MONTANA DEPARTMENT OF FISH AND GAME
FISHERIES DIVISION

JOB PROGRESS REPORT

State Montana Title Western Montana Fishery Investigation

Project No. F-12-R-22 Title Study of Instream Flow Requirements for Bitterroot River and Selected Tributaries

Job No. I-b (Stream Flow Segment)

Period Covered July 1, 1975 to June 30, 1976

## ABSTRACT

Stream discharge and fish habitat features of the Bitterroot River and tributary streams were sampled for development of instream flow reservations. Fish habitat features including riffle depth, pool depth, cover, wetted perimeter, stream width, pool width, and current velocity were measured with standard survey equipment and methods. The effect of stream discharge on fish habitat features was evaluated with the use of a hydraulic model (Water Surface Profile Model). After collecting specific channel configuration and stream discharge data, the hydraulic model was used to predict water surface elevations and current velocities at a series of designated flows.

## BACKGROUND

The Bitterroot River has 27 major tributaries on the west side and 12 tributaries on the drier east side. In general, the west side contributes 40% of the stream discharge and the drier east side 24.5% of the stream discharge, headwater areas contribute the remaining 35.5% (Senger, 1975).

Fishery workers have recognized the problems of stream dewatering and intensive land-use practices as major factors in the deterioration of the fishery resource in the Bitterroot drainage. In many areas of the Bitterroot River drainage, primarily in the tributary streams, demand for water has exceeded that which the drainages can produce on a year-round basis, and dry stream channels are testimony to this fact. Dry channels occur in late summer and fall. Irrigation diversions are the major cause of the dewatering. However, the complete dewatering of a stream channel is not the only problem facing the fishery resource. The reduction of stream flow to a level that does not adequately fill the channel can seriously reduce the fisheries potential of a stream.

## OBJECTIVES AND DEGREE OF ATTAINMENT

The objective of this study was to determine the instream flow requirements for migratory and resident fish populations in the Bitterroot River and selected tributary streams. Although much data was obtained on the relationship between flows and fish habitat, the objective was not met because insufficient fish life history data was available.

## PROCEDURES

Nineteen study sections were selected along the Bitterroot River and tributary streams which were representative of the stream stretch (Table 1 and Figure 1). Study sections contained at least one pool-riffle-pool sequence.

Table 1. Bitterroot River and tributary stream study sections surveyed in 1975 for instream flow requirements of the fishery resource.

| Section Name | Water code | Location T | R | Sec. | River mile | Discharge (cfs) | Length (ft) |
|---|---|---|---|---|---|---|---|
| Bitterroot River | | | | | | | |
| Missoula (Maclay Bridge) section | 2-03-0475 | 13N | 20W | 34 | 1.3 | 1675 | 1930 |
| Florence section | 2-03-0475 | 10N | 20W | 12 | 19.0 | 979 | 2140 |
| Stevensville section | 2-03-0475 | 9N | 20W | 28 | 33.0 | 1121 | 829 |
| Hamilton (Anglers Roost) section | 2-03-0500 | 5N | 21W | 12 | 58.0 | 463 | 1286 |
| Darby section | 2-03-0500 | 3N | 21W | 23 | 75.0 | 448 | 614 |
| Lolo Creek | | | | | | | |
| Upper Mormon Peak sec. | 2-03-3475 | 12N | 20W | 33 | 7.3 | 241 | 918 |
| Upper Elk Meadows sec. | 2-03-3475 | 12N | 21W | 31 | 13.8 | 56 | 361 |
| Kootenai Creek | 2-03-3000 | 9N | 20W | 20 | 2.0 | 32 | 163 |
| Big Creek | 2-03-0525 | 8N | 21W | 12 | 2.7 | 104 | 109 |
| Burnt Fork Bitterroot R. | 2-03-0850 | 8N | 18W | 14 | 11.4 | 108 | 336 |
| Skalkaho Creek | 2-03-5475 | 5N | 20W | 16 | 4.4 | 85 | 188 |
| Sleeping Child Creek | 2-03-5550 | 4N | 20W | 2 | 7.6 | 24 | 110 |
| Tin Cup Creek | 2-03-6425 | 2N | 21W | 17 | 5.0 | 34 | 115 |
| West Fork Bitterroot R. | | | | | | | |
| Rombo | 2-03-6800 | 1S | 22W | 11 | 16.0 | 138 | 267 |
| Alta | 2-03-6800 | 2S | 22W | 34 | 25.5 | 59 | 234 |
| NezPerce Fork Bitterroot River | 2-03-4275 | 1N | 22W | 34 | 2.7 | 37 | 256 |
| East Fork Bitterroot R. | | | | | | | |
| Spring Gulch section | 2-03-1950 | 1N | 20W | 1 | 9.4 | 206 | 264 |
| Mink Creek section | 2-03-1950 | 1N | 18W | 5 | 17.8 | 142 | 277 |
| Moose Creek | 2-03-4075 | 2N | 20W | 9 | 1.3 | 26 | 159 |

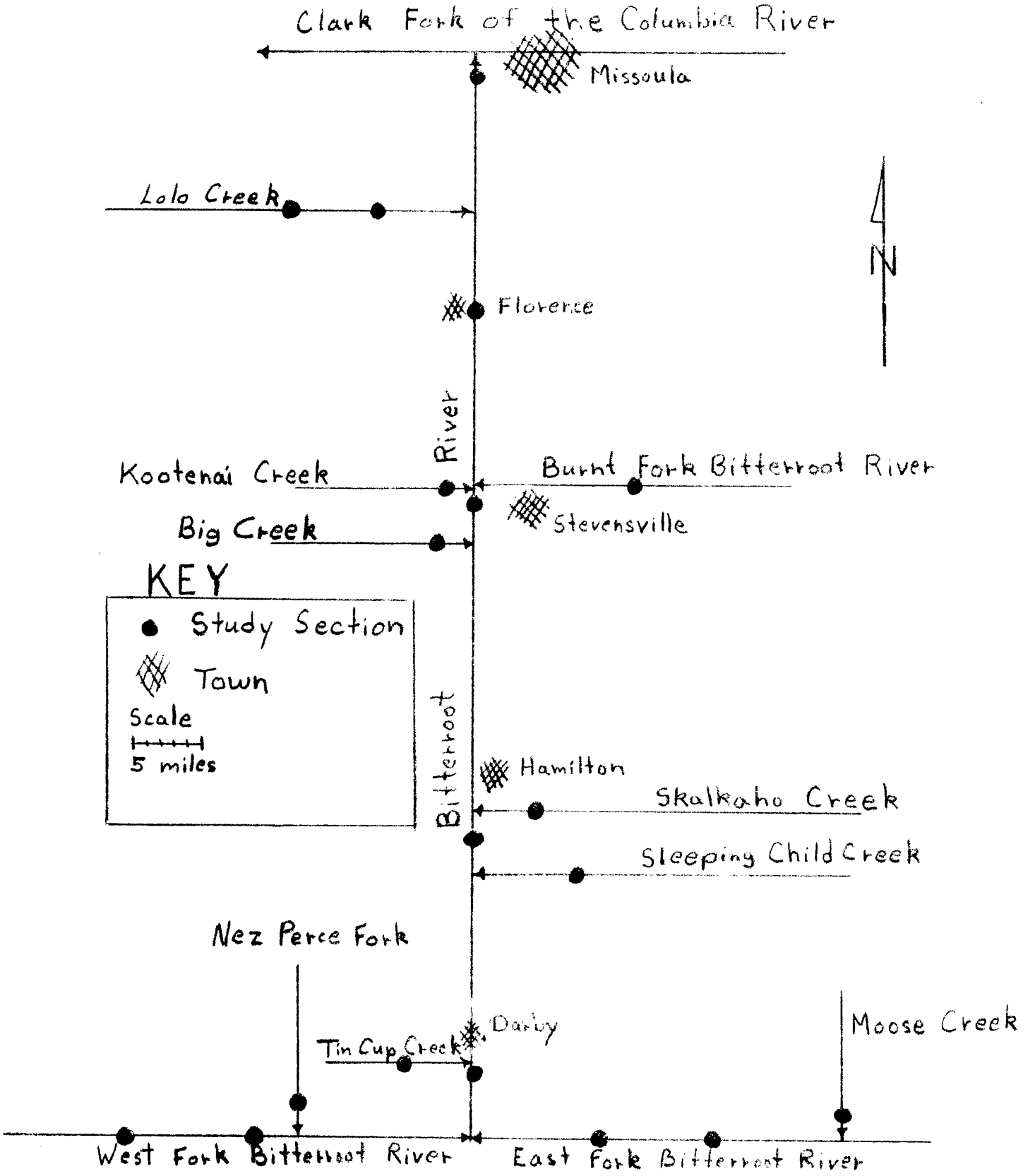


Figure 1. Location of stream flow and fish habitat sampling sections in the Bitterroot River, 1975.

Length of the study sections ranged from 109 feet to 2,140 feet. Stream size determined the length of the section; the larger the stream, the longer the section.

The study had three distinct phases. First, the field data collection phase, secondly, the analysis of the field data on the Water Surface Profile Model (WSP), and thirdly the analysis of the information derived from WSP as related to aquatic habitat.

## Data Collection

Stream channel cross-sections were measured at frequent intervals within the study section to give an accurate representation of the channel configuration. Fish species and key habitat were surveyed within each study section. Detailed maps were made and color photographs taken of each study section. Standard survey equipment including a transit, Philadelphia rod, and chain were used to do the surveys.

Stream discharge was measured at a suitable site within the study sections or in the immediate vicinity of the study section. The current-meter method of measuring discharge developed by the United States Geological Survey was used at each study section (Buchanan and Somers, 1969). A Price type AA vertical-axis current meter was used for the current velocity measurements.

## Water Surface Profile Analysis

The Water Surface Profile Program (WSP) is a computer adaptation of the Bureau of Reclamation's Water Surface Profile Computation Method B, used for predicting tailwater and backwater elevations (Spence, 1975). WSP is adaptable to instream applications. The program allows the user to study various changes in stream channel characteristics at many different flows without having to make numerous field observations at these flows. The program is calibrated to a specific stream section using one or two observed flows, the corresponding water surface elevations, and channel profile data at various locations in a stream section. The characteristics of the stream determine the number of transects needed to obtain data on various types of aquatic habitat being measured, and channel configuration determines the number of elevation measurements needed along a transect (Spence, 1975).

The predicted values from WSP are within the accuracy of the field data. Elevation measurements were read to the nearest 0.01 of a foot. Channel widths were measured to the nearest foot.

## Analysis of WSP Results

Habitat features of the stream channel, including vegetation, logs, pool areas, riffle areas, and substrate types, were added to the stream channel cross-section plots. Water surface elevations derived from the WSP analysis were also

plotted with the cross-section data resulting in a plot of the channel features at various stream flows (Figure 2). Linear measurements of fish habitat parameters were taken directly from the cross-section plots (Figure 3). Fish habitat parameters included the following: stream width, pool width, stream width with depth $\geq$1.0 ft., pool width with depth $\geq$2.0 or 3.0 feet (depending on stream size), pool width with depth $\geq$0.5 ft. and overhead cover, and conveyance area[1] current velocity. Wetted perimeter was eliminated because of the close correlation to stream width in the Bitterroot drainage. On large streams the channel cross-section was divided into nine approximately equally spaced conveyance areas. Fewer conveyance areas were used on small streams. The Water Surface Profile Program calculated current velocity within each of the conveyance areas. Current velocities in pools and riffles were averaged for each cross-section.

Abbreviations of fish species names used within this report are:

Ct - cutthroat trout
Rb - rainbow trout
Eb - brook trout
DV - Dolly Varden
LL - brown trout
Mwf - mountain whitefish

[1] Stream cross-sections are divided horizontally into as many as 9 subdivisions; each subdivision is referred to as a conveyance area. Current velocity and discharge are calculated within each of the conveyance areas by the WSP program.

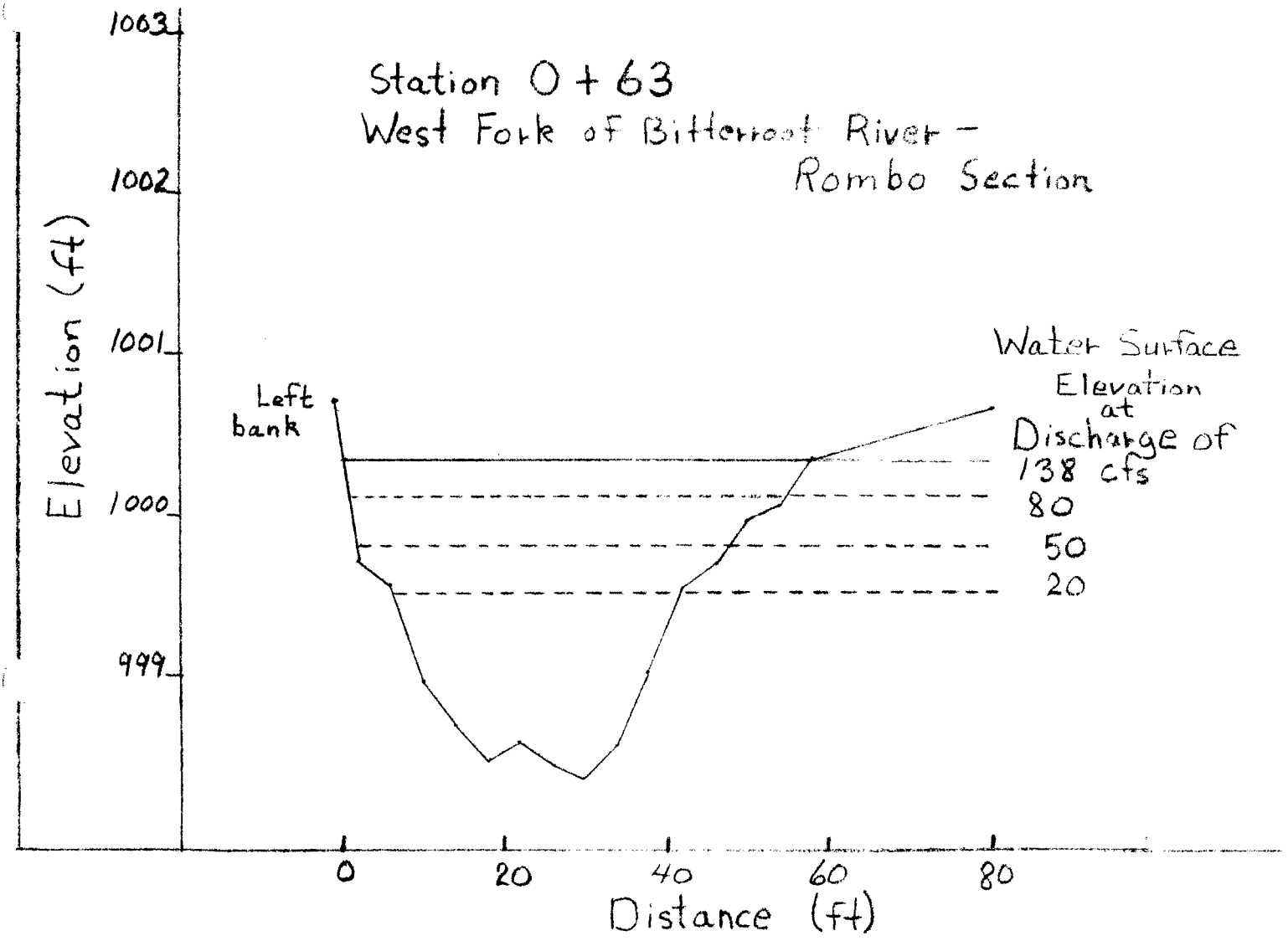


Figure 2. Stream channel cross-section from the West Fork of Bitterroot River, Rombo section, showing predicted water surface elevations plotted for 80, 50, and 20 cfs discharge. Stream flow measured the day of the survey was 138 cfs.

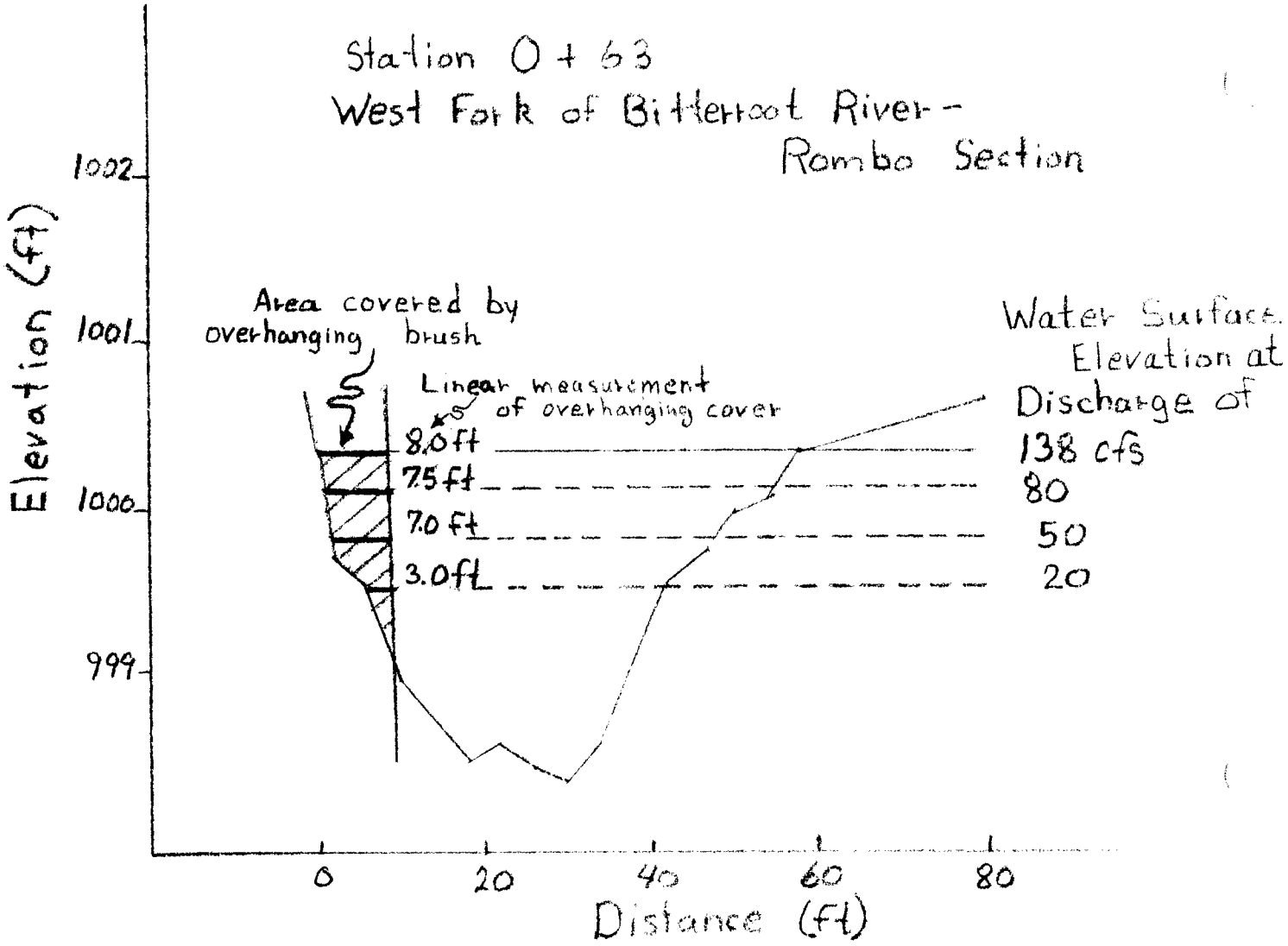


Figure 3. Stream channel cross-section from the West Fork of the Bitterroot River, Rombo Section. Linear measurements were made of fish habitat-related parameters along the predicted water surface elevation for each stream discharge.

## FINDINGS

### Bitterroot River

The Bitterroot River was sampled at five locations in the 80 mile stretch between its confluence with the Clark Fork River, and the East and West Forks of the Bitterroot River (Table 1). Two main channel types occur within the Bitterroot River; a single channel that is slightly sinuous and a braided channel. The slightly sinuous channel type occurs from the mouth at Missoula to Florence, and from Hamilton to the confluence of the East and West Forks. Braided channel occurs between Florence and Hamilton. The channel of the Bitterroot River is characteristically wide and shallow, a feature directly related to the loosely consolidated gravel and rock channel banks and substrate, (Leopold, Wolman and Miller, 1966). The stream bottom is primarily rubble; however, fine sand and silt occur in pools and occasional boulders in the riffles and runs. The percentage of fine sediment in the stream substrate appears to increase in the lower sections of the river.

Of the five major fish habitat functions including spawning, rearing, migration, food production, and cover; cover and suitable spawning areas appear to be the greatest limiting functions affected by stream flow in the Bitterroot River. Cover is provided primarily by deep pools, logs and log jams (Table 2). Pools greater than 3.0 ft. depth and pools and runs with depth greater than 0.5 ft. with overhead cover were the fish habitat parameters most sensitive to stream discharge changes (Tables 3, 4, 5 and 6). Riffle areas with a depth greater than 1.0 ft. were also sensitive to changes in discharge, but to a lesser extent (Tables 4 and 6).

Spawning areas in the Bitterroot River are probably limited in the spring by heavy bedload and sediment movement. Tributary streams are frequently dry before deposited eggs would finish incubation.

Table 2. Description of fish species and key habitat features within sections of the Bitterroot River and selected tributary streams sampled in the 1975 stream flow study.

| River stretch | Fish species | Fishable size | Spawning | Migration | Rearing | Cover | Substrate |
|---|---|---|---|---|---|---|---|
| West Fork Bitterroot River above Painted Rocks Reservoir | Ct | x | x | x | x | Overhanging vegetation and undercut banks predominate | Rubble & gravel |
| | Rb | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | LL | x | x | x | x | | |
| | Mwf | x | x | x | x | | |

Table 2. Cont'd.

| River stretch | Fish species | Fishable size | Spawning | Migration | Rearing | Cover | Substrate |
|---|---|---|---|---|---|---|---|
| West Fork Bitterroot River below Painted Rocks Reservoir | Ct | x | x | x | x | Pools associated with overhanging banks and logs predominate | Boulder, rubble & gravel |
| | Rb | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | LL | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| Nez Perce Fork Bitterroot River | Ct | x | x | x | x | Deep pools and runs predominate, some logs & overhanging vegetation | Boulder, rubble |
| | Eb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| Moose Creek | Ct | x | x | x | x | Logs & overhanging banks & vegetation | Rubble & gravel |
| | DV | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| East Fork Bitterroot River above Sula | Ct | x | x | x | x | Deep pools & runs predominate, some log & overhanging vegetative cover | Boulder & rubble |
| | Rb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| East Fork Bitterroot River below Sula | Ct | x | x | x | x | Deep pools & Runs predominate cover, boulders to a lesser extent | Boulder & rubble |
| | Rb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| Bitterroot River confluence of Forks to Lost Horse Creek | Ct | x | x | x | x | Deep pools and runs predominate, logs & boulders infrequent | Boulder, rubble & gravel |
| | Rb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | LL | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| Tin Cup Creek | Ct | x | x | x | x | Logs & overhanging vegetation provide majority of cover | Gravel & rubble |
| | Eb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | Mwf | x | x | x | x | | |

Table 2. Cont'd.

| River stretch | Fish species | Fishable size | Spawning | Migration | Rearing | Cover | Substrate |
|---|---|---|---|---|---|---|---|
| Bitterroot River, Lost Horse Creek to Big Creek | Ct | x | x | x | x | Deep pools & runs, undercut banks, log jams predominate | Rubble |
| | Rb | x | x | x | x | | |
| | LL | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| Sleeping Child Creek | Ct | x | x | x | x | Boulder & overhanging vegetation predominate | Boulder,rubble |
| | DV | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| Skalkaho Creek | Ct | x | x | x | x | Overhanging vegetation & log cover | Rubble,gravel |
| | DV | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | LL | x | x | x | x | | |
| Bitterroot River Big Creek to Bass Creek | Ct | x | x | x | x | Deep pools,log & debris, deep runs | Rubble,gravel |
| | Rb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | LL | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| Big Creek | Ct | x | x | x | x | Log & boulder created pools in channel, deep pools in channel predominate | Rubble & boulder |
| | Eb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| Burnt Fork of Bitterroor River | Ct | x | x | x | x | Overhanging vegetation & banks, some log produced cover | Rubble |
| | Eb | x | x | x | x | | |
| | DV | x | x | x | x | | |
| Kootenai Creek | Ct | x | x | x | x | Deep pools in channel predominate | Rubble,boulder |
| | DV | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| Bitterroot River Bass Creek to Lolo Creek | Ct | x | x | x | x | Deep pools & runs predominate | Rubble,gravel |
| | Rb | x | x | x | x | | |
| | LL | x | x | x | x | | |
| | DV | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | Mwf | x | x | x | x | | |

Table 2. Cont'd.

| River stretch | Fish species | Fishable size | Spawning | Migration | Rearing | Cover | Substrate |
|---|---|---|---|---|---|---|---|
| Lolo Creek above School House Gulch | Ct | x | x | x | x | Log & debris cover provides most cover, to a lesser extent overhanging vegetation | Rubble |
| | Rb | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| Lolo Creek below School House Gulch | Ct | x | x | x | x | Deep pools provide most cover overhanging vegetation less extensive | Rubble |
| | Rb | x | x | x | x | | |
| | LL | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | Mwf | x | x | x | x | | |
| Bitterroot River Lolo Creek to confluence with Clark Fork River | Ct | x | x | x | x | Deep pools and runs predominate, overhanging banks & vegetation to a lesser extent. | Rubble |
| | Rb | x | x | x | x | | |
| | LL | x | x | x | x | | |
| | Eb | x | x | x | x | | |
| | Mwf | x | x | x | x | | |

Table 3. Summary of fish habitat data derived from the Water Surface Profile Program on the Bitterroot River, 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 3.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| Bitterroot River - Florence Section | | | | | |
| 1100 | 224 | 154 | 57 | 2 | 173 |
| 800 | 208 | 146 | 46 | 1 | 147 |
| 600 | 190 | 134 | 34 | 1 | 119 |
| 400 | 169 | 120 | 0 | 0 | 96 |
| 200 | 130 | 108 | 0 | 0 | 58 |

Table 3. Cont'd.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 3.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| | | Bitterroot River - Maclay's Bridge | | | |
| 2000 | 235 | 184 | 88 | 2 | 213 |
| 1500 | 225 | 174 | 70 | 1 | 186 |
| 1000 | 213 | 167 | 50 | 1 | 160 |
| 800 | 194 | 163 | 43 | 1 | 148 |
| 600 | 182 | 156 | 35 | 1 | 136 |
| 400 | 162 | 137 | 30 | 1 | 103 |
| 200 | 142 | 122 | 21 | 1 | 75 |

Table 4. Percent of potential aquatic habitat at various stream discharges in study sections on the Bitterroot River sampled in 1975.

| Study section | Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥ 1.0 ft. depth (%) | Pool width ≥ 0.5 foot depth & overhead cover (%) | Pool width ≥ 3.0 ft. depth (%) |
|---|---|---|---|---|---|---|
| Bitterroot River Florence Section | 1100 | 100 | 100 | 100 | 100 | 100 |
| | 800 | 93 | 94 | 85 | 43 | 80 |
| | 600 | 85 | 87 | 68 | 28 | 59 |
| | 400 | 75 | 78 | 55 | 14 | 0 |
| | 200 | 58 | 70 | 33 | 0 | 0 |
| Bitterroot River Maclay Bridge Section | 2000 | 100 | 100 | 100 | 100 | 100 |
| | 1500 | 96 | 94 | 87 | 80 | 80 |
| | 1000 | 91 | 90 | 75 | 75 | 57 |
| | 800 | 82 | 88 | 69 | 75 | 49 |
| | 600 | 77 | 85 | 64 | 70 | 40 |
| | 400 | 69 | 74 | 48 | 65 | 35 |
| | 200 | 60 | 66 | 35 | 60 | 24 |

Table 5. Summary of fish habitat data derived from the Water Surface Profile Program on the Bitterroot River, 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 3.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| | | Bitterroot River - Darby Section | | | |
| 500 | 126 | 79 | 40 | 5 | 57 |
| 400 | 120 | 75 | 31 | 5 | 52 |
| 300 | 116 | 74 | 28 | 4 | 46 |
| 100 | 97 | 68 | 18 | 2 | 32 |
| 50 | 85 | 66 | 15 | 1 | 29 |
| | | Bitterroot River - Angler's Roost Section | | | |
| 500 | 171 | 98 | 31 | 3 | 97 |
| 300 | 162 | 94 | 24 | 3 | 79 |
| 200 | 146 | 92 | 20 | 2 | 69 |
| 100 | 129 | 91 | 16 | 1 | 56 |
| 50 | 94 | 84 | 14 | 0 | 45 |
| 20 | 71 | 74 | 9 | 0 | 37 |
| | | Bitterroot River - Stevensville Section | | | |
| 1121 | 149 | 112 | 59 | 9 | 117 |
| 900 | 141 | 109 | 51 | 2 | 103 |
| 700 | 133 | 101 | 39 | 0 | 95 |
| 500 | 119 | 90 | 22 | 0 | 84 |
| 300 | 100 | 79 | 18 | 0 | 68 |
| 100 | 75 | 81 | 0 | 0 | 48 |

Table 6. Percent of potential aquatic habitat at various stream discharges in study sections on the Bitterroot River sampled in 1975.

| Study Section | Discharge (cfs) | Stream width (%) | Pool width (%) | ≥Riffle width 1.0 ft. depth (%) | Pool width ≥0.5 ft.depth & overhead cover (%) | Pool width ≥3.0 ft.depth (%) |
|---|---|---|---|---|---|---|
| Bitterroot River Darby Section | 500 | 100 | 100 | 100 | 100 | 100 |
| | 400 | 95 | 95 | 92 | 89 | 78 |
| | 300 | 92 | 93 | 84 | 76 | 69 |
| | 100 | 77 | 86 | 58 | 30 | 44 |
| | 50 | 68 | 83 | 50 | 17 | 37 |
| Bitterroot River Angler's Roost Section | 500 | 100 | 100 | 100 | 100 | 100 |
| | 300 | 95 | 96 | 82 | 85 | 80 |
| | 200 | 85 | 94 | 71 | 50 | 66 |
| | 100 | 76 | 93 | 58 | 30 | 53 |
| | 50 | 55 | 86 | 46 | 5 | 45 |
| | 20 | 41 | 76 | 39 | 0 | 29 |
| Bitterroot River Stevensville Section | 1121 | 100 | 100 | 100 | 100 | 100 |
| | 900 | 95 | 97 | 88 | 22 | 86 |
| | 700 | 89 | 90 | 74 | 0 | 66 |
| | 500 | 80 | 80 | 56 | 0 | 28 |
| | 300 | 67 | 70 | 42 | 0 | 8 |
| | 100 | 51 | 54 | 5 | 0 | 0 |

West Fork Bitterroot River and Nez Perce Fork Bitterroot River

The West Fork of the Bitterroot River was sampled above and below Painted Rocks Reservoir. The West Fork is slightly sinuous through the entire stretch from headwaters to mouth, however, the channel above the reservoir differs greatly from the channel below the reservoir. Above Painted Rocks Reservoir the channel is relatively narrower and deeper than below the Reservoir. Boulders, rubble and gravel frequent the West Fork substrate below the Reservoir and rubble and gravel occur most frequently above the reservoir (Table 2). Fish habitat functions most critically affected by changes in discharge above the reservoir are food producing areas, spawning areas, and cover (Tables 7 and 8). Below the reservoir at the Rombo section, shelter areas having overhead cover and depth greater than 0.5 ft., and cover areas with depth greater than 2.0 ft. were most severely affected by changes in discharge (Tables 7 and 8). Below Painted Rocks the majority of cover was provided by deep pools.

Table 7. Summary of fish habitat data derived from the Water Surface Profile Program on the West Fork Bitterroot River, 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 3.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| | | | Alta Section | | |
| 100 | 47 | 16 | 0.9 | 3.3 | 20.5 |
| 70 | 46 | 16 | 0.4 | 2.9 | 13.2 |
| 50 | 43 | 15 | 0.2 | 2.6 | 8.4 |
| 30 | 38 | 15 | 0 | 1.6 | 2.7 |
| 10 | 30 | 14 | 0 | 0.4 | 1.2 |
| | | | Rombo Section | | |
| 250 | 70 | 68.8 | 12.0 | 6.5 | 34.0 |
| 150 | 62 | 60.2 | 6.8 | 4.2 | 28.4 |
| 110 | 53 | 50.5 | 3.8 | 2.9 | 23.4 |
| 80 | 47 | 44.7 | 1.0 | 2.5 | 17.8 |
| 50 | 39 | 35.0 | 0 | 1.7 | 12.6 |
| 20 | 28 | 22.8 | 0 | 1.0 | 7.0 |

Table 8. Percent of potential aquatic habitat at various stream discharges on stream flow study sections in the West Fork of the Bitterroot River, sampled in 1975.

| Study Section | Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥ 1.0 ft. depth (%) | Pool width ≥ 0.5 ft. depth (%) | Pool width ≥ 2.0 ft. depth (%) |
|---|---|---|---|---|---|---|
| West Fork | 100 | 100 | 100 | 100 | 100 | 100 |
| Bitterroot River | 70 | 97 | 99 | 64 | 88 | 43 |
| Alta Section | 50 | 91 | 97 | 41 | 78 | 17 |
| | 30 | 81 | 94 | 13 | 48 | 0 |
| | 10 | 63 | 90 | 6 | 11 | 0 |
| West Fork | 250 | 100 | 100 | 100 | 100 | 100 |
| Bitterroot River | 150 | 89 | 88 | 84 | 65 | 45 |
| Rombo Section | 100 | 76 | 73 | 69 | 44 | 25 |
| | 80 | 67 | 65 | 52 | 38 | 7 |
| | 50 | 55 | 51 | 37 | 26 | 0 |
| | 20 | 39 | 33 | 21 | 15 | 0 |

The Nez Perce Fork of the Bitterroot River flows into the West Fork of the Bitterroot River 8 miles below Painted Rocks Reservoir. Boulder and Rubble substrate types are the most prevalent substrate types found in the Nez Perce Fork (Tables 9 and 10). The substrate is well washed with very little sand or fine sediments. Cover for fish is mainly provided by pools created by logs and overhanging banks.

Cover for fish and fish food producing areas are most sensitive to changes in discharge. At flows below 15 cfs both functions are reduced to 20% of potential assuming 60 cfs flow provides maximum potential habitat.

The Nez Perce Fork of the Bitterroot probably plays an important role in maintaining minimum survival flows in the West Fork during frequent dam repairs to Painted Rocks Reservoir.

Table 9. Summary of fish habitat data derived from the Water Surface Profile Program on the Nez Perce Fork of the Bitterroot River, 1975.

| Discharge (cfs) | Mean width (ft) | Pool width (ft) | Pool width $\geq$ 2.0 ft. depth (ft) | Mean pool width $\geq$ 0.5 ft. Depth + overhead cover (ft) | Mean width $\geq$ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| 60 | 42 | 18 | 0 | 15 | 14 |
| 40 | 38 | 18 | 0 | 12 | 7 |
| 30 | 35 | 17 | 0 | 10 | 5 |
| 20 | 32 | 16 | 0 | 7 | 4 |
| 15 | 30 | 15 | 0 | 5 | 3 |
| 10 | 27 | 14 | 0 | 2 | 3 |

Table 10. Percent of potential aquatic habitat at various stream discharges on the Nez Perce Fork of the Bitterroot River sampled in 1975.

| Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width $\geq$ 1.0 ft. depth (%) | Pool width $\geq$ 0.5 ft. depth + overhead cover (%) | Pool width $\geq$ 2.0 ft. depth (%) |
|---|---|---|---|---|---|
| 60 | 100 | 100 | 100 | 100 | 0 |
| 40 | 91 | 96 | 53 | 79 | 0 |
| 30 | 84 | 93 | 34 | 64 | 0 |
| 20 | 77 | 87 | 26 | 47 | 0 |
| 15 | 71 | 84 | 22 | 34 | 0 |
| 10 | 66 | 78 | 19 | 13 | 0 |

East Fork Bitterroot River and Moose Creek

The East Fork of the Bitterroot River was sampled at two locations, one section above Sula and one below Sula. Moose Creek was sampled at one location (Table 1). Cover for fish in the East Fork is provided by deep pools and runs, to a lesser extent overhanging vegetation also occurs (Table 2). The boulder and rubble bottom types provide excellent cover for juvenile fish and fish food organisms. Moose Creek differs from the East Fork because logs and overhanging banks provide the majority of fish cover.

In the East Fork, fish cover is most sensitive to changes in discharge; however, riffle areas, where the majority of food production takes place, are also sensitive to changes in discharge (Tables 11 and 12). In Moose Creek adequate water coverage of riffles areas should be of major concern. Fish cover is maintained at extremely low flows because of narrow and deep channel morphology.

Table 11. Summary of fish habitat data derived from the Water Surface Profile Program on the East Fork Bitterroot River, 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 2.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. Depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| | | | Mink Creek Section | | |
| 150 | 52 | 48 | 1.7 | 1.7 | 29 |
| 120 | 49 | 46 | 0.4 | 1.0 | 28 |
| 85 | 46 | 43 | 0.1 | 0.6 | 20 |
| 55 | 41 | 40 | 0 | 0.4 | 1 |
| 35 | 36 | 36 | 0 | 0.1 | 1 |
| | | | Spring Gulch Section | | |
| 200 | 63 | 43 | 9.7 | 5.0 | 41 |
| 150 | 62 | 41 | 4.9 | 2.8 | 33 |
| 100 | 60 | 40 | 1.7 | 0.4 | 25 |
| 80 | 54 | 38 | 0.9 | 0 | 21 |
| 60 | 50 | 36 | 0.5 | 0 | 17 |
| 40 | 44 | 34 | 0.1 | 0 | 12 |
| | | | Moose Creek | | |
| 40 | 26 | 16 | 0 | 1.7 | 6 |
| 30 | 25 | 16 | 0 | 1.0 | 4 |
| 20 | 22 | 14 | 0 | 0.9 | 3 |
| 10 | 20 | 13 | 0 | 0.6 | 1 |
| 5 | 17 | 12 | 0 | 0.2 | 0 |

Table 12. Percent of potential aquatic habitat at various stream discharges from data collected on the East Fork Bitterroot River Drainage, 1975.

| Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥ 1.0 ft. depth (%) | Pool width ≥ 0.5 ft. depth + overhead cover (%) | Pool width ≥ 2.0 ft. depth (%) |
|---|---|---|---|---|---|
| | | | Mink Creek Section | | |
| 150 | 100 | 100 | 100 | 100 | 100 |
| 120 | 93 | 95 | 81 | 56 | 27 |
| 85 | 88 | 90 | 59 | 36 | 4 |
| 55 | 78 | 84 | 24 | 26 | 0 |
| 35 | 68 | 75 | 18 | 7 | 0 |
| | | | Spring Gulch Section | | |
| 200 | 100 | 100 | 100 | 100 | 100 |
| 150 | 99 | 96 | 79 | 55 | 51 |
| 100 | 96 | 92 | 60 | 8 | 17 |
| 80 | 95 | 88 | 51 | 0 | 10 |
| 60 | 80 | 84 | 41 | 0 | 7 |
| 40 | 70 | 78 | 29 | 0 | 1 |
| | | | Moose Creek | | |
| 40 | 100 | 100 | 100 | 100 | 100 |
| 30 | 96 | 98 | 66 | 62 | 0 |
| 20 | 86 | 90 | 43 | 55 | 0 |
| 10 | 75 | 84 | 13 | 36 | 0 |
| 5 | 64 | 77 | 3 | 14 | 0 |

Lolo Creek below School House Gulch

Lolo Creek was divided at School House Gulch into upper and lower stretches. In the lower stretch of Lolo Creek, study of the upper Mormon Peak section revealed deep pools provided the majority of fish cover. The deep pools were usually associated with minor log and debris jams. Overhanging vegetation provided additional cover but was less abundant, (Table 13). In this lower stretch of Lolo Creek, rainbow trout and brown trout are the dominant resident fish (Peters, 1975) with mountain whitefish, cutthroat trout, and brook trout also present but in less abundance.

Fish habitat parameters measured which were sensitive to changes in discharge included: fish cover, food producing areas, and current velocity (Tables 13 and 14). Fish cover is the most sensitive factor and is lost first when stream flow decreases (Table 14). This is a result of the loss of deep pool areas which

accounts for the majority of fish cover. Cover provided by overhanging vegetation is much more resilient to changes in discharge and is essentially still available to fish at flows of 20 cfs. Food producing areas of lower Lolo Creek are reduced significantly below discharges of 80 cfs.

Lolo Creek above School House Gulch

In the Upper Elk Meadows section of the upper stretch of Lolo Creek, logs and debris provide the best fish cover, overhanging vegetation provides less significant cover because it is less abundant. The percentage of cutthroat trout increases in the fish population from lower Lolo Creek to the headwaters. Cutthroat are dominant in the headwaters.

The fish habitat parameters measured which were most sensitive to decreases in discharge were deep pools and fish food producing areas (Tables 13 and 14). Stream flows as low as 10 cfs maintained 55 percent of deep-pool type fish cover and 84 percent of the overhanging vegetative cover (Table 14).

Table 13. Summary of fish habitat data derived from the Water Surface Profile Program on Lolo Creek, 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width $\geq$ 2.0 ft. depth (ft) | Mean pool width $\geq$ 0.5 ft. depth + overhead cover (ft) | Mean width $\geq$ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| | | | Upper Elk Meadows Section | | |
| 65 | 52 | 36 | 2.5 | 1.2 | 13.2 |
| 50 | 46 | 34 | 2.1 | 1.2 | 8.9 |
| 40 | 44 | 33 | 2.1 | 1.2 | 7.6 |
| 30 | 42 | 31 | 2.0 | 1.1 | 3.1 |
| 10 | 37 | 26 | 1.4 | 1.0 | 2.4 |
| | | | Upper Mormon Peak | | |
| 241 | 63 | 42 | 13.7 | 4.9 | 45.9 |
| 200 | 61 | 41 | 7.0 | 4.0 | 42.9 |
| 150 | 58 | 39 | 0.8 | 3.2 | 34.6 |
| 100 | 53 | 36 | 0 | 2.6 | 23.6 |
| 80 | 51 | 36 | 0 | 2.1 | 15.3 |
| 60 | 50 | 35 | 0 | 2.0 | 11.5 |
| 40 | 47 | 34 | 0 | 1.6 | 7.0 |
| 20 | 43 | 32 | 0 | 1.1 | 1.7 |

Table 18. Percent of potential aquatic habitat at various stream discharges for Tin Cup Creek sampled in 1975.

| Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥1.0 ft. depth (%) | Pool width ≥0.5 ft. depth & overhead cover (%) | Pool width ≥2.0 ft. depth (%) |
|---|---|---|---|---|---|
| | | | Tin Cup Creek | | |
| 40 | 100 | 100 | 100 | 100 | 100 |
| 34 | 99 | 99 | 86 | 91 | 77 |
| 25 | 93 | 97 | 78 | 80 | 51 |
| 15 | 83 | 91 | 55 | 66 | 20 |
| 10 | 72 | 83 | 49 | 60 | 0 |
| 5 | 67 | 79 | 44 | 49 | 0 |

Skalkaho Creek

Skalkaho Creek was sampled 3 miles below Newton Gulch. Irrigation demand on Skalkaho Creek frequently exceeds available stream flow. Several fish species occur in Skalkaho Creek: brook trout, cutthroat trout, rainbow trout, Dolly Varden and brown trout. Cutthroat trout are the predominant species present.

Fish habitat functions most severely affected by changes in stream flow include food production areas and cover (Tables 19 & 20). At a flow of 10 cfs, 41% of potential food producing area on the riffles is available. Cover is provided by deep pools and overhanging vegetation; both types are resilient to stream flow reductions to 30 cfs (Table 2).

Table 19. Summary of fish habitat data from the Water Surface Profile Program collected on Skalkaho Creek in 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 2.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. Depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| 80 | 40 | 19.8 | 2.2 | 3.5 | 17.6 |
| 60 | 39 | 19.6 | 1.9 | 3.3 | 16.2 |
| 30 | 30 | 19.2 | 1.1 | 2.7 | 7.8 |
| 20 | 27 | 18.5 | 1.0 | 2.5 | 5.4 |
| 10 | 20 | 16.6 | 0.7 | 2.3 | 2.3 |

Table 20. Percent of potential aquatic habitat at various stream discharges for Skalkaho Creek sampled in 1975.

| Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥1.0 ft. depth (%) | Pool width ≥0.5 ft. depth & overhead cover (%) | Pool width ≥2.0 ft. depth (%) |
|---|---|---|---|---|---|
| | | | Skalkaho Creek | | |
| 80 | 100 | 100 | 100 | 100 | 100 |
| 60 | 96 | 99 | 75 | 89 | 70 |
| 30 | 75 | 96 | 44 | 77 | 52 |
| 20 | 67 | 93 | 31 | 71 | 46 |
| 10 | 50 | 82 | 14 | 66 | 32 |

Kootenai Creek

Kootenai Creek is located between Stevensville and Victor and receives flows from the west side of the Bitterroot Valley. Severe flow reductions occur annually as a result of irrigation demand. The game fish species present include: cutthroat trout, brook trout, and Dolly Varden (Table 2). Fish habitat functions which are most sensitive to flow alterations are cover provided by deep pools and fish food producing areas provided by riffle areas (Tables 21 and 22).

Table 21. Summary of fish habitat data from the Water Surface Profile Program collected on Kootenai Creek, 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 2.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. Depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| 40 | 36 | 9.5 | 1.6 | 0.2 | 6.6 |
| 30 | 33 | 9.1 | 1.2 | 0.2 | 4.9 |
| 15 | 25 | 4.9 | 0.8 | 0.2 | 3.1 |
| 5 | 20 | 4.1 | 0.1 | 0.1 | 2.5 |

Table 22. Percent of total available aquatic habitat at various stream discharges for Kootenai Creek Sampled in 1975.

| Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥1.0 ft. depth (%) | Pool width ≥0.5 ft. depth & overhead cover (%) | Pool width ≥2.0 ft. depth (%) |
|---|---|---|---|---|---|
| | | | Kootenai Creek | | |
| 40 | 100 | 100 | 100 | 100 | 100 |
| 30 | 94 | 94 | 74 | 100 | 78 |
| 15 | 73 | 76 | 47 | 78 | 47 |
| 5 | 57 | 64 | 38 | 28 | 8 |

Burnt Fork Bitterroot River

The Burnt Fork of the Bitterroot River has populations of cutthroat trout, brook trout, and Dolly Varden. The Burnt Fork is dewatered annually due to irrigation demands. Key cover for fish is provided by overhanging banks and vegetation. Substrate in the creek is predominately rubble (Table 2). Water Surface Profile analysis indicated deep pools were most sensitive to flow alteration; overhanging banks and vegetation were less sensitive to flow alteration (Tables 23 and 24).

Burnt Fork of the Bitterroot River is dewatered in the lower section during the low flow season due to irrigation demand.

Table 23. Summary of fish habitat data from the Water Surface Profile Model collected on the Burnt Fork Bitterroot River, 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 2.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. Depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| 125 | 35 | 6.9 | 3.7 | 2.7 | 24 |
| 108 | 34 | 6.9 | 2.0 | 2.6 | 20 |
| 75 | 32 | 6.8 | 1.7 | 1.6 | 16 |
| 50 | 30 | 6.4 | 1.1 | 1.0 | 12 |
| 35 | 27 | 6.0 | 0 | 0.7 | 4 |
| 25 | 26 | 5.9 | 0 | 0.6 | 2 |
| 15 | 22 | 5.6 | 0 | 0.5 | 1 |

Table 24. Percent of total aquatic habitat at various stream discharges for the Burnt Fork Bitterroot River sampled in 1975.

| Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥1.0 ft. depth (%) | Pool width ≥0.5 ft. depth & overhead cover (%) | Pool width ≥2.0 ft. depth (%) |
|---|---|---|---|---|---|
| | | | Burnt Fork Bitterroot River | | |
| 125 | 100 | 100 | 100 | 100 | 100 |
| 108 | 97 | 99 | 87 | 98 | 54 |
| 75 | 90 | 97 | 68 | 60 | 46 |
| 50 | 85 | 93 | 50 | 37 | 30 |
| 35 | 78 | 86 | 17 | 26 | 0 |
| 25 | 75 | 86 | 10 | 23 | 0 |
| 15 | 63 | 80 | 3 | 19 | 0 |

Big Creek

Big Creek flows from the west side of the Bitterroot Valley and enters the Bitterroot River near Victor. Severe flow reductions occur annually due to irrigation demand.

Deep pools, along with logs and boulders, provide the majority of cover for fish. The substrate in Big Creek is primarily rubble and boulder in composition (Table 2). Water Surface Profile analysis indicated that deep pool areas are lost at flows below 104 cfs. Log and boulder created cover is more resilient to flow alteration (Tables 25 and 26). Cover is a prime limiting factor to better trout populations in Big Creek. Fish food producing areas are also very sensitive to flow alterations from 80 cfs to 40 cfs. A reduction of discharge from 80 cfs to 40 cfs resulted in a 59% loss in available fish food producing areas.

Table 25. Summary of fish habitat data from the Water Surface Profile Program collected on Big Creek in 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 2.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. Depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| 104 | 36 | 22 | 1 | 1.0 | 21 |
| 80 | 34 | 21 | 0 | 0.8 | 17 |
| 60 | 32 | 19 | 0 | 0.6 | 9 |
| 40 | 30 | 18 | 0 | 0.4 | 4 |
| 20 | 27 | 16 | 0 | 0.1 | 1 |
| 10 | 23 | 14 | 0 | 0 | 1 |

Table 26. Percent of potential aquatic habitat at various stream discharges for Big Creek sampled in 1975.

| Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥1.0 ft.depth (%) | Pool width ≥0.5 ft. depth & overhead cover (%) | Pool width ≥2.0 ft.depth (%) |
|---|---|---|---|---|---|
| 104 | 100 | 100 | 100 | 100 | 100 |
| 80 | 95 | 93 | 79 | 83 | 0 |
| 60 | 90 | 87 | 43 | 66 | 0 |
| 40 | 84 | 80 | 20 | 41 | 0 |
| 20 | 75 | 70 | 7 | 8 | 0 |
| 10 | 65 | 62 | 4 | 0 | 0 |

## SUMMARY

The major limiting factors to maintaining game fish populations in the Bitterroot River and tributary streams are:

1. Annual low flows and dewatering,

   The majority of tributary streams to the Bitterroot River have water appropriated in excess of available stream discharge, resulting in complete dewatering of the stream channels by mid to late summer.

   The Bitterroot River is approaching the same situation, in several locations.

2. Annual stream discharge fluctuations,

   The channels carved by high flood flows provide limited amounts of trout habitat during low flow periods. Riparian vegetative cover is commonly far from the waters edge. Therefore, the majority of cover and security areas for trout occur in deep pool areas and in association with logs and debris that collect in the channel. Fish population maintenance during low flows in the Bitterroot River and most tributary streams depends upon the maintenance of deep pools, and log and debris cover.

The fishery resource in the Bitterroot River and the majority of its tributary streams have been severily degraded due to irrigation demand. Irrigation useage dewaters stream channels in several major tributary streams in average flow years. In other tributary streams and the Bitterroot River low flows adversely affect fish habitat.

## RECOMMENDATIONS

Dewatering and/or extremely low flows in tributary streams and the Bitterroot River annually should prompt a moratorium on additional water use permits in the Bitterroot drainage, until a thorough evaluation can be made of water availability and adverse impacts on recreation, wildlife, agriculture, sewage disposal, and other water users. A study of the feasibility of acquiring and maintaining adequate stream flow in key tributaries of the Bitterroot River should be considered in the Bitterroot River. Fish life history information including: seasonal distribution, migration, and identification of key spawning areas should be collected to supplement habitat data compiled in this report.

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Date December, 1976

Waters referred to: State of Montana water codes for waters referred to in this report occur in Table 1.

APPENDIX

1) Current velocity tables for all stream flow study sections.

2) A compilation of streams which should be considered in instream flow reservations.

Table A1. Mean current velocity at each X-section and stream discharge for West Fork Bitterroot River - Alta Section, 1975.

| X-Section Station Number (ft) | Stream discharge (cfs) | | | | |
|---|---|---|---|---|---|
| | 100 | 70 | 50 | 30 | 10 |
| 0 + 00 | 2.25 | 1.99 | 1.79 | 1.54 | 1.13 |
| 0 + 62 | 2.48 | 2.20 | 1.96 | 1.62 | 1.10 |
| 1 + 07 | 2.08 | 1.78 | 1.55 | 1.25 | .70 |
| 1 + 73 | 3.53 | 3.31 | 3.07 | 1.03 | 1.11 |
| 2 + 34 | 2.29 | 1.87 | 1.56 | 1.25 | 1.04 |

Table A2. Mean current velocity at each X-section and stream discharge for West Fork Bitterroot River - Rombo Section, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | |
|---|---|---|---|---|---|
| | 150 | 110 | 80 | 50 | 20 |
| 0 + 00 | 2.79 | 2.54 | 2.30 | 1.97 | 1.44 |
| 0 + 63 | 2.39 | 2.06 | 1.77 | 1.41 | .78 |
| 1 + 48 | 2.30 | 2.00 | 1.69 | 1.29 | .73 |
| 2 + 13 | 2.77 | 2.43 | 2.10 | 1.63 | .94 |
| 2 + 67 | 3.30 | 3.23 | 3.12 | 2.75 | 2.07 |

Table A3. Mean current velocity at each X-section and stream discharge for Nez Perce Fork Bitterroot River, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | | |
|---|---|---|---|---|---|---|
| | 60 | 40 | 30 | 20 | 15 | 10 |
| 0 + 00 | 2.24 | 1.98 | 1.81 | 1.59 | 1.46 | 1.29 |
| 0 + 28 | 1.66 | 1.32 | 1.12 | .88 | .74 | .57 |
| 0 + 71 | 2.73 | 2.45 | 2.31 | 2.09 | 1.92 | 1.45 |
| 1 + 06 | 1.40 | 1.17 | 1.02 | .84 | .74 | .67 |
| 1 + 91 | 2.47 | 2.28 | 2.13 | 1.92 | 1.80 | 1.66 |
| 2 + 56 | 1.83 | 1.48 | 1.27 | 1.01 | .84 | .61 |

Table A4. Mean current velocity at each X-section and stream discharge for Moose Creek, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | |
|---|---|---|---|---|---|
| | 40 | 30 | 20 | 10 | 5 |
| 0 + 00 | 1.75 | 1.58 | 1.37 | 1.07 | .85 |
| 0 + 24 | 1.94 | 1.71 | 1.43 | 1.02 | .69 |
| 0 + 57 | 3.22 | 2.98 | 2.66 | 1.22 | 1.05 |
| 0 + 86 | 3.61 | 3.46 | 3.20 | .77 | 1.98 |
| 1 + 17 | 1.89 | 1.58 | 1.24 | .93 | .66 |
| 1 + 59 | 3.59 | 3.64 | 3.66 | 3.02 | 1.60 |

Table A5. Mean current velocity at each X-section and stream discharge for East Fork Bitterroot River, Mink Creek Section, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | |
|---|---|---|---|---|---|
| | 150 | 120 | 85 | 55 | 35 |
| 0 + 00 | 2.84 | 2.65 | 2.38 | 2.05 | 1.74 |
| 0 + 30 | 3.31 | 3.06 | 2.73 | 2.39 | 1.98 |
| 0 + 88 | 3.82 | 3.55 | 3.18 | 2.75 | 2.37 |
| 1 + 39 | 3.07 | 2.98 | 2.77 | 2.46 | 2.15 |
| 1 + 88 | 2.44 | 2.33 | 2.21 | 2.14 | 2.10 |
| 2 + 41 | 2.54 | 2.41 | 2.24 | 2.04 | 1.84 |
| 2 + 77 | 2.08 | 1.87 | 1.58 | 1.25 | .95 |

Table A6. Mean current velocity at each X-section and stream discharge for East Fork Bitterroot River-Spring Gulch Section, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | | |
|---|---|---|---|---|---|---|
| | 200 | 150 | 100 | 80 | 60 | 40 |
| 0 + 00 | 2.36 | 2.15 | 1.90 | 1.78 | 1.64 | 1.46 |
| 0 + 50 | 2.29 | 2.01 | 1.66 | 1.50 | 1.31 | 1.08 |
| 0 + 84 | 3.16 | 2.83 | 2.39 | 2.14 | 1.83 | 1.44 |
| 1 + 10 | 2.88 | 2.86 | 2.92 | 2.94 | 2.96 | 2.91 |
| 1 + 86 | 3.02 | 2.73 | 2.23 | 1.96 | 1.61 | 1.18 |
| 2 + 64 | 2.37 | 2.05 | 1.65 | 1.46 | 1.25 | .97 |

Table A7. Mean current velocity at each X-section and stream discharge for Bitterroot River - Darby Section, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | |
|---|---|---|---|---|---|
| | 500 | 400 | 300 | 100 | 50 |
| 0 + 00 | 2.51 | 2.34 | 2.16 | 1.63 | 1.41 |
| 1 + 22 | 2.10 | 1.85 | 1.56 | .78 | .48 |
| 2 + 62 | 1.66 | 1.49 | 1.28 | .64 | .38 |
| 4 + 76 | 2.01 | 1.74 | 1.43 | .63 | .36 |
| 6 + 14 | 1.42 | 1.20 | .96 | .39 | .21 |

Table A8. Mean current velocity at each X-section and stream discharge for Tin Cup Creek, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | | |
|---|---|---|---|---|---|---|
| | 40 | 34 | 25 | 15 | 10 | 5 |
| 0 + 00 | 1.98 | 1.89 | 1.77 | 1.55 | 1.39 | 1.15 |
| 0 + 22 | 1.12 | 1.03 | .90 | .75 | .67 | .63 |
| 0 + 60 | .72 | .65 | .54 | .38 | .28 | .17 |
| 0 + 93 | .71 | .64 | .52 | .36 | .27 | .17 |
| 1 + 15 | 2.94 | 2.83 | 2.68 | 2.51 | 2.37 | 1.37 |

Table A9. Mean current velocity at each X-section and stream discharge for Sleeping Child Creek, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | |
|---|---|---|---|---|
| | 30 | 20 | 15 | 5 |
| 0 + 00 | 1.60 | 1.41 | 1.29 | .88 |
| 0 + 23 | 2.69 | 2.40 | 2.21 | 1.48 |
| 0 + 54 | 3.59 | 3.42 | 3.27 | 2.40 |
| 0 + 76 | 2.31 | 1.69 | 1.35 | .63 |
| 1 + 10 | 2.07 | 1.66 | 1.39 | .75 |

Table A10. Mean current velocity at each X-section and stream discharge for Skalkaho Creek, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | |
|---|---|---|---|---|---|
| | 80 | 60 | 30 | 20 | 10 |
| 0 + 00 | 3.19 | 2.92 | 2.35 | 2.06 | 1.67 |
| 0 + 25 | 1.90 | 1.60 | .96 | .69 | .39 |
| 0 + 80 | 2.51 | 2.37 | 1.92 | 1.74 | 1.39 |
| 1 + 31 | 2.50 | 2.33 | 2.10 | 2.00 | 1.65 |
| 1 + 72 | 2.24 | 2.01 | 1.63 | 1.54 | 1.39 |
| 1 + 88 | 2.06 | 1.80 | 1.26 | 1.01 | .68 |

Table A11. Mean current velocity at each X-section and stream discharge for Bitterroot River - Anglers Roost Section, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | | |
|---|---|---|---|---|---|---|
| | 500 | 300 | 200 | 100 | 50 | 20 |
| 2 + 21 | 2.96 | 2.65 | 2.50 | 2.42 | 2.40 | 1.93 |
| 3 + 71 | 2.78 | 2.31 | 1.94 | 1.36 | .92 | .79 |
| 5 + 71 | 1.85 | 1.44 | 1.17 | .80 | .51 | .26 |
| 9 + 91 | 1.12 | .76 | .55 | .32 | .18 | .08 |
| 12 + 86 | 2.13 | 1.61 | 1.28 | .85 | .54 | .27 |

Table A12. Mean current velocity at each X-section and stream discharge for Big Creek, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | | |
|---|---|---|---|---|---|---|
| | 104 | 80 | 60 | 40 | 20 | 10 |
| 0 + 00 | 3.65 | 3.39 | 3.12 | 2.78 | 2.28 | 1.94 |
| 0 + 19 | 2.67 | 2.39 | 2.11 | 1.76 | 1.40 | 1.10 |
| 0 + 42 | 2.90 | 2.63 | 2.36 | 2.05 | 1.68 | 1.39 |
| 0 + 75 | 2.61 | 2.31 | 2.00 | 1.63 | 1.12 | .74 |
| 0 + 96 | 3.27 | 2.94 | 2.63 | 2.27 | 1.79 | 1.43 |
| 1 + 09 | 4.11 | 3.83 | 3.54 | 3.17 | 2.62 | 2.15 |

Table A13. Mean current velocity at each X-section and stream discharge for Kootenai Creek, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | |
|---|---|---|---|---|
| | 40 | 30 | 15 | 5 |
| 0 + 00 | 1.49 | 1.38 | 1.21 | 1.05 |
| 0 + 35 | 2.06 | 1.84 | 1.27 | .69 |
| 0 + 61 | 1.42 | 1.14 | .68 | .28 |
| 0 + 76 | 1.90 | 1.57 | .99 | .46 |
| 1 + 11 | 3.25 | 3.03 | 3.02 | 1.01 |
| 1 + 63 | 1.62 | 1.45 | .24 | .68 |

Table A14. Mean current velocity at each X-section and stream discharge for Bitterroot River - Stevensville Section, 1975.

| X-Section Station Number (ft) | Stream discharge (cfs) | | | | | |
|---|---|---|---|---|---|---|
| | 1121 | 900 | 700 | 500 | 300 | 100 |
| 0 + 00 | 3.97 | 3.62 | 3.49 | 3.20 | 2.81 | 2.12 |
| 1 + 66 | 3.13 | 2.82 | 2.48 | 2.08 | 1.61 | .89 |
| 3 + 21 | 3.14 | 2.81 | 2.47 | 2.05 | 1.55 | .83 |
| 4 + 79 | 3.41 | 3.14 | 2.85 | 2.49 | 2.06 | 1.39 |
| 8 + 29 | 4.41 | 4.30 | 4.17 | 3.95 | 3.55 | 2.66 |

Table A15. Mean current velocity at each X-section and stream discharge for Burnt Fork Creek, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 125 | 108 | 75 | 50 | 35 | 25 | 15 |
| 0 + 00 | 2.48 | 2.38 | 2.13 | 1.88 | 1.68 | 1.51 | 1.28 |
| 0 + 40 | 2.83 | 2.70 | 2.40 | 2.13 | 1.92 | 1.77 | 1.60 |
| 0 + 73 | 2.98 | 2.82 | 2.48 | 2.17 | 1.91 | 1.66 | 1.31 |
| 1 + 23 | 3.59 | 3.40 | 2.98 | 2.57 | 2.27 | 2.03 | 1.74 |
| 1 + 76 | 4.30 | 4.14 | 3.73 | 3.32 | 3.01 | 2.08 | 2.79 |
| 2 + 19 | 4.52 | 4.32 | 3.86 | 3.38 | 1.25 | 2.48 | 1.49 |
| 2 + 92 | 2.00 | 1.83 | 1.44 | 1.10 | 2.00 | .88 | 1.39 |
| 3 + 36 | 3.94 | 3.73 | 3.18 | 2.63 | 3.42 | 2.25 | 2.50 |

Table A16. Mean current velocity at each X-section and stream discharge for Bitterroot River - Florence Section, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | |
|---|---|---|---|---|---|
| | 1100 | 800 | 600 | 400 | 200 |
| 0 + 00 | 2.75 | 2.51 | 2.31 | 2.05 | 1.66 |
| 4 + 80 | 3.16 | 3.13 | 3.08 | 2.94 | 2.60 |
| 8 + 40 | 2.85 | 2.74 | 2.56 | 2.24 | 1.65 |
| 13 + 40 | 1.91 | 1.67 | 1.47 | 1.22 | .84 |
| 15 + 10 | 2.21 | 2.01 | 1.82 | 1.54 | 1.14 |
| 16 + 80 | 3.10 | 2.89 | 2.72 | 2.47 | 1.89 |
| 21 + 40 | 3.26 | 3.18 | 3.10 | 2.95 | 2.62 |

Table A17. Mean current velocity at each X-section and stream discharge for Lolo Cr.-Upper Elk Meadows Section, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | |
|---|---|---|---|---|---|
| | 65 | 50 | 40 | 30 | 10 |
| 0 + 00 | 1.44 | 1.33 | 1.25 | 1.14 | .81 |
| 0 + 50 | 1.43 | 1.34 | 1.29 | 1.24 | 1.10 |
| 1 + 17 | 2.08 | 2.07 | 2.05 | 1.97 | .27 |
| 1 + 63 | 2.49 | 2.20 | 1.95 | 1.66 | .51 |
| 1 + 96 | 2.33 | 2.13 | 1.96 | 1.75 | .73 |
| 2 + 50 | 1.69 | 1.45 | 1.23 | 1.00 | .42 |
| 2 + 96 | 3.27 | 2.07 | 1.61 | 1.45 | 1.15 |
| 3 + 61 | 1.93 | 1.88 | 1.72 | 1.44 | .89 |

Table A18. Mean current velocity at each X-section and stream discharge for Lolo Creek-Upper Mormon Peak Section, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 241 | 200 | 150 | 100 | 80 | 60 | 40 | 20 |
| 0 + 00 | 3.13 | 2.94 | 2.67 | 2.32 | 2.16 | 1.95 | 1.69 | 1.32 |
| 0 + 58 | 2.74 | 2.54 | 2.24 | 1.86 | 1.66 | 1.43 | 1.15 | .73 |
| 1 + 60 | 3.50 | 3.31 | 3.04 | 2.68 | 2.50 | 2.29 | 2.03 | .75 |
| 2 + 66 | 3.30 | 3.14 | 2.88 | 2.50 | 2.31 | 2.06 | 1.71 | 1.33 |
| 3 + 56 | 3.35 | 3.26 | 2.95 | 2.57 | 2.38 | 2.16 | 1.88 | 1.51 |
| 4 + 38 | 2.99 | 2.92 | 2.75 | 2.57 | 2.46 | 2.33 | 2.18 | 1.74 |
| 4 + 77 | 2.75 | 2.67 | 2.47 | 2.25 | 2.15 | 2.06 | 1.97 | 1.93 |
| 6 + 01 | 2.81 | 2.61 | 2.30 | 1.89 | 1.67 | 1.41 | 1.04 | .51 |
| 7 + 05 | 3.27 | 3.07 | 2.74 | 2.28 | 2.05 | 1.77 | 1.40 | .78 |
| 8 + 21 | 3.94 | 3.82 | 3.67 | 3.45 | 3.32 | 3.10 | 2.75 | 2.08 |
| 9 + 18 | 3.83 | 3.60 | 3.28 | 2.90 | 2.72 | 2.55 | 2.44 | 2.25 |

Table A19. Mean current velocity at each X-section and stream discharge for Maclay's Bridge, 1975.

| X-Section Station number (ft) | Stream discharge (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2000 | 1500 | 1000 | 800 | 600 | 400 | 200 |
| 0 + 00 | 2.99 | 2.71 | 2.37 | 2.18 | 1.96 | 1.69 | 1.33 |
| 6 + 20 | 3.45 | 3.09 | 2.66 | 2.46 | 2.19 | 1.84 | 1.30 |
| 11 + 10 | 3.57 | 3.32 | 3.01 | 2.84 | 2.65 | 2.39 | 1.97 |
| 15 + 10 | 3.40 | 3.00 | 2.48 | 2.24 | 1.93 | 1.53 | .98 |
| 18 + 20 | 2.64 | 2.24 | 1.76 | 1.54 | 1.28 | .98 | .62 |
| 19 + 30 | 3.25 | 2.88 | 2.38 | 2.12 | 1.81 | 1.43 | .91 |

Table B1. Tributary streams to the Bitterroot River, East Fork Bitterroot River and West Fork Bitterroot River that could be included in minimum in stream flow reservations. Bitterroot River Drainage area encompasses 2,851 mi.[2/] and flows into the Clark Fork of the Columbia at River Mile 350.5.

| Bitterroot River Mile | Name | Stream Flow Records | Source of Records | Period of Record | Location |
|---|---|---|---|---|---|
| 0.8 | O'Brien Creek | No | | | |
| 6.6 | Hayes Creek | No | | | |
| 7.2 | Miller Creek | No | | | |
| 11.8 | Lolo Creek | No | | | |
| 13.5 | Davis Creek | No | | | |
| 16.2 | Carlton Creek | No | | | |
| 18.9 | Woodchuck Creek | No | | | |
| 22.64 | Eightmile Creek | No | | | |
| 26.1 | Ambrose Creek | No | | | |
| 28.1 | Bass Creek | No | | | |
| 31.8 | Burnt Fork Creek | No | | | |
| 32.1 | Kootenai Creek | Yes | USGS | 1948-53<br>1957-73 | near Stevensville |
| 32.4 | Mill Creek | No | | | |
| 32.5 | McCallo Creek | No | | | |
| 36.3 | Big Creek | No | | | |
| 39.0 | Sweathouse Creek | No | | | |
| 41.2 | Bear Creek | Yes | USGS | 1938-54<br>1957-59 | near Victor |
| 46.4 | Mill Creek | No | | | |
| 50.7 | Blodgett Creek | Yes | SCS,USGS<br>USFS | 1947-69 | near Corvallis |
| 54.2 | Canyon Creek | No | | | |
| 54.6 | Sawtooth Creek | No | | | |

Table B1. Cont'd.

| Bitterroot River Mile | Name | Stream Flow Records | Source of Records | Period of Record | Location |
|---|---|---|---|---|---|
| 55.1 | Roaring Lion Cr | No | | | |
| 55.6 | Skalkaho Creek | Yes | USGS | 1957-present | near Hamilton |
| 58.8 | Judd Creek | No | | | |
| 60.4 | Sleeping Child Cr | No | | | |
| 61.3 | Camas Creek | No | | | |
| 64.0 | Hays Creek | No | | | |
| 64.8 | Lost Horse Cr | No | | | |
| 66.2 | Harlan Creek | No | | | |
| 66.9 | Lick Creek | No | | | |
| 68.4 | Rock Creek | No | | | |
| 69.1 | Jerry Gulch | No | | | |
| 70.2 | Waddel Creek | No | | | |
| 72.1 | Bunkhouse Cr | No | | | |
| 72.8 | Burk Creek | No | | | |
| 74.4 | Tin Cup Creek | No | | | |
| 75.2 | McCoy Creek | No | | | |
| 77.5 | Chaffin Creek | No | | | |
| 78.1 | Rye Creek | No | | | |
| 80.2 | Confluence of East fork and West Fork of Bitterroot | No | | | |
| East Fork of Bitterroot River (4th order) | | Yes | USGS,SCS USFS | 1956-72 | near Conner |
| 0.2 | Whitsett Creek | No | | | |
| 1.55 | Robbins Gulch | No | | | |
| 3.0 | Dickson Creek | No | | | |
| 3.5 | Medicine Tree Cr | No | | | |
| 7.00 | Moon Cr | No | | | |
| 7.6 | Elk Gulch | No | | | |
| 9.1 | Warm Spring Cr | No | | | |
| 9.1 | Spring Gulch | No | | | |
| 11.0 | Maynard Creek | No | | | |
| 12.0 | Cameron Cr | No | | | |
| 12.5 | Camp Cr | No | | | |
| 14.3 | Reime Creek | No | | | |
| 16.2 | Tolan Creek | No | | | |
| 16.2 | Bunch Gulch | No | | | |
| 17.8 | Mink Creek | No | | | |
| 19.3 | Springer Creek | No | | | |
| 20.8 | Guide Creek | No | | | |
| 21.5 | Jennings Camp Cr | No | | | |
| 24.15 | Bertie Lord Cr | No | | | |
| 24.25 | Meadow Creek | No | | | |
| 25.0 | Tepee Creek | No | | | |

Table B1. Cont'd.

| Bitterroot River Mile | Name | Stream Flow Records | Source of Records | Period of Record | Location |
|---|---|---|---|---|---|
| 27.0 | Moose Creek | No | | | |
| 27.6 | Needle Creek | No | | | |
| 29.5 | Orphan Creek | No | | | |
| 29.5 | Ness Creek | No | | | |
| 30.4 | Cub Creek | No | | | |
| 30.7 | Carmine Creek | No | | | |
| 32.2 | Clifford Creek | No | | | |
| 33.1 | Buck Creek | No | | | |
| 34.6 | Star Creek | No | | | |
| 36.35 | Alpine Creek | No | | | |
| 36.40 | Park Creek | No | | | |
| West Fork Bitterroot River (4th order) | | Yes | USGS,SCS USFS | 1941-present | near Conner |
| 4.2 | Trapper Creek | No | | | |
| 6.45 | Baker Creek | No | | | |
| 6.45 | Piquett Creek | No | | | |
| 8.3 | Christian Creek | No | | | |
| 9.2 | Lavene Creek | No | | | |
| 11.0 | Boulder Creek | No | | | |
| 12.0 | Swamp Creek | No | | | |
| 12.8 | Nez Perce Fork | No | | | |
| 13.8 | Beavertail Creek | No | | | |
| 16.4 | Ditch Creek | No | | | |
| 19.8 | West Fork Dam Spillway | No | | | |
| 19.9 | Little Boulder | No | | | |
| 20.4 | Slate Creek | No | | | |
| 20.5 | Blue Joint Creek | No | | | |
| 21.7 | Overwhich Creek | No | | | |
| 26.7 | Hughes Creek | No | | | |
| 28.9 | Deer Creek | No | | | |
| 30.9 | Woods Creek | No | | | |
| 32.4 | Salt Creek | No | | | |
| 34.0 | Beaver Creek | No | | | |

Table 14. Percent of potential aquatic habitat at various stream discharges on Lolo Creek study sections sampled in 1975.

| Discharge (cfs) | Stream width (%) | Pool width (%) | Riffle width ≥1.0 ft. depth (%) | Pool width ≥0.5 ft. depth & overhead cover (%) | Pool width ≥2.0 ft. depth (%) |
|---|---|---|---|---|---|
| | | | Lolo Creek Upper Elk Meadows Section | | |
| 65 | 100 | 100 | 100 | 100 | 100 |
| 50 | 89 | 93 | 90 | 94 | 85 |
| 40 | 86 | 89 | 86 | 94 | 85 |
| 30 | 81 | 85 | 77 | 90 | 78 |
| 10 | 72 | 73 | 65 | 84 | 55 |
| | | | Lolo Creek Upper Mormon Peak Section | | |
| 241 | 100 | 100 | 100 | 100 | 100 |
| 200 | 97 | 98 | 94 | 83 | 51 |
| 150 | 92 | 93 | 75 | 66 | 6 |
| 100 | 85 | 86 | 51 | 53 | 0 |
| 80 | 81 | 85 | 33 | 44 | 0 |
| 60 | 79 | 82 | 25 | 40 | 0 |
| 40 | 74 | 80 | 15 | 33 | 0 |
| 20 | 68 | 76 | 4 | 23 | 0 |

Sleeping Child Creek

Sleeping Child Creek is located on the east side of the Bitterroot Valley. Fish habitat functions most sensitive to changes in discharge include riffle areas and cover (Tables 15 and 16). The majority of cover is provided by pools which are created around boulders (Table 2).

The Hot Spring development located in this drainage will require sufficient dilution water to prevent high water temperatures downstream. Hot water flushing of swimming pools at the Hot Springs development have caused extreme water temperature fluctuations in the past (Figure 4).

Table 15. Summary of fish habitat data derived from the Water Surface Profile Program on the Sleeping Child Creek, 1975.

| Discharge (cfs) | Mean width (ft) | Mean pool width (ft) | Mean pool width ≥ 2.0 ft. depth (ft) | Mean pool width ≥ 0.5 ft. Depth + overhead cover (ft) | Mean width ≥ 1.0 ft. depth (ft) |
|---|---|---|---|---|---|
| 30 | 22 | 16 | 0 | 10.3 | 3.6 |
| 20 | 20 | 15 | 0 | 8.9 | 2.6 |
| 15 | 18 | 14 | 0 | 7.6 | 2.2 |
| 5 | 12 | 11 | 0 | 4.2 | 0.3 |

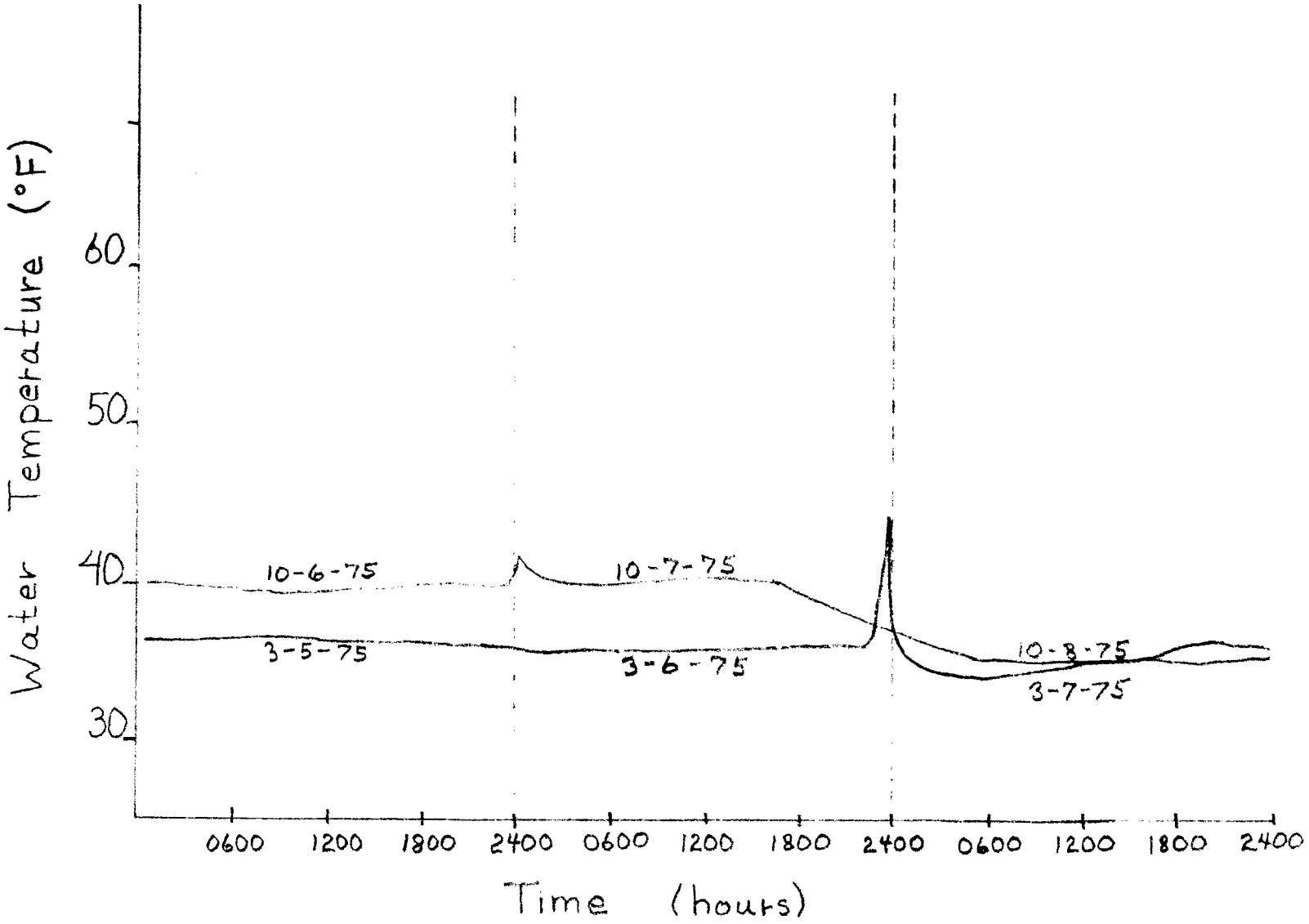


Figure 4. Plot of temperature increases associated with a discharge of warm water into Sleeping Child Creek, 0.3 mile below the hot springs outlet.