FISH COMMUNITIES AND HABITATS IN THIRTEEN MILE CREEK, DAWSON COUNTY, MONTANA

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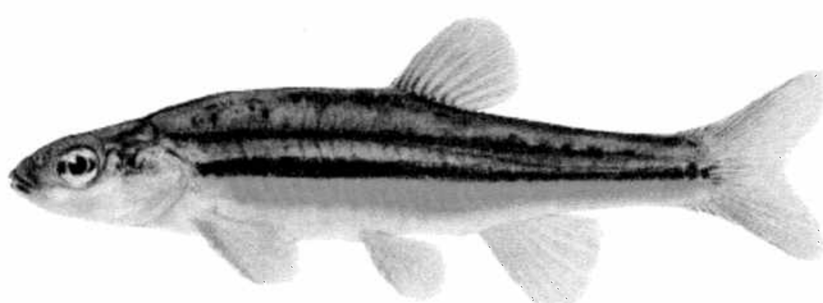

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INTRODUCTION

Until recently, little research has inquired into the distribution, habitat requirements, and ecological relationships 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 for the assessment of potential impacts of coal mining in the area. Barfoot (1993, 1999) 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 test the hypothesis that longitudinal zonation of fish communities in streams is related primarily changes in stream geomorphology.

Several wider 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 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.

More recently, the Montana Department of Fish, Wildlife and Parks and the Montana Cooperative Fish and Wildlife Research Unit initiated extensive surveys of Montana prairie streams covering 305 sites in 240 drainages east of the Rocky Mountain region (Jones-Wuellner and Bramblett 2004, McDonald 2003). In addition, Bramblett et al. (2004) developed a multimetric index of biological integrity for Montana prairie streams using fish assemblages.

Given the potential impacts of current land uses, including livestock grazing and irrigated agriculture, and of future energy development, including coal bed methane production, 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 that influence longitudinal zonation of fish communities in small prairie streams.

From 1997 to 2000, Barnes (1997, 1999), Barnes and Westlind (2000), and Barnes and Silbernagle (2001) conducted a quantitative study of fish population densities, longitudinal distribution, and habitat variables in Burns Creek, a perennial groundwater driven stream in Dawson and Richland counties, Montana. Results of this study suggested that a few temporally more persistent habitat factors as well as random contingent phenomena both strongly influenced density and longitudinal distribution of fishes in that system. The most important persistent factors were stream width-depth ratio, riparian vegetation height and overhang, and instream cover, whereas the most important contingent phenomena were storm flow flushing and changing patterns in number and location of beaver (*Castor canadensis*) dams.

Because it is perennial and groundwater driven, Burns Creek may not typify small prairie streams in eastern Montana, most of which are runoff driven and highly seasonal. Therefore, during the summers of 2001, 2002, and 2003, the sampling methodology developed for Burns Creek was applied to O'Fallon Creek, a largely runoff driven tributary of the lower Yellowstone River in Prairie, Custer, Fallon, and Carter counties, Montana (Barnes et al. 2002, Barnes and Siegle 2003, Barnes 2004). Results of the O'Fallon Creek studies suggested that contingent phenomena may more strongly influence density and longitudinal distribution of fishes in that system than more persistent habitat factors such as stream width-depth ratio and riparian vegetation. In this intermittent system, fish moving upstream or downstream may be trapped, often in high densities, in shrinking pools with low quality habitat (low dissolved oxygen concentrations, high total suspended solids concentrations, relatively shallow depths, and lack of riparian or instream vegetation) as riffles dry up and interrupt the hydrologic continuity of the stream. Similarly, drying riffles may exclude fish from preferred habitats. The overall "flashiness" of the system probably prevented fish communities from stabilizing and efficiently partitioning available habitats.

During the summers of 2004, 2005, and 2006, we applied the sampling methodology developed for Burns Creek and O'Fallon Creek to Upper Sevenmile Creek, an intermittent tributary of the Yellowstone River near Glendive, Dawson County, Montana (Barnes et al. 2005, Barnes et al. 2006, Barnes et al. 2007), and during the summer of 2007 to Thirteen Mile Creek, an intermittent tributary of the Yellowstone River near Intake, Dawson County, Montana. This report summarizes the results of the first year of study in Thirteen Mile Creek during 2006.

STUDY AREA

Thirteen Mile Creek originates in northwestern Dawson County, Montana, and flows southeast 80.8 km to its confluence with the Yellowstone River at river kilometer 116 near Intake (Figures 1 and 2a). Channel elevation ranges from 945.1 m at the main stem headwaters to 610.0 m at the mouth, with a mean gradient of 4.1 m/km. Thirteen Mile Creek is a third order stream (Strahler 1952) with four major intermittent tributaries: (1) South Fork (Lower) Thirteen Mile Creek (Figure 2b) with confluence at 19.2 km; (2) North Fork Thirteen Mile with confluence at 37.2 km; (2) Center Fork Thirteen Mile Creek with confluence at kilometer 51.08; and South Fork (Upper) Thirteen Mile Creek with confluence at 58.8 km. Total channel length (all stream orders) of the system is 183.2 km. The whole system drains 414.8 km^2 and has a drainage density of 0.4 km/km^2 (MFIS 2008, Morris et al. 1981, NRIS 2008).

The Thirteen Mile Creek watershed occupies the edge of the glaciated Missouri Plateau, Short Grass Region, Great Plains Province. The climate is semiarid continental, with mean maximum temperature of 13.9°C and mean minimum temperature of -0.6°C (daily extremes from -47.2°C on 16 February 1936 to 43.8°C on 6 July 1934), mean annual precipitation of 34.8 cm (annual range from 15.1 cm in 1934 to 68.9 cm in 1906), and mean annual snowfall of 85.1 cm (maximum of 163.8 cm in 1975), with mean annual snow depth of 2.5 cm (as measured at Savage, Montana, 1905-2007) (WRCC 2008). Upland terrain consists of rolling hills that have been dissected into badlands by the stream system. Downstream of State Route 16, Thirteen Mile Creek cuts through alluvial terraces and emerges onto the floodplain of the Yellowstone River. Land use on the watershed is approximately 50% grass rangeland, 40% crop/pasture, 9% mixed rangeland, and 1% other (primarily mine/quarry and other agriculture) (NRIS 2008).

Non-crop upland vegetation of the Thirteen Mile Creek watershed consists predominantly of grasses (Poaceae) and sagebrush (*Artemesia* spp.) with scattered stands of ponderosa pine (*Pinus ponderosa*) and Rocky Mountain juniper (*Juniperus scopulorum*). Valley floors also support scattered stands of eastern cottonwood (*Populus deltoides*), green ash (*Fraxinus pennsylvanica*), Russian olive (*Eleagnus angustifolia*), and buffaloberry (*Shepherdia canadensis*). Riparian and littoral vegetation is dominated by sedges (*Carex* spp.), rushes (*Juncus* spp.), cattails (*Typha* spp.), snowberry (*Symphoricarpos albus*), milkweed (*Asclepias* spp.), and willow (*Salix* spp.).

The Thirteen Mile Creek watershed is underlain by Cretaceous and Paleocene sedimentary rocks consisting primarily of highly erodible sandstones and shales. Exposed rocks in the watershed consist of non-marine sediments of the Fort Union Formation, which contains economically extractable deposits of coal and discharges significant amount of groundwater (Alt and Hynd 1986, Morris et al. 1981). Stream discharge has not been recorded in Thirteen Mile Creek (USGS 2008).

MATERIALS AND METHODS

Fish populations and habitats were evaluated at 16 sites in Thirteen Mile Creek from 25 July to 6 August 2007 (Figure 1, Table 1). A site was defined as a contiguous unit of riffle and pool habitat as defined by Armantrout (1998). Only 40-m lengths of very long riffles and pools were included in fish and habitat sampling. Four sites lacked riffle development: site 2, a low gradient site at the Yellowstone River confluence (Figure 2c); site 5, an isolated beaver impoundment in a long section of dry stream channel adjacent to the old State Route 16 and Burlington Northern Santa Fe (BNSF) railroad crossings; site 15, an isolated pool at the County Road 543 crossing; and site 19, an isolated spring pool on South Fork (Lower) Thirteen Mile Creek (Figure 2b). All other sites sampled consisted of riffle-pool units.

On arrival at each site, a metric Hip Chain distance measurer (No. 06220, Legend, Inc., Reno, NV) was used to measure total site length and the lengths of component riffles and pools. Orange DayGlo ribbon (DayGlo Color Corp., Cleveland, OH) was tied to conspicuous littoral vegetation every five meters to serve as a baseline for installing block seines, determining flow velocity, and spacing habitat sampling transects. A water sample for total suspended solids (TSS) was then collected, dissolved oxygen, conductivity, and pH were measured, and water and air temperatures were recorded as described below. Next, block seines were installed for fish sampling. After fish sampling was completed, habitat variables were assessed as described below.

Fish. We used a simple DeLury (1947) type capture-removal approach to estimate fish community densities in adjacent riffle and pool habitats. Block seine installation and fish sampling were done before habitat evaluation in order to minimize movement of fish out of the disturbed site. 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, and one 12.1-m x 1.8-m x 6.3-m straight seine were used as block seines. Block seines were installed at the upstream and downstream ends of each site and between adjacent riffles and pools (i.e., three block seines per site).

In pools, we usually used a short, straight minnow seine (3.6-m x 1.5-m x 6.3-mm mesh) to make successive removal passes through each isolated section. In wider pools, a bag seine (8.2-m x 1.5-m x 6.3-mm mesh) was used to make removal passes. In all pools, two operators towed the working seine from the downstream end to the upstream end of each isolated section. The lead line was kept on the stream bottom, and the seine was landed at a convenient upstream location.

In riffles, towing the seine was ineffective due to extremely shallow depths and the tendency of riffle species to hide under cobbles. Therefore, one operator held the working seine stationary at the downstream end of the isolated section, across the whole wetted channel and with the lead line on the stream bottom, while the second operator "kicked down" the riffle or from upstream to downstream, agitating the substrate with his feet. Finally, the seine was lifted quickly by both operators in midstream. We were unable to make fish population estimates on several riffles due to extremely low flow; riffles were either dry or reduced to shallow trickles that we were unable to seine. If small fish were present, they were sampled qualitatively with a dip net.

The number of removal passes (by towing or kicking) ranged from three to five and depended on how quickly we achieved a noticeable reduction in catch. After each removal pass, fish were removed from the seine, held in a bucket of aerated water, identified using Holton and Johnson (2003) and Gould (1998), counted, and returned to the stream downstream of the lowest block seine. To estimate the density of fish in isolated riffles and pools, we regressed catch per pass on sum of catches to yield a gross population estimate. This estimate was then divided by the measured surface area of the habitat unit (length x mean width) to yield number of individuals per 100 m^2.

Habitat Variables. The following habitat variables were evaluated at each site after fish sampling was completed unless otherwise noted.

Location:

- latitude and longitude
- landmark photography and notation on USGS 7.5-min quadrangle map

Water Quality:

- water temperature and air temperature (initial and final)
- dissolved oxygen
- pH
- conductivity
- total suspended solids

Stream Flow:

- flow velocity
- discharge

Channel Morphology:

- total site length and lengths of component riffle, run, and pool habitats
- stream width (wetted width and channel width)

- stream depth

Streambed Composition:

- relative substrate composition
- sediment depth
- embeddedness

Riparian Conditions:

- adjacent land use (left and right banks)
- buffer width (left and right banks)
- bank erosion (left and right banks)
- bank height and angle at water's edge (left and right banks)
- entrenchment bank height and angle (left and right banks)
- channel canopy shading

Cover:

- vegetative height at water's edge (left and right banks)
- vegetative overhang (left and right banks)
- bank undercut (left and right banks)
- woody and other debris
- emergent and submerged aquatic vegetation

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

Location. Each site was marked on a standard USGS 7.5-min quadrangle map, and landmarks were noted. Latitude and longitude of each site were determined with a GPS Pioneer Satellite Navigator (Magellan Systems Corporation, San Dimas, CA); site coordinates were verified by direct measurement on 7.5-min quadrangle maps as described by NASA (2006). For reference and future identification, four color photographs were taken at each site: (1) upper end facing upstream; (2) upper end facing downstream; (3) lower end facing upstream; (4) lower end facing downstream.

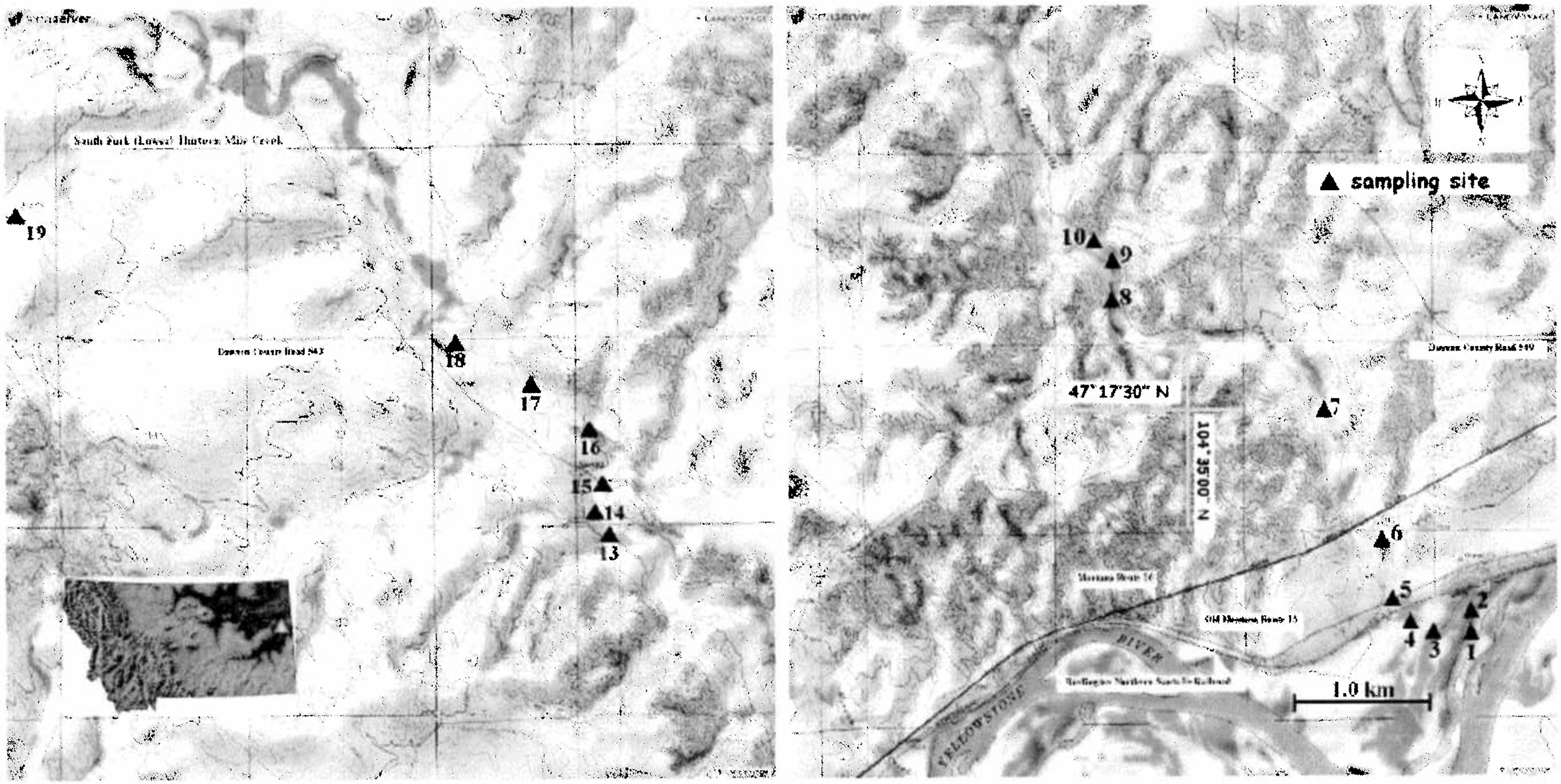

Figure 1. **Map of the Thirteen Mile Creek system, Dawson County, Montana, showing sites sampled in 2007 (based on U.S. Geological Survey, 7.5 Minute Topographic Series, Intake Quadrangle and Kohlberg Ranch Quadrangle, provided by TerraServer 2008).**

Table 1. Locations of sampling sites in the Thirteen Mile Creek system, Dawson County, Montana, 2007.

Site No.	County	Quadrangle[a]	Township	Range	Section	Latitude	Longitude	Stream Km	Elevation (m)	Date Sampled
1[b]	Dawson	Intake	18N	56E	35	47°16'36"	104°32'57"	0.0	603.5	8/01/2007
2	Dawson	Intake	18N	56E	35	47°16'36"	104°33'04"	0.1	606.6	8/01/2007
3	Dawson	Intake	18N	56E	34/35	47°06'43"	104°33'23"	1.1	609.6	8/01/2007
4[c]	Dawson	Intake	18N	56E	34	47°---'---"	104°---'---"	---	---	---
5	Dawson	Intake	18N	56E	34	47°16'41"	104°33'28"	6.0	613.2	8/02/2007
6	Dawson	Intake	18N	56E	34	47°16'52"	104°33'28"	6.2	615.7	8/02/2007
7	Dawson	Intake	18N	56E	27	47°17'30"	104°34'01"	6.8	621.8	7/31/2007
8	Dawson	Intake	18N	56E	21	47°18'02"	104°35'25"	9.6	637.0	7/27/2007
9	Dawson	Intake	18N	56E	21	47°18'12"	104°35'33"	11.6	640.1	7/27/2007
10	Dawson	Intake	18N	56E	21	47°18'16"	104°35'41"	11.8	643.7	7/26/2007
11[c]	Dawson	Intake	18N	56E	17	47°---'---"	104°---'---"	---	---	---
12[c]	Dawson	Intake	18N	56E	17	47°---'---"	104°---'---"	---	---	---
13	Dawson	Intake	18N	56E	18	47°16'29"	104°37'15"	15.8	667.5	8/03/2007
14	Dawson	Intake	18N	56E	7	47°19'36"	104°37'22"	16.2	668.1	8/03/2007
15	Dawson	Intake	18N	56E	7	47°19'43"	104°37'21"	16.8	670.0	7/30/2007
16	Dawson	Intake	18N	56E	7	47°19'55"	104°37'22"	17.9	670.6	7/30/2007
17	Dawson	Kolberg Ranch	18N	56E	7	47°20'10"	105°37'46"	18.7	676.0	7/25/2007
18	Dawson	Kolberg Ranch	18N	56E	7	47°20'22"	105°38'18"	19.3	676.6	7/25/2007
19[d]	Dawson	Kolberg Ranch	18N	56E	3	47°20'59"	105°41'19"	25.1	725.4	8/06/2007
20[c]	Dawson	Bloomfield	19N	54E	13/18	47°---'---"	105°---'---"	---	---	---

[a]U.S. Geological Survey, 7.5 Minute series (Topographic); [b]Yellowstone River; [c]site not sampled in 2007; [d]South Fork Thirteen Mile Creek.

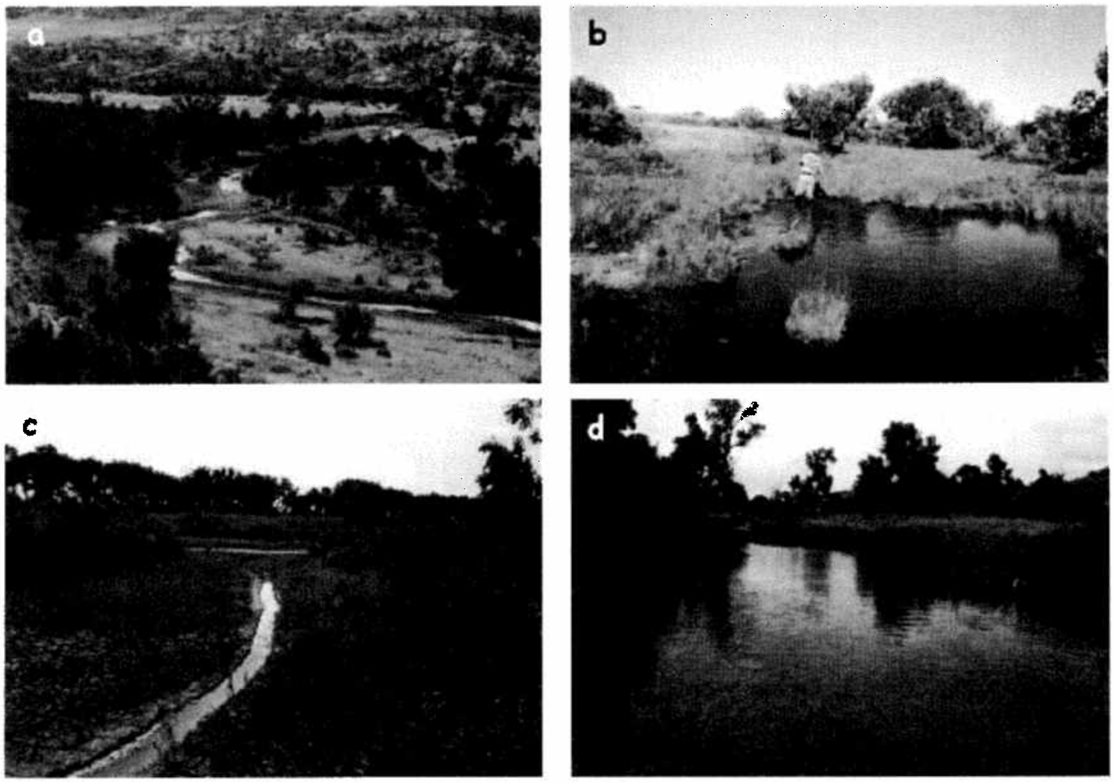

Figure 2. Thirteen Mile Creek system, Dawson County, Montana, July-August 2007: (a) representative section of Thirteen Mile Creek below Dawson County Road 543 crossing (sites 13 and 14); (b) South Fork (Lower) Thirteen Mile Creek (site 19); (c) low gradient reach near mouth on Yellowstone River side channel (site 2); (d) northern redbelly dace (*Phoxinus eos*) habitat (site 17).

Water Quality. Water and air temperatures were measured with a pocket field thermometer at the lower end of the pool at each site at the beginning and at the end of sampling. Dissolved oxygen concentration, water temperature, and conductivity were determined with a YSI Model 85 oxygen, conductivity, salinity, and temperature meter (Yellow Springs Instruments, Inc., Yellow Springs, OH) and pH with a pHep 3 pH meter (Hanna Instruments, Woonsocket, RI) at the lower end of the pool of each site before fish sampling. Whole water samples were collected in one-pint (0.48-liter) glass jars before fish sampling at the upper ends of sites 2, 6, 10, 11, 12, 15, 16, and 20. These samples were analyzed for total suspended solids (TSS) by Amatec Services, Inc. (Billings, MT) using SM 2540D (Clesceri et al. 1999).

Stream Flow. Flow velocity was measured at each site by timing three times the transit of a plastic fishing float over a measured distance of riffle (usually 10 m). An ExTech Digital Stopwatch/Clock (ExTech Instruments Corporation, Waltham, MA) was used for timing, and the results of three runs were averaged to yield mean flow velocity. Discharge was calculated by multiplying the cross-sectional area of the water column (using depth and width measurements as described below) by mean flow velocity (McMahon et al. 1996). Flow velocity in pools was usually too slow to measure using the buoyant object method, especially with wind interference, and low flow in riffles at many sites made estimating flow velocity and discharge impractical.

Channel Morphology. Total length of each site and lengths of component riffle and pool habitats were measured using a Hip Chain distance measurer as described above. Wetted width and channel width were measured to the nearest inch (2.54 cm) along transects at each site using a home-made grade stick fabricated from a 10-ft (3.05-m) length of ¾-in (1.9-cm) aluminum electrical conduit to which an equal length of steel measuring tape graduated in inches was attached with transparent duct tape. At very wide sites we used a 300-ft (91.4-m) fiberglass measuring tape graduated in inches (Model KL-300-18, Keson Industries, Inc., Naperville, IL). When different from wetted width, channel width was delimited by the presence of matted or silt-covered vegetation that had obviously been recently submerged or by the presence of white evaporite deposits. Water depths were measured by grade stick 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. This created six equal-width cells for calculation of mean depth and channel cross-sectional area.

Streambed Composition. Substrate material definitions of Simonson et al. (1994) were used. Substrate composition and embeddedness were estimated visually to the nearest five percent along transects at each site. Sediment depth was defined as the depth of yielding material (silt or muck) overlaying a non-yielding substrate (bedrock, boulders, rubble, cobbles, gravel, or sand). In the field, stream bottom material which could be penetrated with the grade stick was considered sediment, and its depth was measured by grade stick along transects at each site at the same points used for measuring water depth. Embeddedness was defined as percent of rubble, cobble, or gravel particles covered by sediment.

Riparian Conditions. The land use classification and riparian definitions of Simonson et al. (1994) were used. Riparian land use and canopy shading were estimated visually to the nearest five percent along transects at each site. Buffer width, bank erosion, bank slumping, bank height at water's edge, and entrenchment bank height were measured by grade stick, measuring tape, or 25-ft (7.62-m) extension pole (Model 90180, Crane Enterprises, Inc., Mound City, IL) 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). Bank angle (with respect to horizontal) of both water's edge and entrenchment banks was measured with an industrial clinometer (Model No. 78555, Shinwa Rules Co., Ltd., Tsubame City, Niigata Pref., Japan 959-1276, http://www.shinwasokutei.co.jp/index.html). Buffer width was defined as the width of undisturbed riparian vegetation extending from water's edge to a point 10 m inland. Bank erosion was defined as the width of bare riparian soil from water's edge to a point 10 m inland, and slumping was defined as the width of detached whole riparian soil masses, vegetated or not, from water's edge to a point 10 m inland. An entrenchment bank was defined as a bank higher than the water's edge bank and separated from water's edge by a distance of 10-30 m. Entrenchment banks obviously contained stream flow during peak flow periods and often coincided with water's edge banks on outside meander bends.

Cover. Cover was defined as any instream material, riparian material, or streambank configuration that could provide protection for most fishes of the size range (< 15 cm) found in Upper Sevenmile Creek. The amount of wetted channel bottom covered by woody debris, other debris, emergent vegetation (aquatic or flooded riparian), or submerged vegetation (aquatic or submerged riparian) was visually estimated to the nearest five percent along transects at each site. In order to qualify as cover, debris or vegetation had to occur in water at least 15 cm deep; Simonson et al. (1994) used a one-foot (30.5-cm) water depth criterion, but their approach emphasized cover requirements of larger game fishes. Riparian vegetative overhang, vegetative height at water's edge, and bank undercut were measured by grade stick 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 and land use were noted at each site.

RESULTS AND DISCUSSION

Stream Flow. Upstream of site 18, the Thirteen Mile Creek system consisted of long sections of dry channel separating a few isolated pools at bridge crossings (Figure 2b). This reach of the system exhibited no active flow during the sampling period, although it is probably responsive to storm events and surface runoff because the associated drainage area is relatively large. The dry channel sections were occupied by terrestrial vegetation, indicating that duration of flow in these channels is brief. From site 18 downstream to site 15 at the Dawson County Road 543 crossing active flow was evident, but it was barely measurable using the buoyant object method, usually less than 0.1 m^3/s (Table 2). Downstream of site 15 to the mouth at the Yellowstone River, the stream lacked hydrologic continuity. Where zero discharge was recorded, riffles were either dry or reduced to trickles. Pools at all sites downstream of site 15, retained some water. Active flow between sites 18 and 15 was probably a result of seepage from several wells located adjacent to the channel and used for livestock water supply and

Water Quality. Water quality was relatively uniform longitudinally during the sampling period. Water temperature averaged 20.7°C (range 10.0°C to 26.0°C) and generally responded daily to air temperature, which averaged 26.4°C (range 10.0°C to 35.0°C) (Table 2).

Dissolved oxygen (DO) averaged 4.8 mg/l (range from 4.0 mg/l to 5.9 mg/l) and was marginal for support aerobic aquatic life (Table 2). Low DO concentrations may have been a result of high air temperatures, shallow average pool depth, and lack of hydrologic continuity. Average pH was 9.1 with little variation longitudinally (Table 2).

Concentrations of total suspended solids (TSS) varied little longitudinally, averaging 315.4 mg/l (range 234.1 mg/l to 367.3 mg/l). TSS concentrations probably reflected local disturbances such as bank erosion, beaver activity, or cattle use, or (at sites 1 and 2) rather than downstream accumulation of TSS (Table 2). Thirteen Mile Creek probably receives a relatively high natural inorganic sediment load due to weathering of the sparsely vegetated badlands and the unconsolidated glacial outwash that comprise a large part of its watershed.

Table 2. Water quality, stream flow, and channel morphology variables for 20 sites in the Thirteen Mile Creek system, Dawson County, Montana, 25 July to 6 August 2007.

Site[a]	Variable[b]								
	T (°C)	DO (mg/l)	C (µS)	TSS (mg/l)	pH	Q (m^3/sec)	L (m)	W (m)	D (cm)
1 P	20.0	4.1	1300		9.1	0	40	12.2/112.3	15.2
2 P	20.0	4.0	1200	355.3	9.3	0	>40	0.7/9.7	11.1
3 P	26.0	5.3	1750		9.2	<0.1	15.0	1.8/3.4	13.1
3 R						<0.1	1.0	2.4/3.4	7.3
4[c]									
5 P	14.0	4.9	1215		9.1	0	35.1	2.8/3.4	10.6
6 P	23.0	4.1	1350	255.1	9.0	0	30.2	2.8/3.0	15.1
7 P	19.0	5.2	1240		9.3	0	54.4	3.4/4.5	2.1
7 R						0	6.0	1.9/4.5	10.9
8 P	19.0	5.0	1150		9.1	0	10.0	2.5/4.5	21.2
8 R						0	3.0	0/4.1	0
9 P	24.0	4.8	1250		8.9	<0.1	40.0	5.8/9.2	9.3
9 R						<0.1	3.0	2.4/8.0	3.2
10 P	19.0	4.9	1600	365.2	9.1	0	35.0	3.3/5.3	18.9
10 R						0	2.4	1.0/1.5	5.0
11[c]									
12[c]									
13 P	20.0	4.8	1515		8.9	<0.1	8.0	3.9/4.5	17.2
13 R						<0.1	4.0	2.0/4.7	11.0
14 R						<0.1	5.0	1.8/1.8	8.7
14 P	26.0	4.4	1450	367.3	9.1	<0.1	26.0	3.9/4.4	17.5
15 P	26.0	4.7	1500		9.3	0	35.6	5.9/6.5	55.0
16 P	20.5	4.8	1450		9.2	<0.1	>40	5.7/7.5	20.3
16 R						0.2	4.1	2.8/4.2	40.8
17 R						0.3	3.8	6.2/14.8	33.6
17 P	22.0	5.1	955		8.8	<0.1	>40	4.1/5.8	24.4
18 P	23.0	5.2	750	234.1	8.4	<0.1	26.8	4.0/5.6	23.1
18 R						0.4	4.5	2.2/3.0	4.0
19 P	10.0	5.9	800		9.2	0	>40	1.7/4.3	12.2
20[c]									

[a]In order of downstream to upstream occurrence (R: riffle; P: pool; site 1: Yellowstone River).

[b]T: mean water temperature; DO: dissolved oxygen; C: conductivity; TSS: total suspended solids; Q: mean discharge; L: habitat unit length; W: mean wetted width/channel width; D: mean depth. A blank indicates that a variable was not determined at the site; a dash (-) indicates that the value was positive but that it was not measurable with the technique used.

[c]Site not sampled in 2007.

Table 3. Mean values of riparian variables for 20 sites in the Thirteen Mile Creek system, Dawson County, Montana, 25 July to 6 August 2007.

Site[a]	Variable[b]									
	LU	BW (m)	ER (m)	SL (m)	H-1 (cm)	H-2 (m)	A-1 (°)	A-2 (°)	CS (%)
1 P	MI/MI	>10/>10	0/0	0/0	0/0	1.9/2.9	0/5	30/25	0
2 P	MI/MI	>10/>10	0/0	0/0	0/0	1.9/1.7	5/5	20/21`	0
3 P	MI/MI	>10/>10	0/0	0/0	125/26	-- /100	-- /90	-- /90	0
3 R	MI/MI	>10/>10	0/0	0/0	70/20	-- / --	-- /90	-- /90	0
4[c]									
5 P	MI/MI	>10/>10	0/0	0/0	36/65	-- / --	44/72	-- / --	11.1[d]
6 P	ME/ME	>10/>10	0/0	0/0	43/17	-- / --	64/51	-- / --	0
7 P	PA/PA	>10/>10	0/0	0/0	88/ --	-- / --	11/11	-- / --	0
7 R	PA/PA	>10/>10	0/0	0/0	-- /20	-- / --	-- /45	-- / --	0
8 P	EX/PA	>10/>10	-- /0	0/0	8/56	15.0/ --	17/49	54/ --	0
8 R	EX/PA	>10/>10	-- /0	0/0	5/44	15.1/ --	17/49	55/ --	0
9 P	PA/PA	0/0	0/0	0/0	-- / --	-- / --	-- / --	-- / --	0
9 R	PA/PA	0/0	0/0	0/0	-- / --	-- / --	-- / --	-- / --	0
10 P	WO/ME	>10/>10	0/0	0/0	1/ --	0.6/ --	45/ --	10/ --	37.5
10 R	WO/ME	>10/>10	0/0	0/0	2/ --	-- / --	-- / --	-- / --	70.0
11[c]									
12[c]									
13 P	PA/MI	0/>10	0/0	0/0	50/25	-- / --	22/28	-- / --	0
13 R	PA/MI	0/>10	0/0	0/0	-- / --	-- / --	2/2	-- / --	0
14 R	PA/PA	0/0	0/0	0/0	66/ --	-- / --	90/20	-- / --	0
14 P	PA/PA	0/0	0/0	0/0	55/5	-- / --	65/15	-- / --	0
15 P	PA/PA	0/0	0/0	0/0	-- / --	-- / --	5/5	-- / --	100[d]
16 P	PA/PA	0/0	0/0	0/0	75/125	-- / --	24/15	-- / --	0
16 R	PA/WO	0/>10	0/4.5	0/0	40/500	-- / --	30/55	-- / --	0
17 P	PA/SH	5/5	0/0	0/0	14/79	-- / --	-- /58	-- / --	0
17 R	PA/PA	0/0	0/0	0/0	52/25	-- / --	45/10	-- / --	0
18 P	PA/PA	0/0	0/0	0/0	63/40	-- / --	90/36	-- / --	0
18 R	PA/PA	0/0	0/0	0/0	80/38	-- / --	90/90	-- / --	0
19 P	PA/PA	>10/>10	0/0	0/0	8/8	-- / --	20/20	-- / --	0
20[c]									

[a]In order of downstream to upstream occurrence (R: riffle; P: pool; site 1: Yellowstone River).

[b]Mean values per habitat unit [LU: land use (EX: exposed unvegetated rock or gravel bars; ME: meadow; MI: mixed meadow; OP: open marsh; PA: pasture; SH: shrubs); BW: buffer width; ER: erosion; SL: slumping; H-1: bank height at water's edge; H-2: entrenchment bank height; A-1: bank angle (with respect to horizontal) at water's edge; A-2: entrenchment bank angle; CS: canopy shading]. A zero (0) indicates that the feature was absent. A dash (--) indicates that the value was positive but that it was negligible on the scale used; for entrenchment banks, a dash indicates that the bank was greater than 10 m from water's edge. A slash (/) separates left bank/right bank values.

[c]Site not sampled in 2007.

[d]Bridge shading: old Montana State Route 16 at site 5 and Dawson County Road 543 at site 15.

Table 4. Cover variables for 20 sites in the Thirteen Mile Creek system, Dawson County, Montana, 25 July to 6 August 2007.

Site[a]	Variable[b]						
	VH (cm)	VO (cm)	BU (cm)	WD (%)	OD (%)	EV (%)	SV (%)
1 P	0/0	0/0	0/0	0	0	0	0
2 P	-- / --	0/0	0/0	0	0	0	0
3 P	100/113	83/23	0/0	0	0	6	10
3 R	0/85	25/35	0/0	0	0	0	10
4[c]							
5 P	56/42	0/0	0/0	0	0	15	3
6 P	88/96	0/0	0/0	0	0	8	14
7 P	0/0	-- / --	0/0	0	0	1	8
7 R	0/77	-- / --	0/0	0	0	15	45
8 P	50/50	0/ --	0/0	0	0	1	51
8 R	50/50	0/ --	0/0	0	0	--	--
9 P	65/57	0/0	0/0	0	0	9	38
9 R	35/30	0/0	0/0	5	0	0	0
10 P	66/63	28/ --	16/0	2	0	2	12
10 R	85/0	0/0	0/0	0	0	0	2
11[c]							
12[c]							
13 P	30/30	0/0	0/0	0	0	1	65
13 R	-- / --	0/0	0/0	0	0	0	80
14 R	-- /50	0/0	0/0	0	0	0	50
14 P	45/28	0/0	0/0	0	0	4	14
15 P	0/0	0/0	0/0	0	0	0	0
16 P	16/35	-- / --	0/0	16	0	0	2
16 R	23/11	-- / --	0/0	23	0	0	3
17 P	52/20	-- / --	0/0	0	0	0	5
17 R	170/0	-- / --	0/0	0	0	0	2
18 P	51/25	0/0	0/0	0	0	0	30
18 R	50/90	0/0	0/0	0	0	0	10
19 P	-- / --	37	0/0	0	0	0	0
20[c]							

[a]In order of downstream to upstream occurrence (R: riffle; P: pool).

[b]Mean values per habitat unit (VH: vegetative height; VO: vegetative overhang; BU: bank undercut; WD: woody debris; OD: other debris; EV: emergent vegetation; SV: submerged vegetation. A slash (/) separates left bank/right bank values. A zero (0) indicates that the feature was absent. A dash (--) indicates that the value was positive but that it was negligible on the scale used.

[c]Site not sampled in 2007.

Table 5. Streambed composition variables for 20 sites in the Thirteen Mile Creek system, Dawson County, Montana, 25 July to 6 August 2007.

Site[a]	Substrate Composition[b]							Sedimentation[b]	
	BO (%)	RC (%)	GR (%)	SA (%)	SI (%)	CL (%)	MU (%)	SD (cm)	EM (%)
1 P					100			5	45
2 P					100			4	100
3 P		5	85		10			0	10
3 R		5	90		5			0	5
4[c]									
5 P			70		20	10		0	20
6 P			26		81	3		4	81
7 P			34		39	27		0	10
7 R		5	95		5			0	10
8 P	7	3	80		10			0	4
8 R		10	90					0	0
9 P			81		19			0	19
9 R			45		55			0	5
10 P		7	81		12			2	12
10 R				100				0	0
11[c]									
12[c]									
13 P		60	65		5			0	5
13 R		5	90		5			0	5
14 R		30	70					0	0
14 P	3	25	62		10			0	8
15 P		20	70		10			0	10
16 P		6	88		6			0	5
16 R		5	90		5			0	10
17 P		3	61	1	35			16	35
17 R		5	50	5	40			7	40
18 P			43	18	39			17	32
18 R			80	10	10			8	10
19 P					100[d]			4.8	100
20[c]									

[a]In order of downstream to upstream occurrence (R: riffle; P: pool).

[b]BO: boulders; RC: rubble/cobble; GR: gravel; SA: sand; SI: silt; MU: muck; SD: sediment depth; EM: embeddedness. A blank indicates that a component was not visually apparent.

[c]Site not sampled in 2007.

[d]Black organic muck and loose detritus underlain by gravel.

Table 6. Species and numbers of fishes collected in the Thirteen Mile Creek system, Dawson County, Montana.

Species[a]	Pre-1981[b]	MFISH[c]	2007[d]	Total
goldeye (*Hiodon alosoides*)	✓	✓		
common carp (*Cyprinus carpio*)	✓	✓		
brassy minnow (*Hybognathus hankinsoni*)	✓	✓		
emerald shiner (*Notropis atherinoides*)	✓			
sand shiner (*Notropis stramineus*)	✓	✓	33	33
northern redbelly dace (*Phoxinus eos*)	✓	✓	52	52
fathead minnow (*Pimephales promelas*)	✓	✓	19	19
flathead chub (*Platygobio gracilis*)	✓	✓	68	68
lake chub (*Couesius plumbeus*)	✓	✓		
longnose dace (*Rhinichthys cataractae*)	✓	✓	212	212
creek chub (*Semotilus atromaculatus*)	✓	✓	2026	2026
river carpsucker (*Carpiodes carpio*)	✓	✓	3	3
longnose sucker (*Catostomus catostomus*)	✓	✓	15	15
mountain sucker (*Catostomus platyrhynchus*)	✓	✓		
white sucker (*Catostomus commersoni*)	✓	✓	248	248
smallmouth buffalo (*Ictiobus bubalus*)	✓	✓	1	1
bigmouth buffalo (*Ictiobus cyprinellus*)	✓	✓		
shorthead redhorse (*Moxostoma macrolepidotum*)	✓	✓	4	4
black bullhead (*Ameiurus melas*)	✓	✓	1	1
channel catfish (*Ictalurus punctatus*)	✓	✓		
stonecat (*Noturus flavus*)	✓	✓		
northern pike (*Esox lucius*)	✓	✓		
plains killifish (*Fundulus zebrinus*)	✓	✓	184	184
brook stickleback (*Culaea inconstans*)	✓	✓	848	848
green sunfish (*Lepomis cyanellus*)	✓	✓	3	3
pumpkinseed (*Lepomis gibbosus*)	✓	✓		
sauger (*Sander canadense*)	✓	✓		
TOTAL FISH	--	--	**3737**	**3737**
TOTAL SPECIES	**27**	**26**	**15**	**28**

[a]Common and scientific names according to Robins et al. (1991).

[b]Elser et al (1980), Morris et al. (1981); check (✓) means present but numerical data not available.

[c]MFIS (2008); check (✓) means present but numerical data not available.

[d]Present study (2007).

Table 7. Species and numbers of fishes collected in the Thirteen Mile Creek system, Dawson County, Montana, 25 July – 6 August 2007.

Common Name	Scientific Name	Number/Site																				
		1[a]	2	3	4[b]	5	6	7	8	9	10	11[b]	12[b]	13	14	15	16	17	18	19[c]	20[b]	Σ
sand shiner	*Notropis stramineus*	8				5	20															33
northern redbelly dace	*Phoxinus eos*																34	8	10			52
fathead minnow	*Pimephales promelas*	1		1		4	6	2	2								3					19
flathead chub	*Platygobio gracilis*	68																				68
longnose dace	*Rhinichthys cataractae*		18	9		5	36		17	3	30			8	57		21		8			212
creek chub	*Semotilus atromaculatus*					114	215	78	107	108	127			82	339	28	281	170	377			2026
longnose sucker	*Catostomus catostomus*								12		3											15
white sucker	*Catostomus commersoni*					18	14	1	31	5	28			12	24	12	28	6	69			248
smallmouth buffalo	*Ictiobus bubalus*	1																				1
shorthead redhorse	*Moxostoma macrolepidotum*								4													4
river carpsucker	*Carpiodes carpio*	2		1																		3
black bullhead	*Ameiurus melas*					1																1
plains killifish	*Fundulus zebrinus*					2	46	35						1	99			1				184
brook stickleback	*Culaea inconstans*					14	30				1			5	3		17	5	59	714		848
green sunfish	*Lepomis cyanellus*					1					2											3
TOTAL (Σ)		**80**	**18**	**11**	**---**	**164**	**367**	**116**	**173**	**116**	**191**	**---**	**---**	**108**	**522**	**40**	**384**	**190**	**523**	**714**		**3717**

[a]Yellowstone River side channel adjacent to mouth of Thirteen Mile Creek.

[b]Sites proposed for 2008; not sampled in 2007.

[c]South Fork Thirteen Mile Creek.

Conductivity was relatively high, averaging 1279.7 μS (range 750 μS to 1750 μS) (Table 2). High conductivity reflects high concentrations of total dissolved solids (TDS), which are derived from runoff inputs of a sparsely vegetated watershed in a highly evaporative climate.

Channel Morphology. Downstream of site 18, Thirteen Mile Creek exhibited well defined riffle-pool development, although riffles were often dry under prevailing low flow conditions. Pools ranged from 8 m to greater than 40 m in length, averaging 4.0 m in wetted width and 17.8 cm in depth. Riffles ranged from 1 m to 6 m in length, averaging 1.2 m in wetted width and 12.4 cm in depth. Because of low flow conditions, channel width was usually more than wetted width (Table 2).

Riparian Conditions. Adjacent land use at most sites on Thirteen Mile Creek was pasture and mixed meadow. Where entrenchment banks were relatively high and steep, undisturbed meadow, mixed meadow, and shrubs were usually evident, probably because cattle avoided these habitats. Riparian erosion and slumping were minimal and were largely restricted to high angle faces of entrenchment banks. At many sites we evaluated buffer width (width of undisturbed riparian vegetation) as 0 because grazing had modified natural riparian vegetation cover. However, in most locations this indicated a reduction in vegetation height rather than the presence of bare soil or erosion. Banks at water's edge were low, usually less than 0.5 m, and approximately vertical, while most of the channel meandered across a broad floodplain with entrenchment banks, if present, farther than 10 m from water's edge. Although eastern cottonwoods were frequently adjacent to the channel, they were never close enough to provide canopy shading during daylight hours. Significant "canopy" shading at sites 5 and 15 was provided most of the day by bridge cover (Table 3).

Cover. Vegetative height at water's edge averaged 62.0 cm, (range 0.0 cm to 170 cm). Vegetative overhang was absent or negligible at many sites; where present, it averaged 37.7 cm (Table 4). Instream cover, including bank undercut, woody debris, other debris, emergent vegetation, and submerged vegetation, was generally scarce. Most pools had some submerged aquatic vegetation, mostly *Ceratophyllum* sp. and *Chara* sp., but it was difficult to visually assess its extent due to high turbidity. Significant amounts of emergent and submerged vegetation were associated with deeper pools and riffles at sites 8, 9, 13, 14, and 18 (Table 4). Attached filamentous algae covered the streambed material in most riffles and shallow pools. The most important cover in Thirteen Mile Creek may consist of "virtual" cover provided by tall riparian vegetation.

Streambed Composition. The predominant substrate materials in Thirteen Mile Creek were rubble/cobble, gravel, and silt; silt embeddedness was significant at all pool sites (Table 5). Riffles generally exhibited higher proportions of rubble and cobble than did pools. Boulders were evident only at sites 8 and 13, where the creek had apparently cut through more resistant geological formations, leaving boulders or slabs of limestone in the channel and riparian areas. Most pools were not deeply sedimented except for deep organic muck and lose detritus at site 19 (Figure 2b).

Fish Communities. Since 1975, 28 species of fishes have been collected in Thirteen Mile Creek and the immediately adjacent side channel of the Yellowstone River, to which we added additional new records (Tables 6 and 7).

In 2007 we failed to collect 12 species previously collected in Thirteen Mile Creek, including goldeye (*Hiodon alosoides*), common carp (*Cyprinus carpio*), emerald shiner (*Notropis atherinoides*), brassy minnow (*Hybognathus hankinsoni*), lake chub (*Couesius plumbeus*), mountain sucker (*Catostomus platyrhynchus*), bigmouth buffalo (*Ictiobus cyprinellus*), channel catfish (*Ictalurus punctatus*), stonecat (*Noturus flavus*), northern pike (*Esox lucius*), pumpkinseed (*Lepomis gibbosus*), and sauger (*Sander canadense*) (Table 6). Goldeye, common carp, mountain sucker, bigmouth buffalo, channel catfish, northern pike, and sauger are riverine species associated with the Yellowstone River and its larger tributaries; they may appear in small numbers in the lower reaches of Thirteen Mile Creek, especially during their spring spawning seasons.

Deeper vegetated pools provide ample habitat for brook stickleback and northern redbelly dace in Thirteen Mile Creek, especially in the more perennial section between sites 18 and 15, where they may coexist with lake chubs. We collected 714 brook sticklebacks and no other species in the isolated coldwater pool at site 19 on South Fork Thirteen Mile Creek. The abundance of these species may be limited by nocturnal anoxia when pools become isolated and lack throughflow during the summer. Records of pumpkinseed in many lower Yellowstone River tributaries may represent escapes from populations stocked in ponds and reservoirs in the watershed. However, we think that many of these records represent misidentification of green sunfish (*Lepomis cyanellus*), which bear orange and red spots superficially resembling pumpkinseeds during the first few years of life.

The extent of riffle habitat in Thirteen Mile Creek during the sampling period was minimal, and we collected only a few longnose dace (*Rhinichthys cataractae*) and creek chubs (*Semotilus atromaculatus*) in the riffles at sites 14 and 18. Flathead chub (*Platygobio gracilis*) was also encountered in riffles at site 1 in the Yellowstone River side channel (Table 7). The dewatering of riffles during the summer is probably a significant factor limiting abundance and diversity of riffle fauna, including longnose dace and stonecat (*Noturus flavus*), in Thirteen Mile Creek.

The most abundant and widely distributed pool species were creek chub, longnose dace, white sucker (*Catostomus commersoni*), and plains killifish (*Fundulus zebrinus*) (Table 7). Longnose dace probably retreat to pools when riffles are dewatered in middle to late summer.

We were unable to effectively estimate densities of fish communities in riffles and pools due to low flows, poor capture rates, or failure to achieve significant catch reduction. The greatest numbers of fish were collected at sites 6, 14, 16, 18, and 19, consisting mostly of creek chubs, young-of-year or 1+ white suckers, and brook sticklebacks (at site 19 only). There was no clear relationship between numbers of fish captured at each site and the habitat variables we measured, as was observed in Burns Creek, O'Fallon Creek, and Upper Sevenmile Creek (Barnes 1999, Barnes 2004, Barnes and Siegle 2003, Barnes and Silbernagel 2001, Barnes and Westlind 2000, Barnes et al. 2002, Barnes et al. 2005, Barnes et al. 2006, Barnes et al. 2007).

In Burns Creek, contingent phenomena such as storm flow flushing and distribution of beaver dams in time and space were thought to influence fish community density and diversity as much as relatively "fixed" habitat factors (Barnes and Silbernagel 2001). However, Burns Creek exhibited perennial flow, so fish communities could at least partially stabilize.

In O'Fallon Creek, a similar contingent phenomenon may be the timing and extent of riffle dewatering in the summer. Fish moving upstream or downstream may be trapped, often at very high densities, in shrinking pools with low quality habitat as riffles dry up and interrupt the hydrologic continuity of the stream. Similarly, drying riffles may exclude fish from preferred habitats. The overall "flashiness" of the stream system probably prevents fish communities from stabilizing and efficiently partitioning available habitats (Barnes 2004, Barnes et al. 2002, Barnes and Siegle 2003). Similar factors probably operate in Upper Sevenmile Creek.

Upper Sevenmile Creek is a highly variable system in which extreme high and low flow, hydrologic discontinuity, high sedimentation rates, and high TDS present survival challenges to the resident fish communities. These factors may override other macrohabitat variables, such as substrate composition and instream cover, in controlling density and distribution of these communities.

An understanding of the relationships among fish communities, habitat variables, and contingent phenomena in small intermittent prairie streams such as Thirteen Mile Creek would require several years of study under a full range of stream systems and natural (and anthropocentric) environmental variation.

General Work Plan for 2008. We would like to continue our study of fish communities and habitat variables in Thirteen Mile Creek during the summer of 2008 using the same basic approach and trying to sample at least 20 sites. A disadvantage of trying to understand a system like Thirteen Mile Creek is its longitudinal and seasonal variability. Are the parameters measured at 20 sampling sites during the summer representative of processes in the whole system inter-seasonally and inter-annually? The Thirteen Mile Creek system is similar to the Upper Sevenmile Creek system in size and flashiness but different in lacking extensive sedimentation, similar to the O'Fallon Creek system in flashiness but much smaller in scale, and similar to the Burns Creek system in scale but lacking the hydrologic continuity provided by perennial groundwater driven baseflow.

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Cover Illustration. Northern redbelly dace (*Phoxinus eos*): original artwork by Ellen Edmonson, New York Biological Survey (1927-1940) conducted by New York State Conservation Department (predecessor to New York State Department of Environmental Conservation) (Kraft et al. 2006).

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