FISH ENTRAINMENT INVESTIGATIONS

at the

ST. MARY DIVERSION DAM,

ST. MARY RIVER, MONTANA

2002

A Progress Report

Based on Field Investigations Conducted in 2002

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Introduction

Between 1914 and 1921, the U.S. Bureau of Reclamation (Bureau) built several water-control and delivery structures in the St. Mary River drainage, as part of the Milk River Irrigation Project. Among those structures is the 2-m-high, St. Mary Diversion dam, located about 1.2 km downstream from Lower St. Mary Lake. Annually between about April and October, the dam diverts approximately 750 ft^3/s of water into the St. Mary Canal. The canal conveys the water about 50 km – over the watershed divide and into the Missouri River drainage – to the North Fork of the Milk River (Figure 1). In addition, the lower reach of Swiftcurrent Creek, which formerly flowed into the St. Mary River downstream from Lower St. Mary Lake, was channeled into the lake itself. That allowed water released from Lake Sherburne (Sherburne Reservoir) to be diverted into the St. Mary Canal.

Fisheries have been affected by the Saint Mary delivery system in a number of ways. The diversion dam is a barrier to migration, at least seasonally. The canal headgates do not incorporate any means of excluding fish, and several species are known to enter and reside in the canal during the irrigation season and possibly through the winter. Finally, Swiftcurrent Creek is maintained at bankful discharge from Sherburne Dam to its confluence with Lower Saint Mary Lake during the irrigation season, but after irrigation ends, flows are reduced substantially and Swiftcurrent Creek becomes largely dewatered from Sherburne Dam to the Boulder Creek confluence.

In reaching its decision to list the bull trout (*Salvelinus confluentus*) as a threatened species, the Fish and Wildlife Service (Service) concluded (*Federal Register* 64: 58909), among other things, that bull trout in the St. Mary River drainage are negatively affected by operation of the water-storage and delivery systems that are part of the Milk River Irrigation Project. Results of our ongoing bull trout study support several of the Service's conclusions important to reaching that decision, including the conclusion that bull trout and other native fishes are entrained in the St. Mary irrigation canal (Mogen and Kaeding 2002). Because the canal headgates are barriers to the upstream movement of fish, entrained fish are unlikely to return to the river and are therefore lost from the reproducing population. Numerous electrofishing surveys conducted in May-September, 1993-1995, revealed 10 species of fish inhabiting the St. Mary Canal. Whitefish

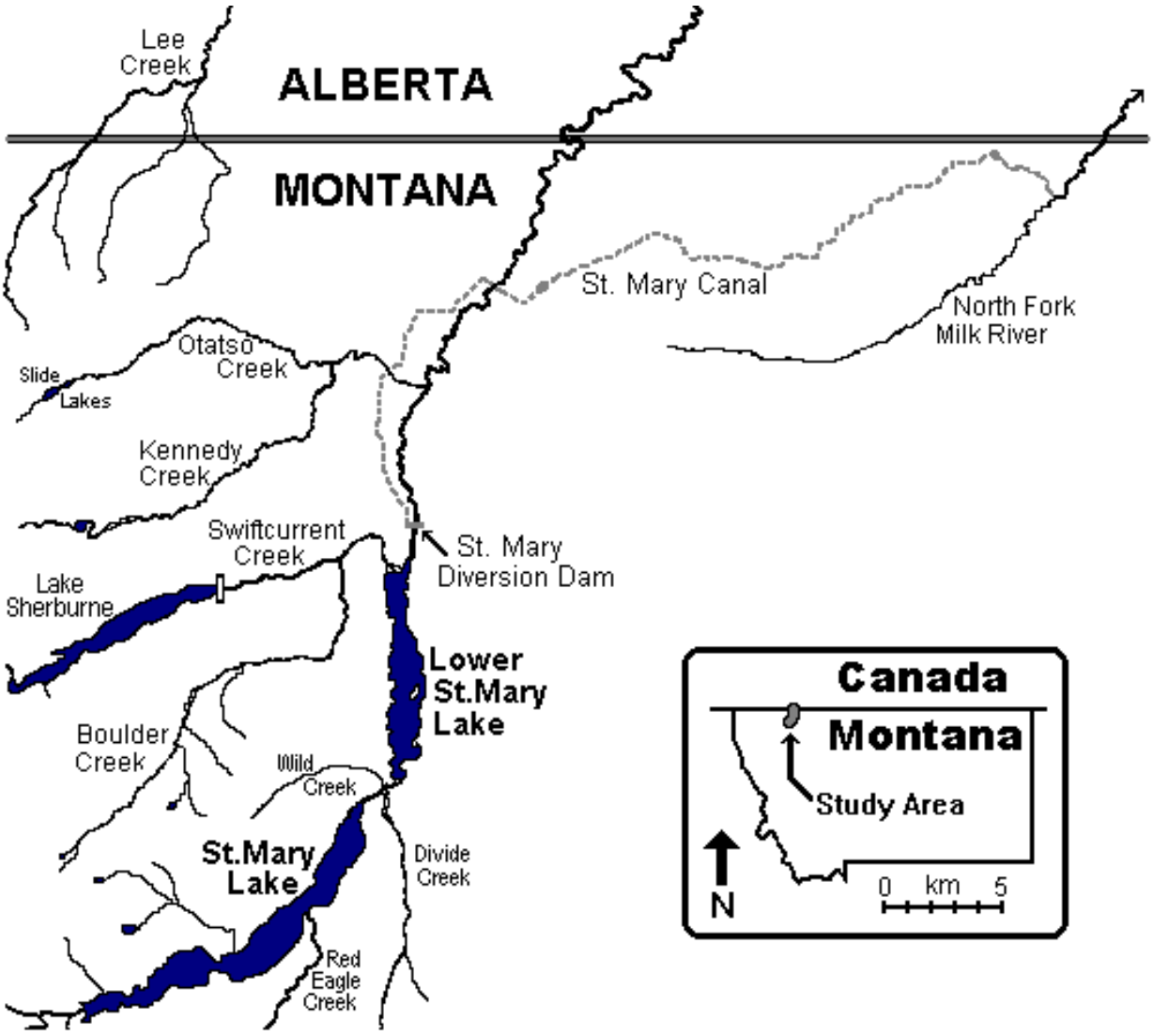

Figure 1. Study area, St. Mary River drainage, U.S. and Canada.

and suckers were most abundant; however, no bull trout and few cutthroat trout were captured (Wagner and FitzGerald 1995). In contrast, our preliminary canal surveys, composed of a total of nine experimental gillnet sets made at six different locations along the first 2 km of the St. Mary Canal in mid-October, 1999, yielded 295 fish, including 6 bull trout (Table 1). In addition, our results from both radio telemetry and conventional tag-recapture techniques show considerable upstream and downstream movements of bull trout past the St. Mary Diversion Dam during the irrigation season; such movements may make those fish especially susceptible to entrainment in the canal (Mogen and Kaeding 2002).

Among the fish species indigenous to the St. Mary drainage, bull trout, westslope cutthroat trout (*Oncorhynchus clarki lewisi*), and mountain whitefish (*Prosopium williamsoni*) are believed to have occurred naturally in all of the streams and lakes to which they had access, including the Slide Lakes, while lake trout (*Salvelinus namaycush*) inhabited only the St. Mary and Lower St. Mary lakes. A degree of habitat partitioning between bull trout and lake trout may have resulted from competition between these piscivores (Donald and Alger 1993; Fredenberg 1996). Also indigenous to the drainage are northern pike (*Esox lucius*), burbot (*Lota lota),* and perhaps lake whitefish (*Coregonus clupeaformis*), all of which inhabit the St. Mary lakes, and white sucker (*Catostomus commersoni*), longnose sucker (*Catostomus catostomus*), lake chub (*Couesius plumbeus*), trout-perch (*Percopsis omiscomaycus*), longnose dace (*Rhinichthys cataractae*), pearl dace (*Margariscus margarita*), mottled sculpins (*Cottus bairdi*), and spoonhead sculpins (*Cottus ricei*), which inhabit many of the streams and lakes of the drainage to which the fish had natural access (Brown 1971).

Stocking of nonnative and native fishes in the St. Mary River drainage began in the late 1890s and continued in Glacier National Park until the mid-twentieth century. The stocking of nonnative species continues today only in some waters on tribal lands. Nonnative fishes that have established self-sustaining stocks in the drainage include Yellowstone cutthroat trout (*O. clarki bouvieri*), rainbow trout (*O. mykiss*), and the genetic intergrades (i.e. fish of various generations and accompanying degrees of genetic purity that have resulted from interbreeding among F_1 hybrids, their parent stocks, and subsequent backcross progeny) of those two fishes, as well as brook trout (*Salvelinus fontinalis*) and kokanee (*O. nerka*).

In an attempt to minimize fish entrainment at the unscreened St. Mary diversion, the Bureau purchased an electric fish barrier to be installed on the canal headgates in spring 2003. The purpose of this study was to estimate the density, species composition, and timing (diel and seasonal) of fish entrained in the St. Mary Canal. This preliminary data will be used to develop a more-detailed study to be accomplished in 2003, when tests of the effectiveness of the electric barrier are scheduled to begin. This report presents results of data collected April 23 to September 26, 2002.

Table 1. Total numbers and ranges in total length (mm) of all fish captured in experimental gill nets set overnight in the St. Mary Canal at six different locations (0-3 km downstream from headgates), St. Mary drainage Montana, 13-21 October. 1999. Data from Mogen and Kaeding (2002).

Location, Variable	Bull Trout	CTT x RBT	Whitefish[a]	Northern Pike	Burbot	Suckers[b]
Pool 1						
Number Caught	3	2	26	2	0	53
Length range	325-360	295-303	211-386	440-500		307-515
Pool 1						
Number Caught	2	4	17	1	0	17
Length range	300-322	289-340	214-456	389		277-437
Headgate Pool						
Number Caught	1	0	17	0	1	1
Length range	332		211-309		230	413
Canal Reach 1						
Number Caught	0	0	7	4	0	5
Length range			340-390	615-730		440-480
Pool 1						
Number Caught	0	1	47	0	0	34
Length range		322	210-380			300-516
Canal Reach 1						
Number Caught	0	0	3	1	0	3
Length range			338-388	530		450-488
Pool 2						
Number Caught	0	0	4	1	0	4
Length range			211-300	220		298-380
Canal Reach 2						
Number Caught	0	0	6	1	0	5
Length range			320-368	1090		452-490
Canal Reach 3						
Number Caught	0	0	8	7	0	7
Length range			332-370	520-795		440-500
Total	6	7	135	17	1	129

[a] Includes mountain whitefish and lake whitefish.
[b] Includes white suckers and longnose suckers.

Methods

The St. Mary Diversion is controlled with eight unscreened headgates, six of which were operable during the 2002 sampling period (Figure 2). A netting system was designed to collect fish immediately after entrainment into the canal on four (gates 2, 4, 6, and 7) of the six functioning headgates (Figure 2). Headgates 1 and 5 remained closed throughout 2002. Sampling nets (fyke nets) of ½ -inch heavy-duty mesh, held open at the upstream ends by metal frames (tubular steel with rollers), were lowered with electric winches along guide rails (I-beam anchored to the concrete sluiceways) into the current at the downstream end of the four sluiceways (Figure 3). Each net received the entire inflow from its upstream sluiceway, which filled the nets and held them rigid in the current. The cod ends (3/16-inch ace mesh) of the nets were 24 inches long and fitted with heavy-duty zippers for easy removal of contents. Rope chokers fastened 4-ft above the cod ends were used to lift the nets from the current while preventing fish from swimming out. During the dark hours, lights (halogen and soft white bulbs) were left on only while working (raising, emptying, and lowering) the nets and measuring fish. Field crews of at least two members operated the nets. A job hazard analysis was performed prior to operation of the nets.

The systematic sampling schedule planned for 2002 included operating the nets for one week (4-day sampling period) during each of the five periods of interest (early-, peak-, and late-runoff, and mid- and late-summer flows); however, high flows and associated debris problems prevented netting operations during May and the canal headgates were closed throughout June and July due to structural damage downstream in the canal. Consequently, the nets were only operated during April (23-25), August (5-29), and September (23-26). To determine diel differences in entrainment rate, sampling effort was divided between day and night hours. Duration of net sets were determined by debris loading and catch rates and varied from 1 to 4 hours throughout the sampling periods. Netted fish were identified to species, weighed (g) and measured to total length (mm). Live fish were released into the river downstream from the diversion structures. Scales were taken from bull trout for age and growth analysis. Water temperatures were recorded bi-hourly throughout the season by two Onset® data-loggers installed on opposite sides of the St. Mary River, approximately 0.5 km upstream from the diversion dam and 0.5 km downstream from Lower St. Mary Lake.

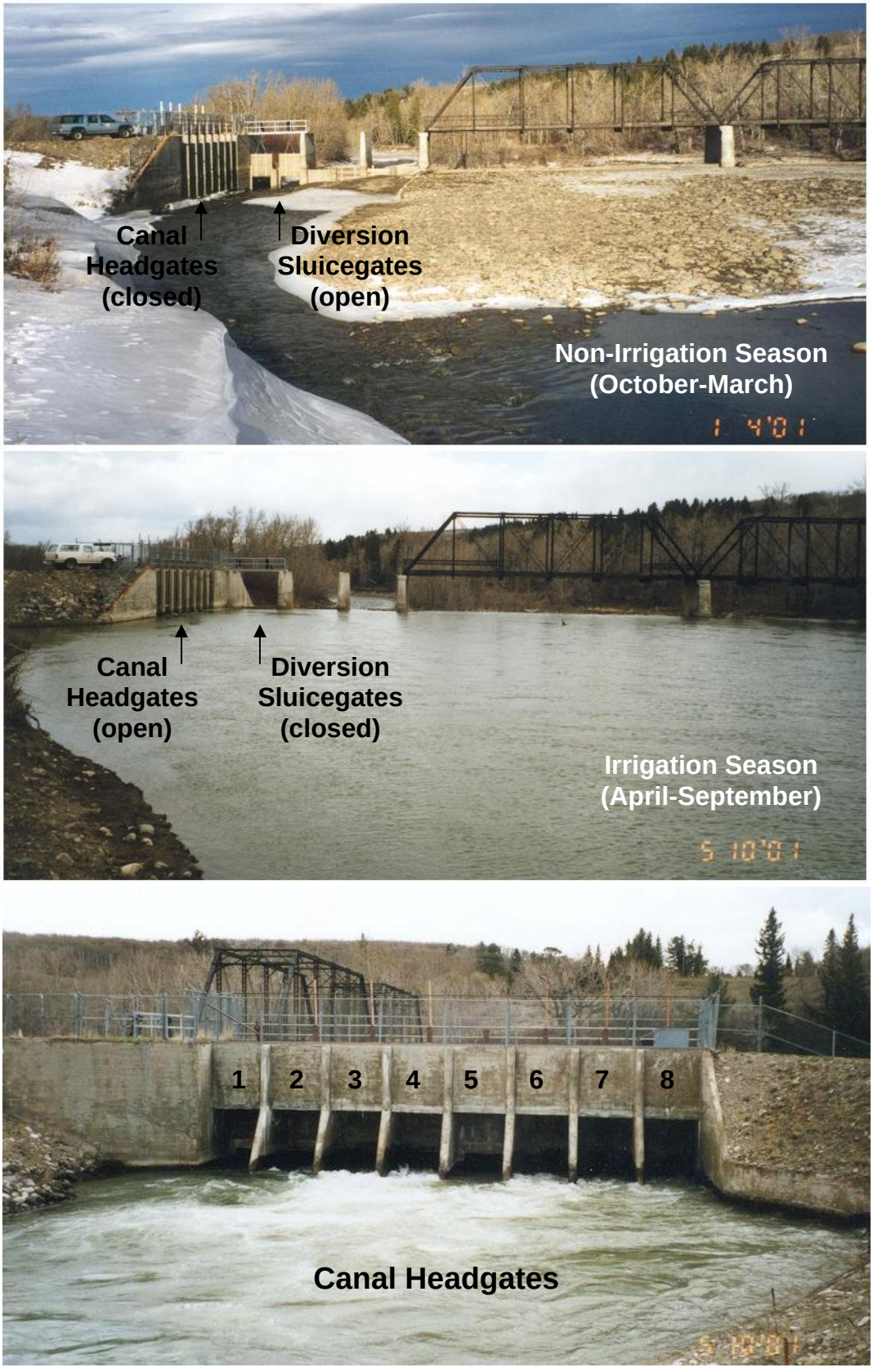

Figure 2. Views of St. Mary Diversion Dam and canal headgates.

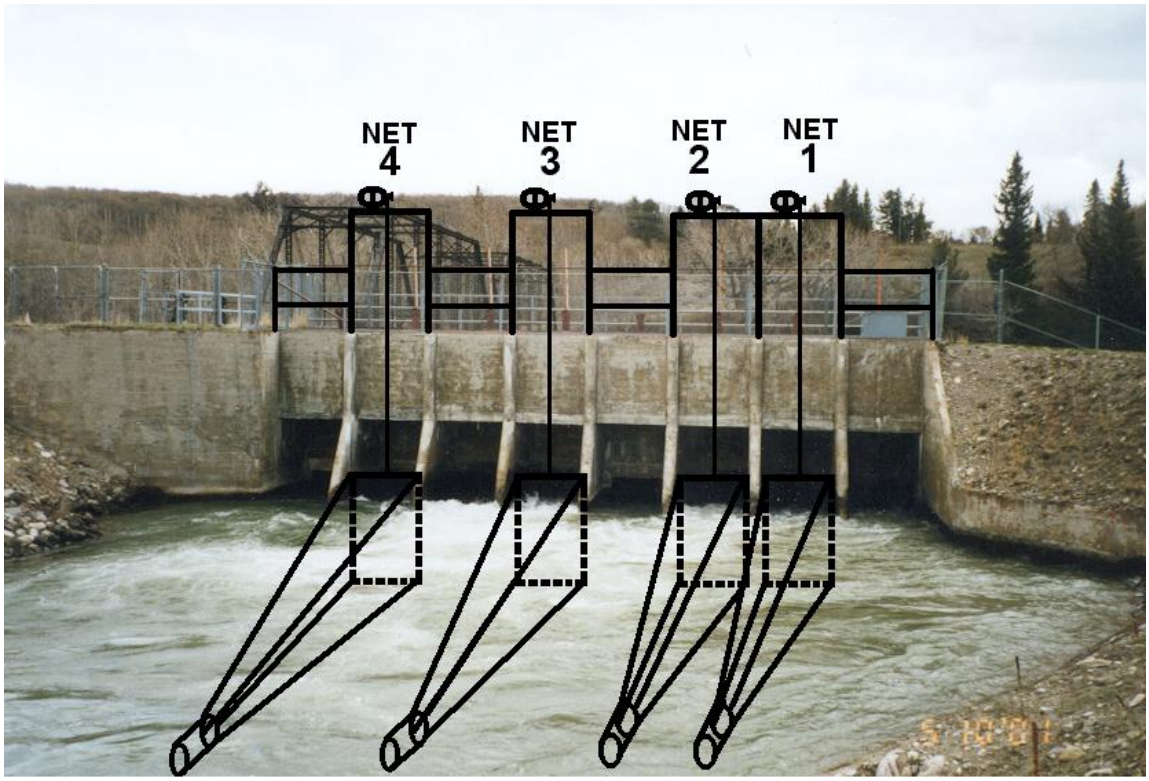

Figure 3. Schematic of entrainment nets installed on the St. Mary Canal headgates, St. Mary River, Montana. Flow of the St. Mary River behind the structure is from right to left.

Results

Entrainment netting collected 436 fish in 31,911 minutes (~532 hours) of sampling in 2002 (Tables 2 and 3; Figures 4 and 5). Twelve species of fish were represented in the catch, including four juvenile (160-182 mm TL) and one adult (554 mm TL) bull trout that was captured in the nets in late September, during its post-spawning, downstream migration. That adult bull trout had been previously captured in the fall of 1998 at the Kennedy Creek fish trap, in the summer of 2000 while electrofishing upper Boulder Creek, in the fall of 2000 at the Boulder Creek fish trap, and again in the summer of 2002 while electrofishing upper Boulder Creek (Mogen and Kaeding 2002). Altogether, salmonids (including 5 bull trout) accounted for 12 percent of the total catch (Figure 5).

Table 2. Catch summary, by month, St. Mary Canal entrainment nets, 2002.

Month	Netted Fish	Minutes Fished	Hours Fished	Catch Rate (fish/hr)
April	1	4309	72	0.014
August	342	18035	301	1.136
September	93	9567	159	0.585
Total	**436**	**31911**	**532**	**0.82**

Table 3. Per net catch summary, species, St. Mary Canal entrainment nets, 2002.

Net Number	FISH SPECIES												Unknown Fish Species	Other Species	TOTAL FISH
	BLT	CTT	MWF	LWF	BUT	NOP	WHS	LNS	TRP	LND	PLD	SCN			
1	3	13	0	0	13	2	6	5	1	22	0	3	1	2	**69**
2	2	6	3	1	23	1	13	6	9	62	2	8	3	5	**139**
3	0	9	1	0	26	0	26	2	1	15	1	4	3	0	**88**
4	0	13	2	1	31	1	52	15	7	15	1	1	1	0	**140**
TOTALS	**5**	**41**	**6**	**2**	**93**	**4**	**97**	**28**	**18**	**114**	**4**	**16**	8	7	**436**
% COMP	**1.1**	**9.4**	**1.4**	**0.5**	**21.3**	**0.9**	**22.2**	**6.4**	**4.1**	**26.1**	**0.9**	**3.7**	1.8	na	100
LENGTH (mm)															
Mean	**249**	**122**	**157**	**59**	**119**	**117**	**142**	**121**	**66**	**64**	**64**	**65**			
Range	160-554	78-221	59-294	59-59	35-362	80-146	41-465	45-443	48-88	29-105	47-72	50-91			

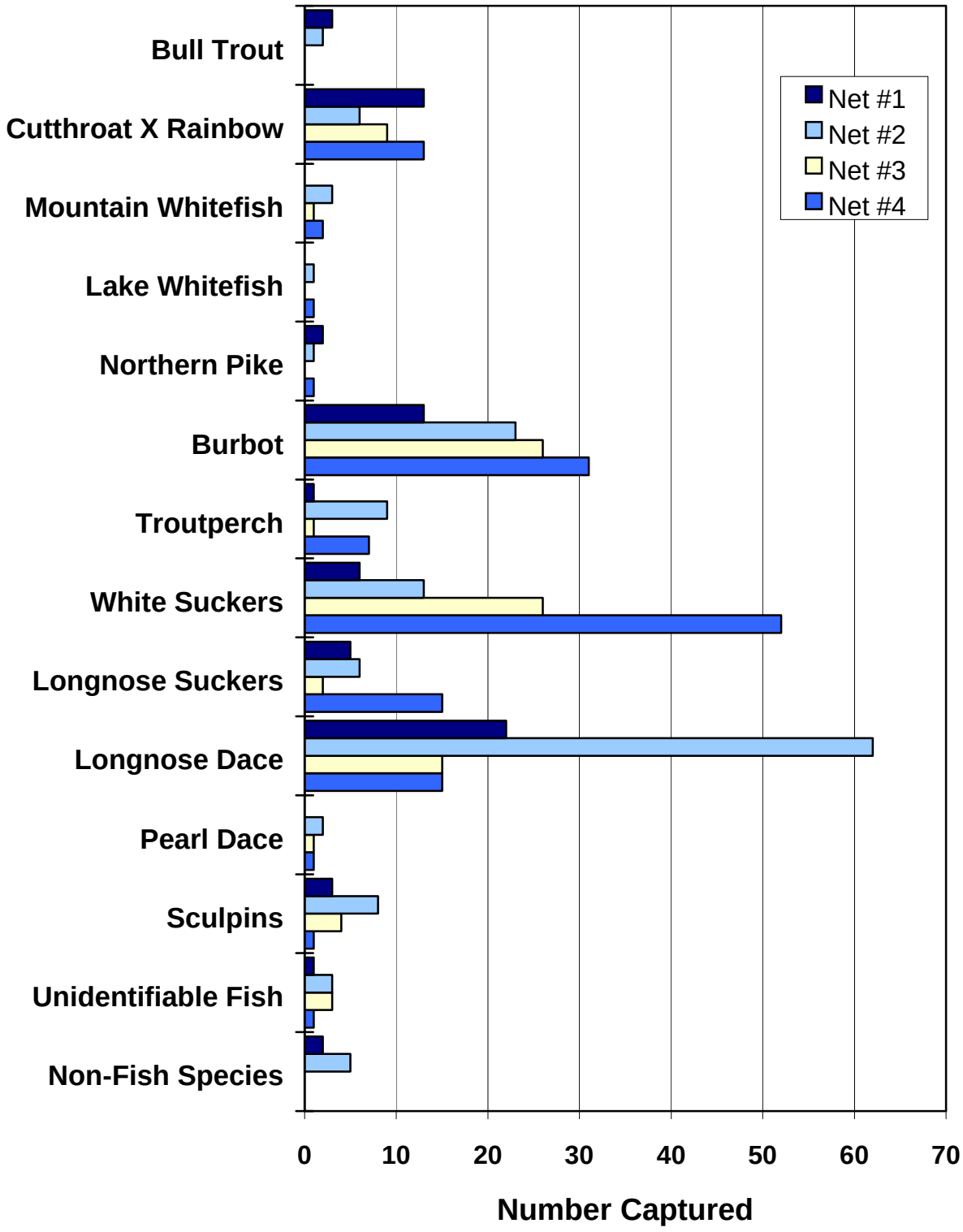

Figure 4. Numbers and species of fish captured, by net, St. Mary Canal entrainment study, St. Mary River drainage, Montana, 2002.

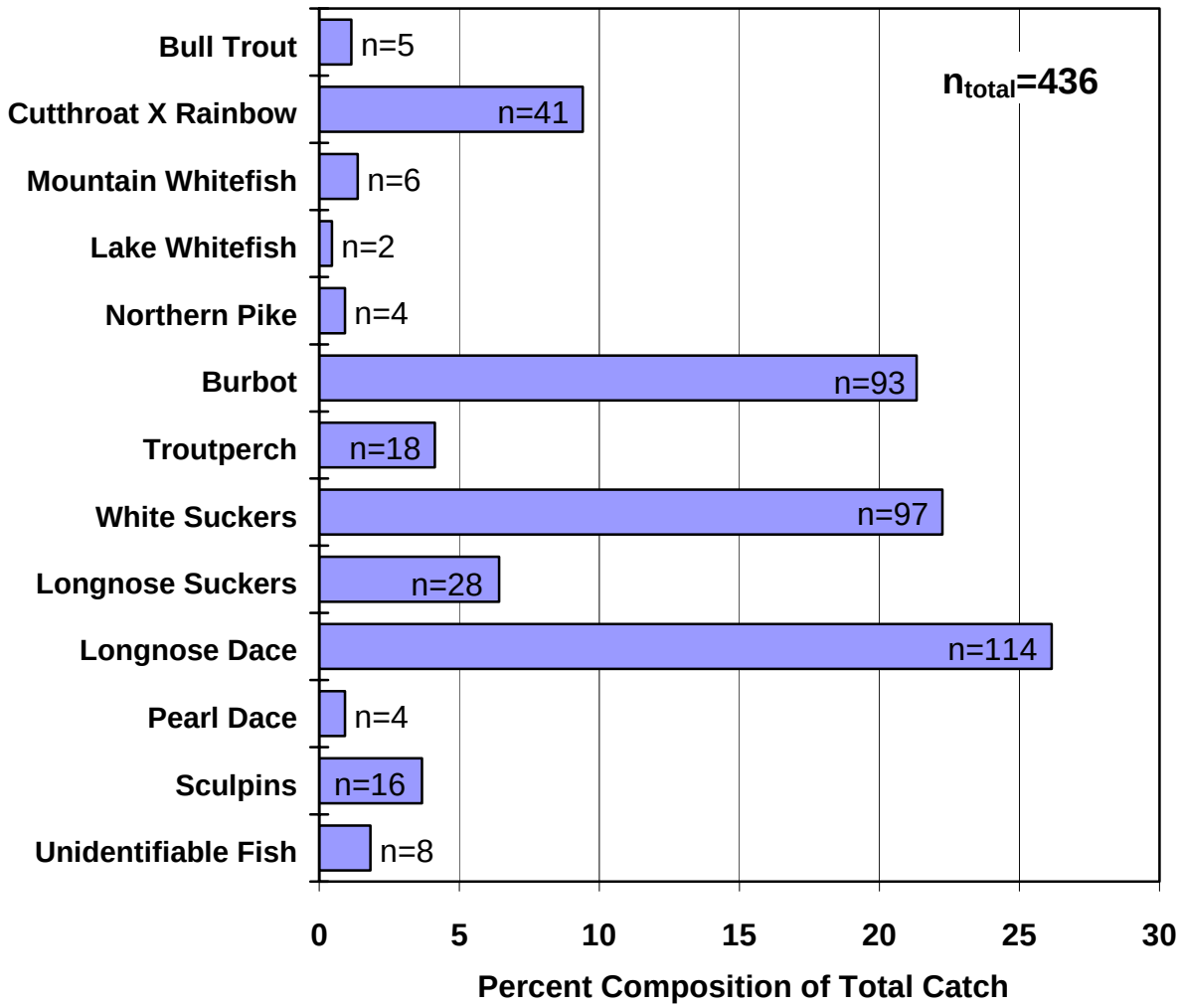

Figure 5. Percent composition of total catch, by species, St. Mary Canal entrainment study, St. Mary River drainage, Montana, 2002.

Longnose dace, suckers and burbot dominated the catch, altogether accounting for over 75 percent of the catch. Total lengths of all fish ranged from 29 to 554 mm; however, most fish were shorter than 150 mm (Table 2; Figure 6).

Catch rates varied markedly between early spring (April) and late summer (August-September). In April, only one fish (mountain whitefish) was captured during 72 hours of netting (0.01 fish/hr) compared to 435 fish (12 species) in 460 hours of netting (0.95 fish/hr) in late summer. Catch rates also showed diel fluctuations (Figure 7) with greater catch rates typically occurring during hours of darkness (dusk to dawn).

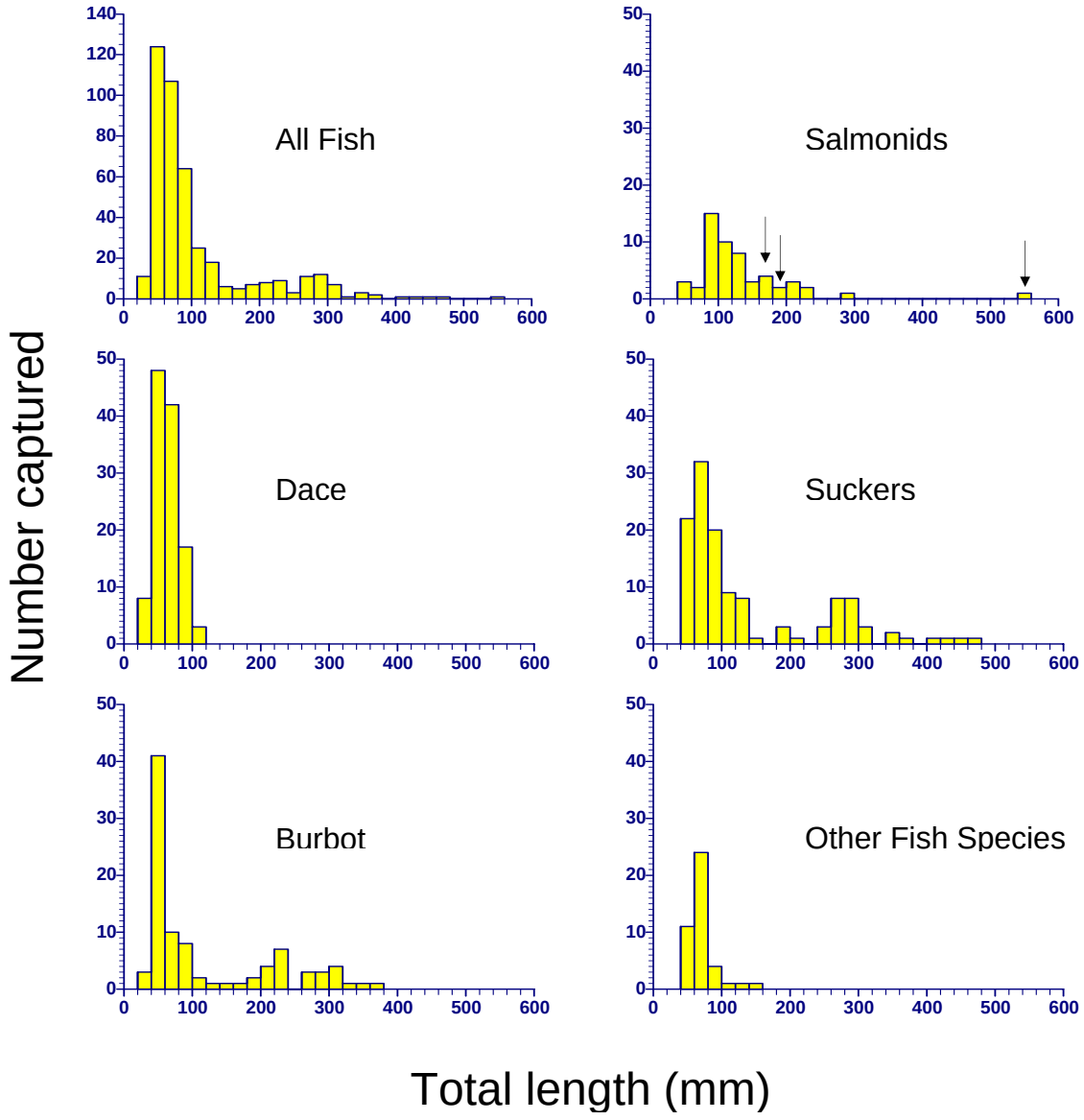

Figure 6. Length-frequency distributions for fish captured in the St. Mary Canal entrainment nets, St. Mary River drainage, Montana, April-September, 2002. Bull trout lengths are designated with small arrows in the salmonid graph.

The water temperature of the St. Mary River varied from lows near 1ºC in early spring and late fall to highs near 17ºC in mid-summer (Figure 7). Although temperatures rarely differed by more than a few degrees, temperatures along the east bank were consistently warmer than those along the west bank, which were influenced by the cooler inflows from Swiftcurrent Creek that enter a short distance upstream.

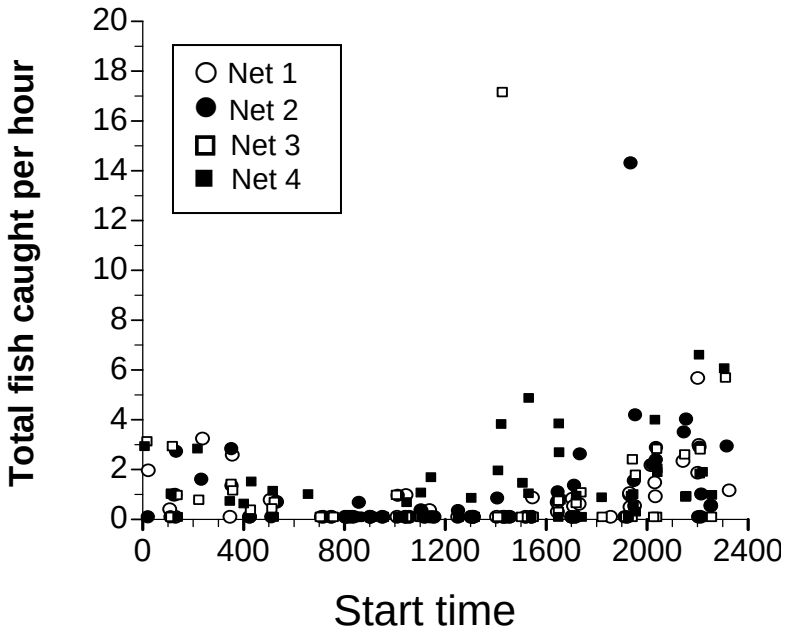

Figure 7. Catch rates (fish/hr) in each of the four entrainment nets plotted against start time of each set, St. Mary Canal, St. Mary River drainage, Montana, April-September, 2002.

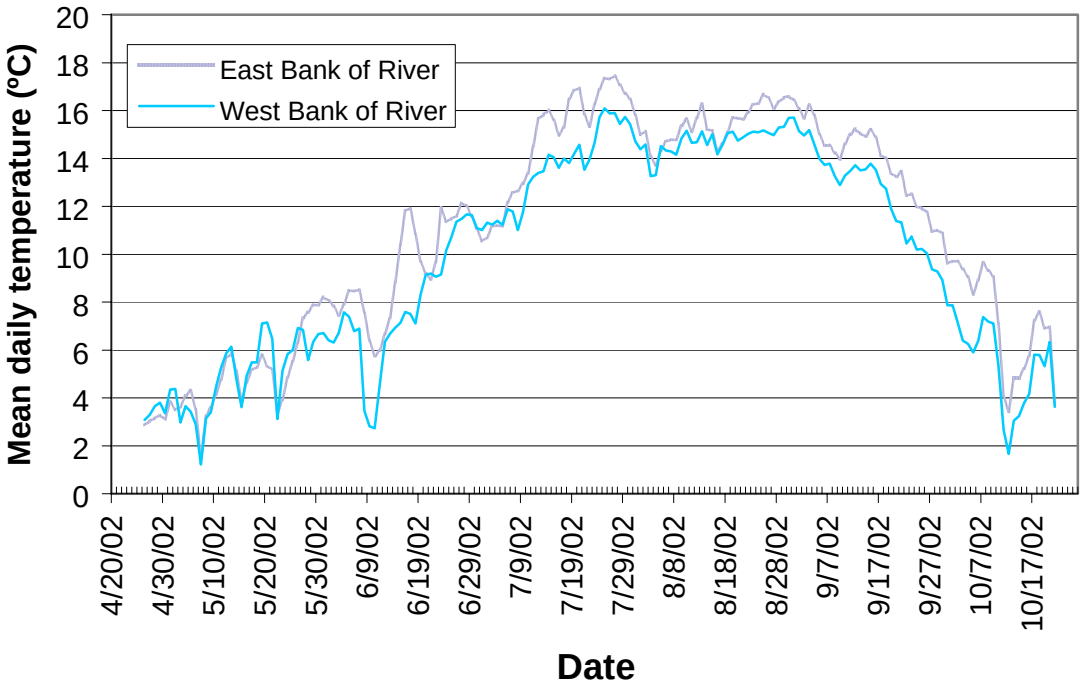

Figure 7. Mean-daily temperatures measured bi-hourly by two thermograph recorders located along opposite banks of the St. Mary River, approximately 0.5 km upstream from the diversion dam, 26 April – 21 October, 2002.

Discussion

The preliminary investigation described in the present report revealed that the nets were effective at sampling fish entrained in the St. Mary Canal. Many species and sizes were caught, including bull trout. Although sampling effort varied greatly among months, catch rates for all species were much higher in late summer than early spring and the expected trends in fish catches were evident (i.e., most fish were captured during darkness). Differences between the species and size distributions of fish captured in entrainment nets and during canal gillnetting operations in October 1999 were also evident. No adult and few juvenile whitefish and northern pike were captured in the entrainment nets; however, those fishes had been commonly captured from the canal in the gill nets. In contrast, burbot were common in the entrainment nets, yet only one burbot was captured in gill nets. Although some small fish may pass through the entrainment nets, small fish dominated catches in the entrainment nets but were not effectively sampled with the gill nets.

Because the canal headgates do not have trash racks, debris (floating and submerged) was a serious problem, especially during high flows. On several occasions, netting time was lost while nets were cleared of logs and snags or while torn nets were repaired. Installation of a floating debris deflector (boom-deflector) with a hanging apron, planned for the upcoming season, should help prevent debris from fouling nets; however, submerged debris floating along the stream bottom will continue to be a problem.

In an attempt to reduce or eliminate fish entrainment at the unscreened St. Mary diversion, the Bureau will install an electric fish barrier on the canal headgates in spring 2003. The sampling apparatus used in the present study should allow us to assess the effectiveness of that fish barrier. However, to make data more comparable, entrainment should be standardized as catch per volume of water sampled. In addition, flows and water turbidity should be routinely measured at the headgates during the 2003 study period.

Acknowledgements

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