STUDIES ON POPULATION DENSITY AND LONGITUDINAL DISTRIBUTION OF FISHES IN BURNS CREEK, DAWSON AND RICHLAND COUNTIES, MONTANA

April 2000

By

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INTRODUCTION

Little research has inquired into the distribution, habitat requirements, and ecology of fishes in small prairie streams in eastern Montana. Clancey (1978) conducted a study of longitudinal distribution of fishes and aquatic habitats in Sarpy Creek, Big Horn and Treasure counties, to provide baseline information against which to assess potential impacts of coal mining in the area. Barfoot (1993) studied longitudinal distribution of fishes and aquatic habitats in Little Beaver Creek, Carter and Fallon counties, Montana, and Bowman and Slope counties, North Dakota, in order to examine the hypothesis that longitudinal zonation of fish communities in streams reflects primarily changes in stream geomorphology.

Several more extensive surveys have sought to develop baseline data on fish communities and habitats in eastern Montana in order to assess the potential impacts of future energy development, particularly strip mining of coal and on-site power generation, on these communities. The results of all these studies were collected and summarized by Elser et al. (1980).

Of these extensive surveys, two generated data on fish communities in smaller prairie streams. Elser et al. (1978) conducted an inventory of fishes and aquatic habitats in Beaver Creek, three of its tributaries, and seven north-flowing tributaries of the lower Yellowstone River. Morris et al. (1981) conducted a similar inventory of 45 tributaries of the lower Yellowstone River and assigned value ratings to each stream based on habitat and species value and recreational fishery potential.

Given the potential impacts of current land uses, including grazing and irrigated agriculture, and of future energy development on stream fish communities in eastern Montana, it would be desirable to learn more about the distribution and habitat requirements of stream fishes in the region. Moreover, from the perspective of basic ecological research, it would be interesting to further explore factors which influence longitudinal zonation of fish communities in small prairie streams.

After a driving and walking inspection of tributaries of the lower Yellowstone River in 1995 and 1996, we selected Burns Creek, Dawson and Richland counties, for a study of fish community density and longitudinal distribution. Selection criteria included perennial flow, relatively natural riparian areas, and good access. In addition, Morris et al. (1981) rated Burns Creek among the eight most valuable of the streams included in their inventory in terms of habitat for fishes of special concern in Montana, aesthetics, and local value for scientific research, nature study, and recreation.

During the summer of 1997, we conducted a semi-quantitative survey of fishes and habitats in Burns Creek in order to get a general idea of longitudinal distribution of fishes, types of aquatic habitats, and sampling problems and to get access permission from landowners (Barnes 1997). Based on the results of this survey, we designed a quantitative study of fish population densities, longitudinal distribution, and habitat variables, which was initiated on Burns Creek during the summer of 1998 (Barnes 1999). This report summarizes the results of a continuation of that study during the summer of 1999.

STUDY AREA

Burns Creek originates in northern Dawson County and flows southeast 99.4 km to its confluence with the Yellowstone River at river kilometer 97.8 near the town of Savage, approximately midway between Glendive and Sidney (Figure 1). Elevations range from 883.9 m at the headwaters to 597.8 m at the mouth, with an average gradient of 2.9 m/km (Figure 2). The major tributary of Burns Creek is its North Fork, which also originates in northern Dawson County and flows 78.3 km to its confluence with the mainstem 1.5 km downstream of the Dawson County Road 549 crossing. The Middle Fork originates midway between the headwaters of the mainstem and the North Fork and flows 49.9 km to its confluence with the North Fork. The whole system drains approximately 600 km^2 and is covered by 10 U.S. Geological Survey 7.5-minute standard topographic quadrangle maps (Savage SW, Knife River Mine, Allard Ranch, Intake NW, Red Top, McCone Heights, Butler Table, Enid SE, Enid, and Clay Butte).

The upland terrain of the Burns Creek watershed consists of rolling hills that have been dissected by Burns Creek and its tributaries into colorful badlands. Downstream of State Route 16, Burns Creek cuts through alluvial terraces and emerges onto the floodplain of the Yellowstone River. Upland land use is primarily agricultural. Cattle grazing predominates upstream of State Route 16, while irrigated crops of grains and sugar beets occupy most of the lowland terraces adjacent to the Yellowstone River. The Lower Yellowstone Project Main Canal, which originates at Intake about 12 km upstream of the mouth of Burns Creek and discharges into the Missouri River near Nohly, Montana, is the main source of irrigation water.

Aside from crops, upland vegetation of the watershed consists predominantly of grasses (Poaceae) and sagebrush (*Artemesia* spp.). Valley floors also support scattered stands of cottonwood (*Populus* sp.), Russian olive (*Eleagnus angustifolia*), and buffaloberry (*Shepherdia canadensis*). Riparian and littoral vegetation is dominated by grasses, sedges (*Carex* spp.), rushes (*Juncus* spp.), cattails (*Typha* spp.), snowberry (*Symphoricarpos* sp.), milkweed (*Asclepias* sp.), and willow (*Salix* sp.).

Geologically, the Burns Creek area is underlain by Cretaceous and Paleocene sedimentary rocks consisting primarily of highly erodible sandstones and shales. The lower part of the drainage below the North Fork confluence is overlain by Wisconsin glacial till. Exposed rocks in the upper part of the watershed consist of non-marine sediments of the Fort Union formation, which contains economically extractable deposits of coal and discharges significant amounts of groundwater (Alt and Hynd 1986, Morris et al, 1981).

The flow regime of Burns Creek, as measured from 1958 to 1986 at a gauging station 0.5 km upstream of the State Route 16 crossing, is typical of small prairie streams in eastern Montana (Figure 3). Mean monthly discharge is slightly greater than 1.0 m^3/sec in March, declining thereafter to late summer and winter lows of 0.1-0.5 m^3/sec. Mean annual discharge is about 0.2 m^3/sec. However, annual, monthly, and daily discharges are highly variable in response to long-term variations in annual precipitation and to short-term, local precipitation events, especially late spring and summer rainstorms. Mean annual flow has ranged from 0.015 m^3/sec (1961) to 0.580 m^3/sec (1979). The highest recorded daily mean discharge (42.45 m^3/sec) occurred on 20 March 1960 and again on 26 February 1986. Although zero flows were frequently recorded in August and September during the period of record, adjacent landowners report that the mainstem below Dawson County Road 549 has never in memory been completely dewatered. The relatively high diversity of the fish communities encountered during the 1997 survey, particularly up-

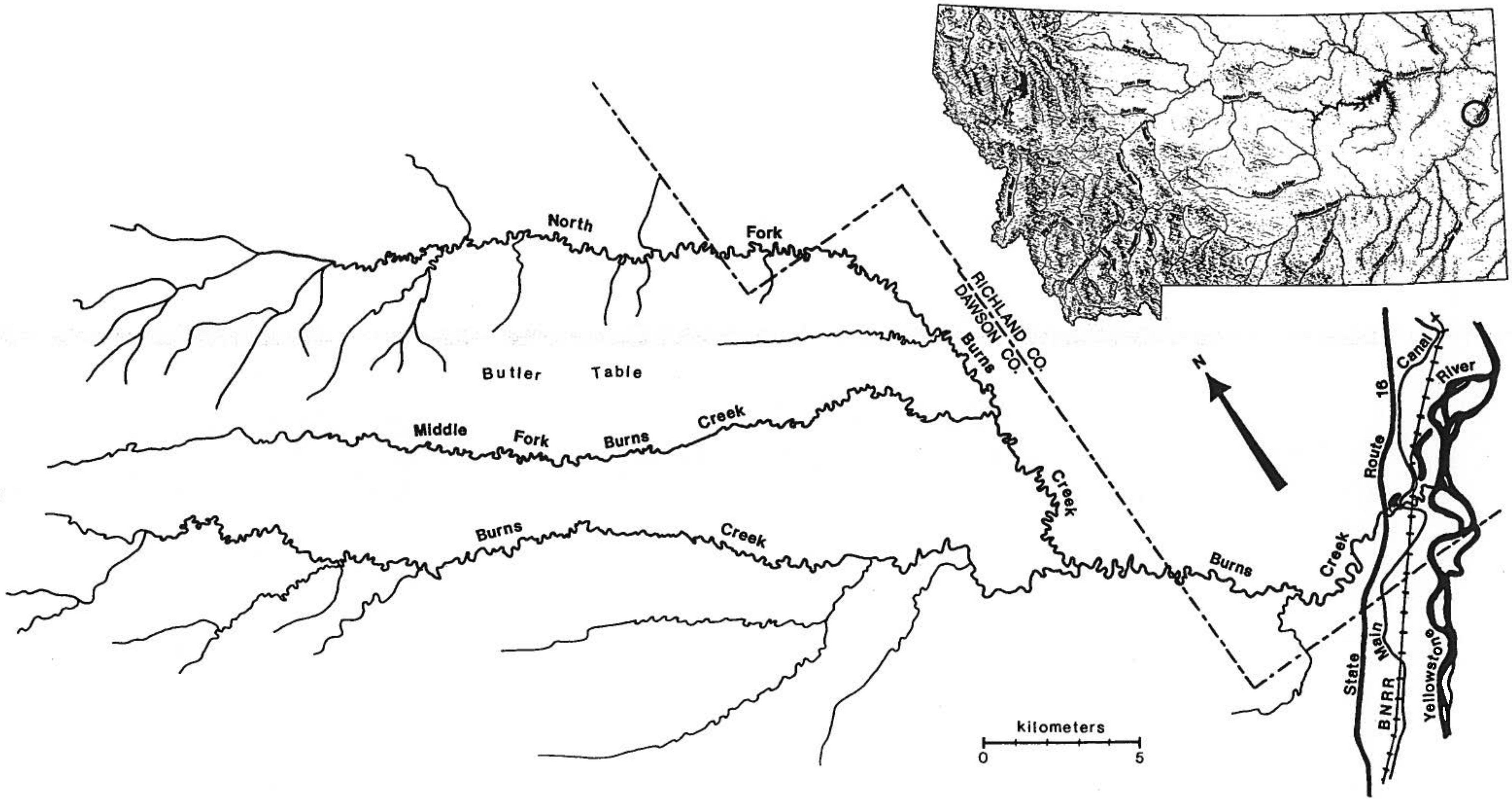


Figure 1. Map of the Burns Creek system, Dawson and Richland counties, eastern Montana (Inset map of Montana shows location of study area as a dark circle).

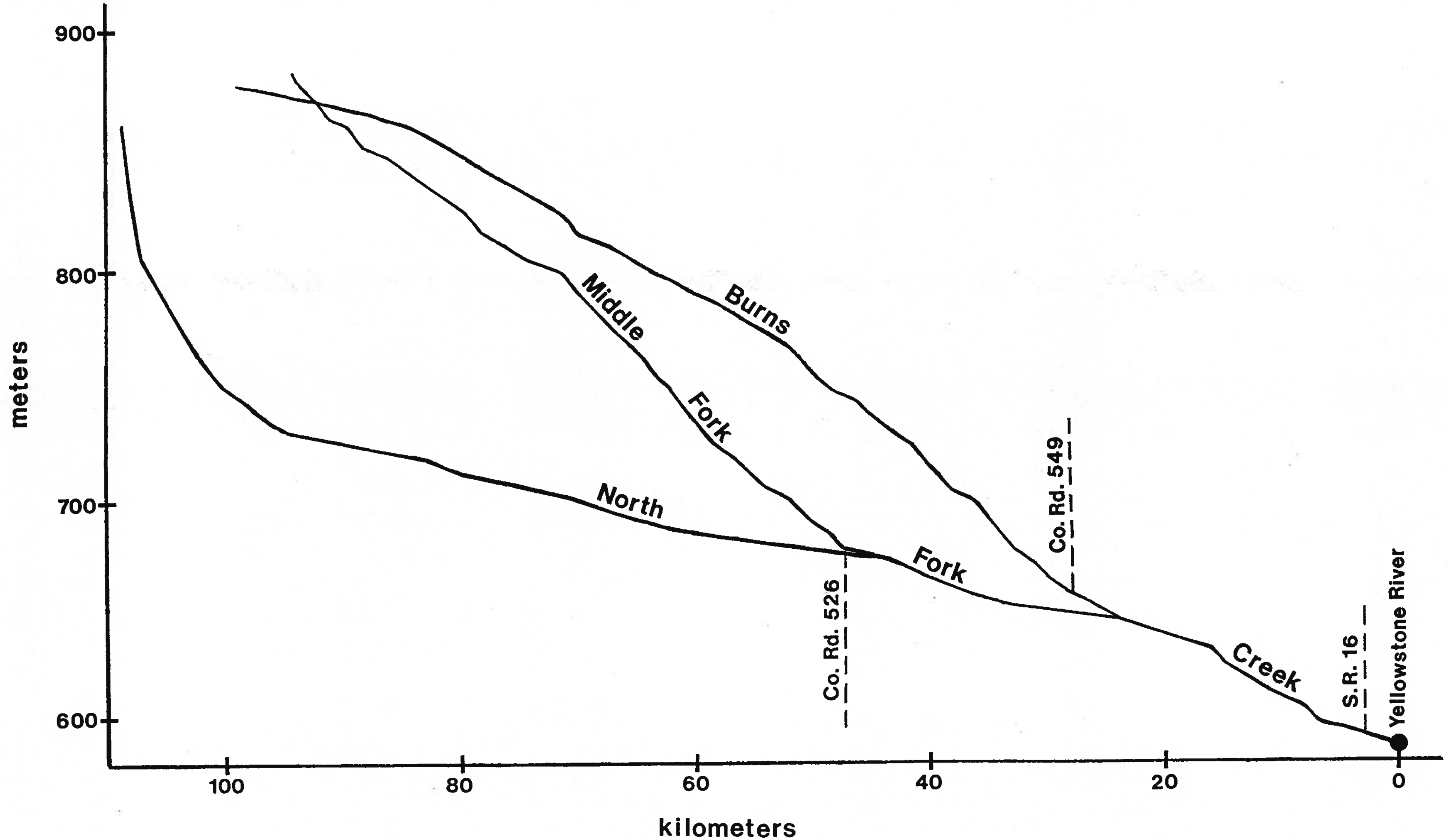


Figure 2. Stream length–elevation profile for the Burns Creek system, Dawson and Richland counties, Montana (determined directly from U.S. Geological Survey 7.5-minute topographic quadrangle maps).

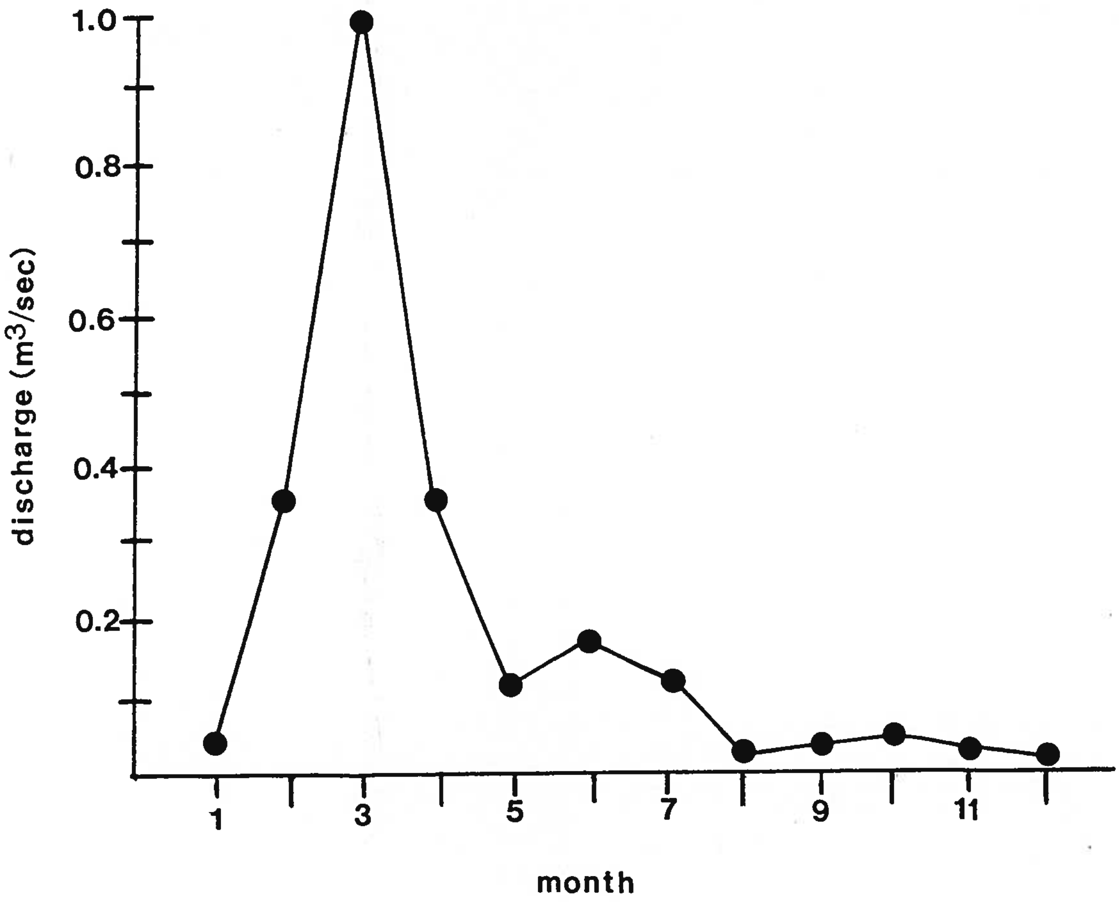


Figure 3. Mean monthly discharge (m^3/sec) of Burns Creek for period of record (1958-1967, 1976-1984, and 1986-1988)(U.S. Geological Survey 1996).

stream of the migration barrier posed by the Main Canal crossing, suggests that a minimal flow, or at least isolated pools, have always persisted in lower Burns Creek during periods of recorded zero flow.

The Burns Creek system can be divided into four sections based on flow regime and general habitat characteristics (Figures 1, 2, 4, and 5).

(1) Intermittent Upland Section. This section comprises the mainstem from its headwaters to just upstream of Dawson County Road 549, the North Fork from its headwaters to Dawson County Road 526, and all of the Middle Fork. These reaches appear to exhibit surface flow only in direct response to precipitation.

(2) Perennial Coldwater Section. This section comprises the mainstem from Road 549 to the North Fork confluence, the North Fork from Road 526 to to its mouth, and the "South Fork." The baseflow of these reaches apparently originates from groundwater discharge along a narrow zone of intersection between the stream channels and the regional aquifer at an elevation of approximately 670-680 m (Figures 2 and 4). Groundwater apparently emerges in a major seepage area marked by a large cattail marsh on either side of Road 549 south of the mainstem crossing. This represents the active baseflow of the mainstem. A smaller tributary we named the "South Fork" also emerges from the seepage area and flows into the mainstem just upstream of the North Fork confluence (Figures 4 and 5a). Water temperature at the Road 549 crossing was 12.0°C in 1997 and 14.0°C in 1998.

The North Fork appears to be a passive intersection of channel and water table. Except during stormflow events, it exhibits no measurable flow due to a slightly higher elevation of the channel bottom at the mouth relative to the rest of the channel bottom below Road 526. Water temperature was 14.5°C in 1997 and 19.0°C in 1998.

In this section, both the mainstem and North Fork channels are entrenched between banks 2-3 m high. The mainstem exhibited distinct riffle-run-pool development during 1997 but was impounded by a series of beaver dams in 1998 and 1999. The North Fork is one long pool habitat of varying depth, and its channel is filled with a dense growth of submerged aquatic vegetation, predominantly stonewort (*Chara* sp.) and coontail (*Ceratophyllum* sp.)(Figure 5b). In the coldwater reaches of both the mainstem and the North Fork, water clarity is generally high enough to render the bottoms of the deepest pools visible, except where obscured by submerged vegetation.

(3) Perennial Warmwater Section (Upper). This section comprises the mainstem from the North Fork confluence to the Main Canal crossing (Figure 4). From the North Fork confluence to the county line, the stream is impounded by a series of beaver dams, eliminating some riffle-run-pool development. Mean flow velocity decreases, turbidity increases to the point where bottoms of most pools are not visible, and summer water temperature ranges from 20-28°C. From the county line to the 90° bend in Richland County Road 100 (site 11), Burns Creek flows through two sections of private land which we could not enter due to lack of landowner permission. Below site 11, few beaver impoundments occur, and riffle-run-pool development is clearly defined (Figure 5d). Proceeding downstream, the channel becomes less entrenched until entrenchment banks are entirely absent (Figure 5e).

(4) Perennial Warmwater Section (Lower). This section comprises the mainstem from the Main Canal crossing to the mouth. At the Lower Yellowstone Project Main Canal, Burns Creek flows over a 3.3 x 3.7-m box culvert through which the canal passes, then drops steeply into a concrete plunge pool (Figure 5f). This forms a barrier to upstream movement by fishes from the lower

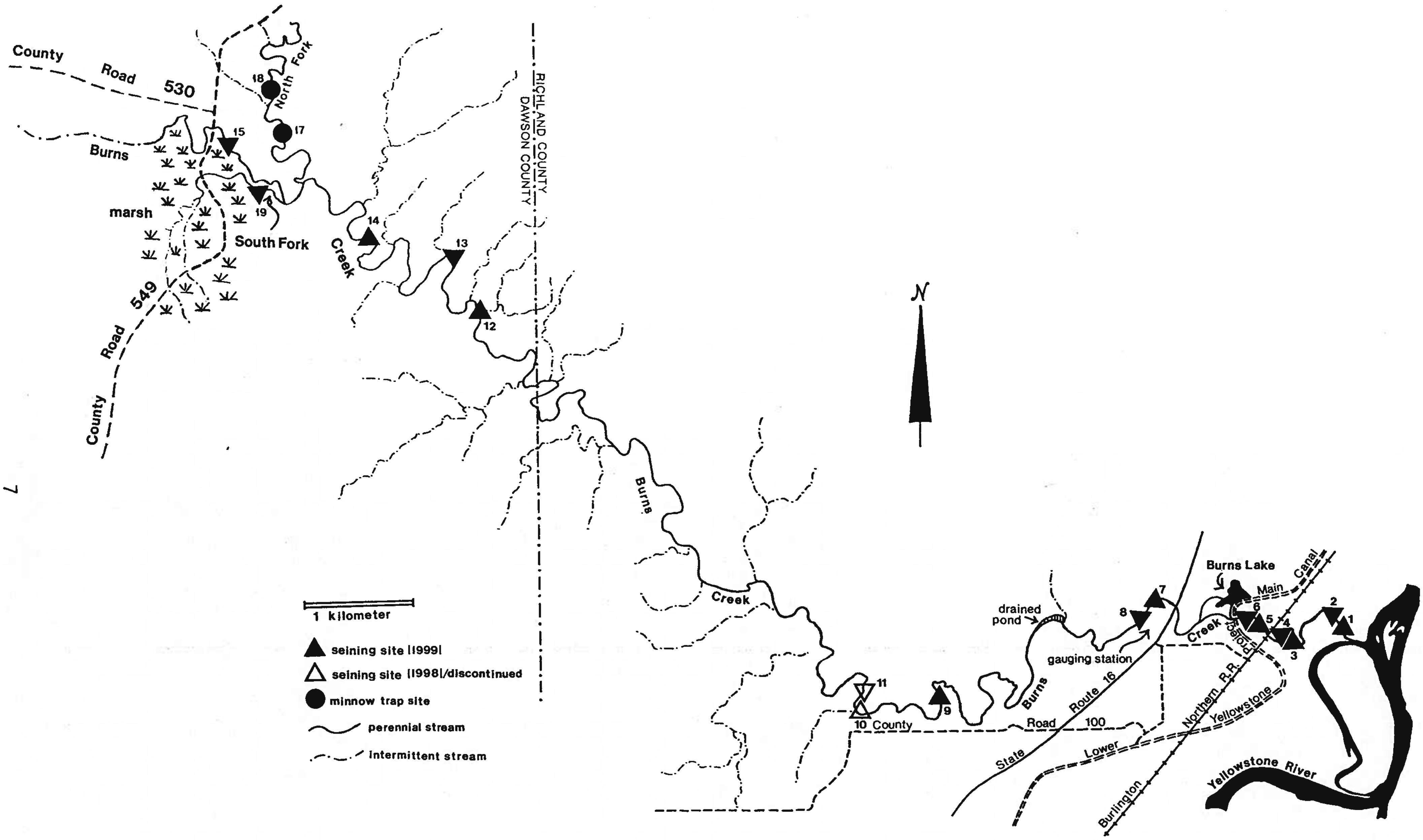
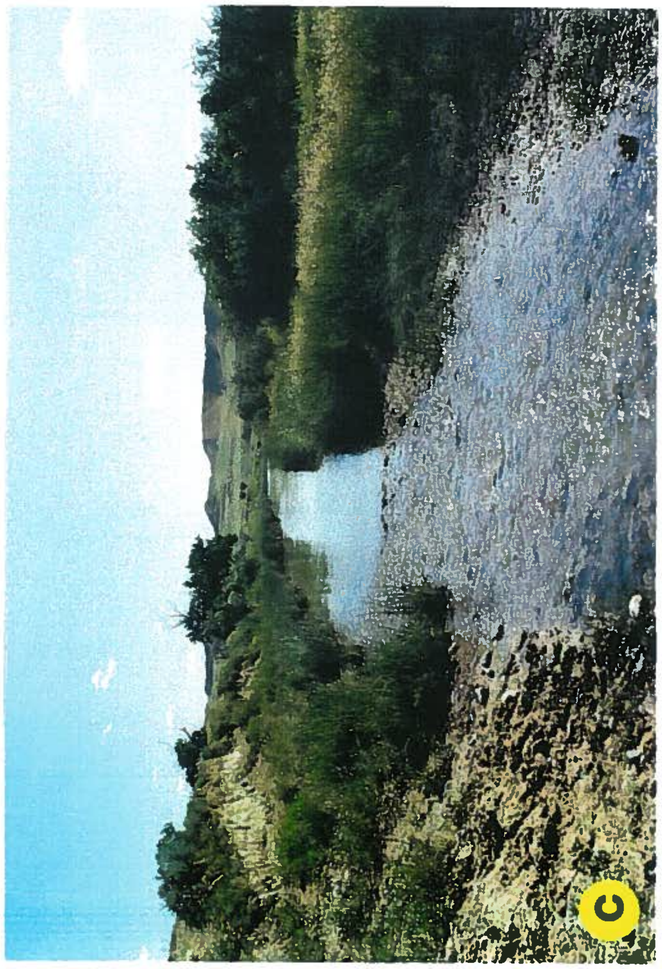


Figure 4. Lower Burns Creek system from Dawson County Road 549 to mouth.

Figure 5. **Photographs of selected sites in the Burns Creek system, Dawson and Richland counties, Montana, 28 July to 13 August 1999 (following two color pages).**

(a) Burns Creek just downstream of Dawson County Road 549 crossing (1999 site 15)
(b) North Fork Burns Creek (1999 site 18)
(c) Burns Creek (1999 site 13)
(d) Burns Creek (1999 site 9)
(e) Burns Creek (1999 site 7)
(f) Burns Creek at Lower Yellowstone Project Main Canal crossing
(g) Burns Creek at BLM land (1999 site 3)
(h) Burns Creek near mouth (1999 site 2); the beaver dam was not present during sampling in July-August 1998 and was constructed and washed out during the intervening year.


A

B

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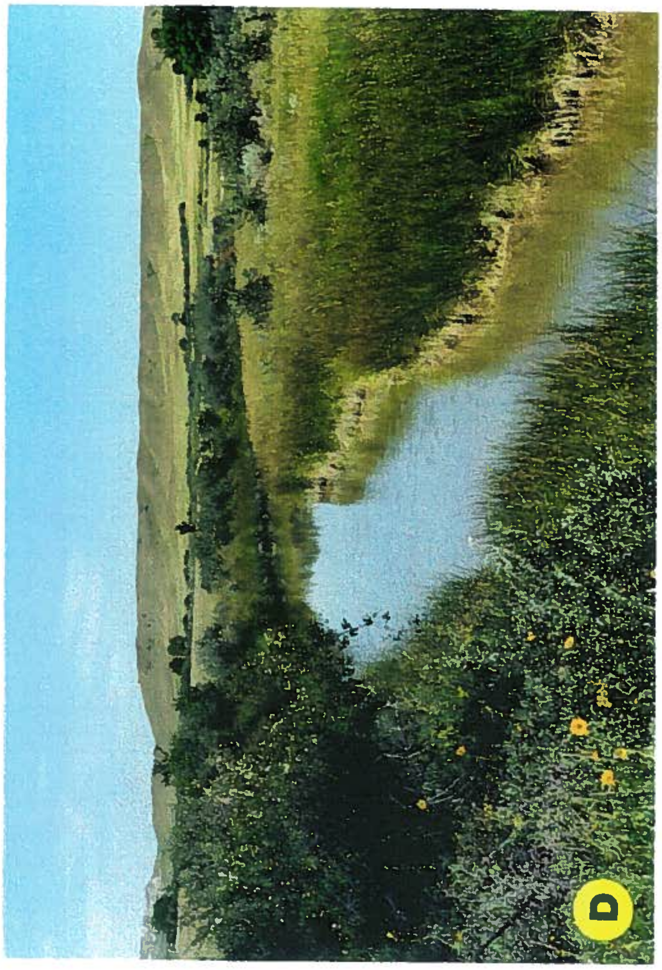
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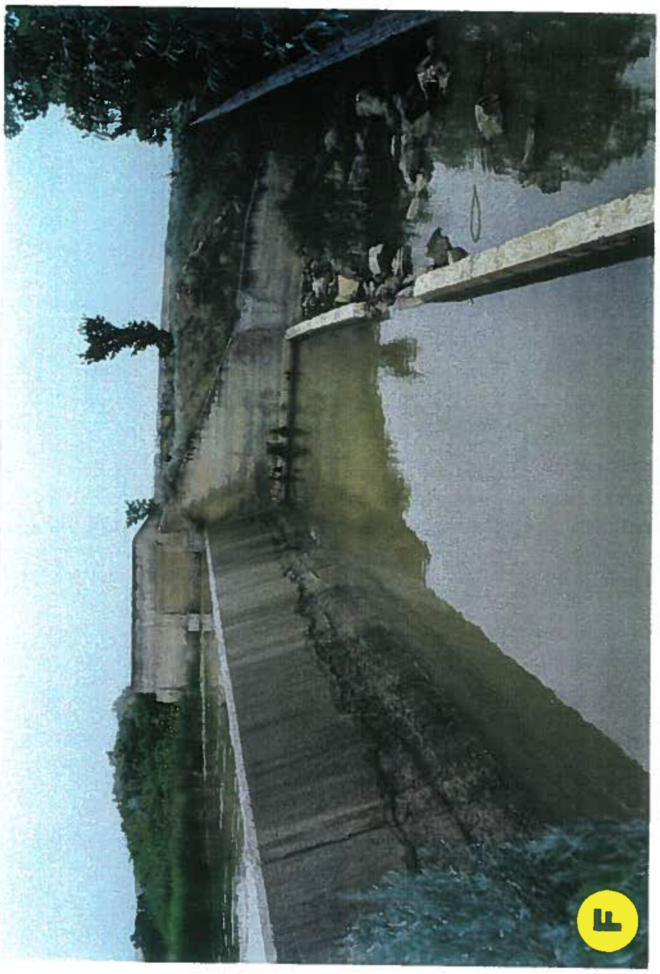
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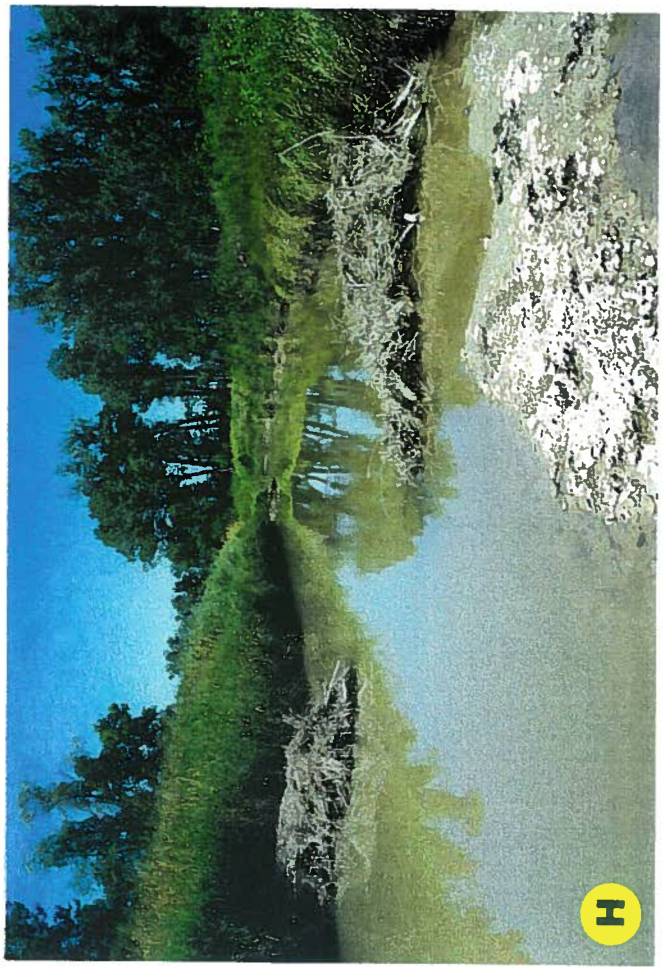
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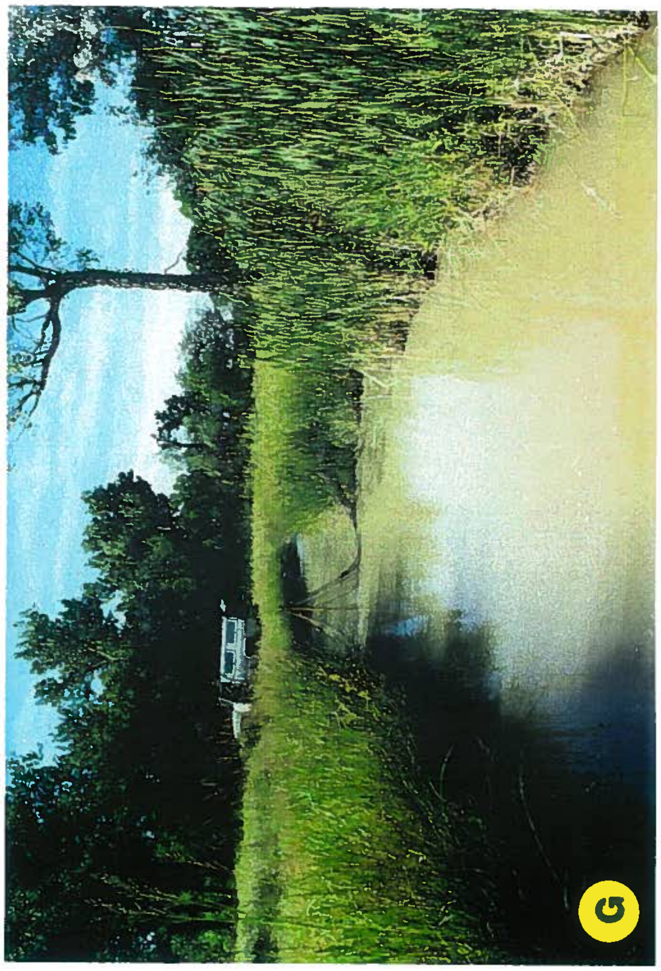
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section. Downstream from the canal crossing to the mouth, riffle-run-pool development is clearly defined, with few active beaver impoundment, and the channel gradually becomes more entrenched until it is confined between banks 1-2 m high near the mouth. Water in this section is relatively turbid, such that the bottoms of most pools are not visible (Figures 5g and 5h). Water temperatures ranged from 22.0-23.5°C in 1997 and from 18.0-27.0°C in 1998.

The riparian zone of the North Fork and mainstem of Burns Creek in sections 2,3, and 4 are generally well vegetated to water's edge. Most of the adjacent land is grazed, but steep entrenchment banks at some locations and apparent use of grazing rotation systems seem to minimize livestock impacts on stream banks.

Downstream of the Burlington Northern Railroad crossing (Figure 4), Burns Creek flows through an apparently ungrazed parcel of Bureau of Land Management (BLM) land., and, approaching the mouth, through a parcel of private land where the owner has allowed vegetation to grow wild for several years in order to encourage wildlife populations (Figures 5g and 5h). Grasses and other herbaceous vegetation are dense, high, and continuous with riparian vegetation to the streambanks. Stands of Russian olive, willows, cottonwoods, and buffaloberry are also more extensive than in upstream sections of the system, and a mature gallery forest of cottonwoods occupies the floodplain terrace adjacent to the mouth of the stream.

MATERIALS AND METHODS

Fish population densities and macrohabitat variables were measured or estimated at 17 sites in Burns Creek, the North Fork, and the "South Fork" during the period 28 July to 13 August 1999 (Figures 4 and 6). Correspondence of 1998 and 1999 sites was as follows:

(1999)	1	2	3	4	5	6	7	8	9	--	--	12	13	14	15	16	17	18	19
(1998)	1	2	3	4	5	6	7	8	9	10	11	--	--	12	13	14	15	--	16

Sites 12 and 13 were new sites in 1999, and sites 10 and 11, sampled in 1998, were not sampled in 1999 due to lack of permission from a new landowner. Site 16, not shown in Figure 4, was located in the intermittent section of the mainstem at the Dawson County Road 530 crossing approximately 5 km upstream of of site 15. A site was generally defined as one contiguous riffle-run-pool, with these three habitat units defined according to Armantrout (1998). The North Fork lacked riffles and runs, so sites 17 and 18 were defined as 40-m lengths of pool habitat. The "South Fork" was one long run, so we defined site 19 as a 40-m length of run habitat. Similarly, only 40-m lengths of extremely long pools and runs at other sites were included in fish and macrohabitat sampling.

Upon arrival at each site, a 300-ft (91.4-m) fiberglass measuring tape* was laid from downstream to upstream the entire length of the site to serve as a baseline for measuring habitat unit lengths, installing block seines, determining flow velocity, and spacing macrohabitat sampling transects. A water sample for total suspended solids was then collected at the upper end of the site, and initial water and air temperatures were taken at the lower end of the site. Block seines were then installed for fish sampling, if applicable. After fish sampling, macrohabitat variables were measured or estimated as described below.

Minnow traps (length = 38.1 cm; outer diameter = 17.8 cm; entry port di-

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*Model KL-300-18, Kelson Industries, Inc., Naperville, IL

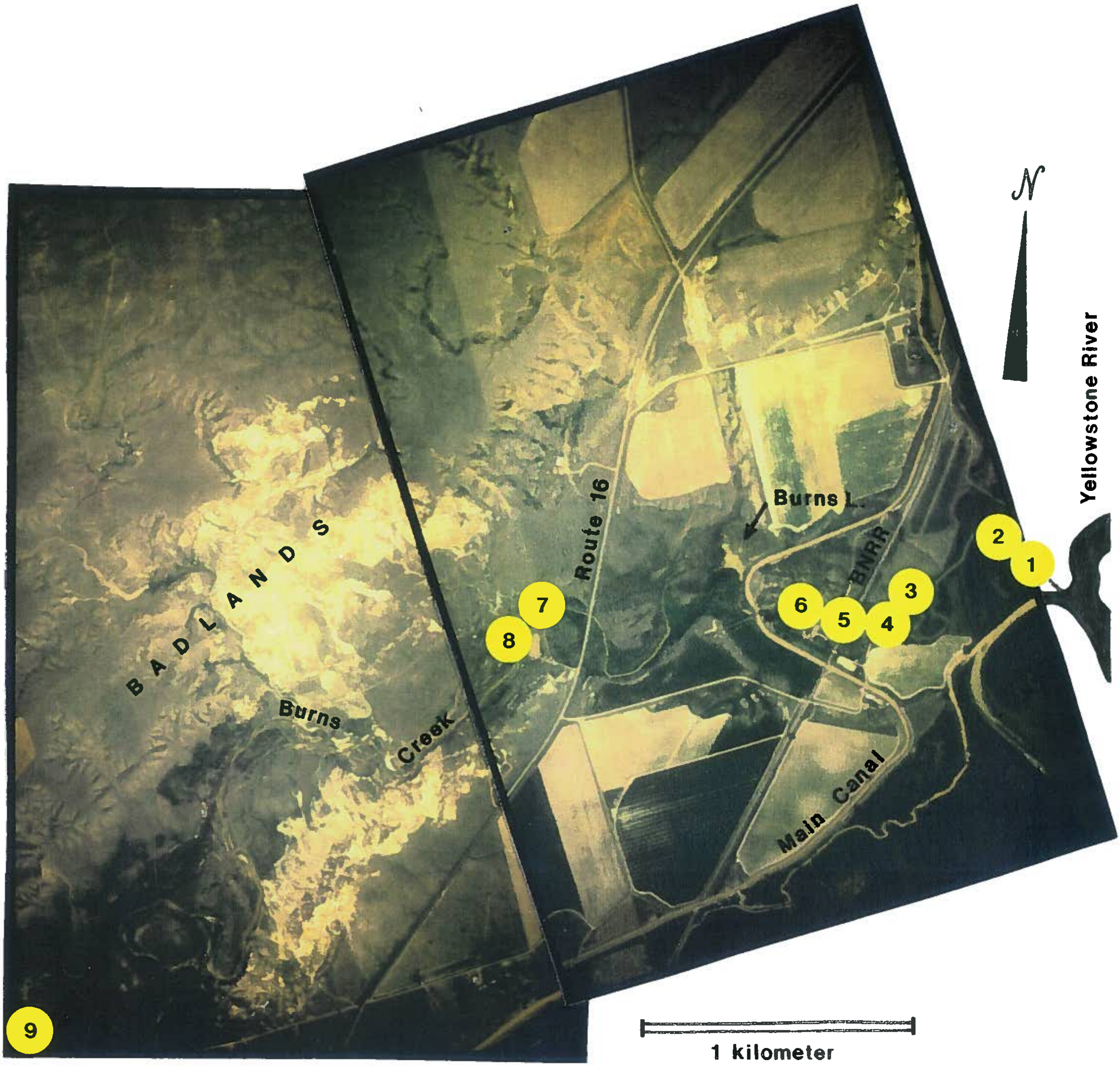

Figure 6. Composite aerial photograph of the lower Burns Creek area, Richland County, Montana, T19N, R57E (U.S. Department of Agriculture, Consolidated Farm Service Agency, Sidney, Montana, 1996/1997). Sites sampled in 1998 are depicted as numbered yellow dots. The two photographs were taken at slightly different altitudes, so features near the bottom of the composite do not correspond precisely.

ameter = 5.0 cm) were used to semiquantitatively sample fish communities at North Fork sites 17 an 18. The North Fork was densely vegetated with mucky sediment 0.3-1.0 m deep; even when vegetation was removed with a rake before seining, the deep sediment prevented us from towing the seine rapidly enough along the channel to collect significant numbers of fish. At each site, six traps were baited with cheese and set equidistantly overnight on 12-13 August. Fish were subsequently removed from the traps, identified with the aid of Holton and Johnson (1996), counted, and returned to the stream.

At sites 1-16 and at site 19 ("South Fork") we used a simple DeLury (1947) type capture-removal approach to estimate fish community densities in adjacent riffle, run, and, pool habitats. Block seine installation and fish samping were done before macrohabitat sampling in order to minimize movement of fish out of the areas disturbed by sampling. Block seines (two 7.5-m x 1.2-m x 6.3-mm mesh straight seines; one 8.2-m x 1.5-m x 6.3-mm mesh bag seine; one 12.1-m x1.8-m x 6.3-mm straight seine) were installed at the upper and lower ends of each site and between adjacent riffles, runs, and pools (i.e., four block seines at each site). After the block seines were installed, we used a short minnow seine (3.7 m x 1.2 m x 6.3 mm mesh) or, in wider pools, a bag seine (8.2 m x 1.5 m x 6.3 mm mesh) to make successive removal passes through each section. In pools, removal passes were made by two operators towing the seine from the downstream end to the upstream end of each isolated section, keeping the lead line on the bottom and beaching the seine at a convenient upstream location. In riffle and runs, towing the seine was ineffective due to higher flow velocities and to the tendency of the dominant riffle-run species to hide under cobbles, so one operator held the seine stationary at the downstream end of the isolated section while the second operator "kicked down" the riffle or run from the upstream end to the downstream end, agitating the substrate with his feet in the process. The seine was then lifted quickly in midstream by both operators. The number of removal passes, either by towing or kicking, ranged from three to seven, depending on how quickly we achieved a noticeable reduction in catch. After each pass, fish were removed from the seine, held in a bucket of aerated water, counted, identified, and returned to the stream downstream of the lowest block seine. To estimate density of fish in each habitat unit at each site, we visually regressed catch per pass on sum of catches, then related estimated total population of each isolated section to its measured surface area (length x mean width) to yield number of individuals per 100 m^2.

The following macrohabitat variables were measured or estimated at each site after fish community sampling unless otherwise noted.

Location:

1. distance from mouth and elevation

Water Quality:

2. water temperature and air temperature (initial and final)
3. total suspended solids (sites 2, 4, 6, 8, 12, 14, 15, 18)

Streamflow:

4. flow velocity and discharge

Channel Morphology:

5. total site length and lengths of component riffle, run, and pool habitats
6. stream width (wetted width and channel width)
7. stream depth

Streambed Composition

8. substrate composition, sediment depth, and embeddedness

Riparian Conditions:

9. adjacent land use (left and right banks)
10. buffer width (left and right banks)
11. bank erosion and slumping (left and right banks)
12. bank height at water's edge (left and right banks)
13. entrenchment bank height (left and right banks)
14. channel canopy shading

Cover:

15. vegetative height at water's edge (left and right banks)
16. vegetative overhang (left and right banks)
17. bank undercut (left and right banks)
18. woody and other debris
19. emergent and submerged vegetation

Macrohabitat variables were measured or estimated using a transect approach as described by Simonson et al. (1994). Transects were spaced at five-meter intervals perpendicular to flow, beginning one meter above the lower end of each site and ending at the last five-meter interval below the upper end of the site. For riparian variables, transects were extended 10 meters inland from water's edge. Transects were numbered and worked from downstream to upstream, with left bank and right bank designated facing downstream. Variables were measured or estimated along a 0.3-m wide band centered on the transect line. A 20-m length of 0.25-in (31.8-mm) nylon line and two metal stakes were used to mark a transect while variables were measured or estimated.

Location. Elevation and distance from mouth were determined from standard U.S. Geoligical Survey (USGS) 7.5-min quadrangle maps (Savage SW, Knife River Mine, and Allard Ranch).

Water Quality. Water and air temperature were measured with a pocket field thermometer at the lower end of each site at the beginning and end of sampling. Whole water samples were collected in one-pint (0.48-liter) glass jars before fish sampling at the upper ends of sites 2, 4, 6, 8, 12, 14, 15, and 18 and analyzed for total suspended solids (TSS) by Amatec (Billings, MT) using U.S. Environmental Protection Agency Method 160.2 (gravimetric).

Streamflow. Flow velocity was measured at each site by timing with a stopwatch the transit of a plastic fishing float over a measured distance of riffle or run (usually 10 m) three times and averaging the results. Discharge was calculated by multiplying the cross-sectional area of the water column (using depth and width measurements, below) by mean flow velocity (McMahon et al., 1996). Flow velocity through pools was usually to slow to measure using the buoyant object method, especially with wind interference.

Channel Morphology. Total length of each site and lengths of component riffle, run, and pool habitats were measured to the nearest foot (0.30 m) using a 300-ft (91.4-m) fiberglass measuring tape as described above. All other length, width, and depth measurement were made to the nearest inch using a six-foot (1.83-m) wooden grade stick graduated in inches*. Wetted width and channel width were measured by gradestick along transects at each site. When different from wetted width, channel width was identified by matted or silt-covered vegetation which had obviously been recently submerged. Water depths were measured by gradestick at five equidistant points along transects at each site, beginning at channel center and proceeding shoreward to within 10 cm of the left and right banks, thus creating six equal-width cells for calculating mean depth and channel cross-sectional area.

*SECO, Model 43428, Forestry Suppliers, Inc., Jackson, MS

Streambed Composition. Substrate composition and embeddedness were estimated visually to the nearest five percent along transects at each site using substrate material definitions of Simonson et al. (1994). Sediment depth was defined (Simonson et al., 1994) as the depth of silt or muck overlaying a harder substrate of bedrock, boulders, rubble, cobbles, gravel, or sand which did not yield under the weight of a person. Sediment depth was measured by gradestick along transects at each site at the same points used for measuring water depth. Embeddedness was defined as percent coverage by silt or muck of harder substrate particles listed above.

Riparian Conditions. Riparian land use and canopy shading (of wetted channel) were estimated visually to the nearest five percent along transects at each site, using the riparian land use classification and riparian definitions of Simonson et al. (1994). Buffer width, bank erosion, bank slumping, bank height at water's edge, and entrenchment bank height were measured by gradestick to the nearest foot (0.30 m) at each site, except for bank height at water's edge, which was measured to the nearest inch (2.54 cm). Buffer width was defined as the width of undisturbed riparian vegetation extending from water's edge to 10 m inland. Bank erosion was defined as the width of bare riparian soil from water's edge to 10 m inland, and slumping was defined as the width of detached whole masses of riparian soil, vegetated or not, from water's edge to 10 m inland. An entrenchment bank was defined as a bank generally higher than the water's edge bank and separated from water's edge by 10-30 m. Entrenchment banks obviously contained streamflow during peakflow periods and occasionally coincided with water's edge at the outer edges of meanders.

Cover. Amount of wetted channel bottom covered by woody debris, other debris, emergent vegetation, or submerged aquatic vegetation was estimated visually to the nearest five percent along transects at each site. In order to qualify as cover, debris or aquatic vegetation had to occur in water at least 15 cm deep; Simonson et al. (1994) used a one-foot (0.30 m) qualification, but their approach emphasized cover requirements of larger game fishes. Vegetative overhang, vegetative height at water's edge, and bank undercut were measured by gradestick to the nearest inch (2.54 cm) along transects at each site. In order to qualify as cover, vegetative overhang, vegetative height, and bank undercut had to be at least 15 cm.

Other. General observations on flora, fauna, hydrology, geology, and water quality were noted at each site. For reference and future site identification, four color photographs were taken at each site: (1) upper end facing downstream; (2) upper end facing upstream; (3) lower end facing downstream; (4) lower end facing upstream.

RESULTS AND DISCUSSION

Macrohabitat Variables

Results of macrohabitat measurements in the Burns Creek system, 28 July-13 August 1999, are shown in Tables 1-4. Water temperature was lower (10-17°C) at the coldwater sites (15, 17, 18, 19) than in 1998, perhaps due to slightly higher groundwater discharge (Table 1). Water temperatures at the warmwater sites ranged from 20-23°C. As in 1998, total suspended solids (TSS) were variable longitudinally and probably reflected local disturbances, such as bank erosion, cattle use, or beaver activity, rather than downstream accumulation of TSS (Table 1). Burns Creek probably receives a relatively high natural inorganic sediment load from erosion of the sparsely vegetated

Table 1. Location, water quality, flow, and channel morphology variables (mean values except location) for 17 sites in the Burns Creek system, Dawson and Richland counties, Montana, 28 July–13 August 1999 (E = elevation; R = distence from mouth; T = water temperature; TSS = total suspended solids; V = velocity; Q = discharge; L = habitat unit length; W = wetted width/channel width; D = water depth).

	Variable**								
Site	E (m)	R (km)	T (°C)	TSS (mg/l)	V (m/sec)	Q (m^3/sec)	L (m)	W (m)	D (cm)
1 Ri	599	0.5	23				5	6/8	11
Po							80	7/9	23
2 Po	599	1.0	23				55	7/9	25
Ru							7	6/8	11
Ri				42	0.41	0.24	12	7/10	10
3 Po	600	1.4	23				10	4/4	29
Ru							13	3/3	16
Ri					0.52	0.22	4	3/3	10
4 Ri	600	1.6	20		0.30	0.21	3	3/4	35
Ru							8	5/6	17
Po				64			158	8/8	54
5 Ri	603	1.8	20		0.44	0.16	37	4/9	11
Ru							8	4/6	11
Po							13	4/5	26
6 Ru	603	1.9	21				14	4/4	16
Ri					0.74	0.31	13	4/4	9
Po				90			160	8/10	35
7 Ru	609	3.5	23				11	2/10	14
Ri							9	4/11	10
Po							68	6/10	24
8 Ru	609	3.7	21				12	3/10	14
Ri					0.64	0.19	8	4/7	6
Po				62			162	9/12	21
9 Po	616	8.0	21				33	5/6	
Ru							8	2/6	
Ri					0.65	0.26	7	3/6	
12 Ru	643	17.8	20				18	5/14	12
Ri					0.31	0.26	15	5/18	7
Po				22			34	5/18	24
13 Ri	646	19.5	23		0.72	0.18	27	3/13	10
Ru							9	3/14	20
Po							400	5/16	57
14 Ru	652	24.0	20		0.63	0.14	5	3/8	9
Ri							7	4/9	5
Po				37			116	5/12	21
15 Po	658	26.0	10	10			24	7/11	38
16 Ri	677	31.3	14				3	2/14	9
Po							7	2/14	9
17 Po	655	26.0						7/47	90
18 Po	658	27.0	17	61				4/44	90
19 Ru	655	25.1	16		0.43	0.18		3/8	17

*Sites 10 lnd 11, sampled in 1998, were not sampled in 1999 due to lack of landowner permission. Ri = riffle; Ru = run; Po = pool; listed in order of downstream to upstream occurrence.
**A blank indicates that a variable was not determined.

Table 2. Riparian variables (mean values) for 17 sites in the Burns Creek system, Dawson and Richland counties, Montana, 28 July-13 August 1999 (LU = land use; BW = buffer width; ER = erosion; SL = slumping; H-1 = bank height water's edge; H-2 = entrenchment bank height; CS = canopy shading).

		Variable**					
Site*	LU***	BW (m)	ER (m)	SL (m)	H-1 (m)	H-2 (m)	CS (%)
1 Ri	MI/MI	10/10	0	0	1.5/1.5	0	0
Po	MI/MI	10/10	0	0	1.5/1.5	0	0
2 Po	MI/MI	10/10	0	0	1.2/1.5	0	0
Ru	MI/MI	10/10	0	0	1.1/1.2	0	0
Ri	MI/MI	10/10	0	0	1.1/1.2	0	0
3 Po	MI/ME	10/10	0	0	0.2/0.2	0	0
Ru	ME/ME	10/10	0	0	0.2/0.2	0	0
Ri	ME/ME	10/10	0	0	0.2/0.2	0	0
4 Ri	ME/ME	10/10	0	0	0.1/0.1	0	0
Ru	ME/ME	10/10	0	0	-/0.1	0	0
Po	ME/ME	10/10	0	0	0.2/0.2	0	0
5 Ri	PA/PA	0	0	0	-/0.2	0	0
Ru	PA/PA	0	0	0	0.4/-	0	0
Po	PA/PA	0	0	0	0.2/0.3	0	0
6 Ru	PA/PA	0	0	0	-/0.3	0	0
Ri	PA/PA	0	0	0	0.2/0.2	0	0
Po	PA/PA	0	0	0	0.6/-	0	0
7 Ru	PA/PA	0	0	0	0.1/0.5	0	0
Ri	PA/PA	0	0	0	-/0.2	0	0
Po	PA/PA	0	0	0	0.6/0.1	0	0
8 Ru	PA/PA	0	0	0	-/-	0	0
Ri	PA/PA	0	0	0	-/-	0	0
Po	PA/ME	0/10	0	0	-/0.1	0	0
9 Po	PA/PA	0	0/2	0/2	0.2/1.4	0	0
Ru	PA/PA	0	0/2	0/4	-/1.8	0	0
Ri	PA/PA	0	0/1	0	-/1.8	0	0
12 Ru	PA/PA	0	0/3	0	0.2/0.2	0/2	0
Ri	PA/PA	0	9/3	0	-/0.1	0/1	0
Po	PA/PA	0	6/0	0	0.2/0.2	0/1	0
13 Ri	PA/PA	0/10	10/0	0	0.2/-	2/0	0
Ru	PA/PA	0/10	2/0	0	0.2/0.2	2/1	0
Po	PA/PA	0/10	1/0	0	0.1/0.3	2/1	0
14 Ru	MI/PA	10/0	0/2	0	-/-	0	0
Ri	MI/PA	10/0	0/3	0	-/1.8	0	0
Po	MI/PA	10/0	0/2	0	0.1/0.6	0/2	0
15 Po	ME/ME	0	0	0	0.2/0.1	3/0	0
16 Ri	PA/PA	0	1/0	0	1.0/-	0	50
Po	PA/PA	0	1/0	0	1.0/-	0	50
17 Po	MI/MI	10/10	0	0	-/-	2/2	0
18 Po	MI/MI	10/10	0	0	-/-	2/2	0
19 Ru	ME/PA	10/0	0/1	0	-/1.0	1/1	0

*Sites 10 and 11, sampled in 1998, were not sampled in 1999 due to lack of landowner permission. Ri = riffle; Ru = run; Po = pool; listed in order of dwonstream to upstream occurrence.
** A blank indicates that a variable was not determined. A dash (-) indicates that the value was positive but negligible on the scale used. A zero (0) indicates that the feature was absent. A slash (/) separates left bank/right bank values.
***ME = meadow (undisturbed); MI = mixed meadow (undisturbed); PA = pasture (grazed).

Table 3. Cover variables (mean values) for 17 sites in the Burns Creek system, Dawson and Richland counties, Montana, 28 July-13 August 1999 (VH = vegetative height; VO = vegetative overhang; BU = bank undercut; WD = woody debris; OD = other debris; EV = emergent vegetation; SV = submerged vegetation).

	Variable**						
Site*	VH (cm)	VO (cm)	BU (cm)	WD (%)	OD (%)	EV (%)	SV (%)
1 Ri	–	0	0	0	0	–	–
Po	100/100	0	0	0	0	–	–
2 Po	100/100	0	0	1	0	–	–
Ru	–	0	0	0	0	–	–
Ri	–	0	0	7	0	–	–
3 Po	100/80	0/20	0	0	0	–	–
Ru	80/80	0	0	0	0	–	13
Ri	80/80	0	0	0	0	–	–
4 Ri	50/50	–	0	90	0	–	20
Ru	45/50	–	0/10	0	0	–	25
Po	56/60	–	0/17	0	0	–	31
5 Ri	–	0	0	0	0	–	–
Ru	–	0	0	0	0	–	–
Po	21/20	0	0	0	17	–	–
6 Ru	–	0	0	0	0	–	–
Ri	–	0	0	0	0	–	–
Po	22/19	0	0	0	0	–	–
7 Ru	27/18	–	0/20	0	0	–	10
Ri	28/30	–	0	0	0	–	10
Po	61/50	–	0	0	0	–	14
8 Ru	–	0	0	0	0	7	–
Ri	–	0	0	0	0	0	–
Po	15/17	0	0	0	0	–	21
9 Po	16/24	–	0	0	0	–	15
Ru	8/10	–	0	0	0	–	17
Ri	9/9	–	0	0	0	–	20
12 Ru	32/30	27/8	30/11	0	0	–	35
Ri	35/30	0	0	0	0	–	–
Po	41/40	0	0	0	0	–	26
13 Ri	–	–	0	0	0	–	8
Ru	21/29	–	0	0	0	–	40
Po	36/38	–	0	0	0	–	36
14 Ru	–/80	–	0	0	0	–	40
Ri	–	–	0	0	0	–	24
Po	–/45	–	2/0	0	0	–	70
15 Po	38/41	–	0/5	0	0	19	33
16 Ri	–/15	–	0	10	0	–	10
Po	–/23	–	0	10	0	–	10
17 Po	110/113	–	0	10	0	60	95
18 Po	111/114	–	0	10	0	60	95
19 Ru	150/34	–	0	0	0	0	100

*Sites 10 and 11, sampled in 1998, were not sampled in 1999 due to lack of landowner permission. Ri = riffle; Ru = run; Po = pool; listed in order of downstream to upstream occurrence.
**A blank indicates that a variable was not determined. A dash (-) indicates that the value was positive but negligible on the scale used. A zero (0) indicates that the feature was absent. A slash (/) separates left bank/right bank values.

Table 4. Stream bed composition variables (mean values) for 17 sites in the Burns Creek system, Dawson and Richland counties, Montana, 28 July-13 August 1999 (BR = bedrock; BO = boulders; RC = rubble/cobble; GR = gravel; SA = sand; SI = silt; CL = clay; MU = muck; DE = detritus; SD = sediment depth; EM = embeddedness).

	Substrate Materials (%)**									Sedimentation**	
Site*	BR	BO	RC	GR	SA	SI	CL	MU	DE	SD (cm)	EM (%)
1 Ri			30	70							
Po			6	94							
2 Po			5	95						5	42
Ru			10	90						3	
Ri			30	70						-	
3 Po				97		3				-	
Ru			2	87	11					-	
Ri			60	40						-	
4 Ri			10	90						-	
Ru			10	90						-	10
Po			1	99						1	41
5 Ri		2	78	20						-	
Ru			50	50						-	
Po				100						-	10
6 Ru			70	30						-	
Ri			77	23						-	
Po			30	60	3	7				2	
7 Ru			30	70						-	10
Ri				97				3		5	10
Po				84				16		9	20
8 Ru				70		30				1	8
Ri			10	90						-	
Po			22	64		14				7	20
9 Po			13	63		24				7	22
Ru			23	70		7				15	17
Ri			80	5		15				5	15
12 Ru			2	95		3				-	58
Ri			20	78		2				4	
Po			3	84		13				14	64
13 Ri			38	62						-	8
Ru			5	95						-	10
Po			24	72				4		9	82
14 Ru			70	30						-	10
Ri			85	15						-	
Po			30	61		5		4		4	53
15 Po				82				18		9	58
16 Ri		20	10	70						-	25
17 Po									100***	45	100
18 Po									100***	45	100
19 Ru						50§		50§		15	100

*Sites 10 and 11, sampled in 1998, were not sampled in 1999 due to lack of landowner permission. Ri = riffle; Ru = run; Po = pool; listed in order of downstream to upstream occurrence.
**A blank indicates an estimate of less than 5%. A dash (-) indicates that the value was positive but negligible on the scale used
***Overlaying muck; SD = depth of both detritus and underlying muck.
§Overlaying clay/gravel.

badlands that comprise much of its watershed.

Average flow velocities, measured only in riffles or runs in 1999, varied from 0.30–0.72 m/sec (Table 1). Discharge varied from 0.14–0.31 m^3/sec, with a mean of 0.21 m^3/sec. The North Fork appeared to exhibit no flow at all. Since the only significant source of baseflow we have observed for the whole system is the marsh-seepage area at Road 549, and since no significant precipitation occured during the sampling period, discharge should have been approximately equal at each site. Evaporative loss would have led to lower discharges at downstream sites, which we did not observe. Irrigation occurs only downstream of the Main Canal crossing, and irrigation return flow may explain the higher discharges observed at those sites. Otherwise, random error in the simple method used is probably responsible for the variation. Mean discharge (0.21 m^3/sec) was slightly higher than in 1998, and water levels in the stream were noticeably higher; these are probably the result of a wetter winter and spring.

Lengths, widths, and depths of riffles, runs, and pools varied considerably, although pools were generally longer, wider, and deeper than riffles and runs (Table 1). Pool length at the same site can vary from year to year (sites 2, 14, 15) as a result of changing patterns of beaver dam distribution, particularly as a result of destruction of dams by peakflows and subsequent reconstruction at different locations.

Riparian conditions were generally stable, with relatively low incidence of bank erosion and slumping and with buffer widths in excess of 10 m at many locations (Table 2). Bank heights at water's edge were generally low except where meanders approached the entrenchment bank (sites 1, 2, and 9). Entrenchment of the stream was most pronounced on the mainstem above site 12 and on the lower part of the North Fork (Table 2). Burns Creek lacks canopy shading except along parts of its intermittent section (site 16), which is shaded by mature cottonwoods.

Perhaps the most striking fisheries-related aspect of the Burns Creek system is scarcity of instream cover (Table 3), an aspect probably shared with many prairie streams. Although most sites were vegetated to water's edge by grasses, sedges, and rushes, little vegetative overhang was observed. Bank undercutting was notable only at sites 4, 7, and 12. The surface width of the run at site 12 was quite narrow, and most of the flow was channelled through undercuts. Instream wood and other debris was scarce except in the vicinity of active or demolished beaver dams (sites 2, 4, 17, 18) or under tree canopy (site 16). Emergent vegetation was scarce or growing in water too shallow to qualify as cover for even small fish. Submerged vegetation, predominantly *Chara* and *Ceratophyllum*, occurred at many sites but provided significant cover only at upstream sites (13, 14, 15, 17, 18). In 1998, we qualitatively noticed a possible relationship between high fish density, narrow wetted width, and high vegetation at water's edge, so we began measuring vegetative height at water's edge in 1999. Greatest vegetative heights occurred at ungrazed sites 1, 2, 3, and 4 and in the area between entrenchment banks at North Fork sites 17 and 18.

Riffles and runs tended to exhibit higher proportions of rubble and cobble, while pools usually exhibited gravelly substrates associated with some silt embeddedness at all sites. Few pools were deeply sedimented, although deep holes in some pools were filled with silt or muck. Substrate in the North Fork consisted of loose detritus overlaying organic muck at an average depth of 45 cm (Table 4).

Fish Communities

Table 5 is a checklist of fish species collected in the Burns Creek system since 1981. In 1999, we collected four species which we had not encountered in 1997 or 1998: goldeye, mountain sucker, black crappie, and walleye. Morris et al (1981) collected goldeye and walleye near the mouth of Burns Creek during their survey in the early 1980s. To date, a total of 26 species of fishes have been collected in the Burns Creek system.

The population estimation approach we used is relatively crude in that it assumes equal catchability per pass and equal catchability among species, conditions which do not hold for several species in the system (Barnes 1999). However, for the most common species in the system we feel that it provides reasonably reproducible and useful results.

In 1998, we sampled riffles and runs as a single habitat unit, but we separated these two units in 1999. The most abundant and widely distributed riffle species were longnose dace and creek chubs (Table 6). Longnose dace reached highest densities in riffles at sites 3, 6, 13, and 14, all of which had relatively high proportions of rubble and cobble in their substrates. Similar results were obtained in 1998. Larger spaces under and between cobbles may be preferred by riffle fishes over the smaller hiding spaces available in predominantly gravel substrates. Short riffles with fine gravelly substrates appeared to support the lowest densities of fish. Density of fishes in riffle habitats did not appear to be strongly related to macrohabitat variables other than substrate composition.

Runs appeared to support fish communities transitional between those in riffle and pool habitats (Table 7). Longnose dace and creek chubs were the dominant species, although other species occurred at greater densities in runs than occurred in riffles. Substrate composition again appeared to be the macrohabitat factor most strongly affecting densities of fishes in runs, with larger average particle size (cobble/rubble) corresponding to highest densities.

Above the Main Canal crossing, creek chubs and white suckers dominated pool fish communities. In pools below the crossing, shorthead redhorse were also common. Brook sticklebacks, fathead minnows, and lake chubs were locally common in upstream coldwater sections of the system. Several species, including northern pike, flathead chub, river carpsucker, longnose sucker, mountain sucker, shorthead redhorse, burbot, black crappie, yellow perch, and walleye, have only been encountered below the Main Canal crossing. These are primarily riverine species which may reside temporarily in lower Burns Creek, especially as adults during spawning seasons or as young-of-year for the first year or two of growth.

The greatest total densities in pool fish communities occurred at sites 5, 12, 13, 14, and 15. In 1998, there appeared to be some correlation be- vegetative height at water's edge and fish densities in pools, especially at lower wetted widths. We hypothesized that narrower, deeper pools with higher adjacent vegetation would exhibit lower "view factors," thus creating a "sense" of cover; in 1999, there appeared to be little relationship between these factors and fish densities. In fact, some of the higher density sites (3 and 4) were lower density sites in 1999. Contingent events such as peakflow flushing and changing patterns of beaver dam distribution may influence pool fish community density and diversity as much as relatively "fixed" macrohabitat factors.

Table 5. Species and numbers of fishes collected in the Burns Creek system, Dawson and Richland counties, Montana, 1981-1999*

Species**	(A) 1981	(B) 1997	(C) 1998	(D) 1999	(E) B+C+D
goldeye (*Hiodon alosoides)*	+			4	4
northern pike (*Esox lucius)*		3	1		4
lake chub (*Couesius plumbeus)*	+		5	36	41
western silvery/plains minnow (*Hybognathus argyritis/placitus)*	+	196	112	96	404
brassy minnow (*Hybognathus hankinsoni)*	+	6	33	167	206
common carp (*Cyprinus carpio)*	+	40	53	35	128
emerald shiner (*Notropis atherinoides)*	+	60	2		62
sand shiner (*Notropis stramineus)*	+	52	80	38	170
fathead minnow (*Pimephales promelas)*	+	74	28	36	138
flathead chub (*Platygobio gracilis)*	+	45	1	5	51
longnose dace (*Rhinichthys cataractae)*	+	52	265	292	609
creek chub (*Semotilus atromaculatus)*	+	396	809	782	1987
river carpsucker (*Carpiodes carpio)*	+		7		7
longnose sucker (*Catostomus catostomus)*	+	6	116	8	130
white sucker (*Catostomus commersoni)*	+	351	446	709	1506
mountain sucker (*Catostomus platyrhynchus)*				1	1
shorthead redhorse (*Moxostoma macrolepidotum)*	+	101	57	43	201
black bullhead (*Ameiurus melas)*	+	1	2	5	8
yellow bullhead (*Ameiurus natalis)*	+				
stonecat (*Noturus flavus)*	+	24	32	46	102
burbot (*Lota lota)*		1	2		3
brook stickleback (*Culaea inconstans)*	+	36	74	186	296
green sunfish (*Lepomis cyanellus)*	+	107	70	59	236
black crappie (*Pomoxis nigromaculatus)*				2	2
yellow perch (*Perca flavescens)*		1			1
walleye (*Stizostedion vitreum)*	+			1	1
SPECIES TOTAL [SPECIES TOTAL A+B+C+D=26]	19	19	20	20	25

*A = Morris et al. (1981), where + means present but numerical data not available; B = Barnes (1997); C = Barnes (1999); D = present study.
** Common and scientific names according to Robins et al. (1991.

Table 6. Fish population densities for 13 riffle habitats in the Burns Creek system, Dawson and Richland counties, Montana, 28 July-13 August 1999.

	Site Numbers and Densities (Individuals/100 m²)																
Species	1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18	19
goldeye																	
northern pike																	
lake chub																	
common carp																	
western silvery/ plains minnow	*				2.	3					2						
brassy minnow					1					2							
emerald shiner																	
sand shiner										2	2	5					
fathead minnow		*								2							
flathead chub			9														
longnose dace			54		*	26	8		19	4	34	463		28			
creek chub			18		4	3		*	24	28	14			14			
river carpsucker																	
longnose sucker		*			*												
white sucker	*	*			9					3	9						
mountain sucker																	
shorthead redhorse		*			5												
black bullhead																	
yellow bullhead																	
stonecat			27	*		2	1					14					
burbot																	
brook stickleback																	
green sunfish					1	3		*	14	*							
black crappie																	
yellow perch																	
walleye																	
TOTAL	*	*	108	*	24	38	9	*	57	40	62	482	X	43	X	X	X

*Present but density not estimated (captured in insufficient numbers or in minnow traps only).
X: Site lacks this habitat unit.

Table 7. Fish population density estimates for 12 run habitats in the Burns Creek system, Dawson and Richland counties, Montana, 28 July-13 August 1999.

Species	Site Numbers and Densities (Individuals/100 m²)															
	1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18	19
goldeye																	
northern pike																	
lake chub												24					2
common carp		*															
western silvery/ plains minnow		*	15	12		25					4						
brassy minnow			3			5				7	9						5
emerald shiner																	
sand shiner			3			8	7	7		14	25						
fathead minnow			9								4	8					
flathead chub						4											
longnose dace		*	3	3			8	7	34	7	9	186					2
creek chub			9	12		26	28	59	75	54	49	32					18
river carpsucker																	
longnose sucker					*	6	10										
white sucker			12	12	*	20		7	9	61	44	8					2
mountain sucker						1											
shorthead redhorse			9	3		12											
black bullhead																	
yellow bullhead																	
stonecat			12	14	*	38	1					8					
burbot																	
brook stickleback											4						
green sunfish				6			5	21	9								
black crappie																	
yellow perch																	
walleye																	
TOTAL	X	*	75	62	*	145	59	101	127	143	148	266	X	X	X	X	31

*Present but density not estimated (captured in insufficient numbers or in minnow traps only).
X: Site lacks this habitat unit.

Table 8. Fish population density estimates for 16 pool habitats in the Burns Creek system, Dawson and Richland counties, Montana, 28 July-13 August 1999.

	Site Numbers and Densities (Individuals/100 m^2)																
Species	1	2	3	4	5	6	7	8	9	12	13	14	15	16	17	18	19
goldeye		1		*													
northern pike																	
lake chub												20					
common carp		9	3			*	1										
western silvery/ plains minnow	*	2	3	1	7	12	1	3		*	8	*					
brassy minnow		*			6	11	6			4	114	8	2				
emerald shiner																	
sand shiner		*				*	4					3					
fathead minnow		*					1	*		2	4		15				
flathead chub			3			*											
longnose dace			5		2				1			14		32			
creek chub			3	*	19	11	16	34	17								
river carpsucker																	
longnose sucker		*	3		2												
white sucker	*	1	8	5	39	10	26	27	10	55	106	79	112				
mountain sucker																	
shorthead redhorse		1	3	1	23												
black bullhead				1		*			1								
yellow bullhead																	
stonecat			3			*	4										
burbot																	
brook stickleback											49	20	88		*	*	
green sunfish		1	3	1	6	2	6	*	1	1	4	3					
black crappie				1													
yellow perch																	
walleye		*															
TOTAL	*	16	37	10	104	46	65	64	30	98	376	280	249	232	*	*	X

*Present but density not estimated (captured in insufficient numbers or in minnow traps only).
X: Site lacks this habitat unit.

General Work Plan for 2000

We would like to sample one more summer in Burns Creek using the approach we developed during 1998 and 1999. After evaluating data collected in 2000, we can decide whether another year of sampling would be desirable or whether to go ahead and publish the results we have. A significant research problem in Burns Creek is that most of the sites are in private ownership, and access from year to year is uncertain. This is a disadvantage in trying to do a very long-term study. In 1999, a new landowner at sites 10 and 11 was reluctant to grant access, so we discontinued those sites. After sampling Burns Creek in 2000, we will probably do a reconnaissance of a larger stream system, such as O'Fallon Creek or Mizpah Creek, to assess access and feasibility in case we decide not to continue sampling Burns Creek in 2001. We could do this using our own transportation, since no equipment would be necessary.

We have also been working on a research project concerning isolated populations of longnose suckers in the Black Hills, South Dakota and Wyoming. These populations have apparently been isolated in several coldwater, perennial streams in the northern Black Hills since the hypsithermal period about 7,000 years ago and may be distinct subspecies. They are separated by several hundred miles of lowland, warmwater habitat from main longnose sucker populations to the north and west. Among possible entry routes to the Black Hills are a retreat up the Cheyenne River system from a wider northern plains distribution during the immediate post-Pleistocene and the headwaters capture of the Little Missouri River by the Belle Fourche River during the last 10,000 years. An argument against the Little Missouri hypothesis is the lack of historical records of longnose suckers from the Little Missouri drainage. However, Elser et al. (1980) showed one record of longnose sucker from Box Elder Creek, a Little Missouri tributary, in Montana near the North Dakota state line. Given time and vehicle availability this summer, we would like to try to quickly and qualitatively look at a few sites in Box Elder Creek, Little Beaver Creek, and the Little Missouri River in extreme eastern Carter and Fallon counties. If we can find longnose suckers in any of those streams, it would support the Little Missouri origins hypothesis; in addition, some recent information about fish communities in those systems would be gained.

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