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

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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, I 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, I 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, I designed a quantitative study of fish population densities, longitudinal distribution, and habitat characteristics. Field work for this study was initiated on Burns Creek during the summer of 1998 with the assistance of Samuel K. Westlind of Glendive, Montana. This report summarizes the results of that work.

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-

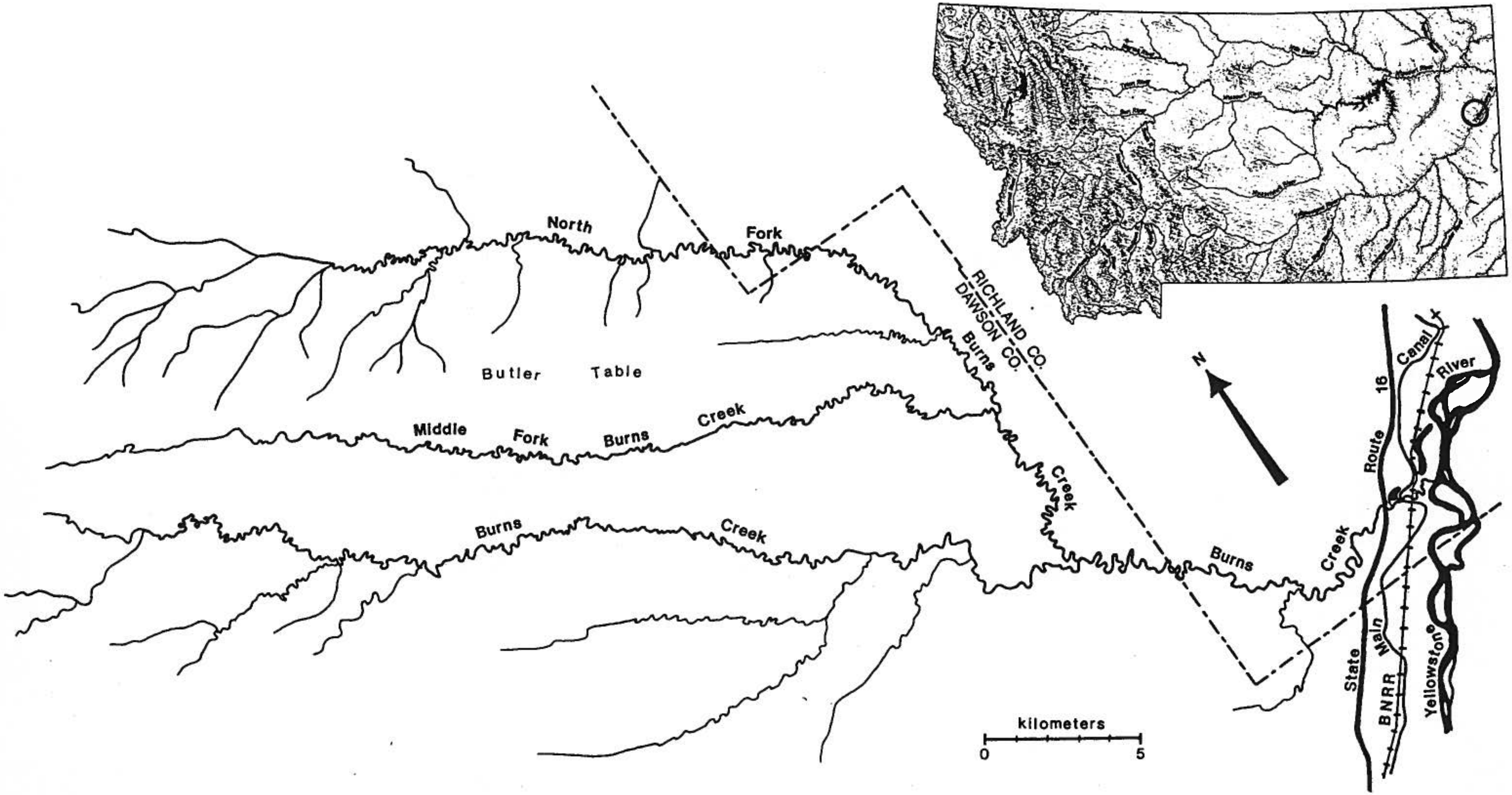

Figure 1. Map of the Burns Creek system, Dawson and Richland counties, eastern Montana (Inset map of Montana shows location of study area as a dark circle).

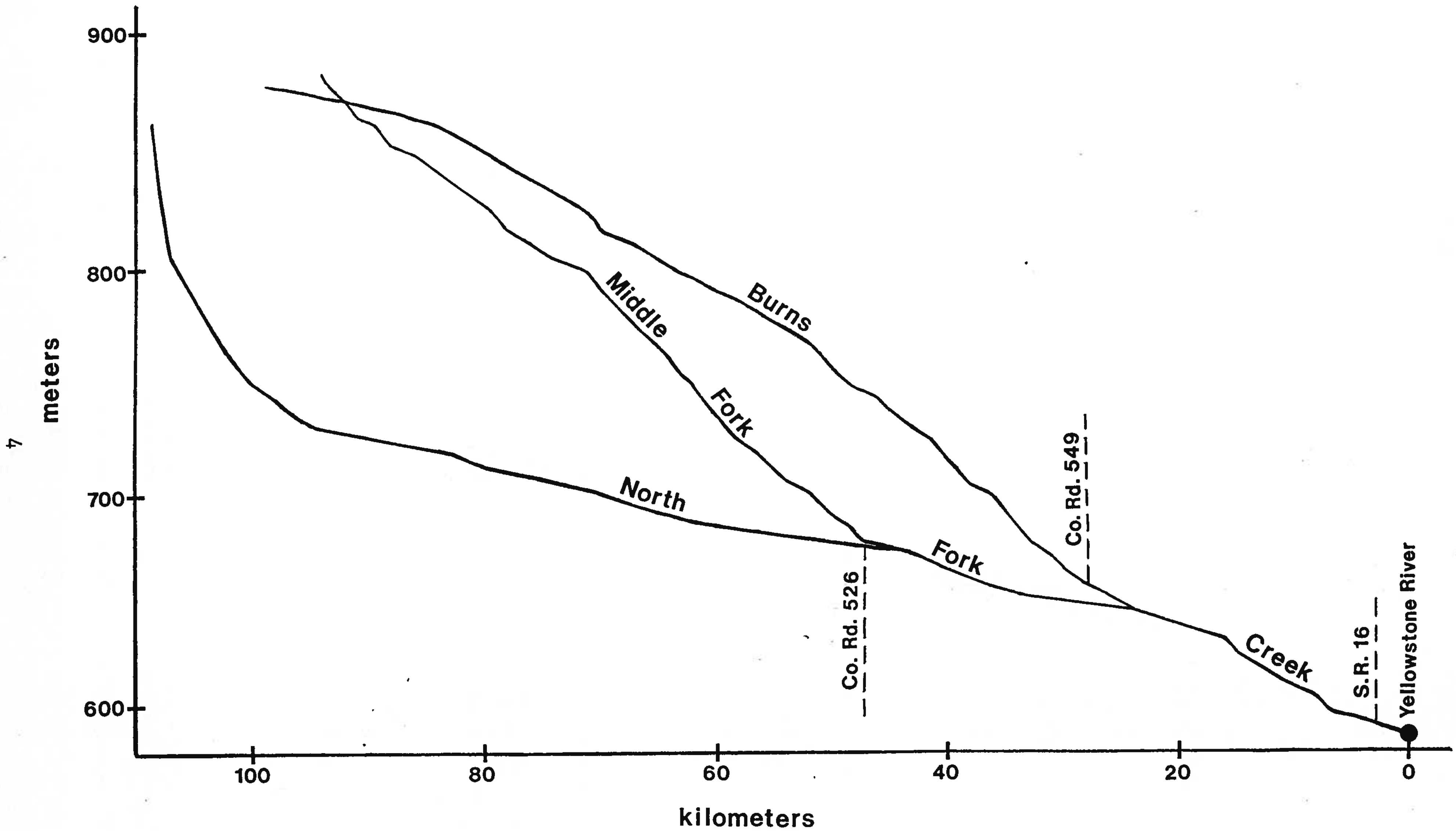

Figure 2. Stream length-elevation profile for the Burns Creek system, Dawson and Richland counties, Montana (determined directly from U.S. Geological Survey 7.5-minute topographic quadrangle maps).

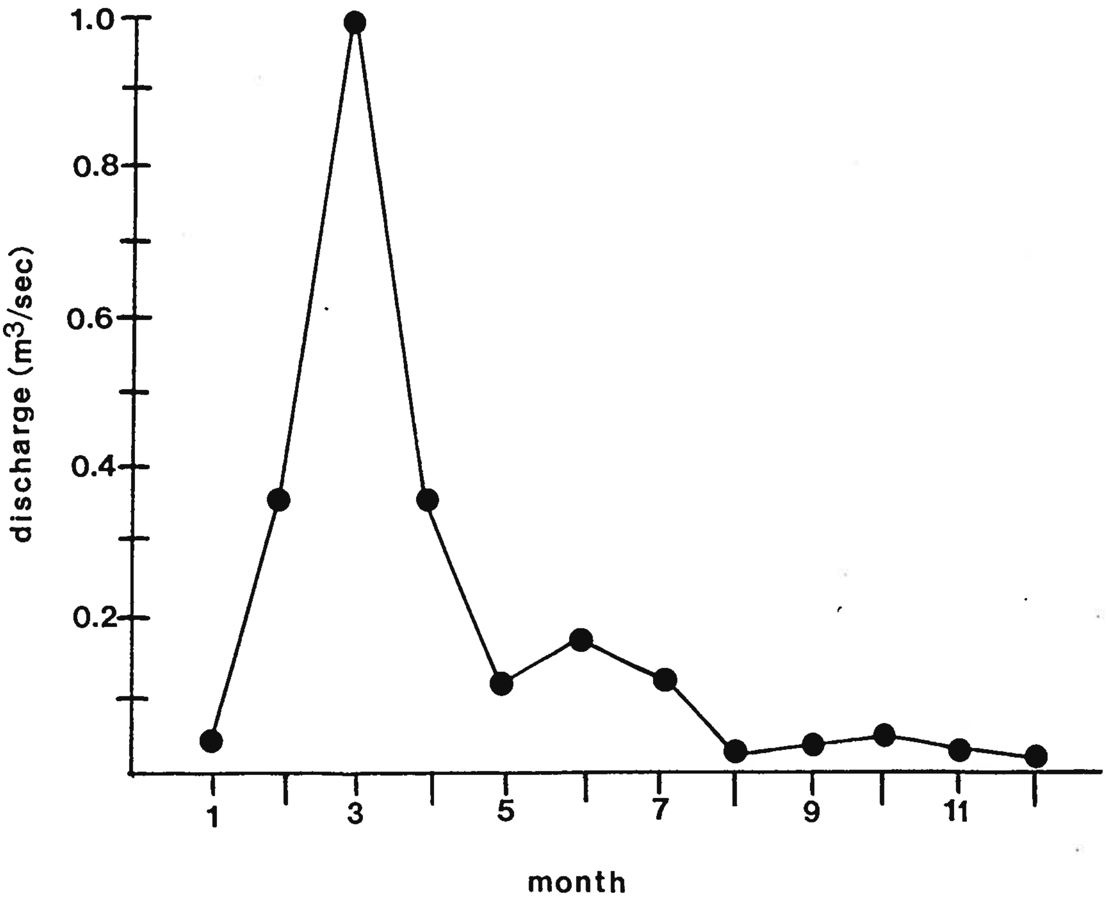

Figure 3. Mean monthly discharge (m^3/sec) of Burns Creek for period of record (1958-1967, 1976-1984, and 1986-1988)(U.S. Geological Survey 1996).

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 and the North Fork from Road 526 to its mouth. 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 under some pressure 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 this seepage area and flows into the mainstem just upstream of the North Fork confluence (Figures 4 and 5a). In 1997, water temperature at the crossing was 12.0°C.

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 near the mouth in 1997 was 14.5°C.

In this section, both the mainstem and North Fork channels are entrenched between banks 2-3 m high. The mainstem exhibited distinct riffle-pool development in 1997 but was impounded by a series of beaver (*Castor canadensis*) dams in 1998. The North Fork is one long pool 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 aquatic 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 which have eliminated most riffle-pool development. Average flow velocity decreases, turbidity increases to the point where the bottoms of most pools are not visible, and summer water temperature ranges from 20-28°C. The stream channel is still entrenched between steep banks 2-3 m high (Figure 5c). From the county line to the 90° bend in Richland County Road 100 (1998 site 11), Burns Creek flows through two sections of private land which we could not enter due to lack of landowner permission. Below these two sections, beaver impoundments are absent, and riffle-pool development is clearly defined (Figure 5d). Proceeding downstream, the channel becomes less entrenched until the banks are generally less than a meter high between the gauging station and the Main Canal crossing (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

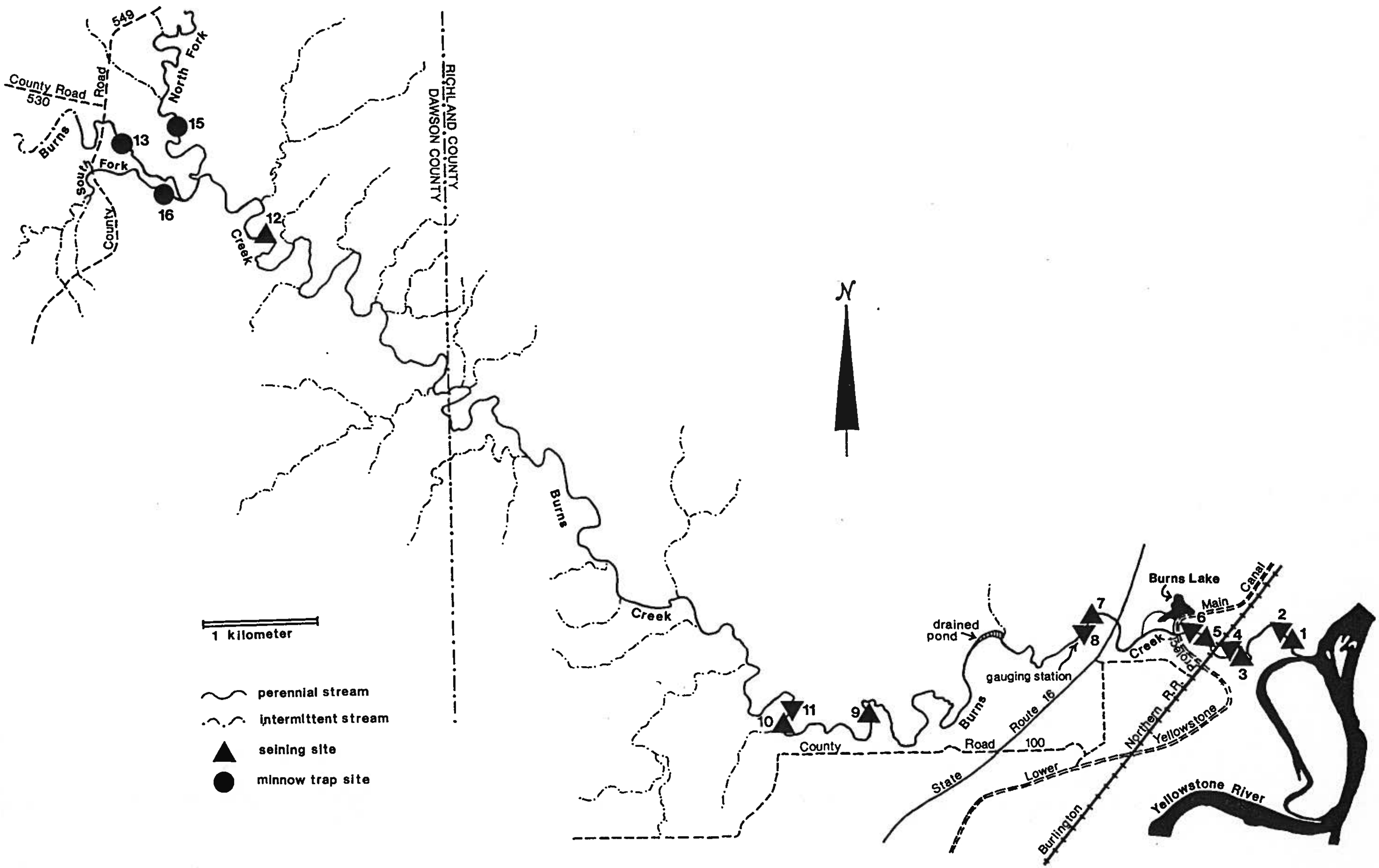

Figure 4. Lower Burns Creek system from Dawson County Road 549 to mouth.

Figure 5. Photographs of selected sites in the Burns Creek system, Dawson and Richland counties, Montana, 23 July to 6 August 1998 (following two pages).

(a) origin of baseflow, Burns Creek mainstem upstream of Dawson County Road 549

(b) North Fork (1998 site 15)

(c) entrenched section with beaver dam downstream of North Fork confluence (1998 site 12)

(d) narrow section with well developed riparian and littoral vegetation

(e) site heavily used by cattle just upstream of State Route 16 (1998 site 8, gauging station in background)

(f) Lower Yellowstone Project Main Canal crossing (Solid arrow shows the direction of flow of Burns Creek; dashed arrow shows the direction of flow of the canal inside the box culvert.)

(g) BLM section (1998 site 3)

(h) mouth area


5a
5b
5c
5d


5e


5f


5g


Yellowstone River
Burns Creek
5h

through which the canal passes, then drops steeply 3.3 m into a concrete plunge pool (Figure 5f). This forms a barrier to upstream movement by fishes from the lower section. Downstream from the canal crossing to the mouth, riffle-pool development is clearly defined, with no beaver impoundments, and the channel gradually becomes more entrenched until it is confined between banks approximately 3.3 m high at the mouth.

The riparian zones of the North Fork and mainstem of Burns Creek in sections 2, 3, and 4 generally consist of densely vegetated borders several meters wide. Although most of the adjacent land is grazed, high entrenchment banks apparently discourage cattle from entering the channel and riparian areas except at five isolated locations we were able to observe.

Downstream of the Burlington Northern Railroad crossing (Figure 4), Burns Creek flows through an 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 many years to encourage wildlife populations (Figures 5g and 5h). Grasses and other herbaceous vegetation are dense, high, and continuous with riparian vegetation to the stream margins. Stands of Russian olive, willows, cottonwoods, and buffaloberry are also more extensive than in upstream sections of the drainage, and a mature gallery forest of cottonwoods occupies the floodplain adjacent to the mouth of the stream.

MATERIALS AND METHODS

Fish were sampled during the period 23 July - 6 August 1998 at 16 sites in Burns Creek, the North Fork, and the "South Fork" (Figures 4 and 6). Site 14, not shown in Figure 4, was located in the intermittent section of the mainstem (flowing at the time) at Dawson County Road 530 approximately 5 km upstream of site 13. Minnow traps (length = 38.1 cm; outer diameter = 17.8 cm; entry port diameter = 5.0 cm; mesh = 1.6 mm) were used to semi-quantitatively sample fish at sites 13, 14, 15, and 16. Sites 13 and 15 were too deep or too densely vegetated to sample effectively by seine. Sites 13 and 16 were only cusorily examined at the end of our sampling period. Traps were baited with cheese and set as follows: 18 along a 1-km section of the North Fork (site 15) overnight on 3-4 August; three along a 0.5-km section of the mainstem comprising a beaver impoundment (site 13) overnight on 3-4 August; six along a 0.5-km section of the "South Fork" (site 16) overnight on 5-6 August; and one in the mainstem at the Road 530 crossing (site 14) overnight on 5-6 August. At each site, fish were removed from the traps, identified, counted, and returned to the stream.

At sites 1-12, we used a simple DeLury (1947) type capture-removal approach to estimate fish population densities in adjacent riffle/run (R) and pool (P) habitats. Two block seines (length = 8.2 m; depth = 1.5 m; mesh = 6.3 mm and length = 7.6 m; depth = 1.2 m; mesh = 6.3 mm) weighted with rocks were used to isolate a section of stream to be sampled. Most shorter pools (length < 50 m) and all riffle/run sites were sampled for their entire lengths, but longer pools were sampled for only one 50-m length. After the block seines were set, we used a shorter minnow seine (length = 3.7 m; depth = 1.2 m; mesh = 6.3 mm) to make successive removal passes through the isolated section. The number of removal passes ranged from three to ten, depending on how quickly we achieved a noticeable reduction in catch. After each pass, captured fish were identified, counted, and returned to the stream downstream of the lower block seine. To estimate density of fishes at each site, we visually regressed catch per pass on sum at catches, then related estimated total population of the isolated section to its measured area to yield numbers/100 m^2.

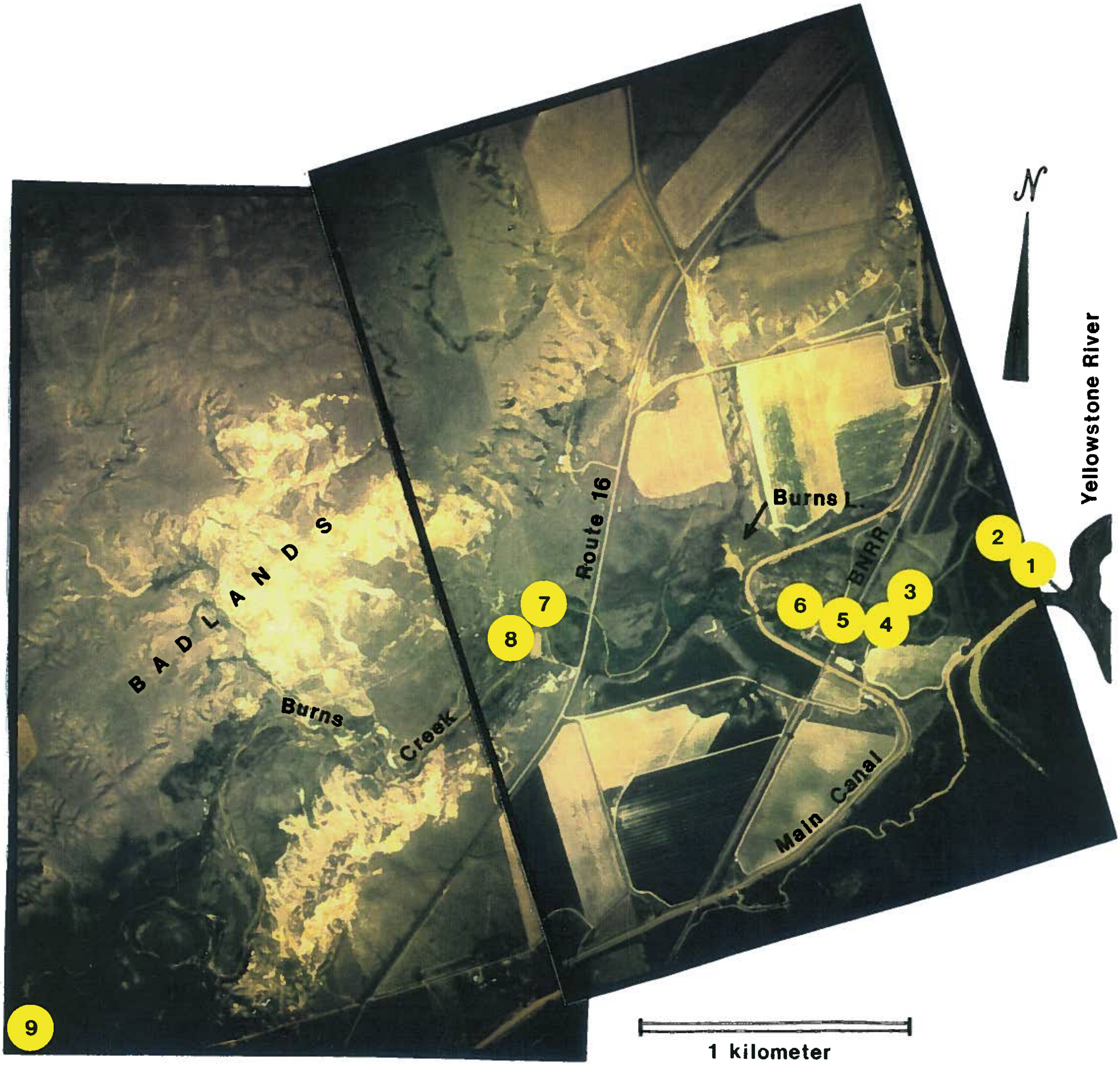

Figure 6. Composite aerial photograph of the lower Burns Creek area, Richland County, Montana, T19N, R57E (U.S. Department of Agriculture, Consolidated Farm Service Agency, Sidney, Montana, 1996/1997). Sites sampled in 1998 are depicted as numbered yellow dots. The two photographs were taken at slightly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

All fishes captured were identified with the aid of Holton and Johnson (1996), and two voucher specimens of some species were retained. Due to the difficulty of differentiating between western silvery minnows (*Hybognathus argyritis*) and plains minnows (*Hybognathus placitus*) in the field, 15 specimens of the genus were retained for closer inspection in the laboratory. All specimens were preserved in 10% formalin and deposited in the Vertebrate Collection, Biology Department, Montana State University, Bozeman.

The following macrohabitat variables were measured at each site (Tables 1 and 2):

1. water temperature
2. total suspended solids
3. flow velocity
4. riffle/run or pool length
5. active channel width
6. right/left bank height (at water's edge)
7. right/left bank vegetative overhang
8. right/left bank undercut
9. water depth
10. relative substrate composition (cobble, gravel/pebble, sand/silt/muck)
11. in-channel cover (woody debris, submerged aquatic vegetation)

Water temperature was measured using a pocket field thermometer. We also set a maximum-minimum thermometer in the water at site 5 overnight on 3-4 August 1998 to get a general idea of diel variation in water temperature. Whole water samples were collected in one-quart (0.95-liter) glass jars at sites 1P, 3P, 6P, 8P, 10P, 13, and 15 and analyzed for total suspended solids by Amatec (Billings, MT) using U.S. Environmental Protection Agency method 160.2.

Flow velocity was determined at each site by timing the transit of a one-quart bottle of motor oil over a measured distance three times and averaging the results. Discharge was calculated at site 7R near the gauging station by multiplying the cross-sectional area of the water column by the average flow velocity, as described by McMahon et al. (1996).

Riffle/run and pool length were measured using a TLR 75/Sure Shot 6 range finder (Bushnell Sports Optics, Overland Park, KS). A 14-ft (4.2-m), 0.75-in (1.9-cm) diameter, length of PVC pipe marked off in 6-in (15-cm) increments was used to measure channel width, bank height, vegetative overhang, bank undercut, and water depth at each site. These measurements were made at five equidistant points between and including the upper and lower ends of each riffle/run or pool, then used to calculate average values for each variable. Average channel depth was determined along five cross-channel transects at the same equidistant longitudinal points at each site according to the method of Platts et al. (1983). Relative substrate composition and in-channel cover were estimated visually as percentages along the same cross-channel transects at each site.

RESULTS AND DISCUSSION

Macrohabitat Variables

Results of macrohabitat measurements in the Burns Creek system, 23 July to 6 August 1998, are shown in Tables 1 and 2. Water temperature was higher in 1998 at the coldwater sites, 13 (mainstem at Road 549) and 15 (North Fork),

Table 1. **Macrohabitat variables measured at 12 riffle/run sites in the Burns Creek system, Dawson and Richland counties, Montana, 23 July to 6 August 1998.**

	Site*											
Variable	1	2	3	4	5	6	7	8	9	10	11	12
water temperature (°C)	18	22	20	21	21	25	21	20	22	28	27	23
total suspended solids (mg/l)	–	–	–	–	–	–	–	–	–	–	–	–
flow velocity (m/sec)**	.50	.36	.65	.26	.32	.09	.74	.29	.44	.45	.18	.31
length (m)	5	19	17	11	52	6	29	21	17	12	11	9
width (m)**	5	6	3	3	3	3	2	3	2	2	2	3
depth (cm)**	11	12	12	11	7	8	8	8	10	4	8	8
right bank height (cm)**	305	113	36	24	269	26	50	5	36	61	109	198
left bank height (cm)**	305	116	49	40	26	6	20	16	94	96	79	61
right bank vegetative overhang (cm)**	30	43	30	17	1	0	34	0	30	12	11	10
left bank vegetative overhang (cm)**	2	0	30	30	0	0	0	6	15	11	8	0
right bank undercut (cm)**	7	5	2	4	1	0	10	0	3	2	6	1
left bank undercut (cm)**	10	2	15	33	0	0	0	2	14	3	9	0
cobble substrate (%)	10	25	30	40	60	50	60	25	30	50	60	90
gravel/pebble substrate (%)	60	20	40	50	30	40	20	50	20	30	20	10
sand/silt/muck substrate (%)	10	55	30	10	10	10	20	25	50	20	20	0
woody debris (%)	0	10	0	0	0	0	0	0	0	0	0	5
submerged vegetation (%)	–	–	20	20	5	–	–	–	10	10	50	5

*A dash (–) indicates that the variable was not measured at the site (total suspended solids) or that a negligible amount was present (submerged vegetation).

**average

Table 2. **Macrohabitat variables measured at 16 pool sites in the Burns Creek system, Dawson and Richland counties, Montana, 23 July to 6 August 1998.**

	Site*															
Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
water temperature (°C)	18	22	20	21	21	25	21	26	22	28	27	23	14	21	21	19
total suspended solids (mg/l)	10.2	-	21.8	-	-	11.6	-	42.5	-	26.4	-	4.2	9.1	-	-	-
flow velocity (m/sec)**	.08	.10	.19	.10	.12	-	.04	-	.04	.05	.05	.14	.06	.08	-	.05
length (m)	80	70	25	120	12	160	65	163	25	25	25	400	-	-	-	-
width (m)**	7	7	4	5	4	3	3	8	4	2	4	5	4	2	4	2
depth (cm)**	15	18	21	28	20	46	11	40	13	31	34	35	52	12	26	23
right bank height (cm)**	21	16	55	457	61	13	20	15	34	46	46	247	157	-	224	-
left bank height (cm)**	256	86	53	65	50	50	90	17	131	98	113	167	86	-	119	-
right bank vegetative overhang (cm)**	1	73	45	18	7	2	0	30	15	9	8	34	23	0	61	-
left bank vegetative overhang (cm)**	27	0	33	24	2	15	0	34	15	4	5	24	27	0	68	-
right bank undercut (cm)**	0	2	11	9	8	1	0	12	8	13	11	8	17	0	1	-
left bank undercut (cm)**	6	0	35	6	10	7	6	7	7	10	8	9	8	0	6	-
cobble substrate (%)	0	20	5	40	30	30	60	30	10	20	20	70	0	30	0	0
gravel/pebble substrate (%)	30	20	60	50	30	30	30	40	40	20	25	20	10	60	0	10
sand/silt/muck substrate (%)	70	60	35	10	40	40	10	30	50	60	65	10	90	10	100	90
woody debris (%)	0	0	0	0	0	5	0	0	0	0	0	5	20	5	20	20
submerged vegetation (%)	-	-	20	20	20	10	-	-	10	10	10	5	60	-	90	50

*A dash (-) indicates that a variable was not measured at the site (total suspended solids at sites 2, 4, 5, 7, 9, 11, 14, 15, 16; bank height, vegetative overhang, and undercut at site 16) or that quantity was negligible and could not be accurately measured (flow velocity and submerged vegetation at several sites).

**average

than it was in 1997, when it was 12.0°C and 14.5°C in the mainstem and North Forks, respectively. This may have been due to lower water levels in the North Fork and to beaver impoundment of the mainstem up to Road 549 in 1998, both of which may have resulted in greater daytime solar warming of the water. Water temperatures at the warmwater sites (1-12) ranged from 18-28°C with no apparent longitudinal pattern. Our single max-min thermometer reading at site 5 was 18.3/27.2°C, an 8.9°C diel variation, so summer water temperature in Burns Creek farther from its coldwater source may be highly responsive to air temperature.

Total suspended solids (TSS) were also quite variable longitudinally and may reflect local habitat disturbances, such as cattle use or beaver activity, more than downstream accumulation of TSS. The highest TSS concentration was recorded at site 8 (Figure 5e), which was heavily used by cattle during the period. It should be pointed out that Burns Creek probably receives a high natural inorganic sediment load from erosion of the sparsely vegetated badlands that comprise much of its watershed.

Average flow velocities also varied from site to site but were, naturally, higher in riffles and runs than in pools. Flow velocity was too low to measure at pool sites 6 and 8, as wind interfered with the buoyant object method, and at site 15 (North Fork), which appears to exhibit no flow at all except during stormflow events. Discharge as calculated at site 7R near the gauging station on 23 July 1998 was 0.05 m^3/sec, which corresponds with summer low flows of less than 0.1 m^3/sec measured by the gauging station when it was in operation.

Lengths, widths, and depths of riffle/run and pool habitats varied considerably, although pools were generally longer, wider, and deeper than riffles and runs. The longest pool (site 12P at 400 m) was partially impounded by beavers and was immediately upstream of the only riffle/run we could find between Road 549 and the county line (Figure 5c). Pools also featured deeper holes (up to 150 cm deep) than is reflected in the average depths shown in Tables 1 and 2.

Although most of the length of the North Fork and mainstem channels is entrenched between banks 2-3 m high, this is usually not reflected by the average bank heights shown in Tables 1 and 2 because we measured bank height at water's edge. At most sites, the "entrenchment bank" was separated from the active channel bank by a narrow floodplain (Figure 5c), but at sites 1-4, as the stream cuts through the last floodplain terrace of the Yellowstone River, the entrenchment banks were at the water's edge.

In general, the greatest vegetative overhang was observed at sites 3 and 4, the ungrazed BLM section, and at sites 9-13, where higher, steeper entrenchment banks apparently discourage cattle from using the riparian zone. Lower vegetative overhangs were observed at sites 5-8, where low entrenchment banks allowed easy access by cattle. However, the amount of vegetative overhang also appeared to be influenced by natural morphological factors, such as bare gravel or mud bars adjacent to the channel (especially at riffles) or steep, poorly vegetated entrenchment banks at the water's edge (Figures 5c and 5h). Bank undercut varied from site to site but was generally greater in pools than in riffles and runs.

Riffles and runs tended to exhibit higher proportions of cobble and gravel substrate, while pools usually exhibited a layer of fines (sand and silt) over gravel/pebble substrates. Deep holes in some pools were filled with mud or black organic muck. In-channel woody debris was relatively uncommon in the system, except at sites 13, 15, and 16 (coldwater mainstem, North Fork, and "South Fork"), where there were numerous logs, snags, and intruding tree and shrub roots in the channels. Submerged aquatic vegetation was also most abundant (50-90% of the bottom covered) at these coldwater sites.

Fish Communities

Table 3 is a checklist of fish species collected in the Burns Creek system since 1981. In 1998, we collected two species, lake chub (*Couesius plumbeus*) and river carpsucker (*Carpiodes carpio*), which were not encountered in 1997, although Morris et al. (1981) had collected them in the system previously. Lake chubs appear to be restricted to the upper perennial part of the system, especially in beaver impoundments, while river carpsuckers (all young-of-year) are transient riverine species found only below the Main Canal crossing. Surprisingly fewer emerald shiners (*Notropis atherinoides*) and flathead chubs (*Platygobio gracilis*) were collected in 1998 than in 1997. To date, a total of 24 species of fishes have been collected in the Burns Creek system.

The DeLury (1947) population estimation method we used in 1998 is relatively crude in that it assumes equal catchability per removal pass and equal catchability among species. During sampling, it was clear that for at least some species these conditions did not pertain. Nocturnal bottom species like longnose dace (*Rhinichthys cataractae*) and stonecats (*Noturus flavus*) tended to be captured in greater numbers on the second or third pass (declining thereafter) than on the first pass. Probably these species were hiding under the substrate during the first pass, which disturbed them enough to emerge, thus increasing their catchability during the second and third passes. Cover-seeking species like green sunfish (*Lepomis cyanellus*) are probably poorly estimated because the first pass causes them to seek deeper cover in littoral vegetation or undercuts, thus decreasing their catchability during subsequent passes. Nevertheless, for the more common species in the system, our DeLury population dnesity estimates, as shown in Tables 4 and 5, suggest some interesting relationships.

The most abundant and widely distributed riffle/run species were longnose dace and creek chubs (*Semotilus atromaculatus*), although the latter were abundant in pools as well. Longnose dace reached highest densities at sites 6R, 11R, and 12R, all of which had a relatively high predominance of cobbles in their substrates. The larger spaces under and between cobbles may be preferred by this species over the smaller hiding spaces available in predominantly gravel/pebble substrates. Density of fishes in riffle/run habitats did not appear to be strongly related to vegetative overhang or bank undercut, which tended to be greater in pools anyway. Thus, substrate composition may be the crucial macrohabitat variable affecting density and longitudinal zonation of riffle/run fishes in Burns Creek.

Above the main canal crossing, creek chubs and white suckers (*Catostomus commersoni*) dominated pool fish communities. In pools below the canal crossing, western silvery/plains minnows, longnose suckers (*Catostomus catostomus*), and shorthead redhorse (*Moxostoma macrolepidotum*) were also very common (in addition to creek chubs and white suckers). The greatest densities in pool fish communities occurred at sites 3P, 4P, 5P, 9P, and 10P. Vegetative overhang was generally greater at 3P, 4P, 9P, and 10P, whereas an old truck chassis in the channel at 5P apparently increased cover enough to encourage higher population densities. There also appeared to be a relationship between fish

Table 3. Species and numbers of fishes collected in the Burns Creek system, Dawson and Richland counties, Montana, 1981-1998*.

Species**	(A) 1981	(B) 1997	(C) 1998	B+C
goldeye *(Hiodon alosoides)*	+			
northern pike *(Esox lucius)*		3	1	4
lake chub *(Couesius plumbeus)*	+		5	5
western silvery/plains minnow *(Hybognathus argyritis/placitus)*	+	196	112	308
brassy minnow *(Hybognathus hankinsoni)*	+	6	33	39
common carp *(Cyprinus carpio)*	+	40	53	93
emerald shiner *(Notropis atherinoides)*	+	60	2	62
sand shiner *(Notropis stramineus)*	+	52	80	132
fathead minnow *(Pimephales promelas)*	+	74	28	102
flathead chub *(Platygobio gracilis)*	+	45	1	46
longnose dace *(Rhinichthys cataractae)*	+	52	265	317
creek chub *(Semotilus atromaculatus)*	+	396	809	1205
river carpsucker *(Carpiodes carpio)*	+		7	7
longnose sucker *(Catostomus catostomus)*	+	6	116	122
white sucker *(Catostomus commersoni)*	+	351	446	797
shorthead redhorse *(Moxostoma macrolepidotum)*	+	101	57	158
black bullhead *(Ameiurus melas)*	+	1	2	3
yellow bullhead *(Ameiurus natalis)*	+			
stonecat *(Noturus flavus)*	+	24	32	56
burbot *(Lota lota)*		1	2	3
brook stickleback *(Culaea inconstans)*	+	36	74	110
green sunfish *(Lepomis cyanellus)*	+	107	70	177
yellow perch *(Perca flavescens)*		1		1
walleye *(Stizostedion vitreum)*	+			
TOTAL SPECIES (TOTAL SPECIES A+B+C=24)	19	19	20	21

*A = Morris et al. (1981), where + means present but numerical data not available; B = Barnes (1997); C = present study.

**Common and scientific names according to Robins et al. (1991).

Table 4. Fish population density estimates for 12 riffle/run sites in the Burns Creek system, Dawson and Richland counties, Montana, 23 July to 6 August 1998.

	Site Number and Density (Individuals/100 m²)											
Species	1	2	3	4	5	6	7	8	9	10	11	12
northern pike												
lake chub												
common carp		4										
western silvery/ plains minnow	*	20	5	11				1			9	
brassy minnow	*	6				4						
emerald shiner											9	
sand shiner				61		96	17	31			33	
fathead minnow	*											
flathead chub						4						
longnose dace		2	65	71	81	116	31	28	33	20	211	202
creek chub		5	6	68		11	18	33	40	42	196	
river carpsucker			1									
longnose sucker		2	8	18		31						
white sucker		13	16	23	3	17		4	3			
shorthead redhorse												
black bullhead												
stonecat			16		13		7	1				
burbot												
brook stickleback												
green sunfish		6				4		16	2		9	
TOTAL		59	116	252	97	283	73	118	78	62	467	202

*Present but captured in insufficient numbers to estimate density.

Table 5. Fish population density estimates for 16 pool sites in the Burns Creek system, Dawson and Richland counties, Montana, 23 July to 6 August 1998.

	Site Number and Density (Individuals/100 m²)															
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
northern pike						1										
lake chub												2				*
common carp	*	4	2	4	5	1		4								
western silvery/ plains minnow	*	1	7	21	68	3		3				1			*	
brassy minnow		*		1	29			4							*	
emerald shiner					3											
sand shiner			2		3		3					1				
fathead minnow			2	4	24	1									*	
flathead chub																
longnose dace			2	4	3				14		1	1				
creek chub			82	184	152	7	52	10	160	102	29	49	*	*	*	*
river carpsucker			2													
longnose sucker			32	7	119	4										
white sucker		1	69	88	49	35	3	12	20	66		60	*		*	*
shorthead redhorse			18	28	29	1										
black bullhead						1					1					
stonecat			5				18			2	1					
burbot			1													
brook stickleback		*		1		1			4						*	*
green sunfish		1	5	11	3	9	8	7			1	1				
TOTAL		7	229	353	487	64	84	40	198	170	33	115				

*Present but density not estimated (captured in insufficient numbers or in minnow traps only).

community density and average active channel width, namely that for a given amount of vegetative overhang and bank undercut, narrower channel appeared to be related to higher density. This relationship can be further investigated in 1999. Brook sticklebacks (*Culaea inconstans*) and fathead minnows (*Pimephales promelas*) were abundant in the heavily vegetated pool habitats of the North Fork, but we have been able to sample these habitats only semi-quantitatively. This problem can also be addressed in 1999.

The effect of the upstream migration barrier posed by the main canal crossing is clearer from our 1998 sampling results. Northern pike (*Esox lucius*), river carpsucker, longnose sucker, shorthead redhorse, and burbot (*Lota lota*) have never been encountered above the canal crossing. Of these species, most of the individuals collected have been young-of-year or smaller adults. Larger adults apparently enter lower Burns Creek from the Yellowstone River only to spawn, are blocked from further upstream movement by the canal crossing, then return to the river after spawning (unless trapped in larger pools by receding water levels). As young of these species mature, they eventually migrate downstream to more suitable riverine habitat.

General Work Plan for 1999

The primary research objective of 1999 will be to continue quantitative studies of density and longitudinal zonation of fishes in Burns Creek and to relate these to major macrohabitat variables. A more rigorous population estimation method may be adopted, and macrohabitat evaluation may be adapted to conform to standard systems like those described by Platts et al. (1983), U.S. Forest Service (1991), and Simonson et al. (1994). A possible approach to quantitatively sampling the heavily vegetated North Fork would be to block off a manageable length of channel, then remove all the enclosed submerged vegetation with a rake.

We did not sample the long section of mainstem between sites 11 and 12 due to poor accessibility and lack of landowner permission. It would be desirable to gain access to that section and sample at least one site there in 1999.

In 1998 we briefly inspected Fox Creek (between Savage and Sidney) as a possible additional study area. The Main Canal passes through a siphon under Fox Creek with no change in channel gradient, so I thought that Fox Creek could be used in a paired stream study with Burns Creek to investigate the effect of the canal crossing in the latter. However, Fox Creek is an intermittent stream whose substantial flow at the Route 16 crossing is derived mostly from irrigation return flow. Upstream of this point, most of the stream in summer consists of dry channel and isolated, stagnant pools. Morgan Creek, which enters the Yellowstone River between Glendive and Savage upstream of the origin of the Main Canal at Intake, is another alternative to be considered in 1999.

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