfoot River below Blackfoot Reservoir.

forbs are the dominant plant species and where stream banks support a fringe of willows.

The average annual precipitation for the Blackfoot River Basin is 16 inches, but ranges up to 50 inches in the highest mountains of the drainage. The seasonal distribution of precipitation in the Basin is 1.3 to 1.7 inches per month from September through June, and 0.6 to 0.8 inches per month in July and August. The precipitation during the cooler months falls largely as snow at high elevations in the basin, leaving most of the runoff as snowmelt in the mountains.

The US Geological Survey has maintained stream discharge gages at the mouth of the Blackfoot River since July 1913. Prior to October 1931 they were maintained only during the summer months. The USGS also maintains a gage on the Blackfoot near Henry (above Blackfoot Reservoir) with records from April 1914 to September 1925, but without winter records except water year 1915. The gage was discontinued from 1925 to 1967, and records have been kept from 1967 to the current year.

Average annual discharge of the Blackfoot River below Blackfoot Reservoir at the 1961 level of development is 185 cfs or 135,000 acre-feet per year, and the average annual discharge where the Blackfoot enters the Snake is 176 cfs or 127,500 acre-feet per year (USGS, 1976). Discharge just below the reservoir reflects a large amount of regulation, irrigation and water imported from Willow Creek drainage. In addition, the runoff at the downstream location also reflects relatively large amounts of exchange irrigation water from the Snake River and large irrigation diversions from the Blackfoot River.

Maximum recorded Blackfoot River discharge, 1,710 cfs, occurred on February 11, 1962. Maximum recorded discharge for the Blackfoot River and Blackfoot River bypass was 1,840 cfs on May 12, 1972. Minimum discharge of record is 0.0 cfs on many days through the period of record.

The rainbow trout and cutthroat trout are the highest valued fish species on the Blackfoot River below Blackfoot Dam. Mountain whitefish and a small population of brook trout are also found in the Blackfoot River. Because of the high nutrient content, the Blackfoot River and the Blackfoot Reservoir are one of the most productive fisheries in Idaho. The fish in the Blackfoot drainage grow quite large for resident trout, and are characteristically deep bodied and range up to 20 inches in length.

The majority of rainbow trout spawning takes place from early May to early June. The cutthroat spawning occurs from late May to late June.

In order to conduct instream flow studies on the Blackfoot River below Blackfoot Reservoir, the Fort Hall Irrigation District made a series of controlled releases from Blackfoot Dam between October 28, 1973, and November 4, 1973. The change was made at 4:00 pm each day. However, neither Blackfoot Dam nor the river below it through the study area is gaged. Thus, the flows released were only approximately those requested. Each release was measured by the investigators at the bridge below the dam.

Flow Requested	Discharge Measured	Date
250 cfs	272	Monday, October 29, 1973
200 cfs	247	Tuesday, October 30, 1973
150 cfs	188	Wednesday, October 31, 1973
100 cfs	145	Thursday, November 1, 1973
75 cfs	115	Friday, November 2, 1973
50 cfs	76	Saturday, November 3, 1973
25 cfs	43	Sunday, November 4, 1973
Return to Normal Operation		

The spawning flow recommendations are: rainbow trout, 92 cfs; and cutthroat trout, 87 cfs (Figures 28 and 29). The recommended incubation flows are 66% of the recommended spawning flows.

The recommended rearing flow, 140 cfs, is based on the greatest amount of wetted perimeter for the least discharge (Figure 30).

Flows for angling were not considered in the recommendations but in most cases, the suggested flows for fish life history periods are probably adequate for that angling.

The recommended low flow regime in cfs, based on fish periodicity charts from Blackfoot Reservoir to Wolverine Creek, is as follows:

Species/Life Stage	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout												
Spawning				92	92	92						
Incubation				62	62	62	62	62				
Cutthroat Trout												
Spawning				87	87							
Incubation				58	58	58	58					
Rearing - All Species	140	140	140	140	140	140	140	140	140	140	140	140
Recommended Flow Regime	140	140	140	140	140	140	140	140	140	140	140	140

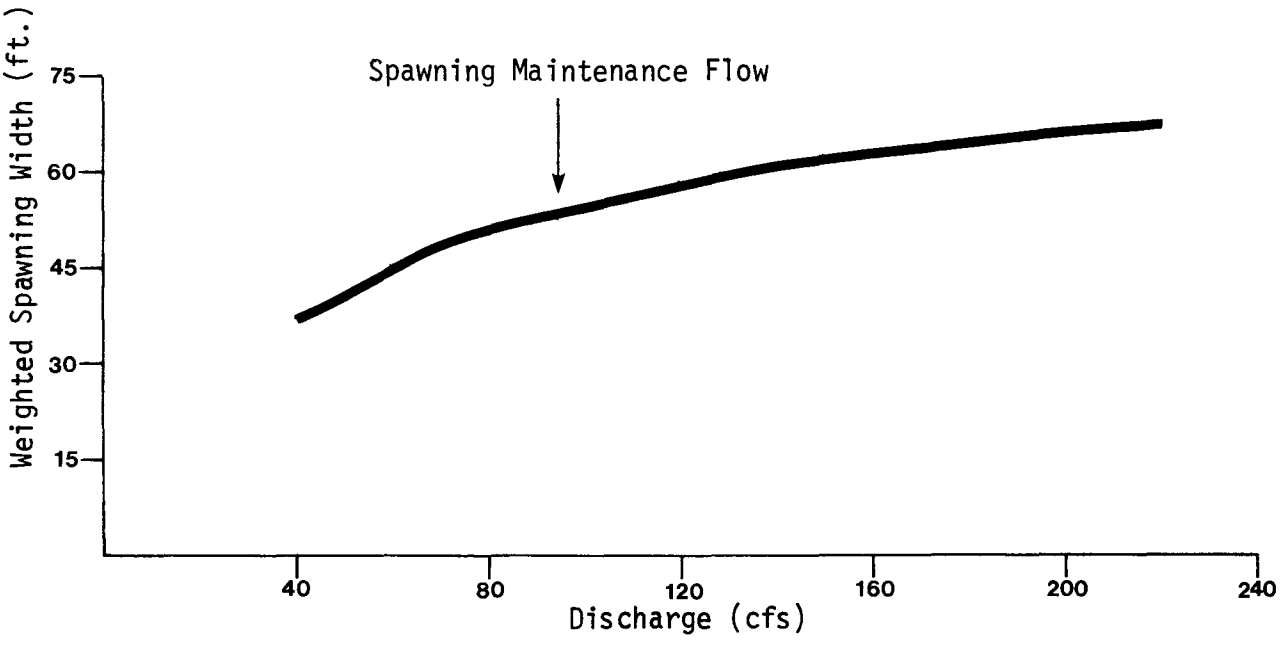


Figure 28. Rainbow trout spawning curve for Blackfoot River below Blackfoot Reservoir.

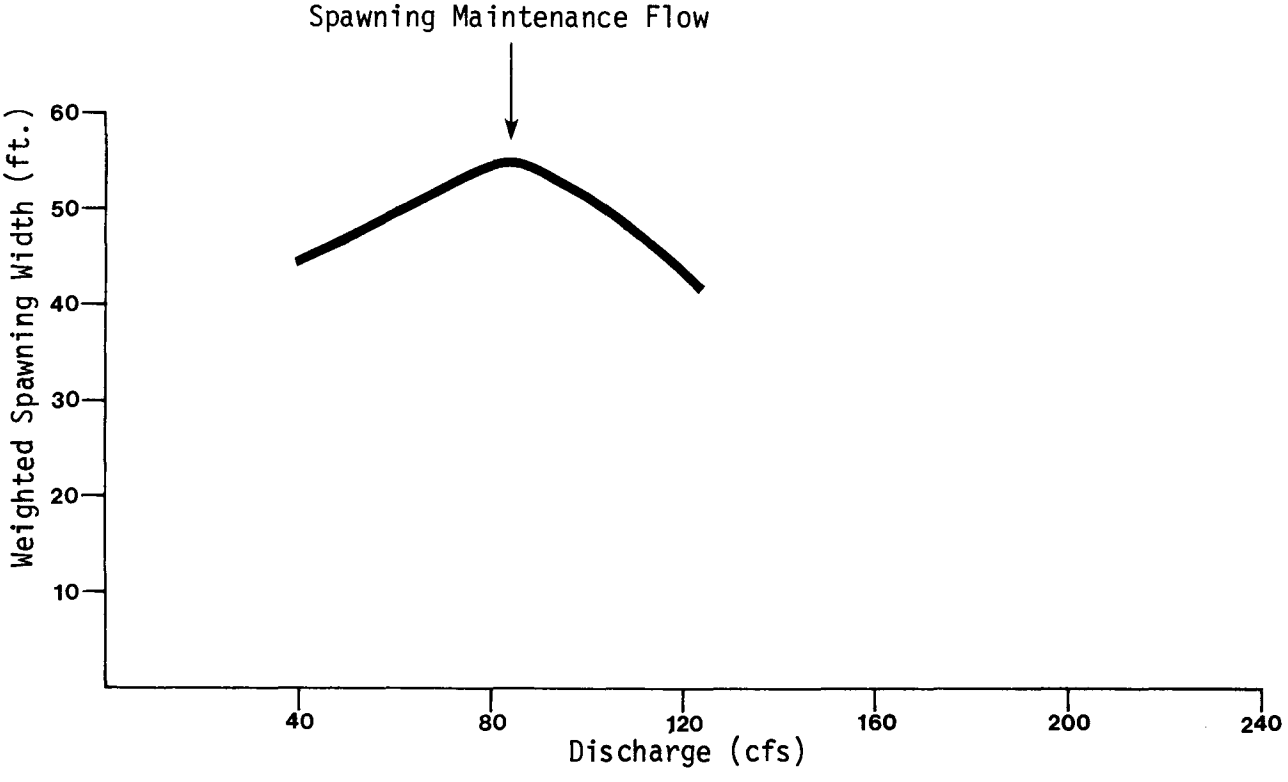


Figure 29. Cutthroat trout spawning curve for Blackfoot River below Blackfoot Reservoir.

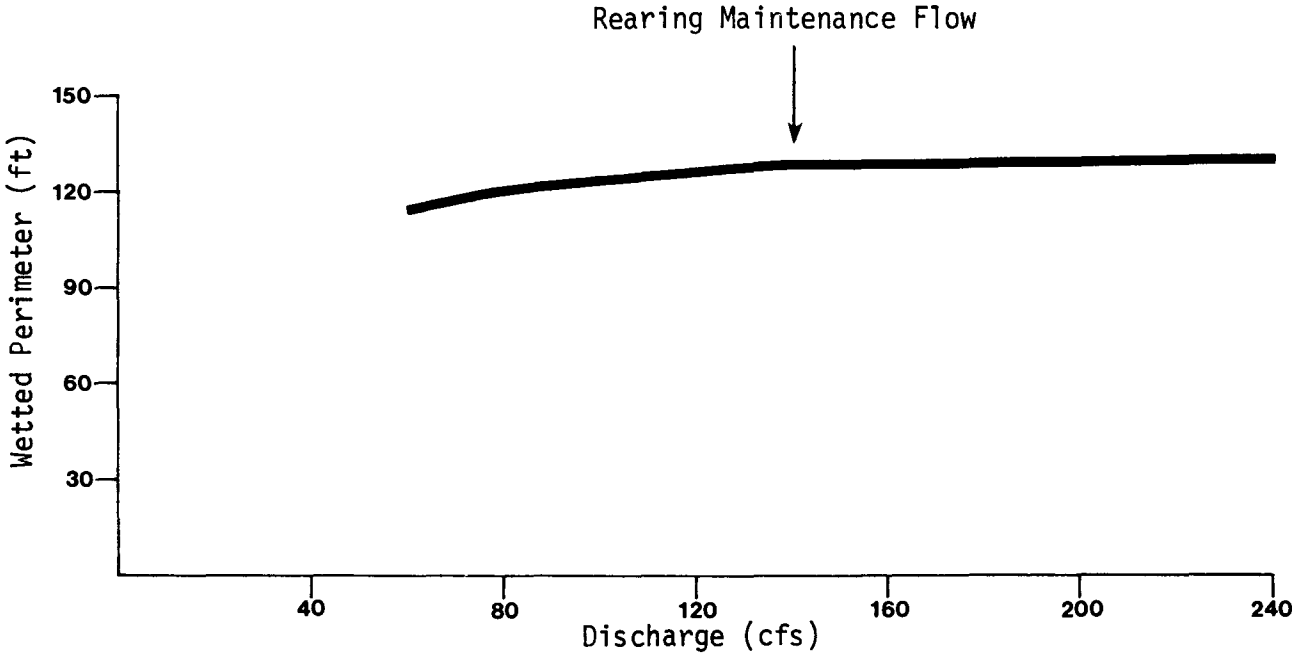


Figure 30. Wetted perimeter curve for Blackfoot River below Blackfoot Reservoir.

WILLOW CREEK

The Willow Creek drainage is located in eastern Idaho north of the Blackfoot River drainage and east of the city of Idaho Falls (Figure 31). From its sources in the Blackfoot Mountains, it flows north and then west to its confluence with the Snake River at river mile 800.4. Approximately 627 square miles are drained by Willow Creek above the study area. Major tributaries to Willow Creek are Grays Lake Outlet, Cranes Creek, Meadow Creek, and Tex Creek. Since 1924 up to 20,000 acre-feet of water a year have been diverted from the Willow Creek drainage to Blackfoot Reservoir through Clark's Cut.

The construction of Ririe Dam, a rock-face, earth filled structure, was completed by the Corps of Engineers in 1976. The dam, located at river mile 20.5, has a total capacity of 100,000 acre-feet between the elevations of 4,997 feet and 5,118.7 feet. Water is diverted for irrigation of about 7,300 acres upstream from Ririe Reservoir but as yet 90,000 acre-feet of the storage in Ririe Reservoir is unobligated (Nelson et. al., 1977). The study area was located approximately 1 mile downstream from Ririe Dam.

The stream elevation of Willow Creek below Ririe Dam is approximately 5,010 feet. From Ririe Dam to its confluence with Snake River, Willow Creek drops 320 feet to an elevation of 4,690 feet. The average gradient through the reach is 0.295% or 15.6 feet per mile.

Mean annual discharge of Willow Creek below Ririe Dam is 188 cfs or 136,200 acre-feet per year. Maximum discharge observed in Willow Creek was 4,200 cfs on May 15, 1917, while the minimum flow of record was 0.27 cfs on January 6-15, 1976, after the construction of Ririe Dam (USGS, 1976).

The US Geological Survey has maintained a stream discharge gage station on Willow Creek about a mile upstream from the mouth of the canyon intermittently since 1903 and constantly since October 1962.

Fish species of consideration in Willow Creek include rainbow trout, cutthroat trout, brook trout, and brown trout. Rainbow and cutthroat trout are spring spawners, while brown and brook trout spawn in the fall.

In order to conduct instream flow studies on Willow Creek, the Corps of Engineers made a series of controlled releases from Ririe Dam. The flows released from the dam were approximately those requested.

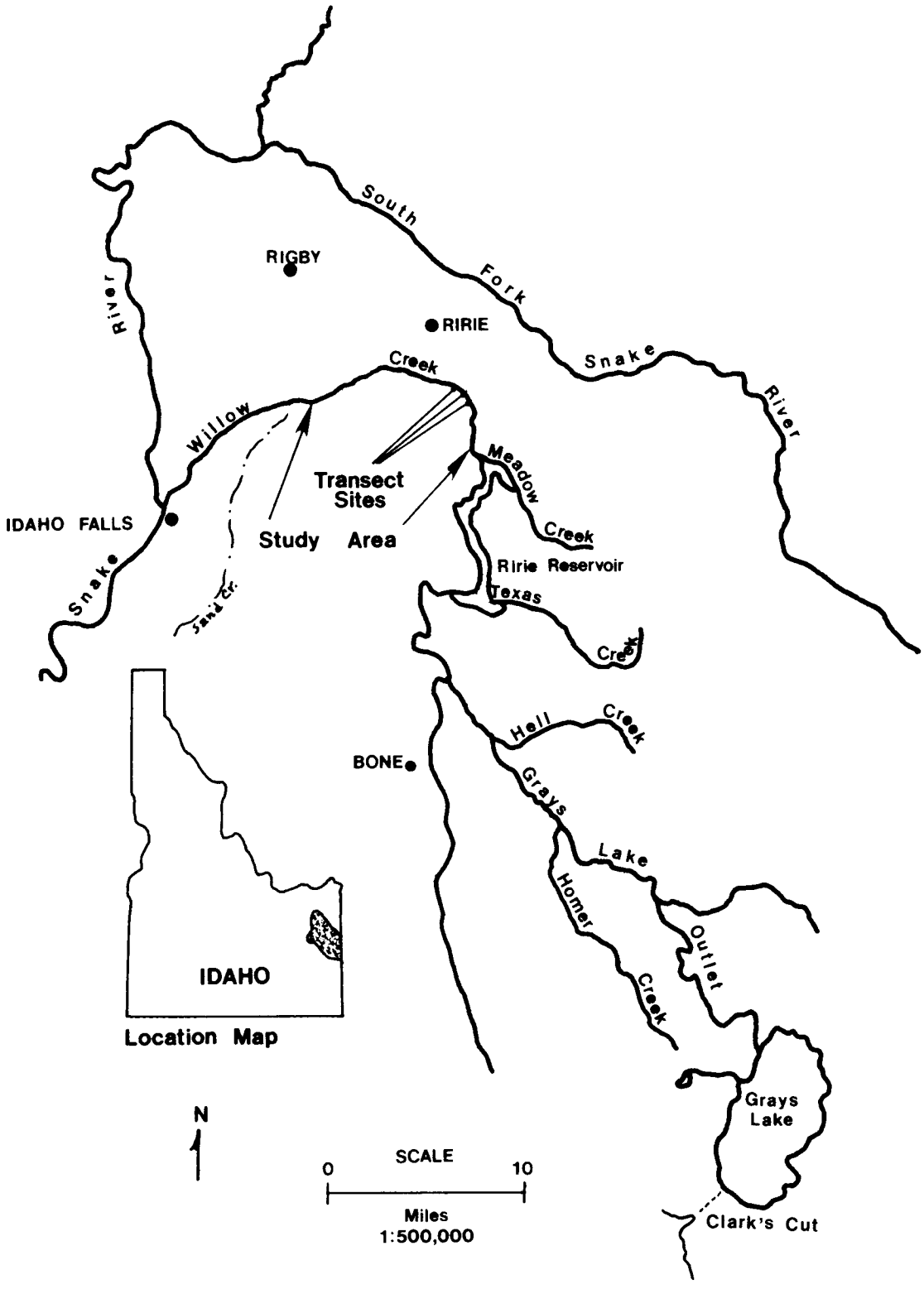


Figure 31. Study area on Willow Creek below Ririe Dam.

Flow (cfs)	Date
10	April 7, 1976
20	April 8, 1976
30	April 9, 1976
50	April 10, 1976
70	April 11, 1976
90	April 12, 1976

The spawning flow recommendations are: rainbow trout, 40 cfs; cutthroat trout, 25 cfs; brown trout, 40 cfs; and brook trout, 23 cfs (Figures 32, 33, 34, and 35).

The recommended rearing flow of 25 cfs is based on the greatest amount of wetted perimeter for the least flow (Figure 36).

Flows for angling were not considered in the study, but in most cases the suggested levels are probably adequate for that purpose.

The recommended low flow regime in cfs, based on fish periodicity charts, in Willow Creek from Ririe Dam to Snake River, is as follows:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rainbow Trout												
Spawning				40	40	40	40					
Incubation				27	27	27	27	27				
Cutthroat Trout												
Spawning					25	25	25					
Incubation					17	17	17	17				
Brown Trout												
Spawning										40	40	40
Incubation	27	27	27	27						27	27	27
Brook Trout												
Spawning										23	23	23
Incubation	15	15	15	15						15	15	15
Rearing - All Species	25	25	25	25	25	25	25	25	25	25	25	25
Recommended Flow Regime	25	25	27	40	40	40	40	27	25	40	40	40

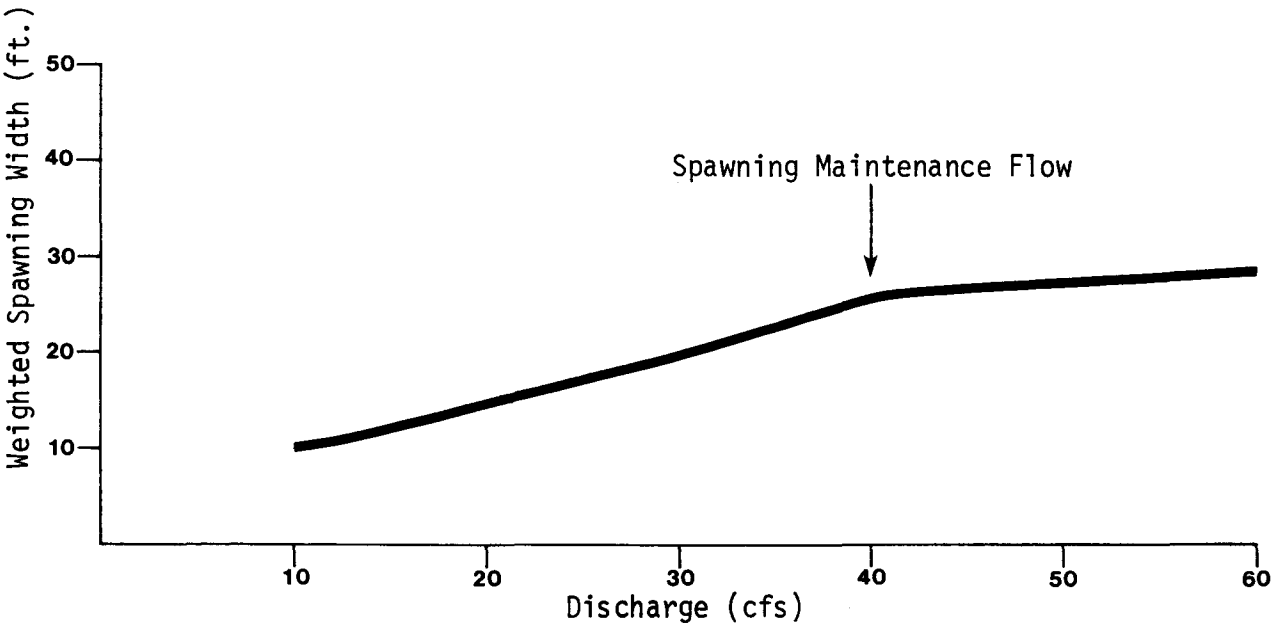


Figure 32. Rainbow trout spawning curve for Willow Creek below Ririe Dam.

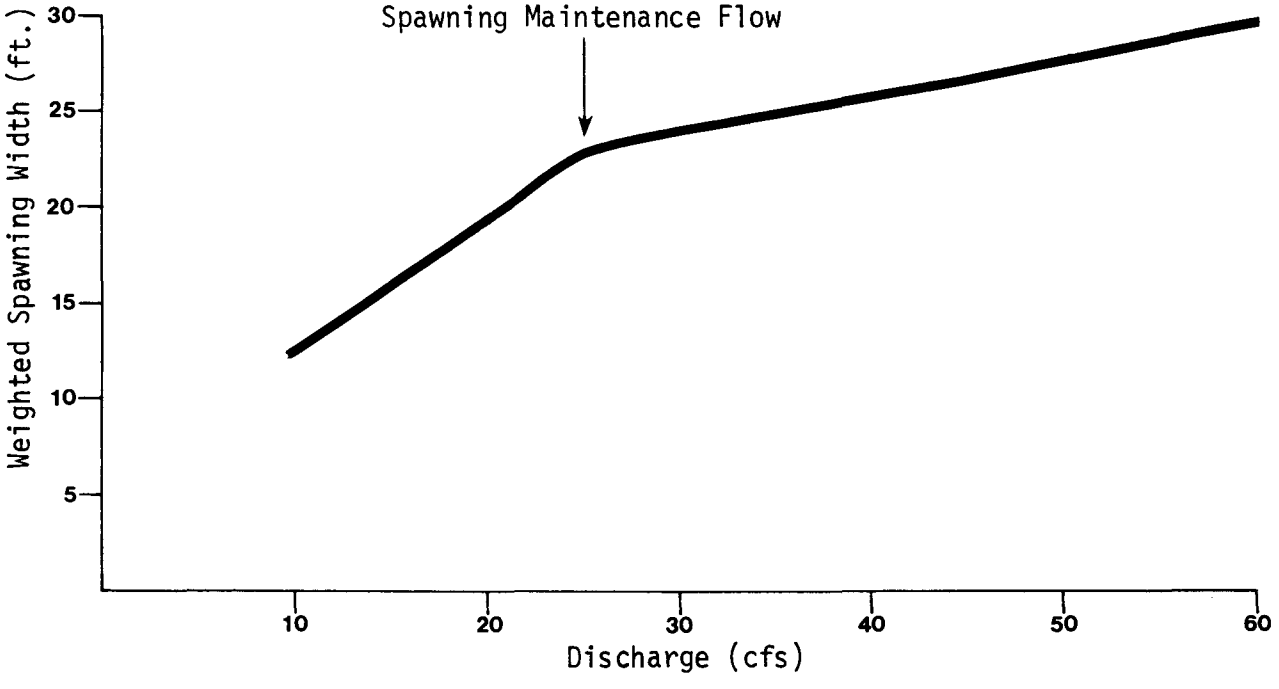


Figure 33. Cutthroat trout spawning curve for Willow Creek below Ririe Dam.

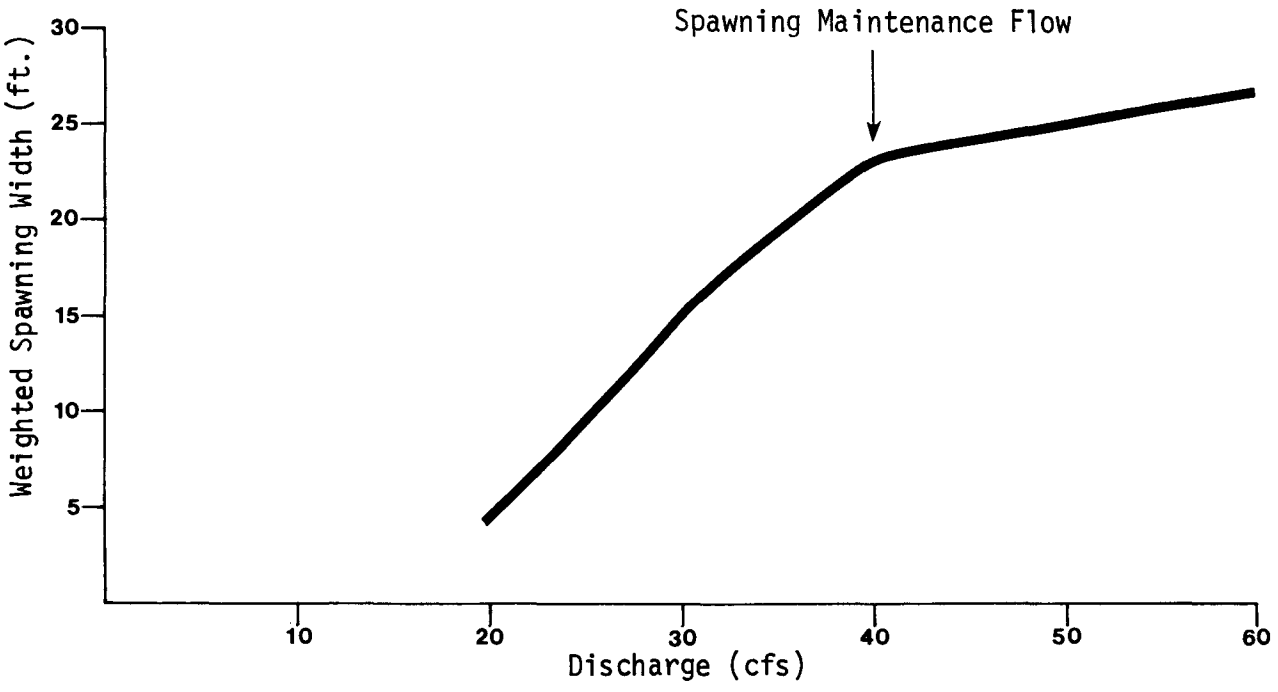


Figure 34. Brown trout spawning curve for Willow Creek below Ririe Dam.

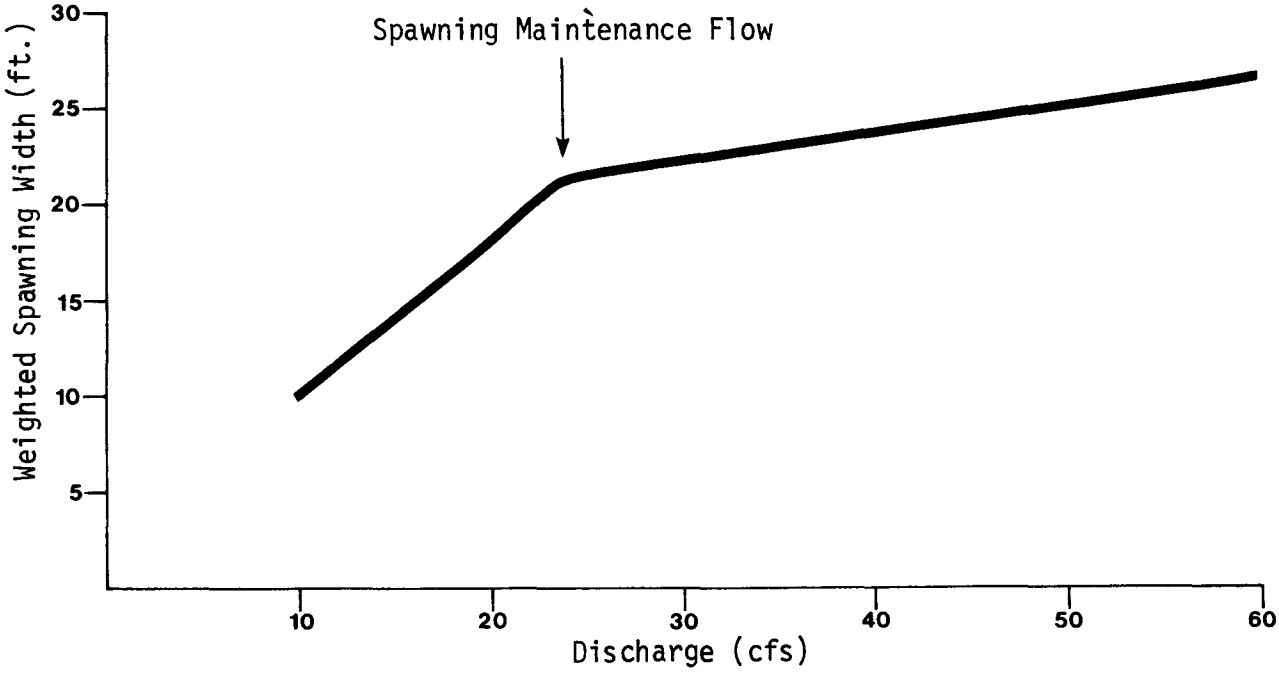


Figure 35. Brook trout spawning curve for Willow Creek below Ririe Dam.

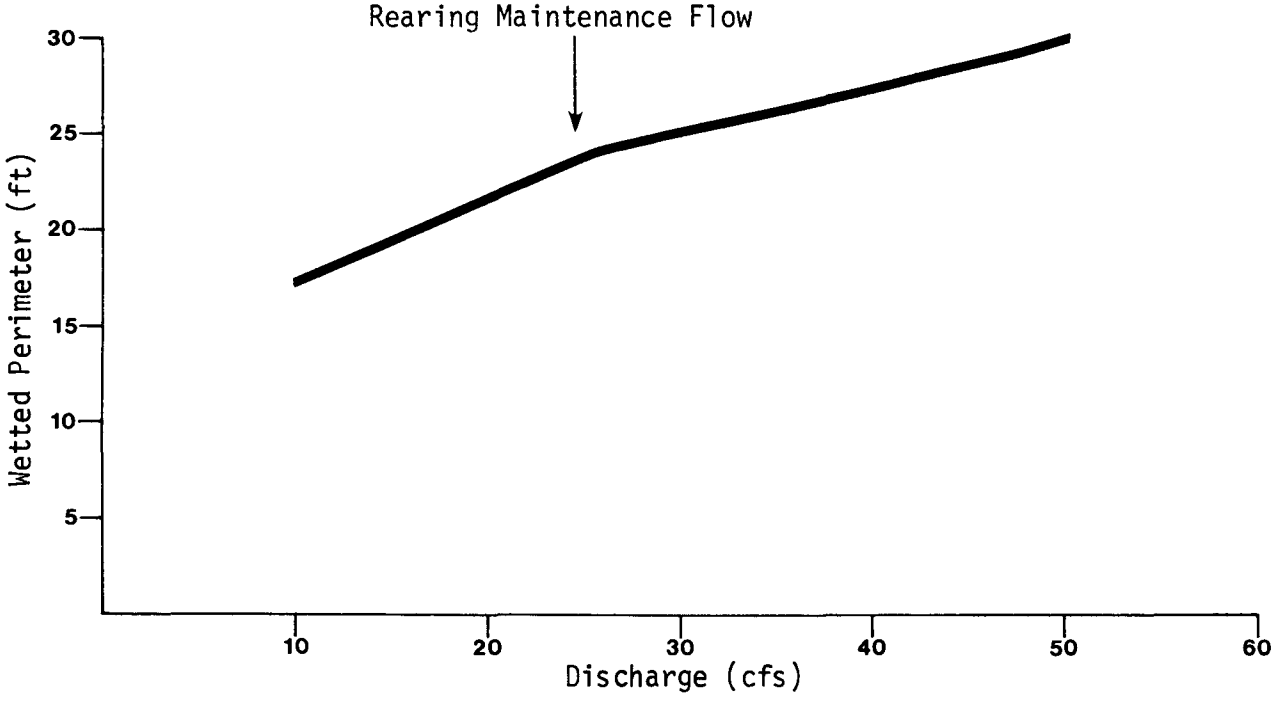


Figure 36. Wetted perimeter curve for Willow Creek below Ririe Dam.

SUMMARY

Stream resource maintenance flow recommendations in cfs for seven stream reaches in southern Idaho were determined, based on field studies performed by personnel of U.S. Fish and Wildlife Service during the period 1972-1974. These recommendations are summarized in Table 2.

Table 2. Recommended stream resource maintenance flows (cfs) for seven study stream reaches.

Study Reach	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Little Weiser River Gray's Creek to Mouth	70	70	70	70	70	70	70	70	70	70	70	70
Deadwood River Deadwood Dam to Mouth	125	125	125	125	125	125	125	125	125	125	125	125
North Fork Payette River Payette Lake to Cascade Reservoir	140	140	140	140	140	140	140	140	140	140	140	140
South Fork Boise River Anderson Ranch Dam to Arrowrock Reservoir	200	200	200	280	280	200	200	200	200	200	200	200
Boise River Lucky Peak Dam to Mouth	150	150	150	225	225	225	150	150	150	225	225	150
Blackfoot River Blackfoot Dam to Mouth	140	140	140	140	140	140	140	140	140	140	140	140
Willow Creek Ririe Dam to Mouth	25	25	27	40	40	40	40	27	25	40	40	40

REFERENCES

Beach, Donald R. 1974. Lake and Reservoir Investigations: Survey of Fish Harvest in South Fork Boise River from Anderson Ranch Dam to Arrowrock Reservoir. Project F-53-R-10, Job IIIe. Idaho Fish and Game Department.

Beach, Donald R. 1975. Lake and Reservoir Investigations: Survey of Fish Populations in South Fork Boise River from Anderson Ranch Dam to Arrowrock Reservoir. Project F-53-R-10. Job IIIf. Idaho Fish and Game Department.

Bovee, Ken D. and Tim Cochnauer. 1977. Development and Evaluation of Weighted Criteria, Probability-of-Use Curves for Instream Flow Assessments: Fisheries. Instream Flow Information Paper No. 3. Cooperative Instream Flow Service Group, Fort Collins, CO. December 1977. 39 pages.

Bovee, Ken D. 1978. Probability-of-Use Criteria for the Family Salmonidae. Instream Flow Information Paper No. 4. Cooperative Instream Flow Service Group, Fort Collins, Colorado, January 1978. 88 pages.

Cochnauer, Tim. 1977. Streamflow Investigations--Stream Resource Maintenance Flow Determination on Idaho Stream Job Performance Report F-66-R-2. Job No. II. Idaho Dept. of Fish and Game, Boise, Idaho. 85 pp.

Collings, M. R. 1974. Generalization of Spawning and Rearing Discharges for Several Pacific Spawning Species in Western Washington, USGS, open file report. 39 pages.

Nelson, Wayne, Gerald Horak, and Martin Lewis. 1977. Unobligated and Unutilized Reservoir Storage at Federally Controlled Dams. FWS/OBS-77/49, US Fish and Wildlife Service. 52 pages.

Mate, Steve. Personal Communications. Idaho Fish and Game Department.

Reid, Will. Personal Communications. Idaho Department of Fish and Game.

Thompson, Ken. 1972. Determining stream flows for fish life. In: Proceedings, Instream Flow Requirements Workshop, Portland, Oregon, Pacific Northwest River Basin Commission, Vancouver, Washington, page 3150.

USGS. 1952. Water Resources Data for Idaho, Part 1 Surface Water Records.

USGS. 1960. Water Resoruces Data for Idaho, Part 1 Surface Water Records.

USGS. 1969. Discharge measurements at gaging stations. Book 3, Chapter A8, of Techniques of Water Resource Investigations of US Geological Survey. Gov't Printing Office. 65 pages.

USGS. 1976. Water Resources Data for Idaho, Part 1 Surface Water Records.

APPENDIX

PROBABILITY-OF-USE CURVES

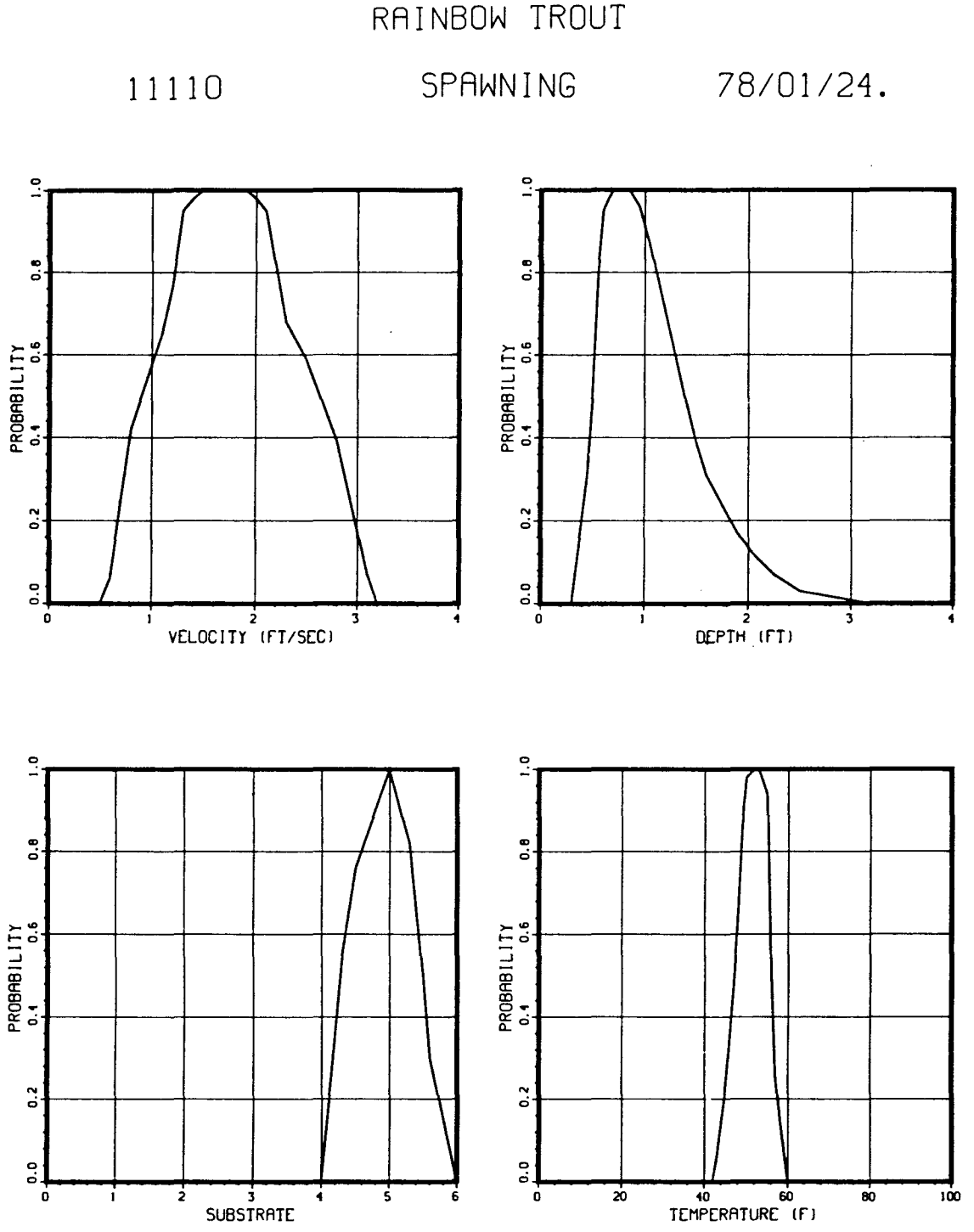


Figure A-1. Rainbow trout spawning probability curves (from Bovee 1978).

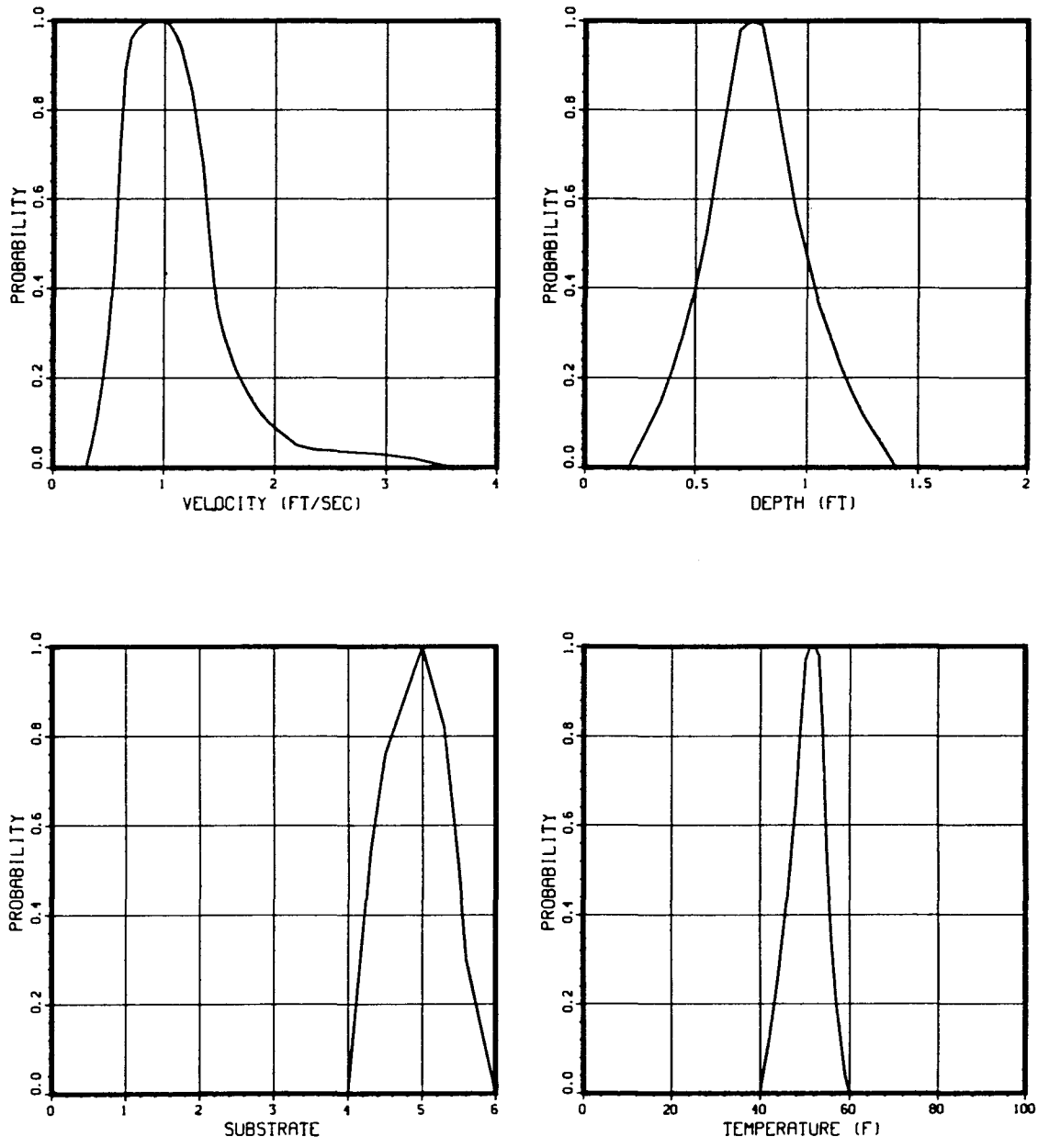


Figure A-2. Cutthroat trout spawning probability curves (from Bovee 1978).

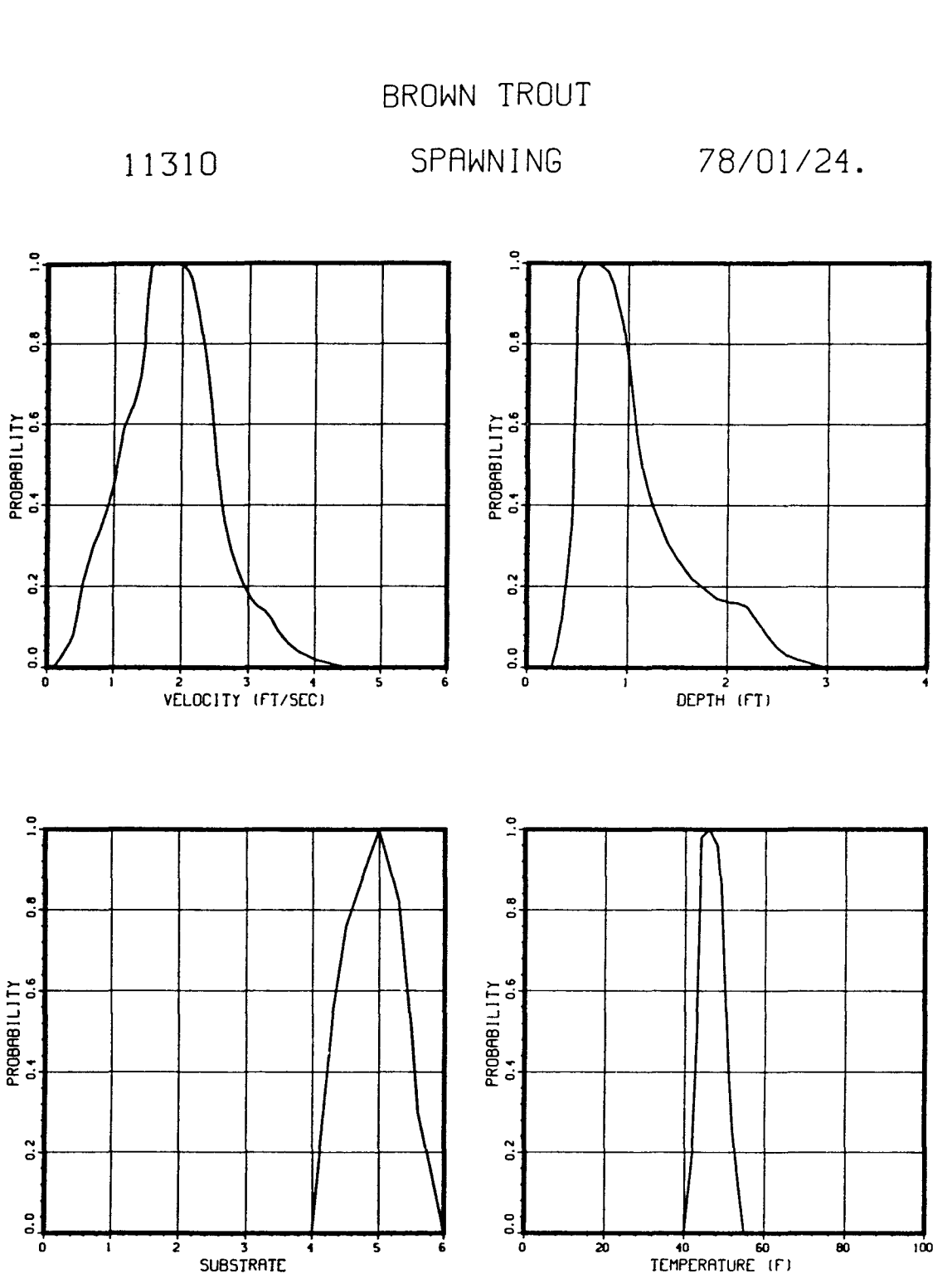


Figure A-3. Brown trout spawning probability curves (from Bovee 1978).

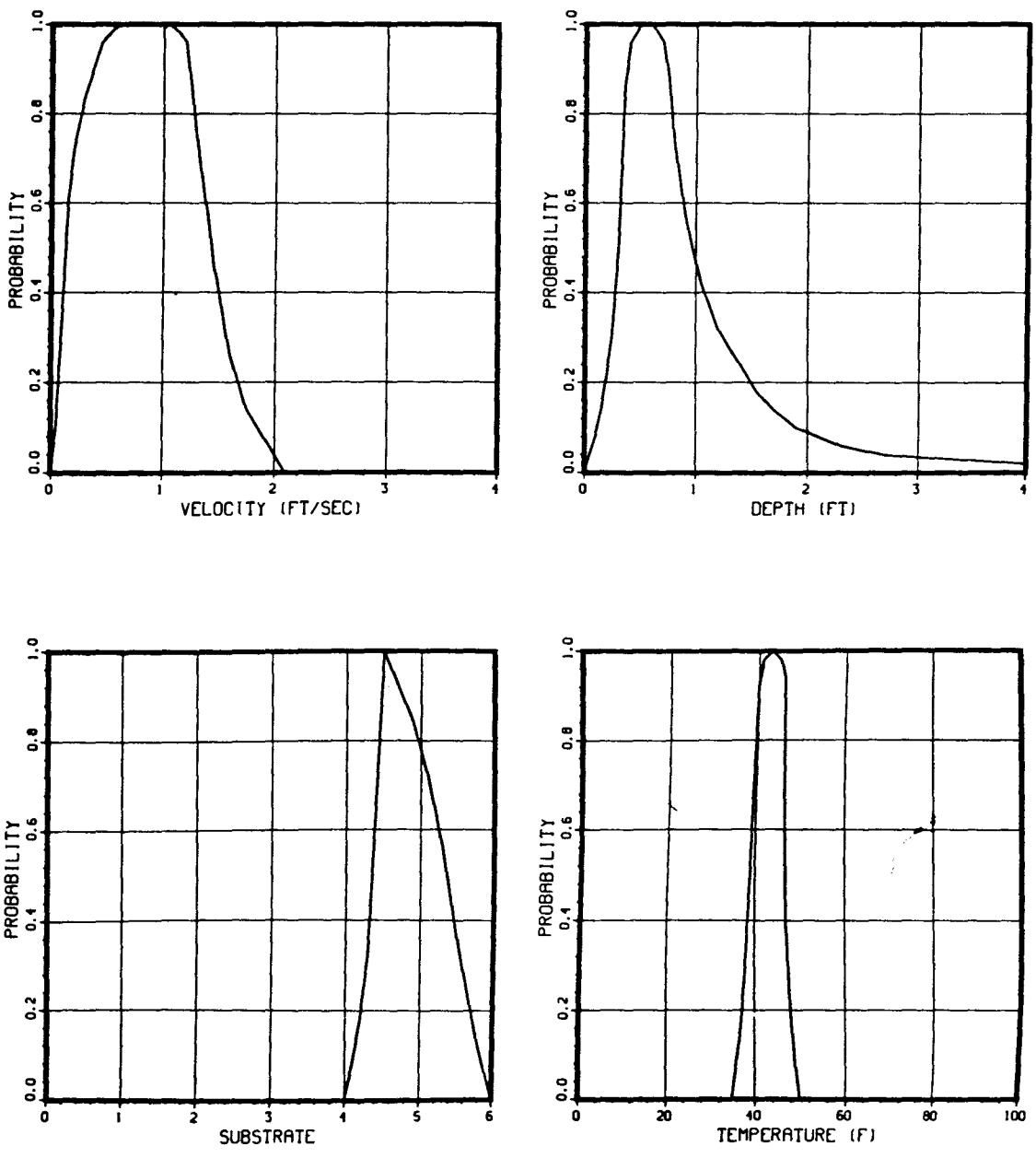
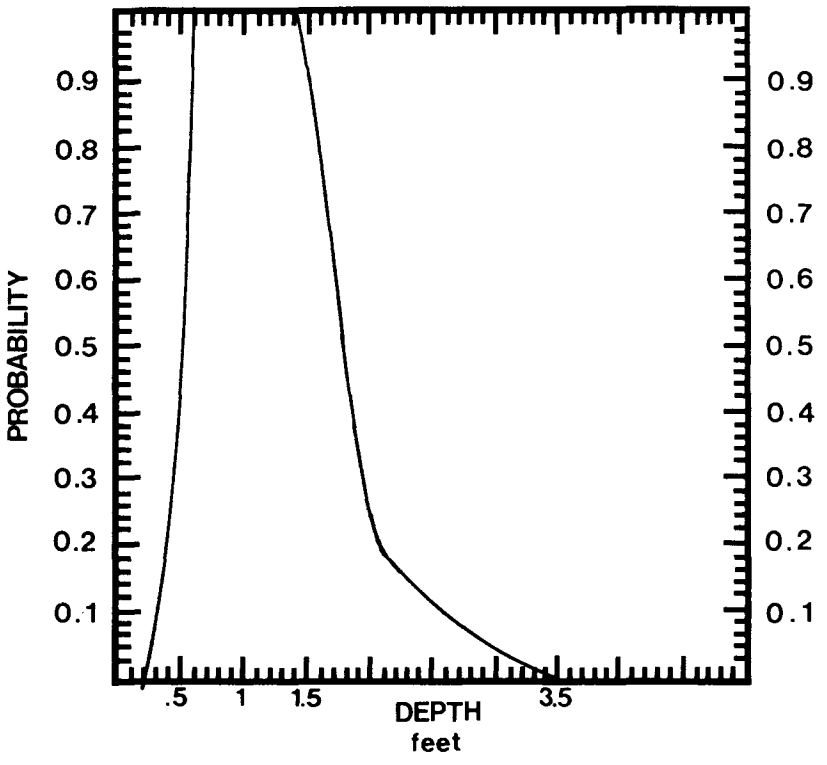


Figure A-4. Brook trout spawning probability curves (from Bovee 1978).



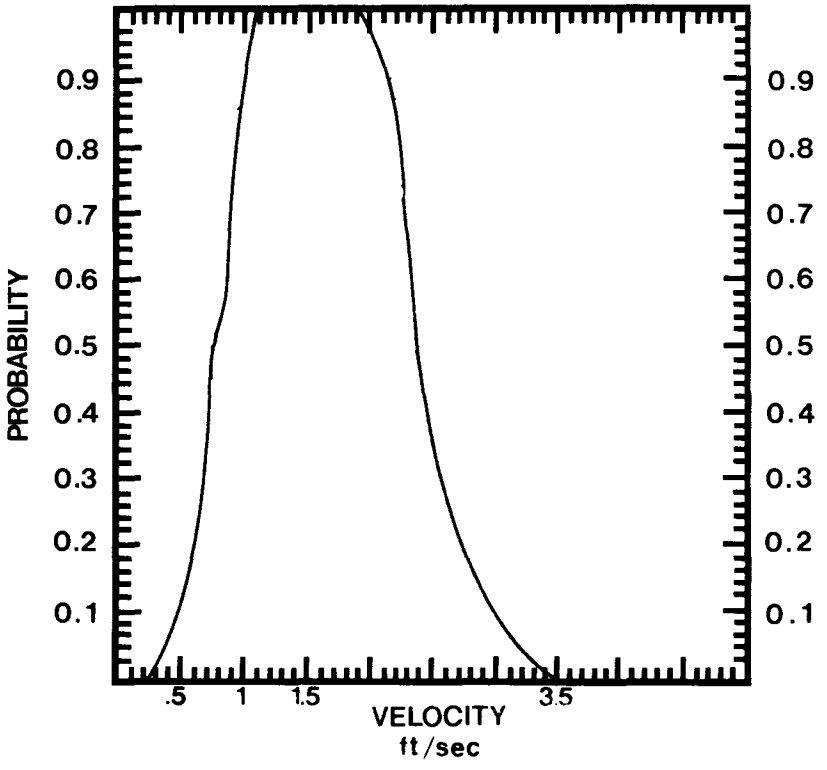


Figure A-5. Dolly Varden spawning probability curves.(From unpublished data provided to Cooperative Instream Flow Service Group by Tim Cochnauer, Idaho Fish and Game Department, Jerome, Idaho.

KOKANEE SALMON

10210 SPAWNING 78/01/24.

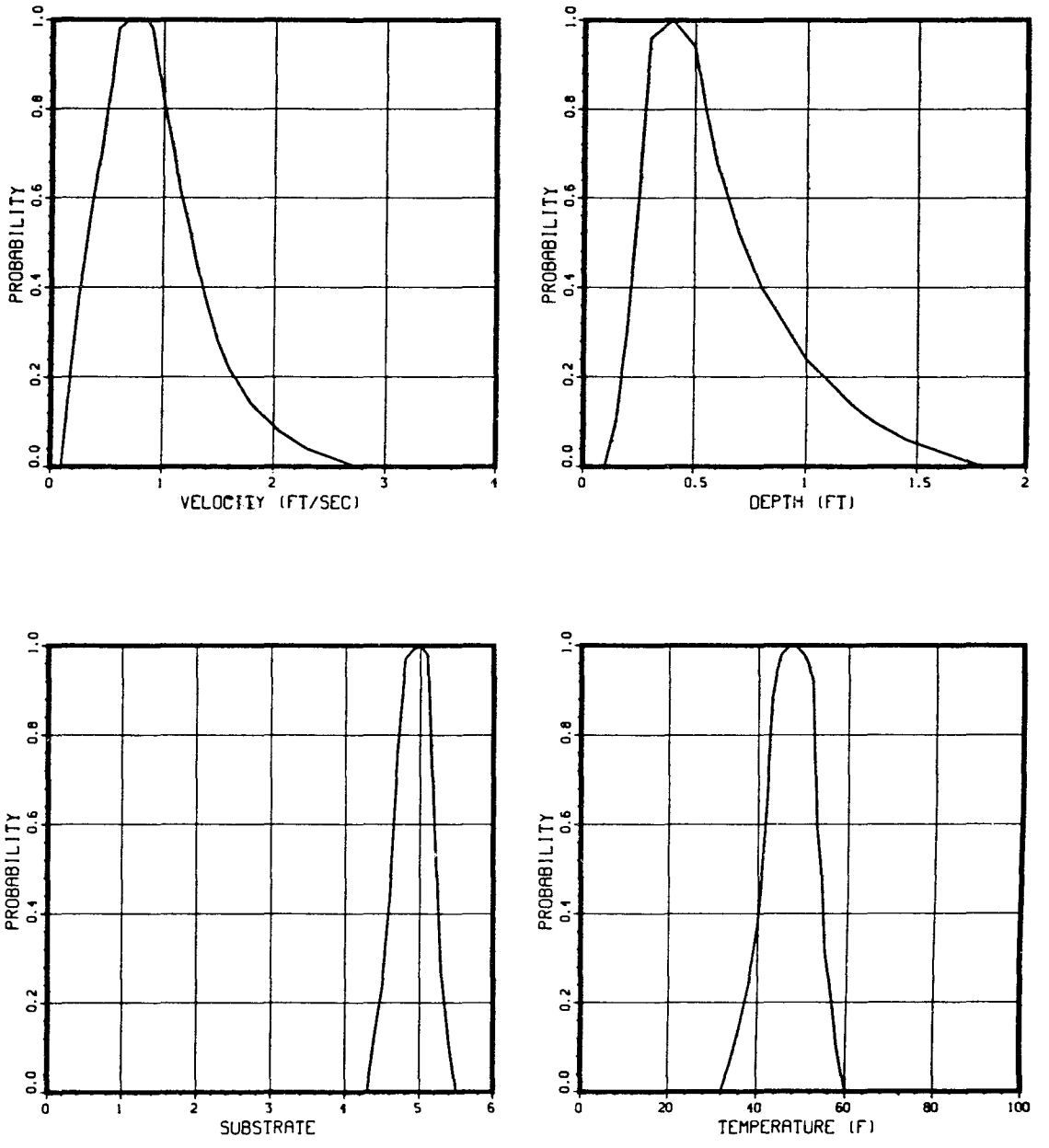


Figure A-6. Kokanee salmon spawning probability curves (From Bovee 1978).

INSTREAM FLOW INFORMATION PAPERS ISSUED

1. Lamb, Berton Lee, Editor. Guidelines for Preparing Expert Testimony in Water Management Decisions Related to Instream Flow Issues. Fort Collins, Colorado, Cooperative Instream Flow Service Group, July 1977, 30 pages. FWS/OBS-77/19. (NTIS Accession Number: PB 268 597; Library of Congress Catalog Card No. 77-83281).

2. Lamb, Berton Lee, Editor. Protecting Instream Flows Under Western Water Law: Selected Papers. Fort Collins, Colorado, Cooperative Instream Flow Service Group, September 1977, 60 pages. FWS/OBS-77/47. (NTIS Accession Number: PB 272 993; Library of Congress Catalog Card No. 77-15286).

3. Bovee, Ken D., and Cochnauer, Tim. Development and Evaluation of Weighted Criteria , Probability-of-Use Curves for Instream Flow Assessments; Fisheries. Fort Collins, Colorado, Cooperative Instream Flow Service Group, December 1977, 49 pages. FWS/OBS-77/63 (NTIS Accession Number: PB ;

4. Bovee, Ken D. Probability-of-Use Criteria for the Family Salmonidae. Fort Collins, Colorado, Cooperative Instream Flow Service Group, January 1978, 88 pages. FWS/OBS-78/07. (NTIS Accession Number: PB

5. Bovee, Ken D. and Milhous, Robert T. Hydraulic Simulation in Instream Flow Studies: Theory and Techniques. Fort Collins, Colorado, Cooperative Instream Flow Service Group, May 1978, pages. FWS/OBS-78/33. (NTIS Accession Number: PB ; Library of Congress Catalog Card No. 78-600110).

6. Hyra, Ronald. Methods of Assessing Instream Flows for Recreation. Fort Collins, Colorado, Cooperative Instream Flow Service Group, May 1978, 49 pages. FWS/OBS-78/34. (NTIS Accession Number: PB ; Library of Congress Catalog Card No. 78-600071).

7. Bayha, Keith. Instream Flow Methodologies for Regional/National Assessments: A State-of-the-Art Review. Fort Collins, Colorado, Cooperative Instream Flow Service Group, July 1978, pages. FWS/OBS-78/61. (NTIS Accession Number: PB ; Library of Congress Catalog Card No. -).

8. Pruitt, Thomas A. and Richard L. Nadeau. Recommended Stream Resource Maintenance Flows on Seven Idaho Streams. Fort Collins, Colorado, Cooperative Instream Flow Service Group, July 1978 pages. FWS/OBS-78/68. (NTIS Accession Number: PB Library of Congress Catalog Card No. -).

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16. Abstract (Limit: 200 words)

This paper documents the results of instream flow investigations conducted on seven south Idaho streams by the Boise Ecological Service Field Office durring 1972-1975. The results were reanalyzed by the Cooperative Instream Flow Service Group using the concept of probability-of-use curves which are based on weighted criteria for depth and velocity. Recommended stream resource maintenance flows are presented.

17. Document Analysis a. Descriptors
Stream resource maintenance flow recommendations
Instream flow studies
Hydrologic units 170402 and 170501
Probability -of-use curves (Mt. Whitefish)

b. Identifiers/Open-Ended Terms
Cooperative Instream Flow Service Group

c. COSATI Field/Group

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2. To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major land and water use changes.

3. To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process, to prevent or minimize the impact of development on fish and wildlife. Biological Services research activities and technical assistance services are based on an analysis of the issues, the decisionmakers involved and their information needs, and an evaluation of the state-of-the-art to identify information gaps and determine priorities. This is a strategy to assure that the products produced and disseminated will be timely and useful.

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The Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams which provide the Program's central, scientific and technical expertise, and which arrange for contracting of Biological Services studies with States, universities, consulting firms, and others; Regional staff who provide a link to problems at the operating level; and staff at certain Fish and Wildlife Service research facilities who conduct inhouse research studies.

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