Fort Peck Flow Modification Biological Data Collection Plan:

Summary of 2008 Activities

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July 2010

Extended Summary

The Missouri River Biological Opinion developed by the U. S. Fish and Wildlife Service formally identified that seasonally altered discharge and water temperature regimes resulting from operations of Fort Peck Dam have precluded successful spawning and recruitment of pallid sturgeon *Scaphirhynchus albus* in the Missouri River below Fort Peck Dam. In response, the U. S. Army Corps of Engineers (USACE) proposed to modify operations of Fort Peck Dam to enhance environmental conditions for spawning and recruitment of pallid sturgeon and other native fishes. As originally planned, modified dam operations included releasing warm surface water over the Fort Peck Dam spillway to rehabilitate discharge and thermal regimes in the Missouri River. The Fort Peck Flow Modification Biological Data Collection Plan (hereafter Fort Peck Data Collection Plan) is a multi-year, multi-component research and monitoring project initiated in 2001 to evaluate the influence of proposed flow and temperature modifications on physical habitat and biological response of pallid sturgeon and other native fishes. Primary components of the Fort Peck Data Collection Plan include: 1) measuring water temperature and turbidity at several locations downstream from Fort Peck Dam, 2) examining movements and relocating adult pallid sturgeon, paddlefish *Polyodon spathula*, blue suckers *Cycleptus elongatus*, and shovelnose sturgeon *Scaphirhynchus platorynchus* in the Missouri River between Fort Peck Dam and Lake Sakakawea, and in the lower Yellowstone River, 3) quantifying larval fish distribution and abundance, 4) quantifying the reproductive success of shovelnose sturgeon and pallid sturgeon based on captures of young-of-year sturgeon, and 5) assisting in the collection of adult pallid sturgeon for the propagation program. Activities associated with the Fort Peck Data Collection Plan were jointly implemented by the Montana Department of Fish, Wildlife, and Parks and the U.S. Geological Survey - Columbia Environmental Research Center.

Similar to 2001 through 2007, proposed flow modifications were not implemented in 2008 due to inadequate precipitation and insufficient water levels in Fort Peck Reservoir. Thus, data collected during 2008 were indicative of physical and biological characteristics under existing environmental conditions and regular operations of Fort Peck Dam.

For component 1, water temperature loggers were deployed at 17 locations in the Missouri River, tributaries, and off-channel areas between April and October during 2008. Turbidity loggers were deployed in the Missouri River and Yellowstone River. For the mainstem Missouri River, water temperature was warmest in the free-flowing reach upstream from Fort Peck Reservoir (mean = 16.3^{o}C, maximum = 25.0^{o}C) and coldest at the site below Fort Peck Dam (mean = 11.7^{o}C, maximum = 16.0^{o}C). Thus, hypolimnetic releases from the dam suppressed mean water temperature by an average of 4.6^{o}C and maximum temperatures by an average of 9.0^{o}C during the deployment period. At 290 km downstream from the dam, mean and maximum water temperature increased to 16.0^{o}C and 23.7^{o}C, respectively, but were still lower than thermal conditions in the free-flowing Missouri River upstream from Fort Peck Reservoir. Modified dam operations and spillway releases of warm water from Fort Peck Reservoir were proposed as a reasonable and prudent alternative to the USACE as listed in the Missouri River Biological Opinion. Specifically, releases of warm water were targeted to increase water temperature at Frazer Rapids to 18.0^{o}C during late May and June. In the absence of spillway releases during 2008, mean daily water temperature at Frazer Rapids was 12.6^{o}C and maximum temperature was 16.8^{o}C. Turbidity tended to be greater in the Yellowstone River than the

Missouri River. Periods of elevated and increasing turbidity generally accompanied periods of elevated or increasing discharge.

Under component 2, radio tracking was conducted between April and November in the Missouri River between Fort Peck Dam and the headwaters of Lake Sakakawea and in the lower Yellowstone River. Manual tracking and ground based telemetry stations resulted in a total of 850 relocations of blue suckers, 459 relocations of shovelnose sturgeon, and 1,183 relocations of pallid sturgeon. Species-specific information on relocation locations and movement patterns are presented. In the spring, 14 new pallid sturgeon were implanted, as well as five pallid sturgeon that were re-implanted during brood stock collection efforts. These individuals, added to the existing population of implanted fish, will be relocated during the next few years to ascertain discharge and temperature-related movement patterns and aggregations prior to, during, and after proposed flow changes are implemented.

Under component 3, 1,900 larval fish samples were collected between late May and early August from sites located in the Missouri River, Milk River, Yellowstone River, and the spillway channel. Greater than 9,000 larval fishes were sampled, and representatives from Catostomidae (sucker family) comprised 76% of all larvae collected. The greatest number of taxa occurred in the Missouri River downstream from the Milk River confluence, and fewest taxa were collected in the Missouri River downstream from Fort Peck Dam. A total of 101 larval paddlefish were collected across sites, but only five larval *Scaphirhynchus* sp. were sampled.

Under component 4, 359 benthic trawls were conducted between mid-July and early September to quantify young-of-year shovelnose sturgeon and pallid sturgeon. Only 18 young-of-year sturgeon were sampled: two from the Missouri River upstream from the Yellowstone River confluence, five from the Yellowstone River, and eleven from Missouri River downstream from the Yellowstone River confluence. Genetic testing indicated that of all young-of-year sturgeon sampled were shovelnose sturgeon.

For component 5, crews assisted in collecting adult pallid sturgeon brood stock for the propagation program. Adults collected in this effort were assessed for reproductive readiness and transported to state and federal hatcheries.

Introduction

The 300 km of the Missouri River from Fort Peck Dam in Montana downstream to the Yellowstone River confluence in North Dakota is subjected to regulated flows and altered water temperature regimes resulting from hypolimnetic releases through the dam. Regulated flows in conjunction with cold water temperatures are hypothesized to severely diminish suitability of this portion of the Missouri River for pallid sturgeon *Scaphirhynchus albus* spawning and recruitment (USFWS 2000; 2003). Following Reasonable and Prudent Alternative II. B. in the Missouri River Biological Opinion (USFWS 2000), modified operations of Fort Peck Dam were proposed with the objectives of enhancing suitability of the river for pallid sturgeon spawning and recruitment, and improving habitat conditions for other native fishes. Proposed changes in dam operations were targeted to occur during late May and early June, and included releasing high volumes of warm water from Fort Peck Reservoir to the river via the Fort Peck Dam spillway. The USACE proposed to conduct a mini-test of the flow modifications in 2001 for the purpose of evaluating structural integrity of the spillway and other engineering concerns (USFWS 2000; USACE 2004). A full-test of the flow modification was projected to occur in 2002 with a maximum of 537.7 m^3/s (19,000 ft^3/s) released through the spillway. Spillway releases were to be accompanied by an additional 113.2 m^3/s (4,000 ft^3/s) released through the dam. Pending results from the full-test, modified flow releases from Fort Peck Dam in subsequent years were to be implemented in an adaptive management framework. However, insufficient water levels in Fort Peck Reservoir during 2001 - 2008 precluded conducting these tests as the minimum water surface elevation of 2230 feet msl (5 feet of head over the base of the spillway gates at 2225 feet msl) was not reached. As a consequence, physical and biological data collected during the initial eight years of this study represent baseline conditions under existing dam operations (see Braaten and Fuller 2002, 2003, 2004, 2005, 2006; Braaten et al. 2007, 2008).

The Fort Peck Flow Modification Biological Data Collection Plan is a multi-component research and monitoring program designed to examine the influence of proposed flow modifications from Fort Peck Dam on physical habitat and biological response of pallid sturgeon and other native fishes. Similar to previous years, primary research activities of the multi-year Fort Peck Data Collection Plan during 2008 included: 1) measuring water temperature and turbidity at several locations downstream from Fort Peck Dam, 2) examining movements and relocating adult pallid sturgeon, paddlefish *Polyodon spathula*, blue suckers *Cycleptus elongatus*, and shovelnose sturgeon *Scaphirhynchus platorynchus* in the Missouri River between Fort Peck Dam and Lake Sakakawea, and in the lower Yellowstone River, 3) quantifying larval fish distribution and abundance, 4) quantifying the reproductive success of shovelnose sturgeon and pallid sturgeon based on captures of young-of-year sturgeon, and 5) assisting in the collection of adult pallid sturgeon for the propagation program. The Fort Peck Data Collection Plan is funded by the USACE, and jointly implemented by the Montana Department of Fish, Wildlife, and Parks (MTFWP) and the U. S. Geological Survey Columbia Environmental Research Center – Fort Peck Project Office.

Study Area

The Missouri River study area extends from Fort Peck Dam located at river kilometer (rkm) 2,850 to near the headwaters of Lake Sakakawea (Figure 1). The headwater region of Lake Sakakawea varies depending on water levels in the reservoir. For 2008, the study area also included about the lower 30 rkm of the Yellowstone River. See Gardner and Stewart (1987), White and Bramblett (1993), Tews (1994), Bramblett and White (2001), Bowen et al. (2003), and Braaten et al. (2009) for a complete description of physical and hydrological characteristics of the study area.

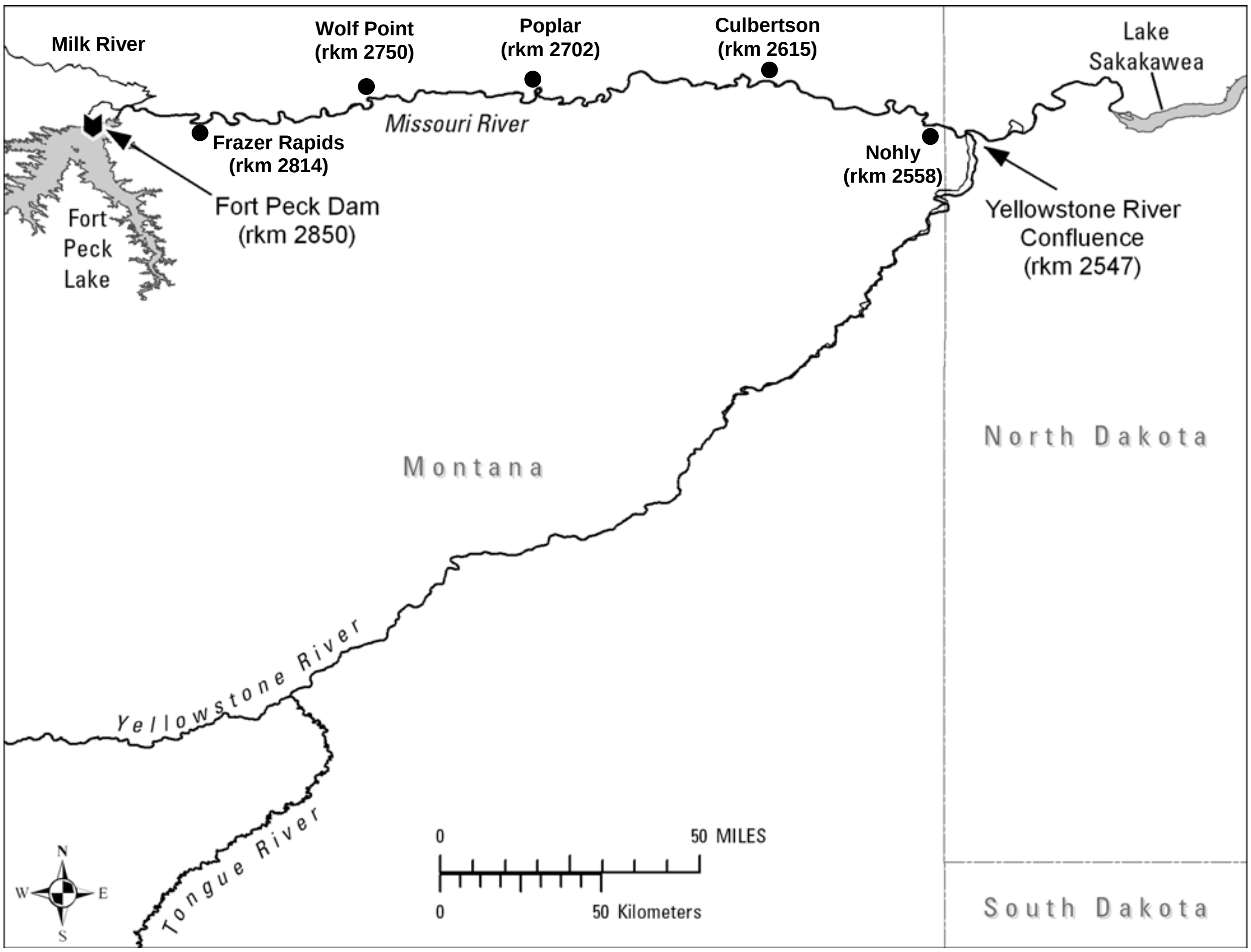


Figure 1. Study area of the Missouri River and lower Yellowstone River.

Methods

Component 1 – Water temperature and turbidity

Field measurements of water temperature.- Water temperature loggers (Onset computer Corporation, HOBO Water Temp Pro v2, operation range -20 to 70^{o}C, 5 min response time, accuracy ± 0.2^{o}C) were deployed at 17 locations (29 total loggers) in the Missouri River, tributaries, and off-channel areas between April and October during 2008 (Table 1). All loggers were deployed, maintained, and retrieved by the Fort Peck crews with the exception of the logger located in the free-flowing Missouri River upstream of Fort Peck Reservoir at the Robinson Bridge site; this logger was deployed and retrieved by Bill Gardner (Montana Fish, Wildlife and Parks Fisheries Biologist, Lewistown, Montana). Loggers were programmed to record water temperature at 1-hr intervals during the deployment period. At most sites, loggers were deployed on opposite banks of the river on the river bed to assess lateral variations in water temperature that may result from tributary inputs and incomplete lateral mixing of water.

Pre-deployment assessment of water temperature logger precision and accuracy.- Prior to deployment in the field, temperature loggers were subjected to a series of common water bath treatments to determine accuracy and precision of loggers in cold water (< 10^{o}C; tailwater of Fort Peck Dam), cool water (10-20^{o}C; laboratory water bath), and warm water (> 20^{o}C; laboratory water bath). Pre-deployment accuracy and precision was assessed with univariate statistics (mean, minimum, maximum, range) computed across all loggers. If precision was low (e.g., broad range of temperature for an individual water bath trial), logger data were scrutinized to determine which logger(s) was contributing to the extreme values. After identifying any “suspect” logger(s), univariate statistics were computed again to assess precision.

Table 1. Water temperature logger deployment sites, approximate river km (rkm; distance upstream from the confluence of the Missouri River at the Mississippi River, or distance upstream in a tributary), lateral bank location (north, south), and dates of deployment in the Missouri River or adjacent areas during 2008. NR = logger not recovered.

Site	Rkm	Bank location	Latitude	Longitude	Logger serial #	Deploy date	Retrieve date
MR at Robinson Bridge	3094				1106516	4/7	10/23
Fort Peck Lake			48.00982	106.36634	1101864	4/18	NR
MR downstream	2840	North	48.05557	106.36460	1101870	4/3	10/21
from Fort Peck Dam	2842	South	48.06225	106.37866	1101902	4/3	10/21
Spillway	2838		48.03994	106.34100	1101895	4/19	10/21
Milk River	4.0				1101913	4/10	10/21
MR at Nickels Ferry	2838	North	48.04535	106.28731	1101901	4/3	10/21
	2838	South	48.04454	106.28635	1101865	4/3	10/21
MR at Nickels	2829	North	48.03433	106.24829	1101889	4/3	10/21
Rapids	2829	South	48.03535	106.25470	1101906	4/3	10/21
MR at Frazer Pump	2819	North	48.03093	106.12473	1101874	4/3	10/21
	2819	South	48.03030	106.12672	1101887	4/3	10/21
MR at Frazer Rapids	2814	North	48.00730	106.12965	1101899	4/3	10/21
	2814	South	48.00639	106.12882	1101911	4/10	10/21
MR at Grand	2808	North	48.03545	106.08548	1101871	4/3	10/21
Champs	2808	South	48.03445	106.08236	1101884	4/3	10/21
MR at Wolf Point	2737	North	48.07932	105.52032	1101868	4/8	NR
	2737	South	48.08466	105.51810	1101900	4/8	10/21
MR at Poplar	2707	North	48.06677	105.20370	1101892	4/8	NR
	2707	South	48.06260	105.21551	1101908	4/8	12/3
MR at Culbertson	2605	North	48.09998	104.44714	1101909	4/8	NR
	2604	South	48.09212	104.43984	1101878	4/8	NR
MR at Nohly	2562	North			1101861	4/8	NR
		South	48.02097	104.09971	1101897	4/8	10/21
Yellowstone River	57.5		47.61192	104.18655	1101880	4/9	10/7
	2.9		47.94960	103.96233	1101888	4/9	NR
MR below	2538	North	48.95938	103.90620	1101903	4/8	NR
Yellowstone River	2538	South	48.95748	103.90087	1101877	4/8	NR
MR near Williston	2500	North	48.10501	103.72504	1101863	4/8	10/12

Field measurements of tubidity.- Turbidity (nephelometric turbidity units, NTU) was measured from late April through August 2008 in the Missouri River near Nohly (rkm 2562) and in the Yellowstone River (rkm 1.0). Turbidity loggers (HydroLab DataSonde 4a, measurement range 0-1000 NTU, accuracy ± 2%) were programmed to record turbidity at 3-hr intervals during the deployment period. The loggers were calibrated to 20 NTU, 200 NTU, and 800 NTU formazin standards prior to deployment. Although calibration to a specific formazin standard caused slight changes in accuracy at another formazin standard, final calibrations provided reasonably accurate values across all formazin levels. For the Nohly turbidity logger, final calibrations resulted in the following mean NTU measurements from five replicated tests: 19.6 NTU (20 NTU standard), 191 NTU (200 NTU standard), 801.2 NTU (800 NTU standard). For the Yellowstone River turbidity logger, mean NTU of replicated measurements was 18.5 NTU (20 NTU standard), 209.3 NTU (200 NTU standard) and 797.3 NTU (800 NTU standard). In addition, turbidity loggers were also programmed to record water temperature at 3-hr intervals.

Monitoring Component 2 – Flow- and temperature-related movements of blue suckers, shovelnose sturgeon, paddlefish, and pallid sturgeon.

Manual tracking of implanted fish.- Manual tracking by boat of fish was initiated in April 2008. The Missouri River between Fort Peck Dam and the Highway 85 bridge near Williston, ND (342 km), was tracked bi-weekly from April through July, and monthly from August through October. The Yellowstone River from its confluence with the Missouri River to Intake Diversion (116 km) was tracked at different intervals by the Fort Peck Flow Modification crew however; most effort was focused on the lower 30 km of river. Two radio frequencies (149.760 MHz, 149.620 MHz) were simultaneously monitored during the boat-tracking run using two 4-element Yagi antennae.

Stationary telemetry logging stations.- Stationary telemetry logging stations were deployed in April 2008 at seven sites including five sites on the Missouri River (Nickels at rkm 2,828; near Wolf Point at rkm 2,755; near Culbertson at rkm 2,603; Erickson Island at rkm 2,533; near Williston at rkm 2,503), one site on the Milk River at rkm 4.0, and one site on the Yellowstone River at the Montana/North Dakota border (rkm 26). Two stations, one near Fort Buford on the Missouri River (rkm 2,533) and one in the Yellowstone River near the confluence (rkm 1) were left in place year-round. The logging stations were placed on shore with two 4-element Yagi antennae. Each logging station was equipped with a battery powered receiver (Lotek SRX- 400), solar panels, and an environmental enclosure kit containing dual 12-volt batteries, and an antenna switchbox. Data recorded by the logging stations were downloaded to a laptop computer two times per month between April and October.

Transmitter implantation.- Our goal was to extend flow- and temperature-related movement inferences to all areas of the Missouri River below Fort Peck Dam and Lake Sakakawea. Therefore, sampling for blue suckers and shovelnose sturgeon for transmitter implantation occurred in several areas between rkm 2,850 and rkm 2,545. However, pallid sturgeon were implanted in the spring during broodstock collection near the confluence of the Missouri and Yellowstone rivers. Fish were sampled using drifted trammel nets, and implanted with radio tags (MCFT-3L tags, 16 mm x 73 mm, air weight = 26 g, 1,624-day longevity, 5-second pulse interval, 149.620 Mhz, Lotek Wireless Incorporated, New Market, Ontario). The coded signal emitted by each tag is unique to facilitate identification of individual fish.

Analyses of telemetry data.-A complete analysis of telemetry data will be conducted after completion of the study; however, summary analyses were conducted to report and illustrate trends. Spatial and temporal use of the Missouri River, Yellowstone River, and Milk River were quantified using the percent of implanted individuals each year relocated in different areas. Relocations and movements of each species were quantified across three riverine reaches that corresponded distinct spatial and temporal use patterns. For blue suckers, the reaches included the Milk River (184 km), Missouri River from Fort Peck Dam to Williston (342 km) and Yellowstone River (116 km). The reaches for shovelnose sturgeon consisted of the Missouri River from Fort Peck Dam to Wolf Point (112 km), the Missouri River from Wolf Point to

Williston (230 km), and the Yellowstone River (116 km). Pallid sturgeon reaches consisted of the Missouri River above the confluence of the Yellowstone River (ATC; 302 km), the Missouri River below the confluence of the Yellowstone River (BTC; 40 km), and the Yellowstone River (116 km). Comparisons were between the 2004 through 2008 tracking seasons. During these years, additional ground based telemetry stations were deployed at various reach breaks. This provided information on when individuals migrated into or out of a particular reach.

Component 3 – Distribution and Abundance of Larval Fish

Sampling protocols. Larval fish were sampled two times per week from late May through early August at six sites (Table 2). Similar to 2001 - 2007, sites on the mainstem Missouri River were located just downstream from Fort Peck Dam, near Wolf Point, and near Nohly. Sites located off the mainstem Missouri River included the spillway channel, the Milk River, and the Yellowstone River. Larval fish at all sites were sampled with 0.5-m-diameter nets (750 µm mesh) fitted with a General Oceanics Model 2030R velocity meter.

Specific larval fish sampling protocols varied among sites and were dependent on site characteristics (Table 2). Two to five replicates were collected at the sites, where one replicate was comprised of four subsamples (two subsamples simultaneously collected on the right and left side of the boat at sampling locations near the left and right shorelines). At all sites except the spillway site, the left and right sampling locations corresponded to inside bend and outside bend locations at the mid-point of a river bend. The spillway channel had minimal sinuosity; therefore, samples did not reflect inside and outside bend locations. Only two replicates were available in the spillway channel, and three replicates were available at the site downstream from Fort Peck Dam. The full complement of five replicates was available at the other sites. At all sites exclusive of the spillway and Milk River, paired subsamples near the left and right bank locations were comprised of two nets fished on the bottom. Thus, each replicate was comprised of four bottom subsamples. Nets were maintained at the target sampling location by affixing lead weights to the net. Larval nets were fished for a maximum of 10 minutes (depending on detrital loads). The boat was anchored during net deployment (e.g., “passive” sampling) except when high velocities warranted use of the outboard motor to maintain a fixed position. In the Milk River and spillway channel, minimal current velocity required an “active” larval fish sampling approach where the boat was powered upstream for a maximum of 10 minutes. In addition, it was necessary to sample in the upper 1-m of the water column at these two sites as irregular bottom contours, shallow depths, and silt substrates were not conducive to bottom sampling. Larval fish samples were placed in a 5-10% formalin solution containing phloxine-B dye and stored.

Table 2. Larval fish sampling locations, number of replicates, samples, and net locations for 2008 sampling events. Abbreviations for net location are as follows: B = bottom, S = surface (0.5 - 1.0 m below the surface).

Site	Approximate river km	Replicates	Samples per replicate	Net location
Missouri River below Fort Peck Dam	2838 - 2843	3	4	B
Spillway channel	2837.6	2	4	S
Milk River	0.8 - 5.6	5	4	S
Missouri River near Wolf Point	2739 - 2750	5	4	B
Missouri River near Nohly	2549 - 2563	5	4	B
Yellowstone River	0.4 - 3.2	5	4	B

Larval fish were sampled at the same replicate and subsample locations throughout the sampling period except when changes in discharge necessitated minor adjustments in the sampling location. For example, an attempt was made to sample larval fish at total water column depths between 1.5 m and 3.0 m. This protocol was used to minimize variations in larval fish density associated with vertical stratification of larvae in the water column. When river discharge changed, water depth in a previously sampled specific location also changed. Consequently, the specific sampling location also changed slightly among sampling events.

Laboratory methods. Larval fish were extracted from samples and placed in vials containing 70% alcohol. Larvae were identified to family and species in some instances, and enumerated. Damaged individuals that could not be identified were classified as unknown. Eggs were identified as paddlefish/sturgeon or other, and enumerated.

Component 4 – Reproductive success of shovelnose sturgeon and pallid sturgeon

Sampling for young-of-year sturgeon (*Scaphirhynchus* sp.) was conducted with a benthic (beam) trawl between mid-July and early September 2008 in the Missouri River above the Yellowstone River confluence (i.e., ATC), Missouri River below the Yellowstone River confluence (i.e., BTC), and in the Yellowstone River. Four replicate sampling locations were established at each site (Table 3) where each replicate was comprised of an inside bend, outside bend, and channel crossover habitat complex (IOCX) associated with a river bend (Sappington et al. 1998). A dual sampling protocol was followed to quantify young-of-year sturgeon. Standard sampling consisted of conducting a single trawl in each habitat type within the IOCX. If a young-of-year sturgeon was collected in the standard trawl, two additional “targeted trawls” were conducted in the exact same location. If young-of-year sturgeon were sampled in either of the two targeted trawls, two additional targeted trawls were conducted. This process was repeated up to a maximum of eight targeted trawls. Targeted sampling was conducted to obtain information on aggregations. An exception to the IOCX sampling protocol was followed at replicate 1 in the Missouri River BTC where nine standard trawl subsamples were used to characterize this location. This location produced several young-of-year sturgeon in previous years (Braaten and Fuller 2002, 2003, 2004, 2005, 2006; Braaten et al. 2007, 2008), thus intensive sampling was conducted at this location. The targeted sampling protocol was followed at this site. Young-of-year sturgeon were measured in the field (total length, mm, excluding the caudal filament). One of the pectoral fins or fin buds was clipped and placed in alcohol for subsequent genetic identification. After fin clipping, the fish was placed in a 5-10% formalin solution.

Table 3. Young-of-year sturgeon sampling sites for 2008. ATC = above the Yellowstone River confluence, BTC = below the Yellowstone River confluence. River km sites denotes distance upstream from the mouth.

Site	Replicate	River km
Missouri River ATC	1	2552
	2	2555
	3	2558
	4	2563
Missouri River BTC	1	2500
	2	2507
	3	2539
	4	2545
Yellowstone River	1	0.4
	2	0.8
	3	3.2
	4	7.2

Component 5 - Assisting in the collection of adult pallid sturgeon for the propagation program.

For this component, crews assisted the USFWS in capturing adult pallid sturgeon for the hatchery propagation program. Crews were involved in sampling the Missouri River and Yellowstone River during April and May 2008. Pallid sturgeon were sexed and staged, and selected individuals were transported to hatcheries.

Results and Discussion

Hydrologic Conditions

Discharge in the Milk River during 2008 was low throughout much of the year with the exception of a 2-week period between mid- and late-June when flows increased and attained a maximum of 85 m^3/s on 16 June (Figure 2). Between April and October, median daily discharge in 2008 (2.6 m^3/s) was the second lowest during all years of the Fort Peck Project.

Discharge patterns in the Missouri River during 2008 exhibited characteristics of regulated releases from Fort Peck Dam augmented by periodic inputs from the Milk River (Figure 2). Discharge was relatively low (< 200 m^3/s) through late April, then increased to greater than 200 m^3/s during late April and May. Elevated inputs from the Milk River during mid- and late-June contributed to increased discharge in the Missouri River during this time period. As contributions from the Milk River declined, discharge in the Missouri River remained near or declined to less than 200 m^3/s for much of the summer and fall. Median discharge during 2008 (200 m^3/s) was about average for all years of the Fort Peck Project as four years (2002, 2003, 2004, and 2006) exhibited greater median discharge and three years (2001, 2005, 2007) exhibited lower median discharge.

Discharge conditions in the Yellowstone River during 2008 were unique among all years of the Fort Peck Project with regard to magnitude and duration of elevated flow conditions. Following relatively low flows from April to mid-May 2008, discharge increased rapidly in late-May, and remained high through late July (Figure 2). During this time frame, discharge peaks of 1070 m^3/s and 1303 m^3/s occurred during late May and early June, respectively; however, the seasonal maximum discharge peak occurred in late June at 1599 m^3/s. Although median discharge in the Yellowstone River during 2008 (235 m^3/s) was similar to 2006 (242 m^3/s), discharge during most of June and July of 2008 was higher than other years.

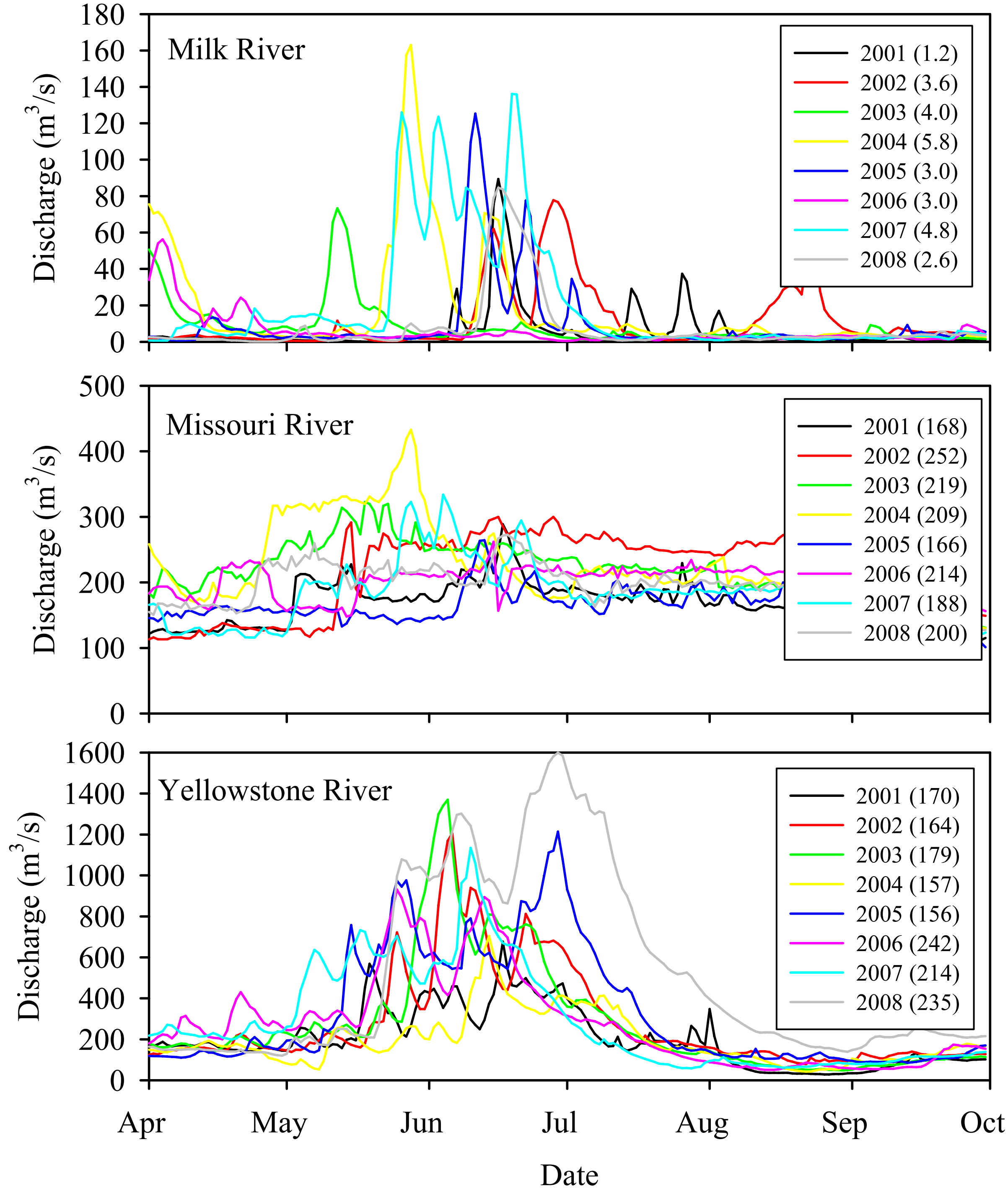


Figure 2. Median daily discharge in the Milk River (gage 06174500), Missouri River at Wolf Point, Montana (gage 06177000), and in the Yellowstone River at Sidney, Montana (gage 06329500) during 2001-2008. Values listed in parentheses represent median daily discharge between April 1 and September 30. Note change in the ordinate among graphs.

Component 1 – Water temperature and turbidity

General comments.- Water temperature loggers were retrieved from most sites following deployment in 2008 (Table 1). However, loggers could not be found for sites including Fort Peck Reservoir, Wolf Point north river bank, both loggers at Culbertson, Nohly north bank, and both loggers in the Missouri River below the Yellowstone River confluence. In addition, a few loggers experienced periods of being buried in the substrate or being out-of-water. For example, the south bank logger at the site downstream from Fort Peck Dam was out of water after August 8. Four loggers (south bank logger Frazer Pump, logger near Williston, south bank logger at Nohly, and one logger in the Yellowstone River) were buried in sediments for a portion of the deployment period. Temperature data recorded while buried in the sediments or out-of-water were omitted from the temperature data sets. For the Nohly and Yellowstone River sites, water temperature data recorded by the turbidity loggers were used to characterize the thermal regime for the time periods when temperature loggers were buried.

Pre-deployment assessment of water temperature logger precision and accuracy.- Prior to deployment, water temperature loggers in the cold, cool, and warm water treatments exhibited a high level of precision and accuracy as evidenced by the narrow temperature of temperatures for all treatments (Table 4). The temperature range was small ($\leq 0.3^{o}C$) for the cold and cool treatments and only slightly greater ($\leq 0.7^{o}C$) for the warm treatments. Based on these results, thermal regimes characterized by the loggers during 2008 likely depicted accurate thermal conditions in the Missouri River, tributaries, and off-channel areas.

Table 4. Pre-deployment summary statistics for 27 water temperature loggers deployed in cold, cool, and warm water temperature (^{o}C) treatments for 2008.

Treatment	Sample	Mean	Minimum	Maximum	Range
Cold	1	5.5	5.3	5.6	0.3
(<10^{o}C)	2	5.3	5.1	5.4	0.3
	3	5.2	5.0	5.3	0.3
	4	5.1	5.0	5.2	0.2
	5	4.9	4.7	5.0	0.3
Cool	1	19.5	19.4	19.6	0.2
(10-20^{o}C)	2	19.0	19.0	19.1	0.1
	3	18.7	18.6	18.7	0.1
	4	18.3	18.2	18.4	0.2
	5	18.0	17.9	18.1	0.2
Warm	1	25.8	25.5	26.1	0.6
(>20^{o}C)	2	24.6	24.1	24.8	0.7
	3	23.5	23.1	23.8	0.7
	4	22.6	22.2	22.8	0.6
	5	21.8	21.5	22.0	0.5

Lateral comparisons of water temperature.- Water loggers deployed on opposite banks (north and south) of the river were retrieved from six sites: 1) below Fort Peck Dam, 2) Nickels Ferry, 3) Nickels Rapids, 4) Frazer Pump, 5) Frazer Rapids, and Grand Champs (Table 1). All sites except the site below Fort Peck Dam were located downstream from the Milk River confluence. During the spring-to-fall deployment period of 2008, mean daily water temperature did not differ significantly between the north and south banks of the river at any of the six sites (Table 5). However, differences in water temperature did occur between bank locations during specific time periods owing to high-discharge inputs of warm water from the Milk River. For example, discharge from the Milk River increased during mid- and late-June, and the warm inputs resulted in a temperature increase that was primarily restricted to the north bank of the river at Missouri River sites downstream the Milk River (Figure 3). Increased temperature primarily on the north bank of the river resulted from the north-bank entry of the Milk River and incomplete lateral mixing of Milk River and Missouri River water across the river channel. However, as distance from the Milk River increased, lateral mixing increased as evidenced by the finding that the difference in water temperature between river banks was greater at Nickels Ferry than Grand Champs (Table 5; Figure 3).

Table 5. Summary statistics (mean; standard deviation, STD; minimum, Min.; Maximum, Max.), dates, and probability values (P-value from t-tests) for comparisons of mean daily water temperature (^{o}C) between water temperature loggers positioned on the north and south banks of the river during 2008.

Site	Logger location	Dates	Number of days	Mean	STD	Min.	Max.	T-test P-value
Below Fort Peck Dam	North	4/3-8/4	124	10.0	4.1	3.2	15.5	0.067
	South			9.0	3.9	2.8	14.3	
Nickels Ferry	North	4/3-10/21	202	12.3	4.1	3.1	18.0	0.155
	South			11.7	4.0	3.0	16.0	
Nickels Rapids	North	4/3-10/21	202	12.1	4.2	3.0	16.9	0.378
	South			11.8	4.0	3.0	16.1	
Frazer Pump	North	4/3-7/8	97	9.8	4.3	2.9	17.0	0.379
	South			9.3	3.8	3.0	15.1	
Frazer Rapids	North	4/10-10/21	195	12.6	3.8	2.8	16.7	0.851
	South			12.6	3.9	2.6	17.0	
Grand Champs	North	4/3-10/21	202	12.4	4.1	2.6	17.2	0.735
	South			12.2	4.0	2.8	16.4	

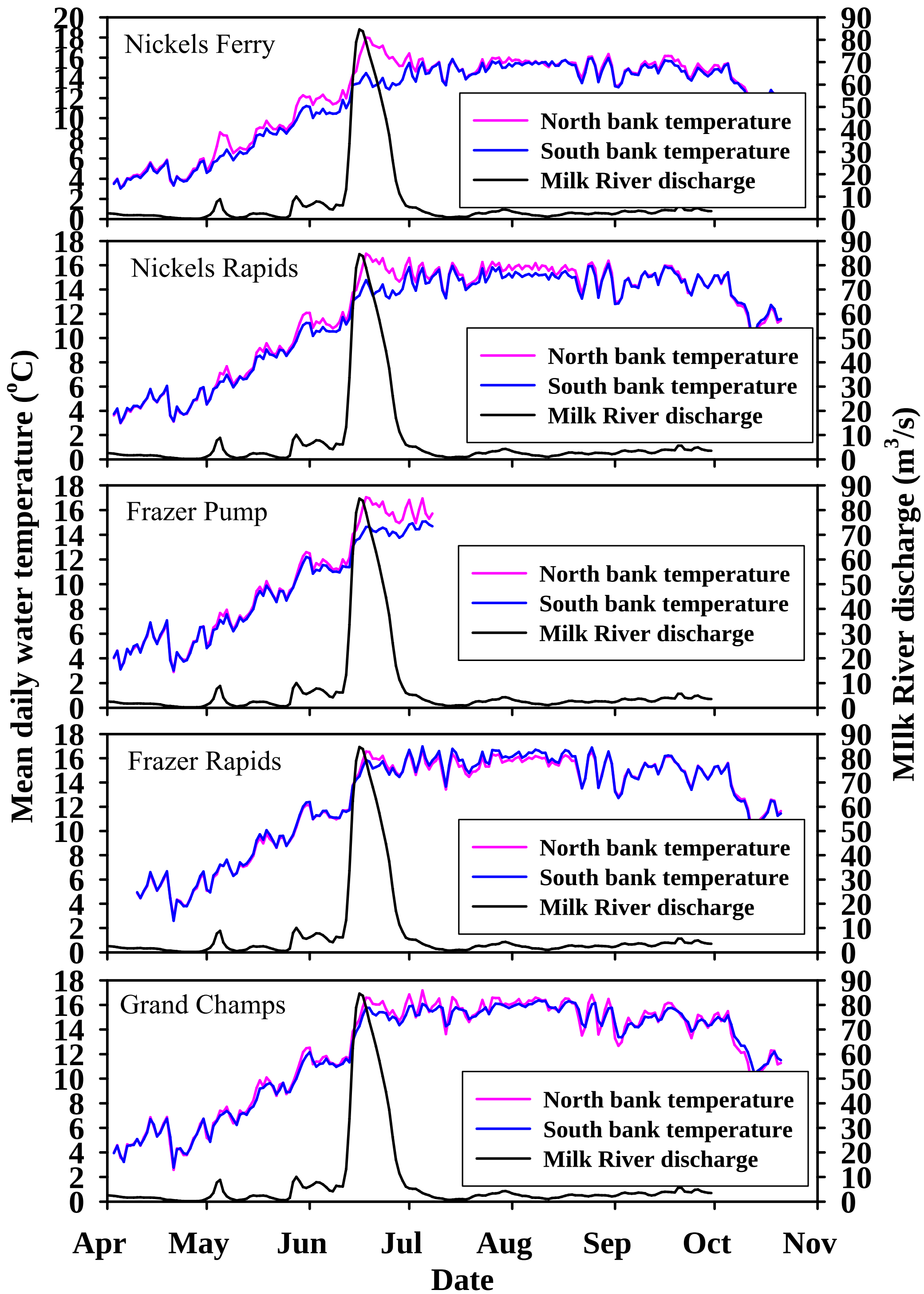


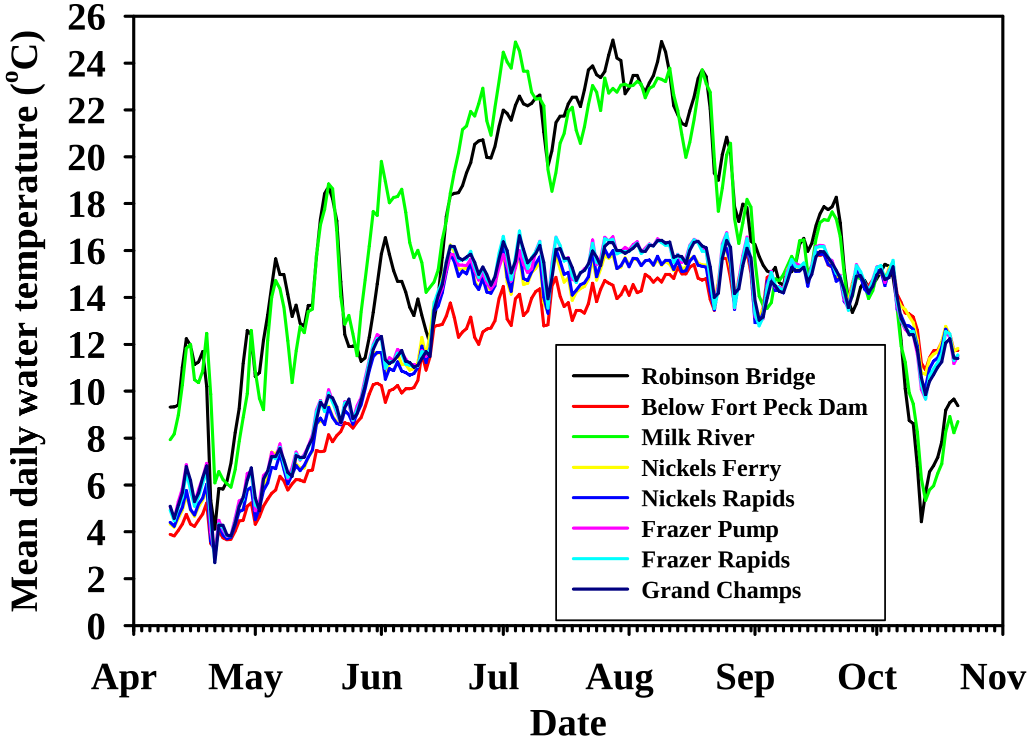
Figure 3. Mean daily water temperature regimes for water temperature loggers positioned on the north and south banks of the river at sites on the Missouri River during 2008. Panels from top to bottom represent sites progressing from upstream to downstream.

Longitudinal water temperature patterns.- Water temperature during the 2008 deployment period varied among sites on the mainstem Missouri River, tributaries, and off-channel areas. For Missouri River sites, water temperature was warmest at Robinson Bridge in the free-flowing reach of the Missouri River upstream from Fort Peck Reservoir (mean = 16.3°C, maximum = 25.0°C; Table 6, Figure 4). Coolest temperatures occurred in the Missouri River at the site downstream from Fort Peck Dam (mean = 11.7°C, maximum = 16.0°C). Thus, river impoundment and hypolimnetic releases through Fort Peck Dam induced a 4.6°C reduction in mean water temperature and a 9.0°C suppression of maximum water temperature. Between Fort Peck Dam and Nohly (lowermost site on the Missouri River prior to receiving inputs from the Missouri River), water temperature gradually increased as the mean and maximum temperature at Nohly reached 16.0°C and 23.7°C, respectively (Table 6). These results indicate that thermal impacts of hypolimnetic releases were still evident nearly 290 km downstream from Fort Peck Dam. Mean and maximum water temperatures were slightly greater in the Yellowstone River than Missouri River upstream from Fort Peck Reservoir.

Suppression of water temperature in the Missouri River downstream from Fort Peck Dam coupled with regulated flows are implicated as significant factors impeding successful spawning and recruitment of pallid sturgeon in this reach (USFWS 2000, 2003). Working to improve suitability of this reach for pallid sturgeon spawning and recruitment, modified dam operations and spillway releases of warm water from Fort Peck Reservoir were proposed as a reasonable and prudent alternative to the USACE as listed in the Missouri River Biological Opinion (USFWS 2000, 2003). Specifically, releases of warm water were targeted to increase water temperature at Frazer Rapids to 18.0°C during late May and June. In the absence of spillway releases during 2008, mean daily water temperature at Frazer Rapids was 12.6°C and maximum temperature was 16.8°C (Table 6).

Table 6. Summary statistics for daily water temperature (°C; mean, minimum, Min.; maximum, Max.; standard deviation, STD; coefficient of variation, CV; number of days, N) at sites in the mainstem Missouri River, and off-channel areas or tributaries during 2008. Inclusive dates span from 10 April to 21 October, except for the Spillway (19 April – 21 October), Yellowstone River (10 April – 7 October), and Highway 85 Bridge near Williston, North Dakota (10 April – 1 July). See Figure 6 for a graphical representation of mean daily data.

Location	Site	Mean	Min.	Max.	STD	CV	N
Mainstem Missouri River	Robinson Bridge	16.3	4.1	25.0	5.2	31.6	195
	Below Fort Peck Dam	11.7	3.2	16.0	3.8	32.4	195
	Nickels Ferry	12.3	3.3	16.2	3.8	30.8	195
	Nickels Rapids	12.3	3.1	16.2	3.8	31.2	195
	Frazer Pump	12.6	3.0	16.8	3.8	31.2	195
	Frazer Rapids	12.6	2.7	16.8	3.9	30.6	195
	Grand Champs	12.6	2.7	16.6	3.8	20.2	195
	Wolf Point	14.3	4.1	20.5	4.4	30.8	195
	Poplar	14.6	4.6	21.6	4.6	31.6	195
	Nohly	16.0	5.5	23.7	5.1	31.7	195
	Hwy 85	13.6	6.2	20.6	3.7	27.6	83
Off-channel or tributary	Spillway	16.2	5.0	22.9	4.5	37.9	186
	Milk River	16.5	5.3	24.9	5.2	31.6	195
	Yellowstone River	17.3	7.0	25.2	4.7	26.9	181



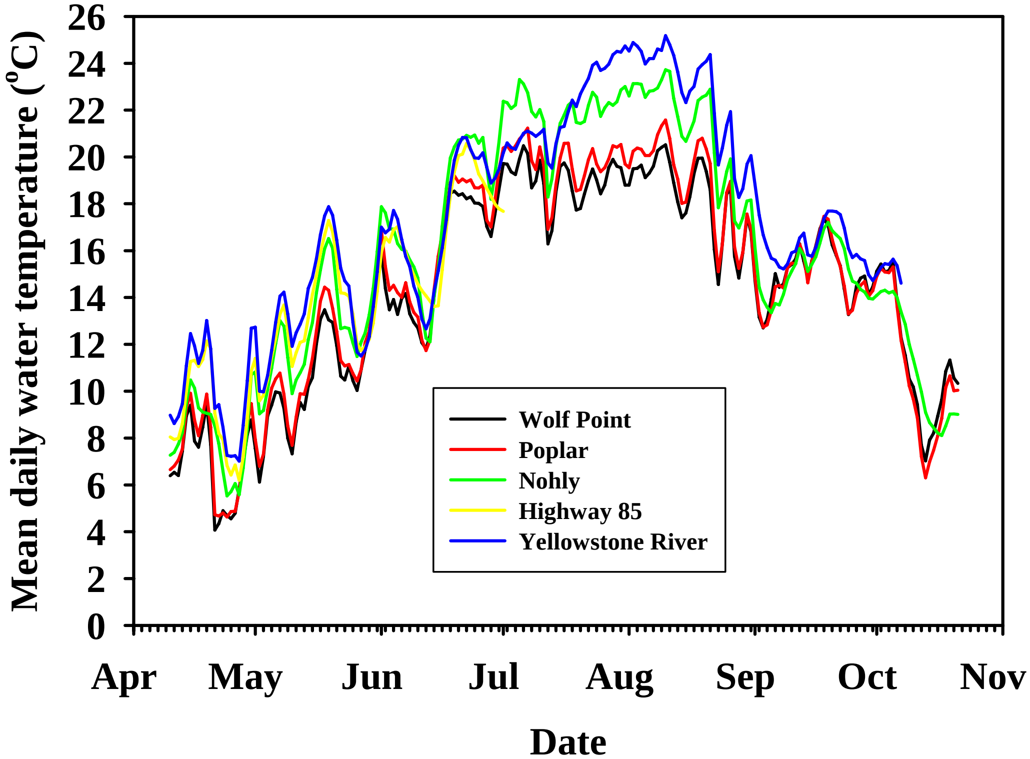


Figure 4. Mean daily water temperature (°C) at sites on the mainstem Missouri River, tributaries, and off-channel sites during 2008.

Inter-annual comparisons of water temperature within sites.- For sites with complete 2001-2008 data sets, long-term water temperature trends are emerging from the Fort Peck project. For example, water temperature for most sites on the mainstem Missouri River (below Fort Peck Dam, Nickels Ferry, Nickels Rapids, Frazer Pump, Frazer Rapids, Grand Champs, Wolf Point, Poplar) was warmest during 2007 and coolest during 2002 or 2003 (Table 7). In contrast to these sites, the free-flowing Missouri River upstream from Fort Peck Reservoir was warmest during 2006 and coolest during 2008. Water temperature in two tributaries of the Missouri River (Milk River, Yellowstone River) was generally warmest during 2003 and coolest during 2004. Water temperature at Nohly (lowermost site on the Missouri River prior to receiving inputs from the Missouri River) exhibited warmest temperatures during 2006 and coolest temperatures during 2004.

Table 7 (continues on subsequent pages). Summary statistics (mean, ^{o}C; minimum, maximum, standard deviation, SD; coefficient of variation, CV; number of days, N) for mean daily water temperature among 2001 - 2008 at mainstem Missouri River sites and off-channel sites. Common dates for all years are 5/17 – 10/9 (N = 146 days) with the exception of Fort Peck Reservoir (5/17 – 8/29; 105 days), Milk River in 2005 (5/17 – 9/17, N = 124 days), Yellowstone River in 2008 (5/17 – 10/7, N = 144 days), and the Missouri River near Williston, North Dakota in 2008 (5/17 – 7/1, N = 46 days).

Site	Year	Mean	Min.	Max.	STD	CV	N
Robinson Bridge (Missouri River upstream	2001	20.1	10.3	25.8	3.7	18.4	146
From Fort Peck Reservoir)	2002	18.7	9.2	26.7	4.2	22.5	146
	2003	19.4	11.4	25.2	4.0	20.5	146
	2004	18.7	10.8	26.7	3.9	20.9	146
	2005	19.0	8.9	25.7	3.9	20.7	146
	2006	20.6	10.4	26.9	3.9	19.1	146
	2007	20.1	9.2	27.6	4.7	23.3	146
	2008	18.3	8.8	25.0	4.0	21.7	146
Fort Peck Reservoir	2003	19.0	8.4	23.6	3.8	20.2	105
	2004	16.4	7.9	22.0	3.7	22.3	105
	2006	19.1	9.8	24.5	3.9	20.2	105
	2007	19.0	8.4	25.5	4.4	22.8	105
Missouri River Below Fort Peck Dam	2001	13.0	8.2	15.2	1.5	11.6	146
	2002	12.2	6.3	15.4	2.0	16.6	146
	2003	12.4	7.5	15.5	1.7	13.7	146
	2004	13.5	8.0	16.3	1.8	13.5	146
	2005	13.4	9.1	16.8	1.8	13.3	146
	2006	13.5	9.2	15.6	1.7	12.5	146
	2007	13.9	7.6	17.0	1.9	14.0	146
	2008	13.3	7.4	16.0	2.1	15.9	146

Table 7 continued.

Site	Year	Mean	Min.	Max.	STD	CV	N
Spillway channel	2001	18.4	10.7	23.8	3.0	16.6	146
	2002	15.7	8.6	20.0	2.7	16.9	146
	2003	16.9	11.5	22.5	3.0	17.9	146
	2004	17.0	9.7	21.4	2.8	16.4	146
	2005	17.6	8.3	22.3	2.8	15.7	146
	2006	18.0	9.7	22.8	2.8	15.3	146
	2007	18.4	9.0	24.3	3.4	18.5	146
	2008	18.0	10.7	22.9	3.0	16.5	146
Milk River	2001	19.1	9.9	26.2	3.8	19.6	146
	2002	18.9	8.4	26.9	4.5	23.8	146
	2003	20.3	10.9	27.4	4.7	23.3	146
	2004	18.4	10.7	27.4	3.7	20.3	146
	2005	20.3	15.0	26.4	2.9	14.2	124
	2006	19.7	9.3	25.7	3.9	19.6	146
	2007	19.2	8.3	26.4	4.3	22.4	146
	2008	18.7	9.9	24.9	3.7	19.6	146
Missouri River at Nickels Ferry	2001	13.4	8.3	18.4	1.8	13.6	146
	2002	13.2	6.5	19.1	2.5	18.7	146
	2003	12.5	8.5	15.3	1.5	11.8	146
	2004	14.5	9.1	17.1	1.6	10.8	146
	2005	14.4	10.2	19.5	1.8	12.2	146
	2006	14.4	10.3	16.5	1.5	10.7	146
	2007	15.0	8.8	18.2	1.8	12.0	146
	2008	14.1	8.6	16.2	2.0	14.1	146
Missouri River at Nickels Rapids	2001	13.5	8.5	16.6	1.7	12.5	146
	2002	12.9	6.7	16.1	2.2	16.9	146
	2003	12.8	8.1	15.9	1.6	12.3	146
	2004	13.9	8.6	16.7	1.8	12.6	146
	2005	13.9	10.3	16.9	1.6	11.4	146
	2006	14.0	9.8	16.0	1.6	11.1	146
	2007	14.4	8.2	16.3	1.7	11.9	146
	2008	14.0	8.6	16.2	2.1	14.6	146
Missouri River at Frazer Pump	2001	13.9	8.5	17.0	1.8	13.2	146
	2002	13.3	7.1	17.9	2.3	17.6	146
	2003	13.3	8.5	16.9	1.7	12.6	146
	2004	14.4	9.0	17.2	1.8	12.5	146
	2005	14.7	10.6	18.6	1.8	12.0	146
	2006	14.8	10.4	17.2	1.7	11.2	146
	2007	15.4	8.4	18.1	2.1	13.7	146
	2008	14.4	8.6	16.8	2.1	14.4	146

Table 7 continued.

Site	Year	Mean	Min.	Max.	STD	CV	N
Missouri River at Frazer Rapids	2001	13.8	8.3	17.3	1.8	13.3	146
	2002	13.1	7.1	17.1	2.3	17.2	146
	2003	12.9	8.1	15.8	1.5	11.8	146
	2004	14.3	8.6	17.1	1.9	13.0	146
	2005	14.8	10.5	18.5	1.8	12.3	146
	2006	14.8	10.5	17.3	1.7	11.3	146
	2007	15.3	8.4	18.0	2.1	13.6	146
	2008	14.4	8.6	16.8	2.1	14.6	146
Missouri River at Grand Champs	2001	14.4	8.5	18.1	2.0	14.2	146
	2002	13.5	7.5	17.3	2.3	16.9	146
	2003	13.6	8.3	17.4	1.8	13.4	146
	2004	14.7	8.6	17.5	2.0	13.3	146
	2005	15.1	10.3	18.9	1.9	12.7	146
	2006	15.0	10.2	17.7	1.7	11.4	146
	2007	15.4	8.5	18.3	2.2	14.3	146
	2008	14.4	8.7	16.6	2.1	14.4	146
Missouri River at Wolf Point	2001	16.5	9.5	22.7	3.1	18.7	146
	2002	15.0	9.3	19.4	2.8	18.8	146
	2003	15.6	9.0	21.2	2.9	18.4	146
	2004	15.8	8.9	20.9	2.6	16.2	146
	2005	16.7	8.1	22.3	2.9	17.1	146
	2006	16.8	8.7	20.7	2.5	15.0	146
	2007	16.9	9.9	21.5	2.8	16.3	146
	2008	16.3	10.0	20.5	2.8	17.0	146
Missouri River at Poplar	2001	16.8	9.9	21.3	2.8	16.8	146
	2003	16.3	9.4	22.3	3.3	19.9	146
	2004	16.3	9.2	22.2	2.8	17.2	146
	2005	17.4	7.8	24.0	3.2	18.5	146
	2007	17.5	9.0	24.0	3.7	21.0	146
	2008	16.8	10.2	21.6	3.0	18.1	146
Missouri River at Culbertson	2001	17.9	9.7	24.0	3.5	19.3	146
	2002	17.0	8.4	23.9	3.9	23.0	146
	2003	17.9	10.4	24.7	4.0	22.5	146
	2004	17.2	10.5	24.6	3.3	19.4	146
	2005	18.4	6.5	25.5	3.9	21.3	146
	2006	18.5	9.2	23.7	3.5	19.0	146
	2007	18.6	9.4	27.3	4.2	22.7	146

Table 7 continued.

Site	Year	Mean	Min.	Max.	STD	CV	N
Missouri River at Nohly	2001	18.9	11.4	25.3	3.8	20.0	146
	2002	17.5	7.7	25.4	4.3	24.6	146
	2003	18.2	10.2	25.0	4.2	23.0	146
	2004	17.1	10.1	23.9	3.2	18.7	146
	2005	18.6	6.1	25.6	4.1	22.0	146
	2006	19.1	9.2	24.5	3.8	19.9	146
	2007	18.9	8.9	27.8	4.4	23.2	146
	2008	18.2	11.5	23.7	3.7	20.1	146
Yellowstone River	2001	19.3	10.7	26.6	4.2	21.7	146
	2002	19.4	8.4	27.9	4.8	24.7	146
	2003	20.1	11.1	27.2	4.7	23.1	146
	2004	18.7	11.1	26.3	3.4	18.3	146
	2005	19.4	6.1	25.6	4.3	22.1	146
	2006	19.8	9.5	25.9	4.1	20.4	146
	2007	19.3	9.8	25.0	3.7	19.2	146
	2008	18.9	11.5	25.2	3.7	19.3	144
Missouri River below Yellowstone River	2001	19.4	9.8	26.0	4.1	20.9	146
	2002	18.8	8.2	27.3	4.5	24.2	146
	2003	18.9	10.6	27.8	4.4	23.2	146
	2005	19.1	6.2	25.5	4.2	21.8	146
	2006	20.0	9.9	25.7	4.0	20.1	146
	2007	19.7	9.5	28.4	4.4	22.5	146
Missouri River at U.S. Highway 85 near Williston, North Dakota	2006	19.9	10.5	25.8	4.0	19.9	146
	2007	19.7	9.5	28.4	4.4	22.6	146
	2008	16.1	11.7	20.6	2.5	15.3	46

Field measurements of turbidity.- The turbidity logger deployed in the Missouri River at Nohly recorded data as programmed from 22 April through 31 August. During this time frame, all turbidity measurements recorded by the Nohly logger were less than 1000 NTU indicating that turbidity did not exceed the 1000 NTU limit of the logger. The turbidity logger deployed in the Yellowstone River was also programmed to record turbidity from 22 April through 31 August; however, the turbidity sensor did not function from 27-31 August. Nonetheless, a nearly complete turbidity chronology was recorded for the Yellowstone River. During deployment in the Yellowstone River, measured turbidity exceeded the 1000 NTU limit of the logger during at least one 3-hr interval on 7-10 May, and 25 May – 6 June.

Due to the 1000 NTU limit of the turbidity loggers and the observation that turbidity exceeded this limit in the Yellowstone River during 2008, a direct statistical comparison of mean daily turbidity between the Yellowstone River and Missouri River at Nohly cannot be conducted. Rather, only general trends in turbidity can be made between the two river systems based on the fact that values reported for at least a portion of the deployment period in the Yellowstone River represent less-than-actual turbidity values. Across the deployment period, turbidity tended to be greater in the Yellowstone River (median = 198.0 NTU, minimum = 21.0 NTU, lower quartile =

49.0 NTU, upper quartile = 417.0 NTU, nominal maximum = 1000 NTU, N = 127 days) than in the Missouri River at Nohly (median = 61.0 NTU, minimum = 6.0 NTU, lower quartile = 38.0 NTU, upper quartile = 91.0 NTU, maximum = 717.0 NTU, N = 132 days). In both rivers, periods of elevated and increasing turbidity generally accompanied periods of elevated or increasing discharge (Figure 5). For example, increasing discharges in late April through early May and late June in the Missouri River were associated with high turbidity values during these periods. Similarly, turbidity increases in the Yellowstone River during early May, late May, and early June followed discharge increases during these time periods. However, a large increase in turbidity did not correspond to the time period of peak discharge in the Yellowstone River during late June and early July (Figure 5). Although turbidity increased during this time, it is possible that the earlier discharge pulses flushed a high percentage of the fines and sediments out of the system prior to the major discharge pulse.

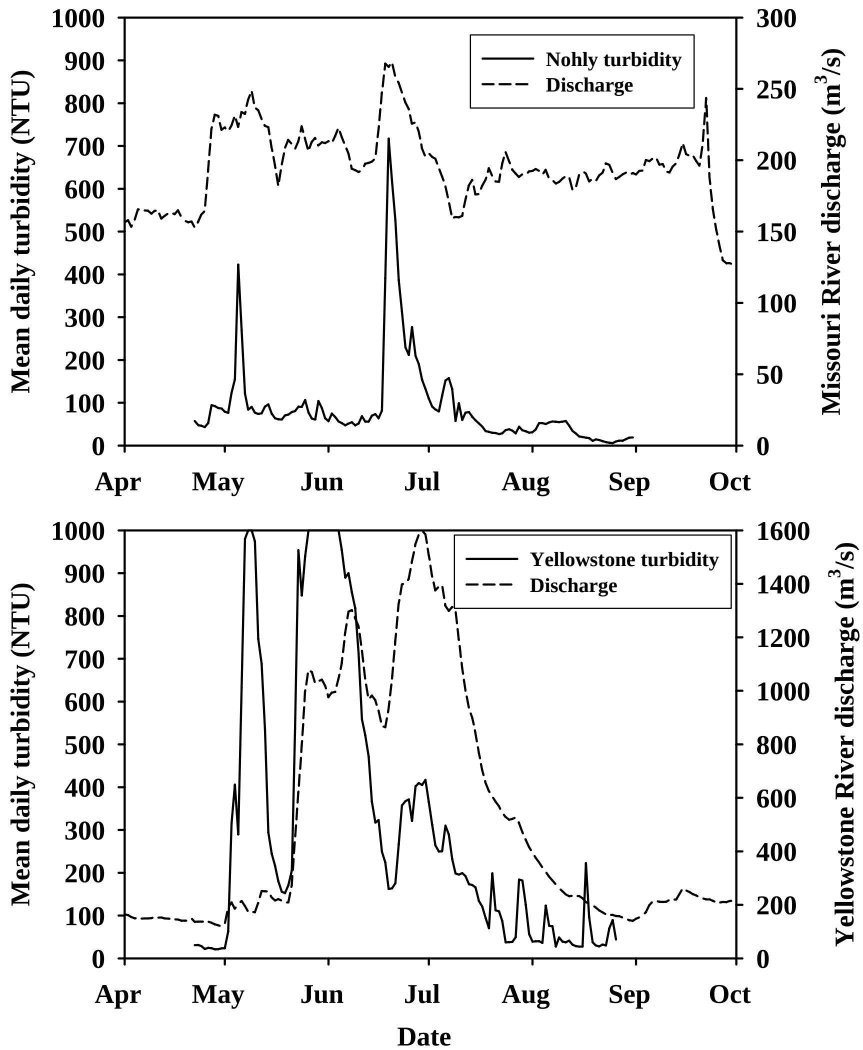


Figure 5. Mean daily discharge (m^3/s) and turbidity (nephelometric turbidity units; NTU) in the Missouri River near Nohly and in the Yellowstone River during 2008.

Monitoring Component 2 – Flow- and temperature-related movements of blue suckers, shovelnose sturgeon, paddlefish, and pallid sturgeon

Blue sucker relocations and movements.

The distribution and relative abundance of blue suckers (N = 47) varied among rivers through time (Figure 6). During April, blue suckers primarily used (98% of individuals) the Missouri River between Fort Peck Dam and Williston and most were relocated upstream from Wolf Point. The percentage of blue suckers relocated in this reach dropped to 53% in early July and remained stable until early September. The increased relative abundance of blue suckers in the reach in late-September was due to movements of blue suckers out of the Yellowstone River when discharge was low and water temperature was high.

The occurrence of blue suckers in the Milk River (Figure 6) was dependant on discharge. Approximately 20% of blue suckers entered the Milk River in late May and again in late June. However, most forays were of short duration. Many fish entered the Milk River, as indicated by our ground based telemetry station during a large pulse of water in late June (Figure 2).

Use of the Yellowstone River by radio tagged blue suckers exhibited a distinct pattern among tracking periods (Figure 6). Relative abundance of blue suckers in the Yellowstone River was low in April (2%) but steadily increased through June and July. The greatest percentage of fish (48%) occurred in the Yellowstone River in late August. Individuals began emigrating out of the Yellowstone River in early September and continued their emigration through October.

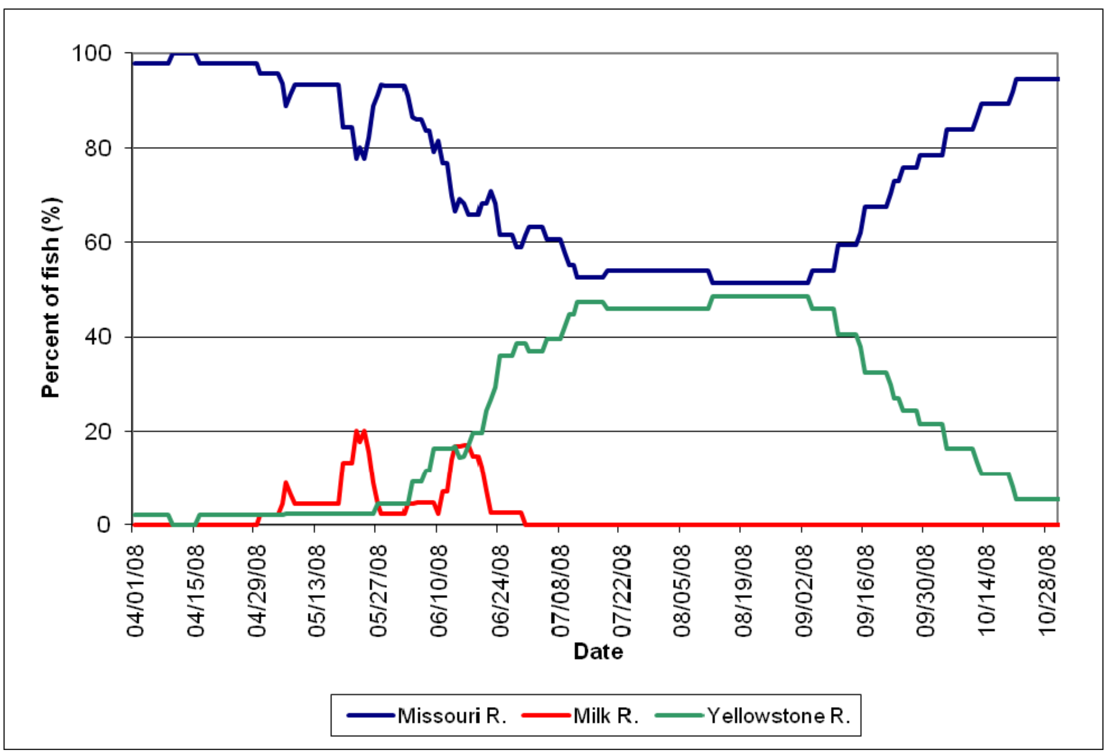


Figure 6. Percent (%) blue suckers relocated in the Missouri, Milk, and Yellowstone rivers in 2008 by date.

Inter-annual trends in blue sucker relocations.-The Missouri River was a concentration area for blue suckers during 2004-2008, but use of this reach varied during the year (Figure 7). Relocations of blue suckers were initially high in April, decreased in May as fish entered the Milk River, then increased as individuals moved out of the Milk River and returned to the Missouri River. After Milk River immigration and emigration events were completed, use of the Missouri River steadily declined as blue suckers exited the Missouri River and entered the Yellowstone River. Fish migrated back into the Missouri in September. However, several individuals remained in the Missouri River for the entire year (minimum 47% in 2004, 37% in 2005, 40% in 2006, 48% in 2007, 51% in 2008). Although similar immigration and emigration dynamics among rivers occurred during these four years, the timing of movement dynamics varied slightly between years. These differences are likely attributed to differences in the dates that the Milk River had suitable water conditions, and the subsequent influence of Milk River hydrologic conditions on immigration and emigration dynamics (see below).

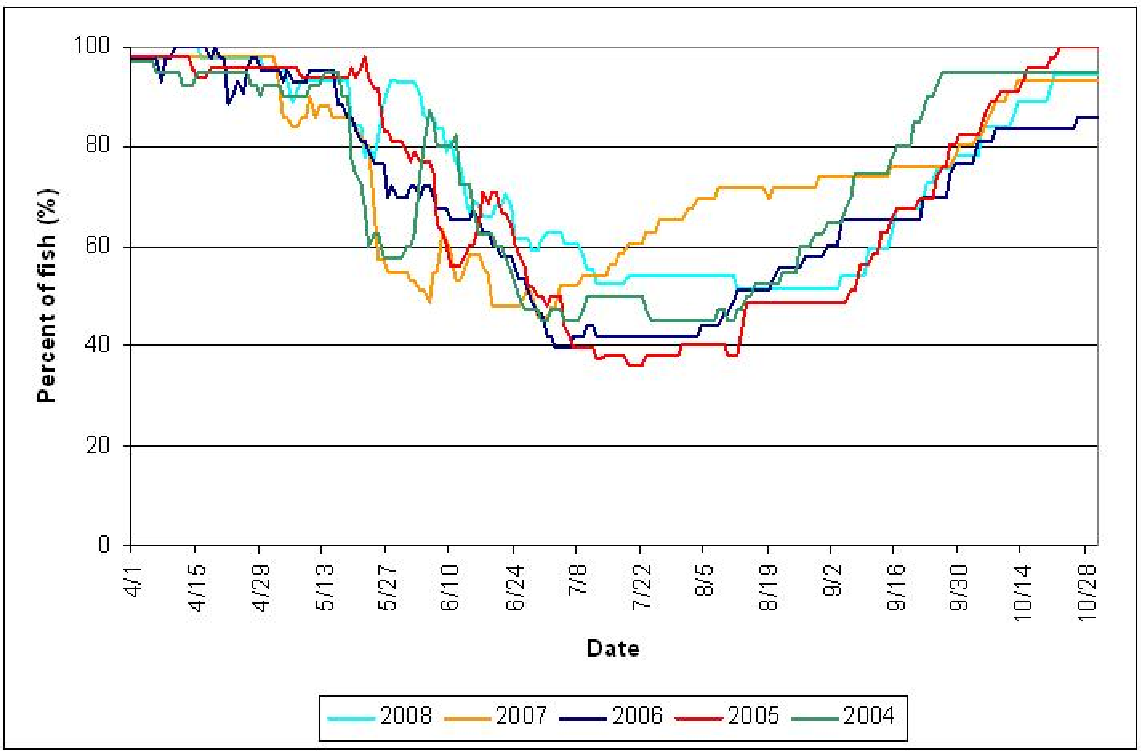


Figure 7. Percent (%) blue suckers relocated in the Missouri River from 2004-2008 by date.

Blue suckers exhibited limited seasonal use of the Milk River in 2004-2008 (Figure 8). Individuals migrated up the Milk River in all years when there was an increase in the hydrograph (maximum 35% in 2004, 22% in 2005, 12 % in 2006, 31% in 2007, 20% in 2008; see Figure 2 for Milk River hydrographs). When discharge declined, blue suckers moved out of the Milk River and re-entered the Missouri River. There were no relocations of blue suckers in the Milk River later than early July in all years. Temporal use of the Milk River was not consistent among years. The lack of consistency is most likely attributed temporal differences in Milk River discharge pulses among years, and the influence of discharge on blue sucker use of the Milk River.

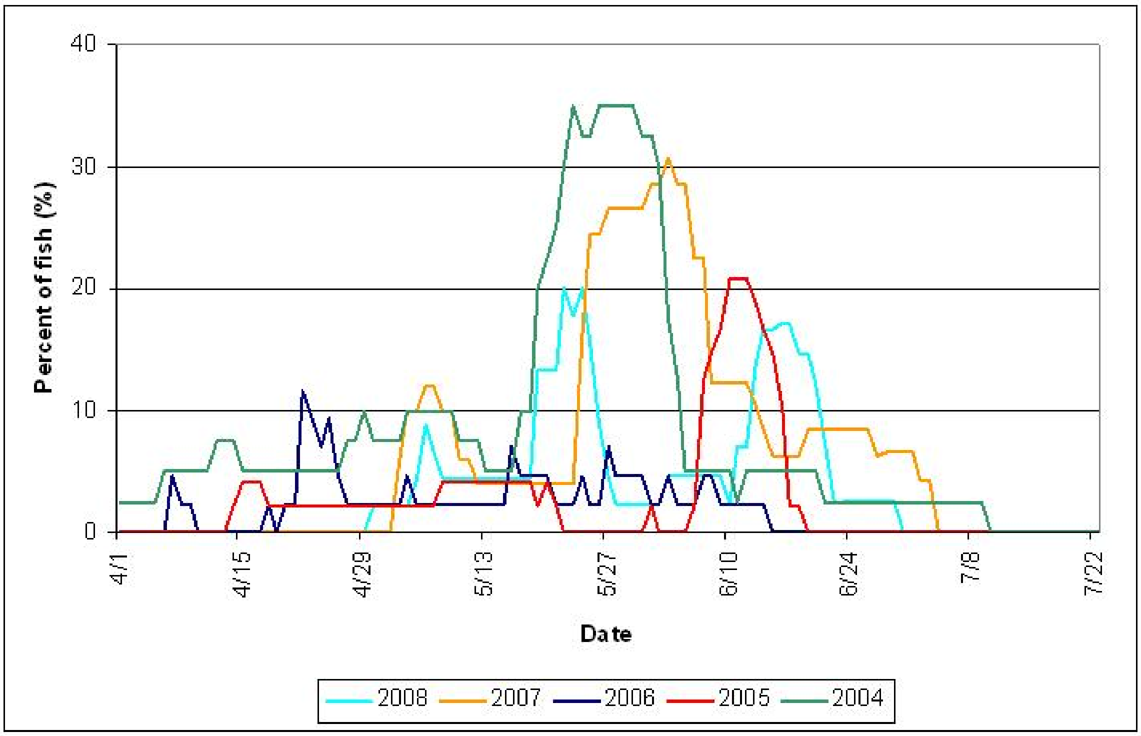


Figure 8. Percent (%) of blue suckers relocated in the Milk River from 2004 - 2008 by date.

The Yellowstone River was rarely used during April and early May by blue suckers during 2004-2008 (Figure 9). Use of the Yellowstone River rapidly increased in early June and reached a maximum in July (55% in 2004, 64% in 2005, 61% in 2006, 48% in 2007, 49% in 2008). Fish began emigrating out of the Yellowstone River in early August in 2004-2006. However, in 2007, fish began emigrating out of the Yellowstone River by early July. Use of the Yellowstone River was low after mid-October in all years. Thus, these results suggest that use patterns of the Yellowstone River by blue suckers are fairly similar between years despite inter-annual differences in Yellowstone River hydrologic conditions. Conversely, temporal use of the Milk River and Missouri River by blue suckers varies between years, and is strongly influenced by temporal (e.g., weekly) variations in hydrologic conditions in the Milk River that subsequently influence immigration and emigration dynamics.

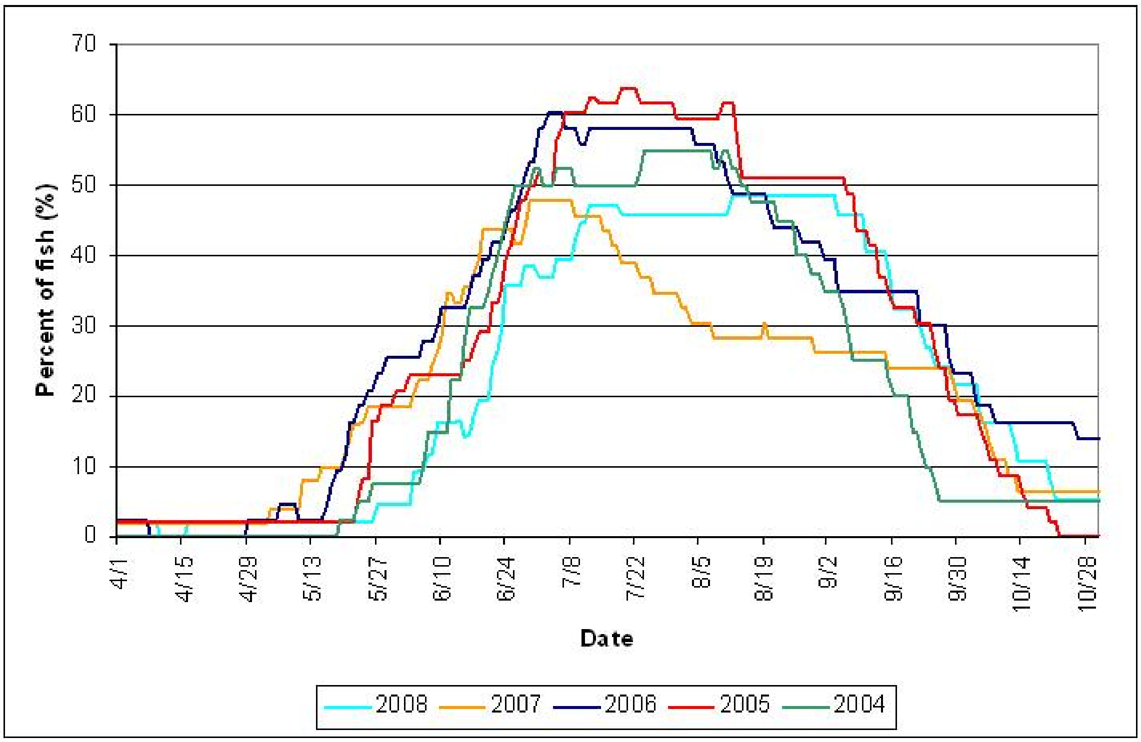


Figure 9. Percent (%) of blue suckers relocated in the Yellowstone River from 2004 - 2008 by date.

Shovelnose sturgeon relocations and movements.

Use of the upper Missouri River between Fort Peck Dam and Wolf Point by shovelnose sturgeon (N = 36) was stable through April and May (Figure 10). Use of this reach declined slightly in June and early July, and increased slightly throughout the remainder of the tracking season. However, a minimum of 40% of the shovelnose sturgeon remained in the study reach for the duration of the season.

The lower Missouri River reach from Wolf Point to the headwaters of Lake Sakakawea is twice as long as the other two reaches. However, this reach exhibited the lowest relative abundance of shovelnose sturgeon (Figure 10). Less than 10% of the individuals were relocated in this reach from June to August. A maximum of 27% was found in April prior to migrations into the Yellowstone River and late October when many shovelnose sturgeon had emigrated out of the Yellowstone River.

The percentage of shovelnose sturgeon relocations in the Yellowstone River steadily increased from early May (28%) through mid July (53%; Figure 10). Use of this reach declined in August and September to 30% of individuals.

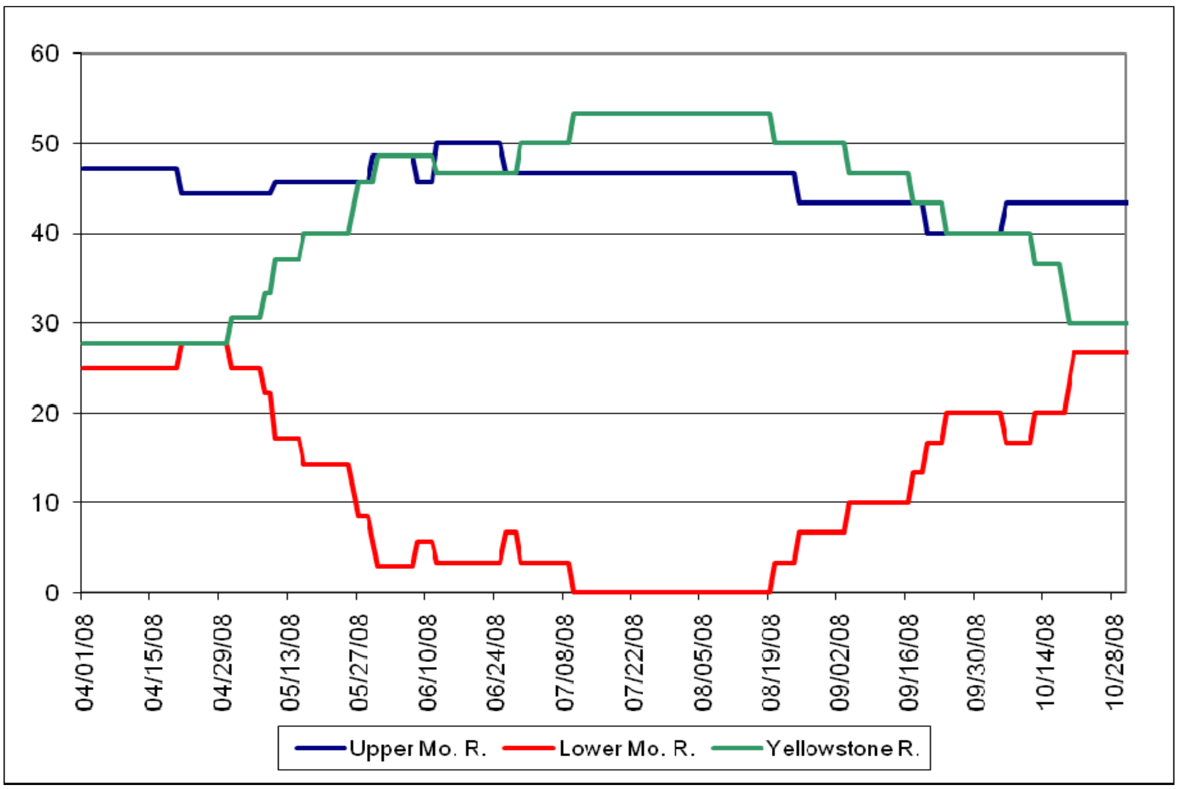


Figure 10. Percent (%) of shovelnose sturgeon relocated in the Missouri River reaches and the Yellowstone River in 2008 by date.

Inter-annual trends in shovelnose sturgeon relocations.- The upper Missouri River from Fort Peck Dam downstream to Wolf Point was a concentration area in all years (Figure 11). Although use gradually decreased from mid-June through early July, a large number of individuals remained in this reach throughout the tracking season (minimum 34% in 2004, 37% in 2005, 42% in 2006, 31% in 2007, 40% in 2008). Temporal use of this reach was generally consistent between years. In general, fish remaining in this reach were implanted in the two upper sampling locations: near Wolf Point and near the Milk River.

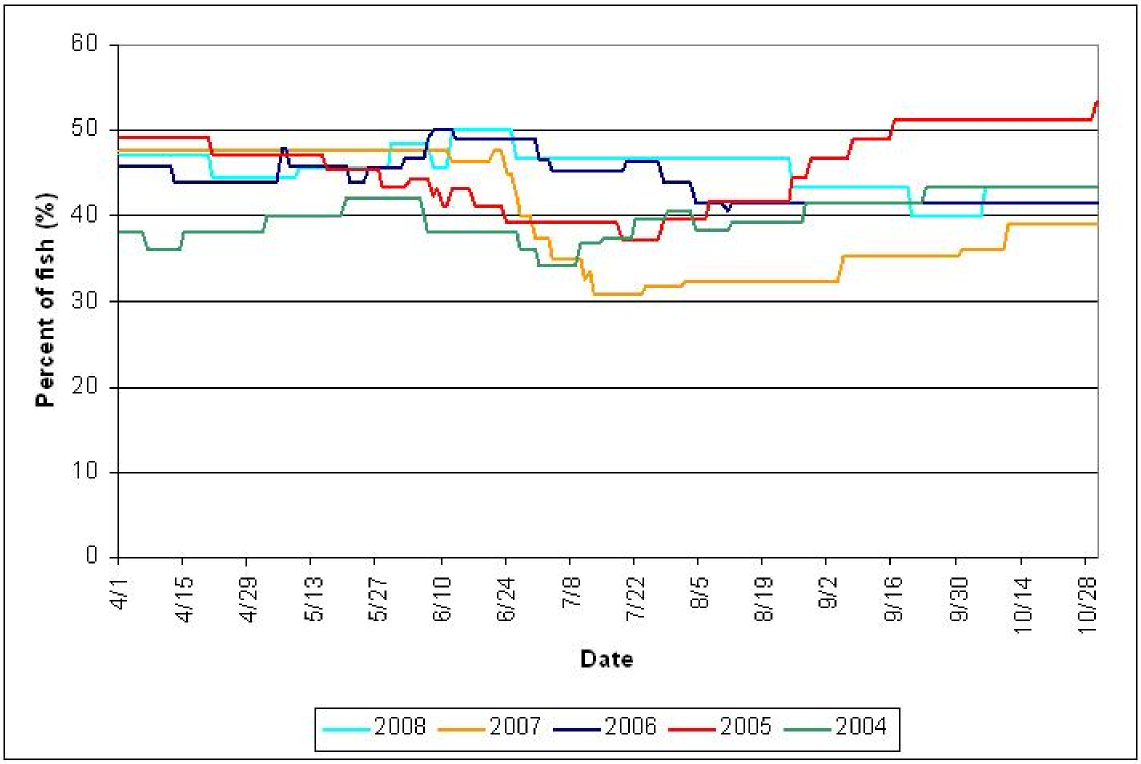


Figure 11. Percent (%) of shovelnose sturgeon relocated in the Missouri River from Wolf Point to Fort Peck Dam from 2004 - 2008 by date.

The lower Missouri River reach from Wolf Point downstream to near Williston, North Dakota was primarily a movement corridor during the tracking season (Figure 12). Shovelnose sturgeon use of this segment decreased from early April to late July as individuals emigrated from this reach and migrated into the Yellowstone River. In 2004 - 2007, densities were at their lowest from late May to early June (3%-15%). However, in 2008, there were no telemetered shovelnose sturgeon in this reach from early July through mid-August. The percentage of shovelnose sturgeon in the lower Missouri River increased during September as individuals emigrated from the Yellowstone River back into this reach. In general, the relative abundance of shovelnose sturgeon in the lower Missouri River is inversely related to the relative abundance in the Yellowstone River.

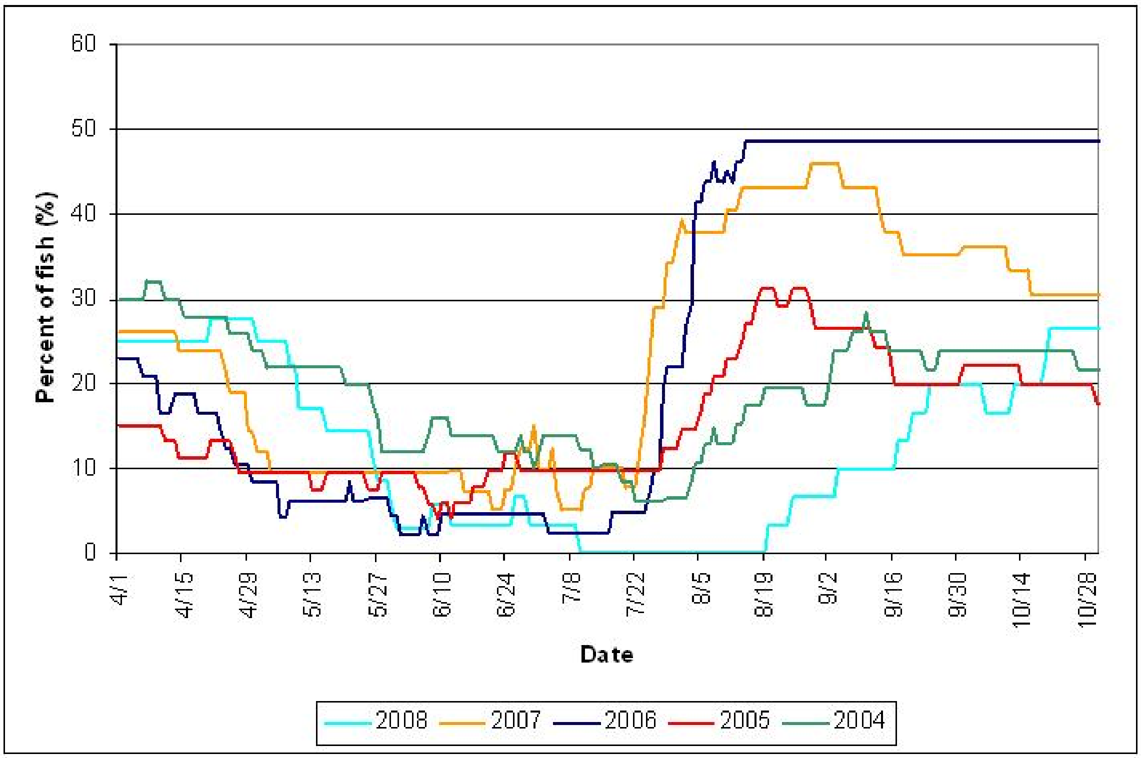


Figure 12. Percent (%) of shovelnose sturgeon relocated in the lower Missouri River from Wolf Point downstream to near Williston, North Dakota from 2004 - 2008 by date.

The Yellowstone River was a concentration area for shovelnose sturgeon, but use of this reach varied during the year (Figure 13). It should be noted that none of these fish were implanted in the Yellowstone River. Use of this reach increased from April through late July (maximum 54% in 2004, 53% in 2005, 53% in 2006, 62% in 2007, 53% in 2008) and then declined through late September and October as individuals moved into the Missouri River. Some shovelnose sturgeon remained in the Yellowstone River throughout the tracking season in all years. From 2004 – 2007, shovelnose sturgeon began emigrating out of the Yellowstone River from July 16 – July 28. In 2008, shovelnose sturgeon did not begin their emigration until August 19. This is most likely due to an exceptionally high water year (Figure 2) when flows did not get below 200 m^3/s until late August.

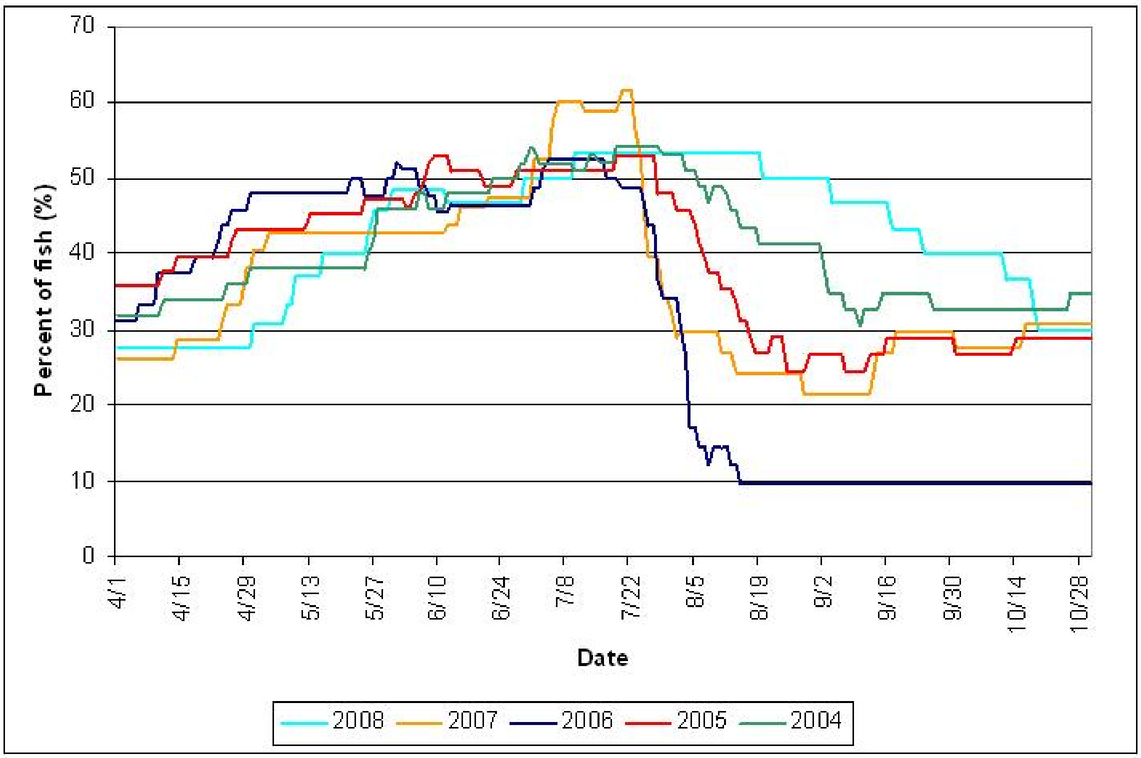


Figure 13. Percent (%) of shovelnose sturgeon relocated in the Yellowstone River from 2004 – 2008 by date.

Paddlefish relocations and movements

The transmitters that were implanted in paddlefish below the confluence in 2001 and 2002 have expired; therefore, paddlefish will no longer be reported on until the final compendium of the Fort Peck Flow Modification project.

Pallid Sturgeon relocations and movements

Use of the Missouri River upstream from the Yellowstone River confluence (i.e., ATC) by pallid sturgeon occurred during 2008, but was minimal (Figure 14). The one individual that was implanted in the tailrace immediately downstream from Fort Peck Dam several years ago remained in the Missouri River until mid-June, migrated into the Yellowstone River for three weeks, and then migrated back up to the tailrace in the fall.

In general, there was inverse pattern for pallid sturgeon between the Yellowstone River and Missouri River below the Yellowstone River confluence (i.e., BTC; Figure 14). Pallid sturgeon use of the Missouri River BTC declined though early April as individuals emigrated from this reach into the Yellowstone River. Pallid sturgeon primarily used the Yellowstone River through early July and then emigrated from the Yellowstone River back to the Missouri River BTC through the end of the tracking season.

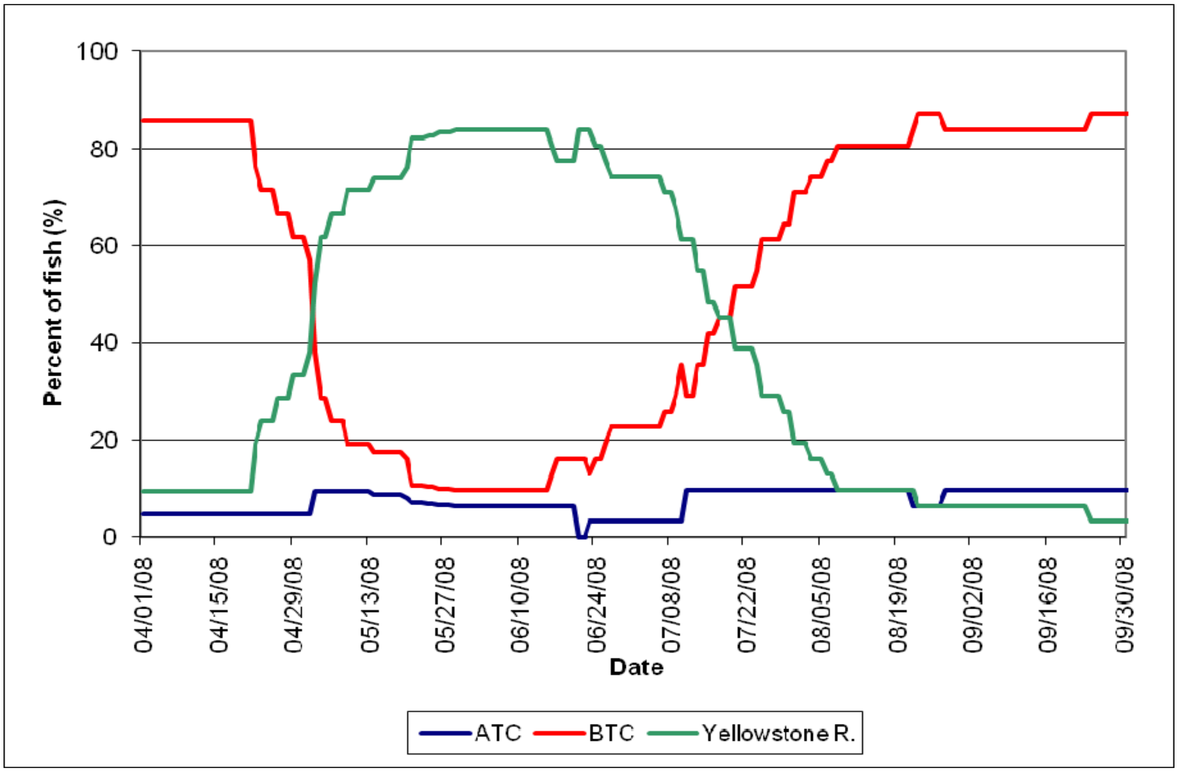


Figure 14. Percent (%) of pallid sturgeon relocated in the Missouri River above (ATC) and below (BTC) the Yellowstone River confluence and in Yellowstone River during 2008.

Inter-annual trends in pallid sturgeon relocations. With the exception of 2004, the Missouri River ATC was seldom used (Figure 15). Relocations in this reach primarily consisted of one fish that was implanted in the tailrace area and another that resides in the Culbertson area during autumn, although other fish did occasionally ascend the Missouri River. The individual that was implanted in the tailrace resides in the Missouri River ATC until early June and then moves downstream and enters the Yellowstone River for a few weeks, and migrates back up to the tailrace area.

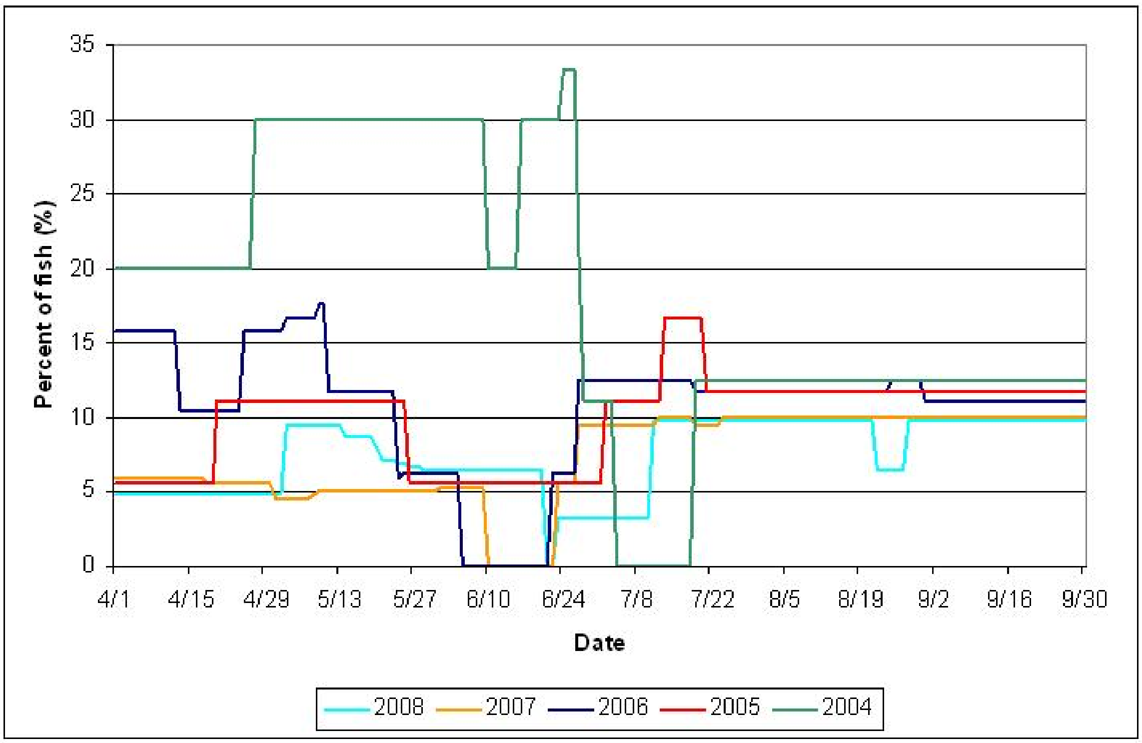


Figure 15. Percent (%) of pallid sturgeon relocated in the Missouri River above the confluence in 2004 - 2008 by date.

Pallid sturgeon primarily used the Missouri River BTC for an over-wintering area (Figure 16). Nearly 10% of fish remained in this reach for the entire year, and these were most likely non-ripe males that did not ascend the Yellowstone River

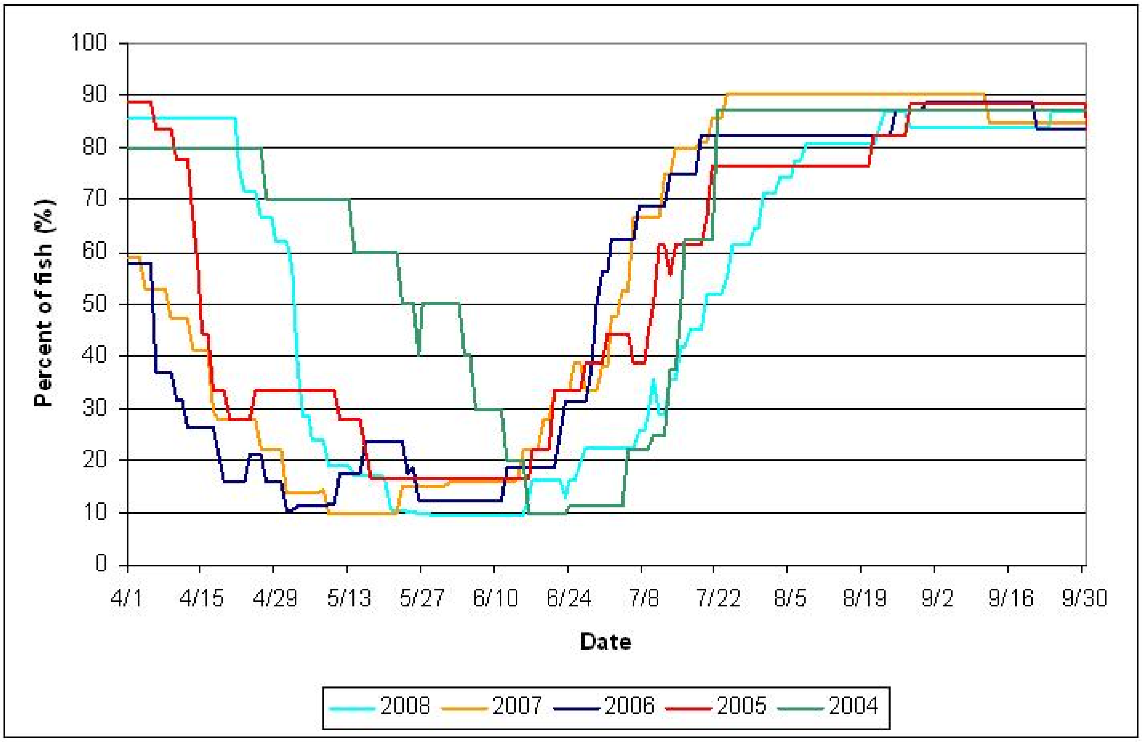


Figure 16. Percent (%) of pallid sturgeon relocated in the Missouri River below the confluence in 2004 - 2008 by date.

With the exception of 2004, pallid sturgeon began migrating up the Yellowstone River in early April prior to an increase in the hydrograph (Figure 17). Maximum relocations of 78% - 88% were found in mid-June. Fish rapidly emigrated out of the Yellowstone River from late June through early July. The late migration in 2004 was most likely due to very low flows (Figure 2).

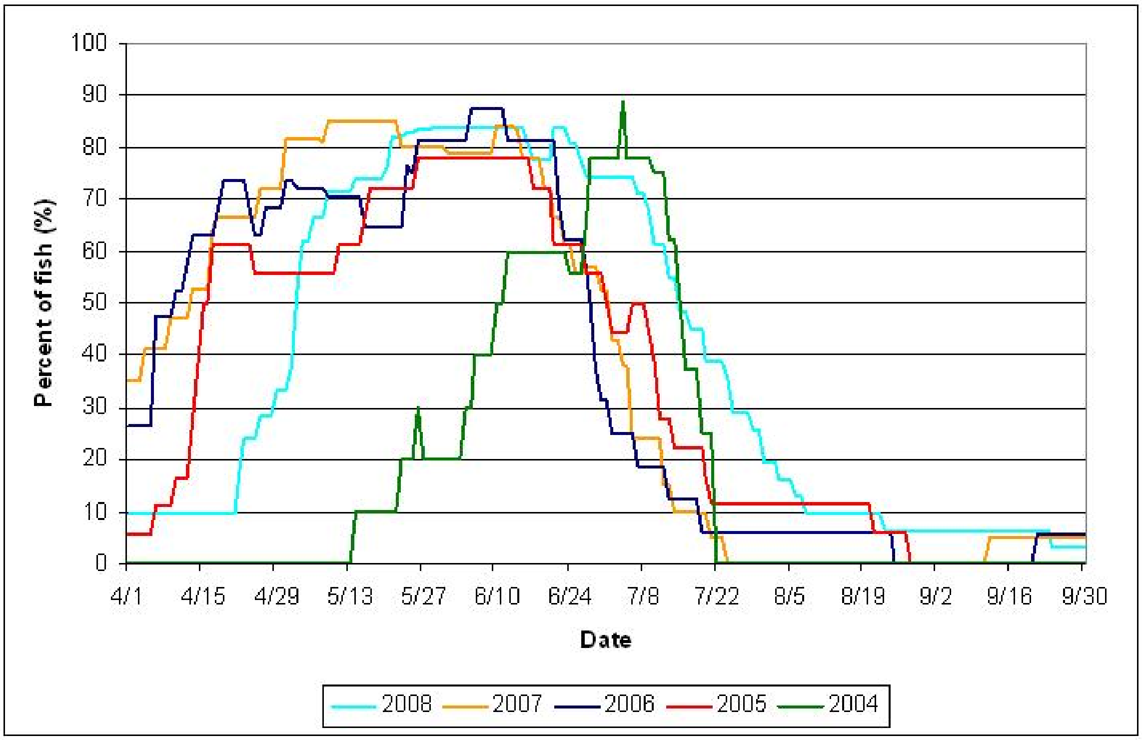


Figure 17. Percent (%) of pallid sturgeon relocated in the Yellowstone River in 2004 – 2008 by date.

Transmitter implantation.- Only one shovelnose sturgeon and one blue sucker were implanted in the fall 2008, both fish were collected in the Missouri River near the Milk River confluence. Fourteen new pallid sturgeon were implanted in April during brood stock collection efforts. Additionally, there were five pallid sturgeon that were re-implanted because the old tags were expiring. These fish were captured in the Missouri River below the confluence and lower Yellowstone River, North Dakota.

Component 3 – Distribution and Abundance of Larval Fish

A total of 1,900 larval fish samples were collected on 20 sampling events between May 28 and August 5, 2008. Samples were collected from the Missouri River below Fort Peck Dam (N = 232), spillway channel (N = 160), Milk River (N = 326), Missouri River near Wolf Point (N = 400), Missouri River near Nohly (N = 386), and Yellowstone River (N = 396). The mean volume of water filtered per subsample was 52 m^3 at the site downstream from Fort Peck Dam (total volume = 12,046 m^3), 20 m^3 in the spillway channel (total volume = 3,121 m^3), 94 m^3 in the Milk River (total volume = 30,599.9 m^3), 70 m^3 at Wolf Point (total volume = 27,809.9 m^3), 36 m^3 at Nohly (total volume = 14,013.3 m^3), and 36.0 m^3 in the Yellowstone River (total volume = 14,266.8 m^3). High discharge in the Yellowstone River backed-up water in the Missouri River near Nohly through mid-July. The back-up water decreased velocities at all larval fish sampling sites at Nohly, contributing to the low volumes of water sampled at this site relative to other Missouri River sites. Volumes of water filtered in the Yellowstone River were also reduced during 2008 as short-duration samples were necessary during much of the season to offset high detrital loads resulting from high discharges.

Relative abundance of larval fishes and eggs. Sampling during 2008 resulted in a catch of 9,447 larval fish across all sites (Table 8). Representatives of Catostomidae (suckers) were the dominant taxon sampled, and composed 76.0% of the larvae sampled. Cyprinids (minnows) and goldeye (Hiodontidae) were the second and third most abundant taxa sampled composing 8.0% and 7.4%, respectively, of the larvae. Larval paddlefish (Polyodontidae) and sturgeon (Acipenseridae) composed 1.1% (N = 101) and 0.05% (N = 5) of the larvae sampled, respectively. Two larvae sampled in the Yellowstone River could not be positively identified as paddlefish or sturgeon. Acipenserifom eggs were sampled at Wolf Point (N = 1) and in the Yellowstone River (N = 17). Across all sites, greater than 25,000 unidentified eggs were sampled. Catostomids were sampled at all six sites followed by cyprinids that were sampled at five of the six sites. Several taxa (Centrarchidae, goldeye, Percidae, paddlefish, Salmonidae) were sampled at four sites (Table 8). Sturgeons, freshwater drum (Sciaenidae), and catfishes (Ictaluridae) were sampled at two sites. The greatest number of taxa sampled (9) occurred at Wolf Point on the Missouri River. Eight taxa were sampled at Nohly, and six taxa were sampled from the Milk River and Yellowstone River. Fewest taxa were sampled in the Missouri River below Fort Peck Dam (3) and in the spillway (4).

Table 8. Number and frequency (%) of larval fishes by taxon, and numbers of juvniles, adults, and eggs sampled at six sites during 2008. T = trace (< 0.1%).

	Below Fort Peck Dam		Spillway		Milk River		Wolf Point		Nohly		Yellowstone River	
Taxon	N	%	N	%	N	%	N	%	N	%	N	%
Acipenseridae							1	T			4	0.9
Catostomidae	65	78.3	1471	88.3	4225	77.5	998	76.5	222	43.0	198	46.5
Cyprinidae			15	0.9	540	9.9	62	4.8	25	4.8	110	25.8
Centrarchidae			165	9.9	2	T	1	T	1	0.2		
Hiodontidae					490	9.0	23	1.8	161	31.2	22	5.2
Ictaluridae									1	0.2	22	5.2
Percidae	1	1.2					185	14.2	85	16.5		15.7
Polyodontidae					4	T	15	1.1	15	2.9	67	
Salmonidae	14	16.9	2	0.1			9	0.7	3	0.6		
Sciaenidae					163	3.0	1	T				
Acipenseriform larvae[1]											2	0.5
Unknown larvae[2]	3	3.6	12	0.7	28	0.5	10	0.8	3	0.6	1	0.2
Total larvae	83		1665		5452		1305		516		426	
Juveniles			12		9		2				10	
Adults			2		65							
Acipenseriform eggs							1				17	
Other eggs	1041		69		9590		4494		4796		5252	

[1] Larvae that could not be definitively distinguished as paddlefish or sturgeon
[2] Larvae other than Acipenseriform larvae that could be definitively identified.

Spatial and temporal periodicity and densities of larval Scaphirhynchus spp. and paddlefish. No *Scaphirhynchus* spp. were sampled in the Milk River during 2008, and only four paddlefish were collected (Table 9). Larval paddlefish were sampled on June 24 and June 27, but densities were low (≤ 0.35 larvae/100 m^3).

Table 9. Number of larval paddlefish, and mean (median), minimum and maximum densities (number/100 m^3) sampled by date in the Milk River during 2008.

Date	Number sampled	Mean (median)	Minimum	Maximum
5/29				
6/3				
6/5				
6/10				
6/12				
6/17				
6/19				
6/24	3	0.35 (0)	0	1.27
6/27	1	0.04 (0)	0	0.21
7/01				
7/03				
7/08				
7/11				
7/15				
7/15				
7/21				
7/25				
7/28				
8/01				
8/04				

Only one larval sturgeon was collected in the Missouri River at Wolf Point during 2008, and this individual was sampled on July 28 (mean density = 0.07 larvae/100 m^3; Table 10). A total of 14 larval paddlefish was sampled at Wolf Point with occurrence in the drift spanning from June 23 (mean density = 0.58 larvae/100 m^3) to July 7 (mean density = 0.10 larvae/100 m^3).

Table 10. Number (N) of larval *Scaphirhynchus* spp. and paddlefish, and mean (median), minimum and maximum densities (number/100 m^3) sampled by date in the Missouri River at Wolf Point during 2008.

	Scaphirhynchus spp.				Paddlefish			
Date	N	Mean (median)	Min.	Max.	N	Mean (median)	Min.	Max.
5/28								
6/02								
6/04								
6/09								
6/11								
6/16								
6/18								
6/23					9	0.58 (0.56)	0	1.35
6/26					4	0.28 (0.33)	0	0.40
6/30					1	0.06 (0)	0	0.30
7/02								
7/07					7	0.10 (0)	0	0.50
7/09								
7/14								
7/16								
7/21								
7/24								
7/28	1	0.07 (0)	0	0.33				
7/31								
8/04								

In the Missouri River at Nohly, larval sturgeon were absent on all sampling dates between May 29 and August 5 (Table 11). Larval paddlefish were collected on two dates as 13 paddlefish larvae were sampled on June 26 (mean density = 10.41 larvae/100 m^3) and two larvae were sampled on June 29 (mean density = 0.39 larvae/100 m^3). The apparently high mean and maximum densities of larval paddlefish on both dates relative to the Wolf Point site were primarily sampling artifacts due to low volumes of water sampled. For example, sample volumes were reduced and water velocity was low at the Nohly site due to ponding and high flows in the Yellowstone River. Collections of few larvae in low-volume samples resulted in the inflated densities.

Table 11. Number (N) of larval *Scaphirhynchus* spp. and paddlefish, and mean (median), minimum and maximum densities (number/100 m^3) sampled by date in the Missouri River at Nohly during 2008.

	Scaphirhynchus spp.				Paddlefish			
Date	N	Mean (median)	Min.	Max.	N	Mean (median)	Min.	Max.
5/29								
6/03								
6/05								
6/10								
6/12								
6/17								
6/19								
6/24								
6/26					13	10.41 (0)	0	35.08
6/29					2	0.39 (0)	0	1.10
7/01								
7/08								
7/10								
7/15								
7/17								
7/22								
7/24								
7/29								
7/31								
8/05								

Larval sturgeon in the Yellowstone River during 2008 exhibited limited occurrence and low numbers in the drift (Table 12). Only two larvae were sampled on July 8, and one individual was captured on July 22 and July 24. Mean density on these dates varied from 0.04 – 0.96 larvae/100 m^3. In contrast to sturgeon, larval paddlefish were collected on 11 sampling events between June 10 and July 17. Mean densities of larval paddlefish on these dates varied from 0.32 – 3.80 larvae/100 m^3. In addition to the identified sturgeon and paddlefish larvae, individual acipenseriform larvae that could not be positively identified as sturgeon or paddlefish were sampled on June 17 and June 19.

Table 12. Number (N) of larval *Scaphirhynchus* spp. and paddlefish, and mean (median), minimum and maximum densities (number/100 m^3) sampled by date in the Yellowstone River during 2008.

	Scaphirhynchus spp.				Paddlefish			
Date	N	Mean (median)	Min.	Max.	N	Mean (median)	Min.	Max.
5/30								
6/03								
6/05								
6/10					5	1.42 (1.19)	0	3.36
6/12					10	1.39 (0.67)	0	3.84
6/17					11	2.16 (1.69)	0	6.04
6/19					16	3.80 (1.87)	0	14.28
6/24					3	0.69 (0.81)	0	1.71
6/26					2	0.38 (0)	0	1.06
6/29					7	2.08 (2.01)	0	3.60
7/02					7	1.04 (0.71)	0	2.03
7/08	2	0.96 (0)	0	4.78	3	1.18 (0)	0	5.11
7/10								
7/15					1	0.14 (0)	0	0.71
7/17					2	0.32 (0)	0	0.89
7/22	1	0.21 (0)	0	1.06				
7/24	1	0.04 (0)	0	0.22				
7/29								
7/31								
8/05								

Spatial and temporal periodicity and density of larval fishes exclusive of larval sturgeon and paddlefish. The larval fish assemblage in the Missouri River downstream from Fort Peck Dam was comprised of three taxa, and each taxon exhibited variable periodicity of occurrence (Figure 18). Larval representatives of Salmonidae were present on the initial two sampling dates (May 29, June 3), but absent from collection on other dates. Percids were present on one date (June 5). Conversely, Catostomidae were collected on 13 of 20 sampling dates between June 12 and August 4, and exhibited greatest densities (mean = 3.87 larvae/100 m^3) on June 27.

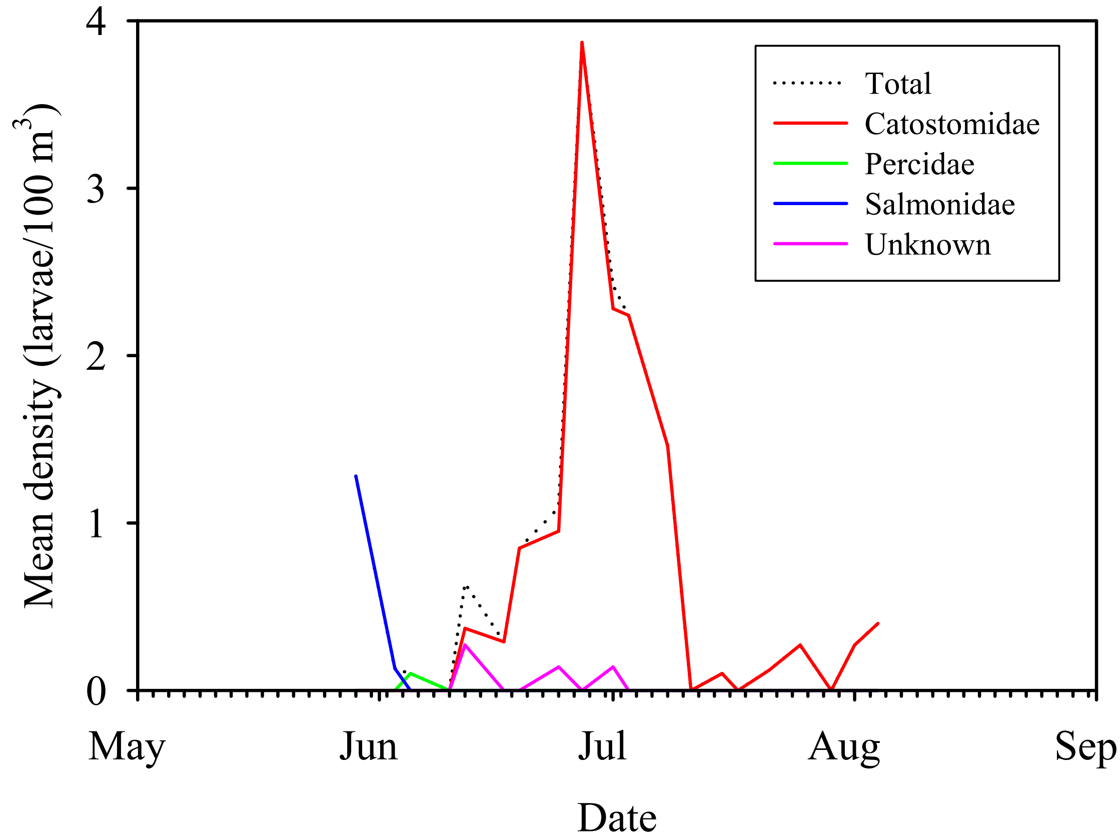


Figure 18. Mean density (number/100 m^3) by date of all larval fishes (Total), Catostomidae, Percidae, Salmonidae, and Unknown individuals sampled in the Missouri River below Fort Peck Dam during 2008.

Four taxa of larval fishes were identified from the spillway channel (Cyprinidae, Catostomidae, Salmonidae, Centrarchidae; Figure 19). Salmonids were collected on two dates (May 29, July 3), cyprinids on six dates between June 27 and August 4, centrarchids on 12 dates between June 12 and August 1, and catostomids on 14 dates between June 19 and August 4. Across taxa, densities were low through June 24, then increased to a maximum on July 11 (mean = 424.8 larvae/100 m^3) as Catostomidae and Centrarchidae composed 86% and 13% of the larvae sampled, respectively.

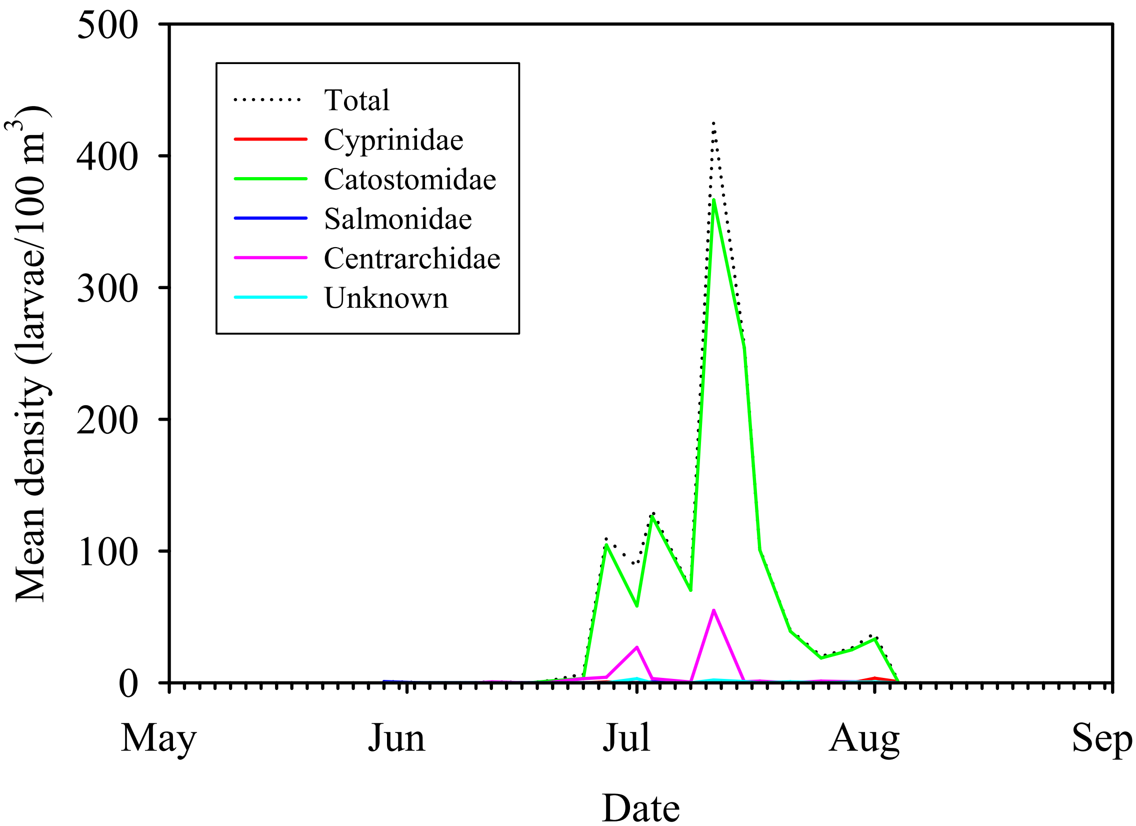


Figure 19. Mean density (number/100 m^3) by date of all larval fishes (Total), Cyprinidae, Catostomidae, Salmonidae, Centrarchidae, and Unknown individuals sampled in the spillway channel during 2008.

The five taxa of larval fishes identified from the Milk River during 2008 exhibited relatively low densities through mid-June (Figure 20). Densities increased on June 24 and were maximized on June 27 (mean = 127.6 larvae/100 m^3) as representatives of Catostomidae composed 92% of the larvae sampled. Following a period of declining densities, a secondary peak in densities occurred on July 11 (mean = 47.1 larvae/100 m^3) when catostomids and goldeyes composed 53% and 33% of the larvae sampled, respectively. Total densities declined through mid-July and early August, but densities of cyprinids peaked (mean = 8.7 larvae/100 m^3) on July 17.

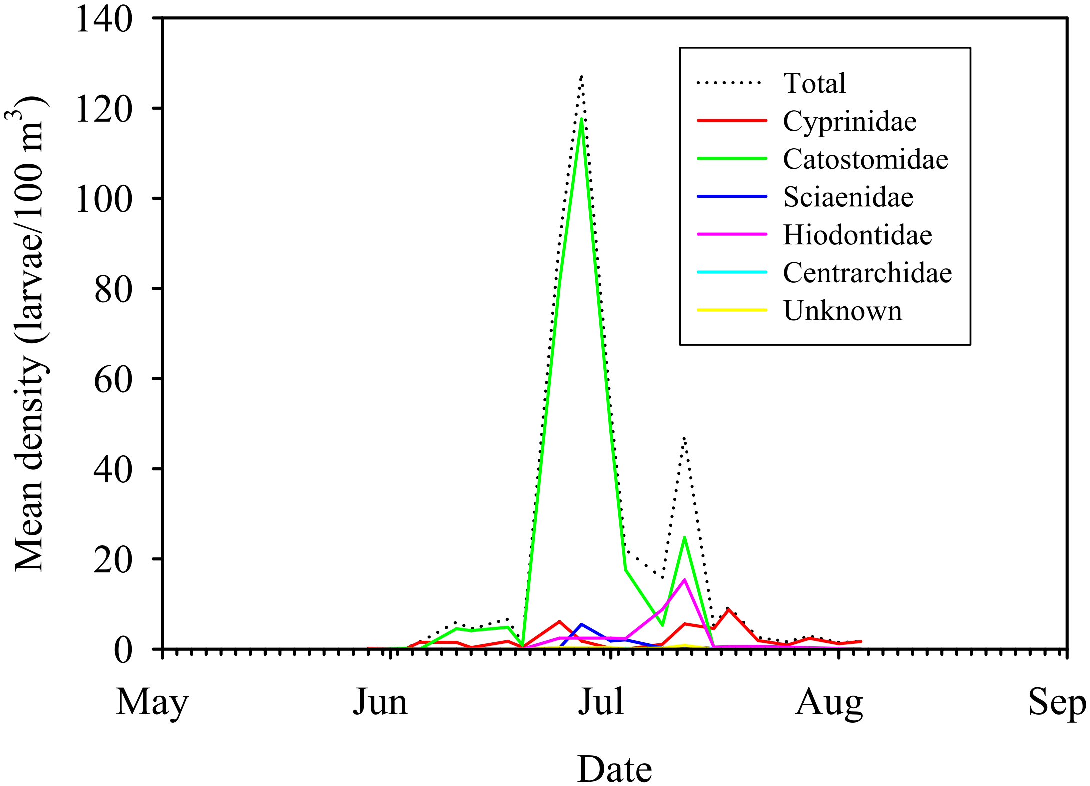


Figure 20. Mean density (number/100 m^3) by date of all larval fishes (Total), Cyprinidae, Catostomidae, Sciaenidae, Hiodontidae, Centrarchidae, and Unknown individuals sampled in the Milk River during 2008.

Collections of larval fishes at Wolf Point on the Missouri River indicated a relatively unimodal pattern of peak densities complemented with periods of elevated densities at other time periods (Figure 21). Percids were collected on the initial seven sampling dates between May 28 and June 18, and densities of percids peaked on June 2 (mean = 3.68 larvae/100 m^3). As percids declined, total densities of larvae reached maximum levels on June 26 (mean = 32.5 larvae/100 m^3) when catostomids composed 95% of all larvae sampled. Following the period of peak densities, total densities of larval fishes declined through early August. Larval cyprinids occurred in the drift between June 16 and July 31, but densities were low ($\leq$ 1.8 larvae/100 m^3). Similarly, larval goldeyes and larval representatives of Salmonidae and Centrarchidae were collected periodically but in low densities.

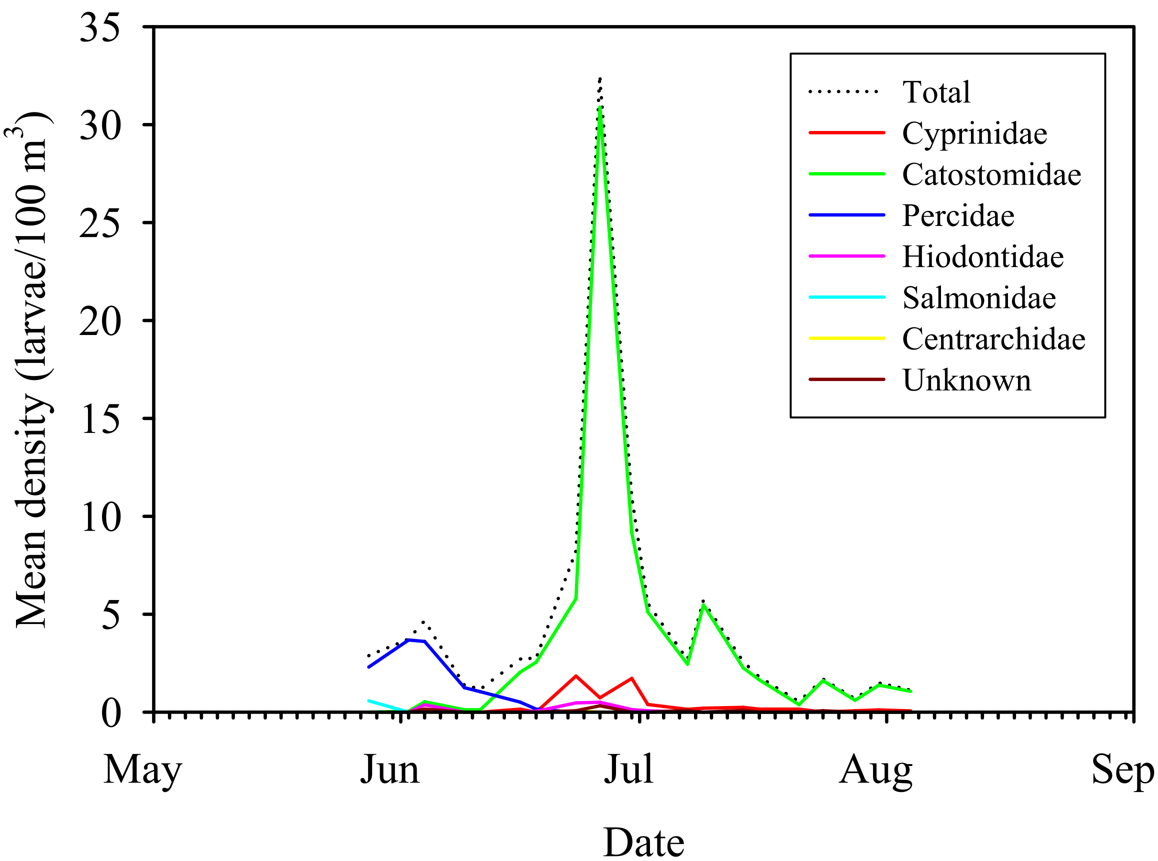


Figure 21. Mean density (number/100 m^3) by date of all larval fishes (Total), Cyprinidae, Catostomidae, Percidae, Hiodontidae, Salmonidae, Centrarchidae, and Unknown individuals sampled in the Missouri River at Wolf Points during 2008.

In the Missouri River at Nohly, larval percids were sampled between May 29 and June 24 and densities of this taxon peaked on June 3 (mean = 12.5 larvae/100 m^3; Figure 22). Following the decline in percids, two nearly equal peaks in total density occurred. The initial peak occurred on June 24 (mean = 69.6 larvae/100 m^3) as goldeye composed 70% of the larvae. On June 29, mean density increased to 70.3 larvae/100 m^3 as goldeye composition decreased and catostomids composed 67% of the larvae sampled. Larval cyprinids were collected on nine sampling events between May 29 and July 24, but densities were greatest on June 29 (mean = 4.6 larvae/100 m^3)

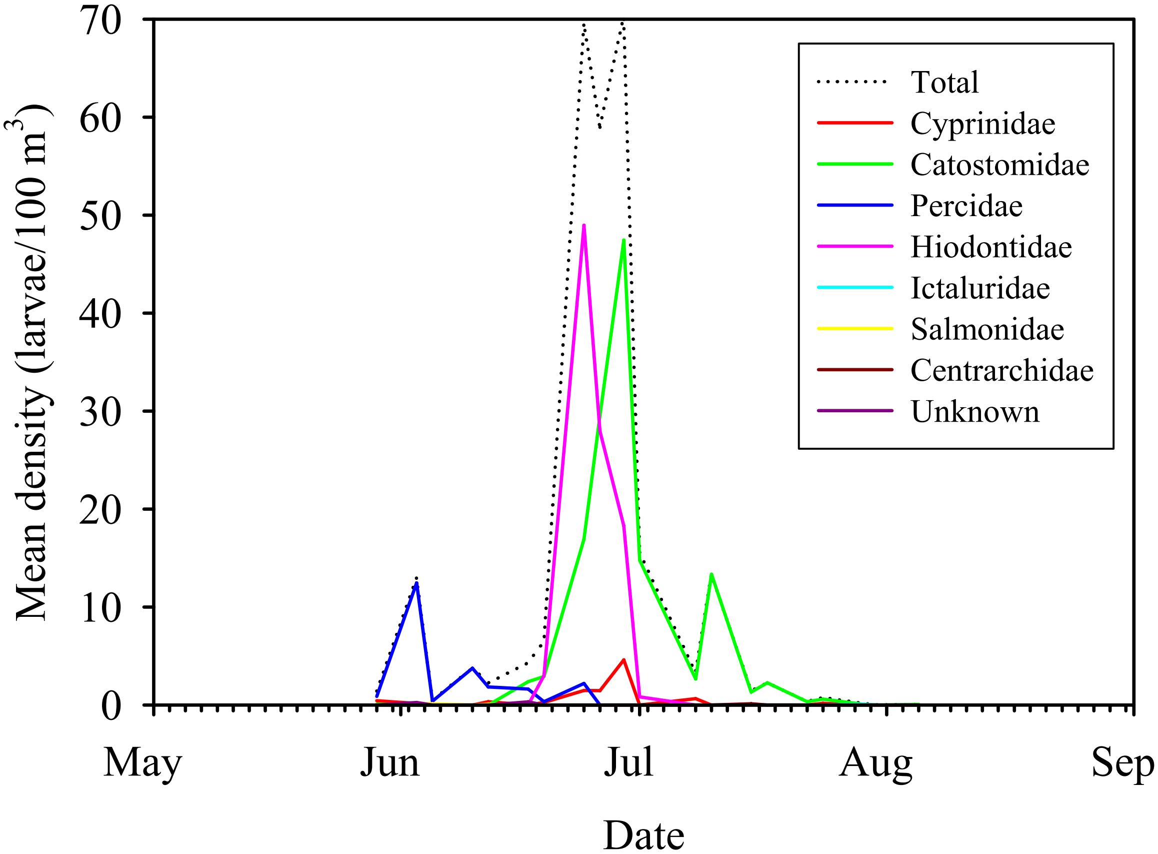


Figure 22. Mean density (number/100 m^3) by date of all larval fishes (Total), Cyprinidae, Catostomidae, Percidae, Hiodontidae, Ictaluridae, Salmonidae, Centrarchidae, and Unknown individuals sampled in the Missouri River at Nohly during 2008.

Larval fishes in the Yellowstone River during 2008 were highly variable through time, and four periods of elevated densities were evident (Figure 23). An initial increase in densities occurred on June 5 when Catostomidae composed 66% of the total densities (mean = 2.51 larvae/100 m^3). Peak densities occurred on June 24 (mean = 9.77 larvae/100 m^3) as Catostomidae composed 60% of the larvae and Cyprinidae and goldeye represented 20% of the larvae sampled. Following a decline after the June 24 peak, densities of larval fish increased on July 22 (mean = 8.84 larvae/100 m^3) as Catostomidae composed 83% of the larvae. Representatives of most taxa declined through late July; however, cyprinids increased and composed 96% of total densities on July 31 (mean = 8.84 larvae/100 m^3).

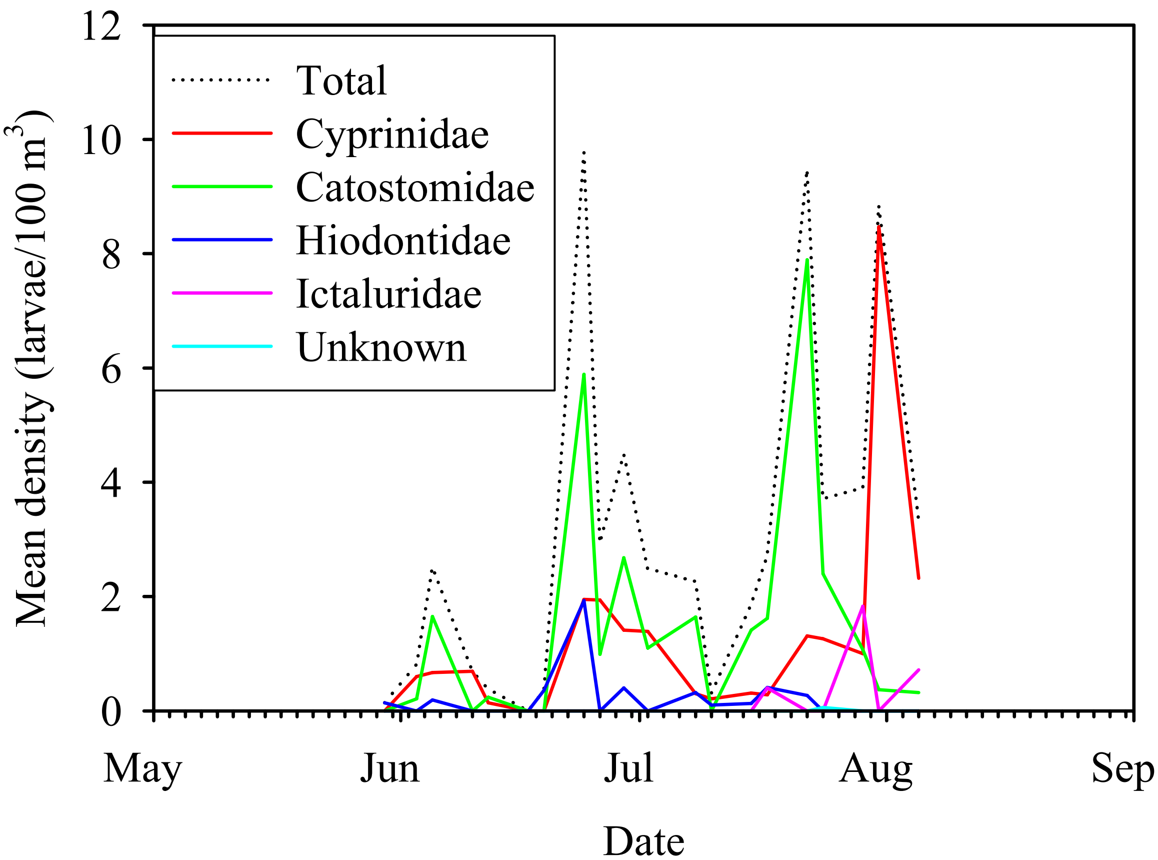


Figure 23. Mean density (number/100 m^3) by date of all larval fishes (Total), Cyprinidae, Catostomidae, Hiodontidae, Ictaluridae, and Unknown individuals sampled in the Yellowstone River during 2008.

Component 4 – Reproductive success of shovelnose sturgeon and pallid sturgeon

Young-of-year sturgeon sampling.- Beam trawling for young-of-year sturgeon (*Scaphirhynchus sp*.) was conducted on eight weekly sampling events between mid-July and early September. A total of 359 trawls was conducted across the eight weekly sampling events, as 100 trawls were conducted in the Missouri River ATC (96 standard trawls, 4 targeted trawls), 156 trawls in the Missouri River BTC (142 standard trawls, 14 targeted trawls), and 103 trawls in the Yellowstone River (95 standard trawls, 8 targeted trawls; Table 13).

A total of 18 young-of-year sturgeon were sampled, and these were partitioned among the Missouri River ATC (N = 2), Missouri River BTC (N = 11), and Yellowstone River (N = 5; Table 13). Young-of-year sturgeon were sampled in the Missouri River ATC on August 6 (length = 30 mm) and September 3 (length = 90 mm). In the Missouri River BTC, young-of-year sturgeon were sampled on August 7 (lengths = 25, 46, 66, 69, 70, 75 mm), August 13 (length = 66 mm), September 4 (lengths = 119, 169 mm), and September 10 (lengths = 125, 135 mm). Collections of young-of-year sturgeon in the Yellowstone River occurred on July 29 (lengths = 31, 31, 39, 61 mm) and August 19 (length = 125 mm). Genetic analyses indicated that all individuals sampled in 2008 were shovelnose sturgeon (Bartron and Kalie 2010). Thus, no recruitment of pallid sturgeon to the young-of-year life stage was observed in 2008.

Table 13. Summary of trawling effort and catches of young-of-year sturgeon in the Missouri River above the confluence (MOR ATC), below the confluence (MOR BTC) and in the Yellowstone River during 2008.

Site	Sampling protocol	Metric	Jul 22-23	Jul 29-30	Aug 6-7	Aug 12-13	Aug 19-20	Aug 27-28	Sep 3-4	Sep 8-10
MOR ATC	Standard	Sturgeon	0	0	1	0	0	0	1	0
		Trawls	12	12	12	12	12	12	12	12
		Minutes	48	48	48	48.6	48	47.2	48	48
	Targeted	Sturgeon			0				0	
		Trawls			2				2	
		Minutes			8				8	
MOR BTC	Standard	Sturgeon	0	0	2	1	0	0	1	2
		Trawls	18	18	17	17	18	18	18	18
		Minutes	72	71.5	68	68	72	72	72.1	72
	Targeted	Sturgeon			4	0			1	0
		Trawls			4	2			4	4
		Minutes			16	8			16	16
Yellowstone	Standard	Sturgeon	0	2	0	0	1	0	0	0
		Trawls	12	12	12	12	12	12	11	12
		Minutes	48	46.7	48	48	48	48	44	48
	Targeted	Sturgeon		2			0			
		Trawls		6			2			
		Minutes		22.5			8			

Component 5 – Assisting in the collection of adult pallid sturgeon for the propagation program.

Personnel from the Fort Peck Flow Modification project participated in pallid sturgeon broodstock collection activities during spring 2008. Pallid sturgeon sampled during spring 2007 were sexed and staged by hatchery personnel and reproductive physiology experts, and either transported to hatcheries or returned to the river based on sexual state and need. Collection records were submitted to the USFWS Bismarck office for inclusion in the pallid sturgeon database.

Acknowledgments

Funding for this project was provided by the U. S. Army Corps of Engineers (Omaha District, John Palensky, Project Manager). Thanks are extended to Fort Peck Flow Modification personnel (Brady Miller, Ross Kastet, Mike Ruggles, Christina Talley, Brad Tribby) and personnel associated with the Pallid Sturgeon Population Assessment Program (Scott Geda, Tyler Haddix, Landon Holte, John Hunziker, Landon Johnson, Robert Lipscomb) who provided periodic assistance. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U. S. Government.

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