Fort Peck Flow Modification Biological Data Collection Plan
Summary of 2009 Activities

Patrick J. Braaten
U. S. Geological Survey
Columbia Environmental Research Center
Fort Peck Project Office
Fort Peck, Montana 59223

David B. Fuller and Ryan D. Lott
Montana Fish, Wildlife and Parks
Fort Peck, Montana 59223

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Extended Summary

The Fort Peck Flow Modification Biological Data Collection Plan is a multi-year multi-component research and monitoring study designed to evaluate the influence of proposed flow and water temperature enhancements from Fort Peck Dam on habitat conditions and biological response of pallid sturgeon *Scaphirhynchus albus* and other native fishes. As originally outlined in the Missouri River Biological Opinion, proposed flow modifications included releasing warm water from Fort Peck Reservoir through the spillway to increase discharge and water temperature in the river downstream from the dam. Research and monitoring components of the project during 2009 included: 1) assessing water temperature and turbidity regimes in the Missouri River, tributaries and off-channel areas, 2) examining movements and migrations of pallid sturgeon, shovelnose sturgeon *Scaphirhynchus platorynchus*, blue suckers *Cycleptus elongatus*, and paddlefish *Polyodon spathula,* 3) quantifying larval fish distribution and abundance, 4) assessing the reproductive success of pallid sturgeon and shovelnose sturgeon based on catches of young-of-year sturgeon, and 5) assisting in the collection of adult pallid sturgeon for the pallid sturgeon propagation and augmentation program. The project was initiated in 2001, and has been jointly implemented each year by Montana Fish, Wildlife and Parks and the U. S. Geological Survey Columbia Environmental Research Center.

Proposed flow modifications were originally planned for 2001 or the first year that reservoir elevation and runoff criteria provided adequate conditions for release of reservoir water through the spillway. However, since inception of the project, low water levels in Fort Peck Reservoir have precluded implementation of spillway releases. Thus, similar to 2001-2008, data obtained under the Fort Peck Project during 2009 are representative of physical and biological characteristics under existing environmental conditions in the absence of modified dam operations.

Under Component 1, water temperature in the mainstem Missouri River was warmest (mean = 18.4°C, maximum = 25.4°C) at Fred Robinson Bridge in the free-flowing river section upstream from Fort Peck Reservoir and coolest at the site downstream from Fort Peck Dam (mean = 11.3°C, maximum = 13.6°C). Thus, impoundment and hypolimnetic releases through the dam suppressed mean water temperature by 7.1°C and maximum temperature by 11.8°C. Water temperature warmed gradually as the river flowed 280-km downstream from the dam, but mean (17.5°C) and maximum (23.7°C) temperatures remained 0.9°C and 1.7°C cooler, respectively, than temperatures in the free-flowing river upstream from Fort Peck Reservoir. The Missouri River Biological Opinion specified that releases of warm water through the spillway were targeted to provide a minimum temperature of 18°C at Frazer Rapids downstream from the dam. Lacking spillway releases in 2009, water temperature remained cool at Frazer Rapids as mean temperature was 12.6°C and maximum temperature only reached 14.8°C. Turbidity in the Missouri River progressively increased as downstream distance from the dam increased, but tended to be greater in the Yellowstone River.

For 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 434 relocations of blue suckers, 200 relocations of shovelnose sturgeon, and 872 relocations of pallid sturgeon. Species-specific information on locations and movement patterns are presented. In the spring, 11 new pallid sturgeon were implanted with transmitters. These individuals, added

to the existing population of implanted fish, will be relocated during the next year to ascertain discharge and temperature-related movement patterns and aggregations.

Under Component 3, a total of 1,100 larval fish samples were collected between late-May and early August from the Milk River, Missouri River at Frazer Rapids and Wolf Point, and Yellowstone River. Nearly 2,000 larval fishes representative of eight families (Acipenseridae, Catostomidae, Cyprinidae, Hiodontidae, Percidae, Polyodontidae, Salmonidae, Sciaenidae) were sampled, but family representation was greatest (N = 7) in the Missouri River at Wolf Point. Larval sturgeons and paddlefish were not sampled in the Milk River or Missouri River at Frazer Rapids during 2009. One sturgeon larvae and six paddlefish larvae were sampled in the Missouri River at Wolf Point. Samples from the Yellowstone River yielded 40 sturgeon larvae and 151 paddlefish larvae.

Under Component 4, 358 trawls targeting young-of-year pallid sturgeon and shovelnose sturgeon were deployed among sites in the Yellowstone River and Missouri River above and below the Yellowstone River confluence. During the mid-July through early September sampling period, a total of 11 young-of-year sturgeon were collected and genetic testing indicated that all young sturgeon were shovelnose sturgeon. One individual was sampled from the Missouri River upstream from the Yellowstone River confluence, and ten young shovelnose sturgeon were sampled from the Missouri River downstream from the Yellowstone River confluence. No young sturgeon were sampled from the Yellowstone River. Similar to earlier years of the Fort Peck Project, there was no evidence of successful recruitment for pallid sturgeon.

For component 5, personnel associated with the Fort Peck project assisted in collecting adult pallid sturgeon for the propagation and augmentation program. Greater than 450 trammel net drifts were deployed during spring 2009 in the Missouri River and lower Yellowstone River during spring 2009. Efforts resulted in the collection of several pallid sturgeon that were sexed and staged, and transported to hatcheries.

Introduction

A section of the upper Missouri River basin including the Missouri River from Fort Peck Dam to Lake Sakakawea and the lower Yellowstone River contains a remnant population of federally endangered pallid sturgeon *Scaphirhynchus albus*. The size structure of this wild population is skewed almost exclusively towards large (> 1000 mm; USFWS 2007) and presumably old individuals. The lack of small size classes in the population coupled with the finding that wild-produced young pallid sturgeon have not been documented for several years in this section of the Missouri River basin (e.g., Braaten et al. 2007, 2008, 2010a; Haddix et al. 2010; Wilson et al. 2010) suggests that natural spawning and recruitment are extremely limited or nonexistent (USFWS 2007).

The Missouri River Biological Opinion (USFWS 2000) formally identified that operations of mainstem dams on the Missouri River diminish suitability of river reaches for pallid sturgeon. For the Missouri River below Fort Peck Dam, regulated flows in conjunction with hypolimnetic releases of cold water through the dam are hypothesized to severely diminish suitability of this portion of the Missouri River for pallid sturgeon spawning and recruitment (USFWS 2000). 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 environmental 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. A mini-test of the flow modifications was proposed for 2001 (or first year that reservoir elevation and runoff criteria could be met) for the purpose of evaluating structural integrity of the spillway and other engineering concerns, and obtaining information on discharge-temperature relationships resulting from various combinations of powerhouse releases and spillway releases (USFWS 2000; USACE 2004). A full-test of the flow modifications was projected to occur after the mini-test when a maximum discharge of 537.7 m^3/s (19,000 ft^3/s) was to be released through the spillway USFWS 2000). 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.

As part of Reasonable and Prudent Alternative II. B. in the Missouri River Biological Opinion (USFWS 2000), the Fort Peck Flow Modification Biological Data Collection Plan was designed in 2001 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. The Fort Peck Data Collection Plan is funded by the U. S. Army Corps of Engineers, and has been jointly implemented since 2001 by Montana Fish, Wildlife, and Parks and the U. S. Geological Survey Columbia Environmental Research Center – Fort Peck Project Office. Similar to previous years of the project (see Braaten and Fuller 2002, 2003, 2004, 2005, 2006; Braaten et al. 2007, 2008, 2010a), primary activities of the multi-year Fort Peck Data Collection Plan during 2009 included: 1) assessing water temperature and turbidity regimes in the Missouri River, tributaries and off-channel areas, 2) examining movements and migrations of pallid sturgeon, shovelnose sturgeon *Scaphirhynchus platorynchus*, blue suckers *Cycleptus elongatus*, and paddlefish *Polyodon spathula*, 3) quantifying larval fish distribution and abundance, 4) assessing the reproductive success of pallid sturgeon and shovelnose sturgeon based on catches of young-of-year sturgeon, and 5) assisting in the collection of adult pallid sturgeon for the pallid sturgeon propagation and augmentation program. Insufficient water levels in Fort Peck Reservoir during 2001 - 2009 precluded conducting the mini-test and full-test 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 nine years of this study represent baseline conditions under existing dam operations.

Study Area

The Missouri River study area extended from Fort Peck Dam located at river kilometer (rkm) 2,850 downstream to rkm 2,500 (near Williston, North Dakota; Figure 1). The study area also included about the lower 30 km of the Yellowstone River (up to the North Dakota/Montana state line) and lower 5.0 km of the Milk 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.

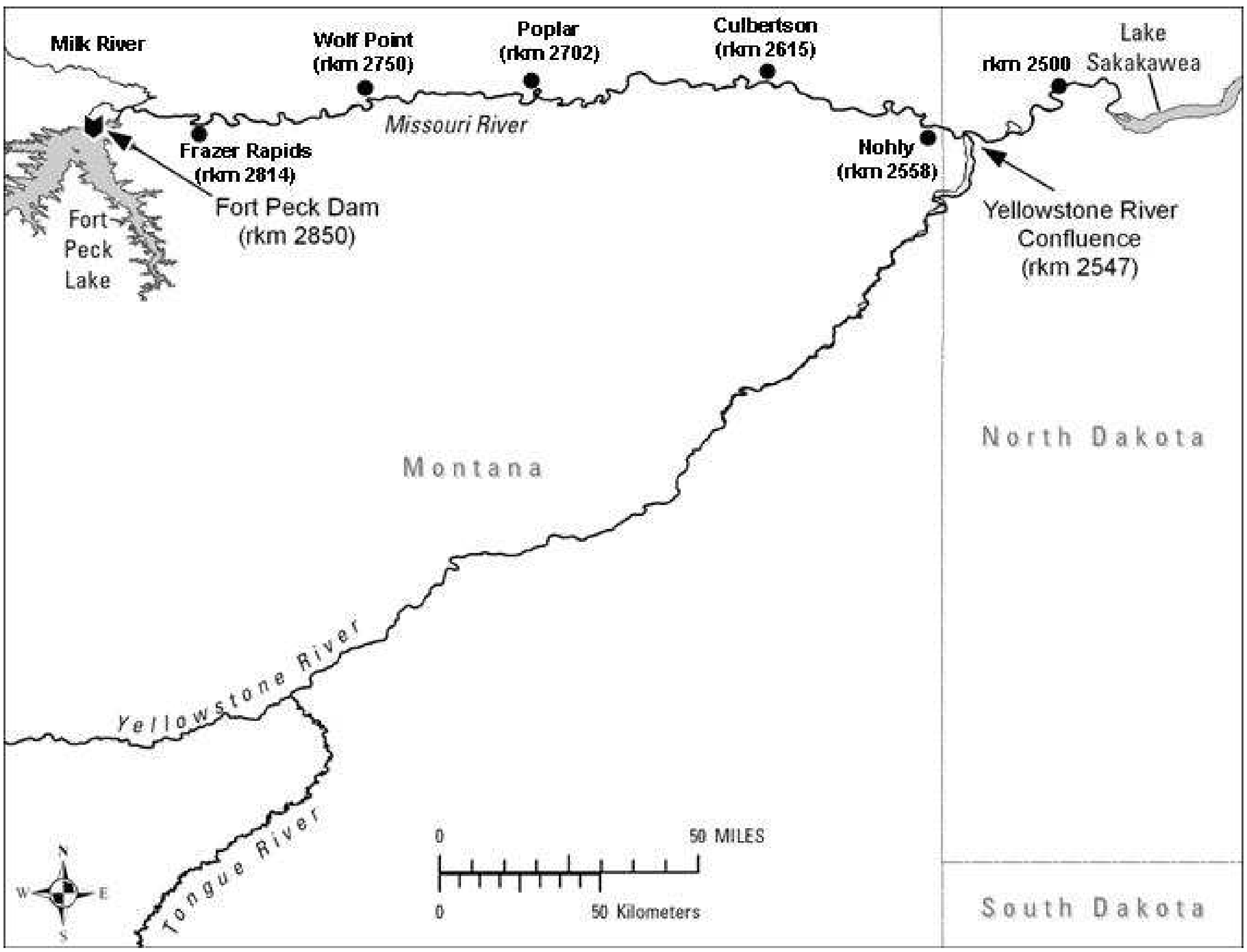

Figure 1. Study area of the Missouri River and lower Yellowstone River.

Methods

Component 1 – Water temperature and turbidity

Continuous logging of water temperature.- Water temperature loggers (Onset computer Corporation, HOBO Water Temp Pro v2, operation range -20 to 70^oC, 5 min response time, accuracy ± 0.2^oC) were deployed at 18 locations (31 total loggers) in the Missouri River, tributaries, and off-channel areas between April and October 2009 (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. Duplicate loggers were placed at the same location in the Milk River and in the spillway channel to safeguard against loss of data for the sites in the event that one logger malfunctioned during deployment.

Continuous logging of turbidity.- Turbidity loggers (HydroLab DataSonde 4a, measurement range 0-1000 NTU, accuracy ± 2%) were deployed from June through August 2009 in the Missouri River near Frazer Rapids (rkm 2814), Poplar (rkm 2705) and Nohly (rkm 2562), and in the Yellowstone River (rkm 1.0). Turbidity loggers were programmed to record turbidity (nephelometric turbidity units, NTU) and temperature (^oC) at 1-hr intervals during the deployment period. The loggers were shipped to the factory prior to deployment in 2009 for cleaning and calibration.

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 (MR) or adjacent areas during 2009. NR = logger not recovered.

Site	Rkm	Bank location	Latitude	Longitude	Logger serial #	Deploy date	Retrieve date
MR at Robinson Bridge	3093				1106513	4/21	10/15
Fort Peck Lake					1101902	5/7	NR
MR downstream	2841	North	48.05559	106.36459	1101884	5/7	10/29
from Fort Peck Dam	2842	South	48.06222	106.37862	1101881	5/7	10/29
Spillway	0.4		48.03995	106.34098	1101883	5/15	10/29
					1101865	5/15	10/29
Milk River	3.0		48.06748	106.30337	1101872	5/7	10/29
					1101897	5/7	10/29
MR at Nickels Ferry	2832	North	48.04527	106.28727	1101911	5/7	10/29
	2832	South	48.04454	106.28636	1101871	5/7	10/29
MR at Nickels	2829	North	48.03429	106.24839	1101899	5/7	10/29
Rapids	2829	South	48.03540	106.25504	1101889	5/7	10/29
MR at Frazer Pump	2819	North	48.03093	106.12473	1101874	5/15	10/29
	2819	South	48.03034	106.12681	1101880	5/15	10/29
MR at Frazer Rapids	2814	North	48.00731	106.12961	1101900	5/15	10/29
	2814	South	48.00637	106.12880	1101863	5/15	10/29
MR at Grand	2808	North	48.03457	106.08562	1101885	5/15	10/29
Champs	2808	South	48.03450	106.08299	1101887	5/15	10/29
MR at Wolf Point	2738	North	48.08146	105.52082	1101913	5/18	10/21
	2738	South	48.07971	105.52000	1101901	5/18	10/21
Poplar River	1.0		48.08381	105.19495	1101908	5/18	10/21
MR at Poplar	2705	North	48.06623	105.20726	1101870	5/18	10/21
	2705	South	48.06263	105.21551	1101906	5/18	10/21
MR at Culbertson	2605	North	48.09702	104.44346	1101876	5/18	10/21
	2603	South	48.09068	104.43346	1101891	5/18	10/21
MR at Nohly	2562	North	48.02232	104.09602	1101875	5/5	10/21
	2560	South	48.01112	104.10790	1101860	5/5	10/21
Yellowstone River	4.0		47.94926	103.96240	1101862	5/5	10/22
MR below	2537	North	47.96307	103.89116	1101873	5/5	10/22
Yellowstone River	2537	South	47.95876	103.89571	1101866	5/5	10/22
MR near Williston	2500		48.10437	103.72582	1101896	5/14	10/22

Component 2 – 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 2009. The Missouri River between Fort Peck Dam and the Highway 85 bridge near Williston, N.D. (350 km) and the Yellowstone River from its confluence with the Missouri River to the Montana/North Dakota state border (27 km) was tracked bi-weekly from April through July, and monthly from August through October. Two radio frequencies (149.760 MHz, 149.620 MHz) were simultaneously monitored during the boat-tracking run using two 4-element Yagi antennae. Several variables (e.g, radio frequency, fish code, latitude, longitude, time-of-day) were recorded at fish locations.

Stationary telemetry logging stations.- Stationary telemetry logging stations were deployed in April 2009 at seven sites including four sites on the Missouri River (Nickels, rkm 2,828; near Wolf Point, rkm 2,755; near Culbertson, rkm 2,603; Erickson Island below the Yellowstone River confluence, rkm 2,533), one site on the Milk River (rkm 4.0), and two sites on the Yellowstone River (Fairview, rkm 8.0; Montana/North Dakota border, rkm 26.0). Two additional logging stations (Missouri River at rkm 2,533 just upstream from the Yellowstone River confluence; Yellowstone River confluence station at rkm 1.0) 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. Coupled with manual tracking efforts, the array of telemetry logging stations facilitated detection of dates and times of movement events between and within rivers.

Transmitter implantation.- 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. Fish were 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 date 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 (350 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).

Component 3 – Distribution and abundance of larval fish

Sampling sites and protocols.- Larval fish sampling in 2009 was focused towards increasing the likelihood of collecting acipenseriform larvae (sturgeons and paddlefish), increasing the numbers of acipenseriform larvae collected, and providing more refined information on spawning and hatch locations of acipenseriform fishes. Four sampling sites were designated (Table 2). The first sample site was located in the Milk River, and specific sampling locations were similar to previous years of the Fort Peck project. The second sample site was located in the Missouri River near Frazer Rapids (hereafter Frazer Rapids site), and included a river bend upstream from the rapids, the bed immediately downstream from the rapids, and a river bend downstream from the rapids. The Frazer Rapids site had not been sampled in earlier years of the Fort Peck project. The third sample site was located near Wolf Point, and included five river bends sampled in previous years in addition to five downstream river bends that had not been sampled in previous years. The fourth larval fish sampling site encompassed the lower-most 13 km of the Yellowstone River including four replicates (lower portion of the sampling reach) that had been sampled in previous years of the Fort Peck project and six replicates (upper portion of the sampling reach) that had not been sampled in earlier years.

Larval fish at all sites were sampled on the outside bend in the thalweg where concentrations of drifting free embryos are greatest (Braaten et al. 2010b). Sampling was conducted with a pair of rectangular nets (0.75-m width, 0.5-m height, 1000 µm mesh). One net was fished from the port and starboard sides of the boat. Three to 10 replicates were sampled at each site (Table 2), where one replicate was comprised of two nets fished simultaneously for a maximum of 10 minutes. After anchoring at the predetermined sampling site, nets were deployed to the bottom and maintained at the bottom location using lead weights attached to the net frame. Sampling in the Milk River deviated from the typical bottom-sampling and anchoring protocol due to low velocities, irregular bottom contours, and shallow depths. Sampling in the Milk River consisted of deploying the nets to the upper 0.5-1.0-m of the water column and powering the boat slowly upstream using the boat motor. Nets were fitted with a General Oceanics Model 2030R flow meter from which sampling velocity and volume of water sampled could be estimated.

After sampling was completed, net contents were transferred to black rubber trays where acipenseriform larvae (white or light gray in appearance) and eggs (grey or mottled black-grey in appearance) were extracted from the detritus. Extracted acipenseriform larvae and eggs were placed immediately in 95% non-denatured ethanol for genetic analysis. After extracting acipenseriform larvae and eggs, samples from the Milk River and Frazer Rapids and Wolf Point sites on the Missouri River were placed in a 10% formalin solution containing phloxine-B dye. The samples were returned to the laboratory where all larval fish and eggs were extracted, larvae were identified, and larvae and eggs were enumerated. Larval fish samples were expressed as number of larvae/100 m^3.

Table 2. Larval fish sampling locations (rkm = km upstream from the mouth of a tributary or from the mouth of the Missouri River near St. Louis, Missouri), number of replicates, subsamples per replicate, and net locations for 2009 sampling events. Net locations are abbreviated as follows: B = bottom, S = surface (0.5-1.0 m below the surface)

Site	Approximate rkm	Replicates	Subsamples per replicate	Net location
Milk River	0.4-5.0	5	2	S
Missouri River near Frazer Rapids	2,808-2,819	3	2	B
Missouri River near Wolf Point	2,732-2,750	10	2	B
Yellowstone River	0.7-12.7	10	2	B

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 2009 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. 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 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, 2010), 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 95% non-denatured ethanol for subsequent species identification based on genetic analysis. After fin clipping, the fish was placed in a 5-10% formalin solution.

Table 3. Young-of-year sturgeon trawling sites and approximate replicate locations (rkm = km upstream from the mouth of a tributary or from the mouth of the Missouri River near St. Louis, Missouri) for 2009 sampling events in the Missouri River above (ATC) and below (BTC) the Yellowstone River confluence, and in the Yellowstone River.

Site	Replicate	Approximate rkm
Missouri River ATC	1	2553
	2	2555
	3	2558
	4	2563
Missouri River BTC	1	2500
	2	2506
	3	2539
	4	2545
Yellowstone River	1	0.7
	2	1.8
	3	3.9
	4	8.0

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

During spring 2009, personnel associated with the Fort Peck Flow Modification Project assisted the USFWS in capturing adult pallid sturgeon for the propagation and augmentation program. Crews were involved in sampling the Missouri River and lower Yellowstone River. Pallid sturgeon were sexed and staged by hatchery personnel and reproductive physiology experts, and selected individuals were transported to state and federal hatcheries.

Results and Discussion

Hydrologic Conditions

The Milk River exhibited two periods of elevated flow conditions in 2009 as elevated discharge occurred in early April and during May (Figure 2). Following the late-May decline, discharge was relatively low from June through September. Median discharge in the Milk River during 2009 was 5.2 m^3/s, and this flow regime represented the second greatest median discharge level during the 2001-2009 period of the Fort Peck project. However, although median discharge was relatively high during 2009, maximum discharge was less than other years and the timing of maximum discharge in 2009 was earlier than most other years.

Discharge in the Missouri River at Wolf Point (cumulatively reflecting dam releases and upstream contributions from the Milk River) was low through April, increased and remained relatively steady through May as contributions from the Milk River augmented flows, then declined in June (Figure 2). During 2009, median discharge in the Missouri River at Wolf Point was 194 m^3/s. Median discharge during five years of the Fort Peck project (2002, 2003, 2004, 2006, 2008) exceeded conditions observed during 2009 and three years (2001, 2005, 2007) had lower discharges.

Flow conditions in the Yellowstone River during 2009 were the highest encountered during the 9-year Fort Peck project as median daily discharge was 359 m^3/s (Figure 2). Discharge exhibited an initial increase in late-May and high flows persisted through mid-June. A second period of high discharge occurred during late-June and persisted through mid-July. The 2009 flow regime in the Yellowstone River was similar to the pattern observed in 2008, except that peak discharge was slightly greater in 2008.

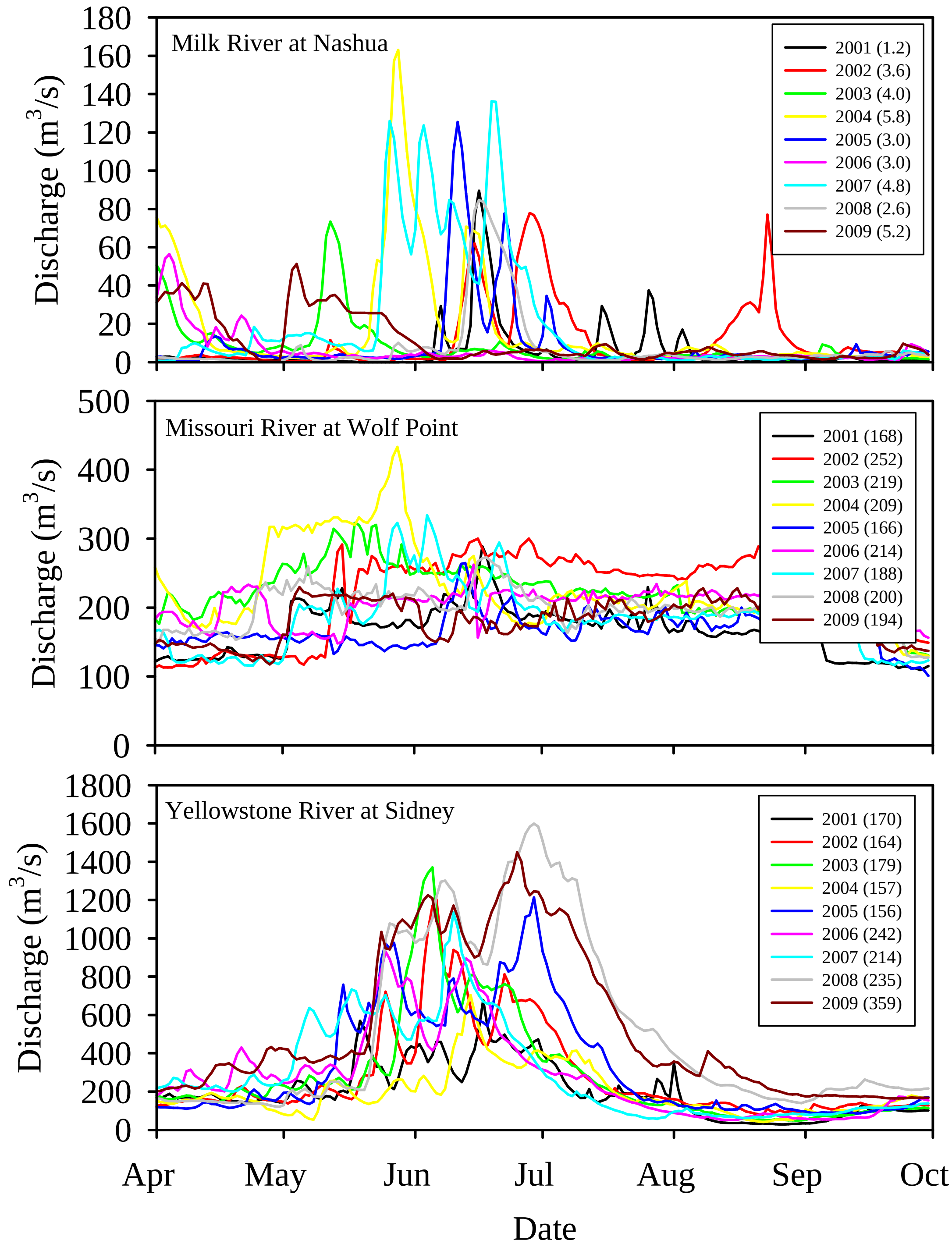

Figure 2. Mean daily discharge (m^3/s) in the Milk River at Nashua, Montana (gage 06174500), Missouri River at Wolf Point, Montana (06177000), and in the Yellowstone River at Sidney, Montana (gage 06329500) during 2001-2009. Values listed in parentheses represent median daily discharge between 1 April and 30 September.

Component 1 – Water temperature and turbidity

General comments.- Problems were encountered with a few temperature loggers deployed during 2009. The logger in Fort Peck Lake was not recovered. Temperature data from the north-bank logger at Nohly exhibited extreme daily variability during portions of July and August suggesting that the logger was likely out of water and periodically exposed to air temperatures. Therefore, data from the Nohly north logger was not used and data from only the Nohly south-bank logger were used to characterize temperatures at this location. Data from loggers deployed in the Poplar River and on the north bank of the Missouri River downstream from the Yellowstone River confluence were not used due to lack of daily variability suggesting that the loggers were buried in the sediments for a portion of the deployment period. Data from the Yellowstone River temperature logger was suspect as this logger exhibited periods of extreme daily variation and periods of little to no daily variation suggesting that the logger experienced periods of exposure to air temperatures and being buried in the sediments, respectively. Therefore, data from this logger were not used. However, daily water temperature data for the Yellowstone River were obtained from Fred Ryckman (North Dakota Game and Fish Department, Williston, ND).

Lateral comparisons of water temperature.- Comparisons of water temperature between north and south banks of the river were conducted for nine sites (Table 4). At the initial site downstream from Fort Peck Dam, water temperature differed significantly ($P < 0.0001$) between bank locations as water temperature was greater on the north (mean = 11.4^{o}C) than south bank of the river (mean = 10.4^{o}C). Downstream from the Milk River confluence, water temperature differed between bank locations at the Nickels Ferry ($P < 0.0001$) and Nickels Rapids ($P = 0.0172$) sites as water temperature was warmer on the north bank of the river. Inputs of warm water from the Milk River during periods of elevated discharge (Figure 2) combined with incomplete lateral mixing likely contributed to lateral differences in water temperature. At sites downstream from Nickels Rapids, mean daily water temperature was similar between bank locations (Table 4). Thus, under Milk River and Missouri River discharge conditions that occurred during 2009, lateral mixing was completed or nearly completed by the time water reached the Frazer Pump location. Water temperatures between lateral bank locations were similar at distant downstream sites (Wolf Point, Poplar, Culbertson) indicating homogeneous thermal conditions. Mean daily water temperature recorded by duplicate loggers positioned in the Milk River and spillway channel were not different (t-test, $P = 0.97$ and $P = 0.95$, respectively); therefore, data were averaged between loggers within each site to obtain a complete data series for both locations.

Table 4. 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 (°C) between water temperature loggers positioned on the north and south banks of the river during 2009.

Site	Logger location	Dates	Number of days	Mean	STD	Min.	Max.	T-test P-value
Below Fort Peck Dam	North	5/8-10/28	174	11.4	1.8	5.9	14.1	0.0001
	South			10.4	1.7	5.6	13.4	
Nickels Ferry	North	5/8-10/28	174	12.3	1.7	7.9	14.9	0.0001
	South			11.4	1.9	5.7	13.9	
Nickels Rapids	North	5/8-10/28	174	12.1	1.9	6.8	14.7	0.0172
	South			11.6	2.1	5.2	14.6	
Frazer Pump	North	5/16-10/28	166	12.4	2.0	6.4	15.0	0.680
	South			12.3	2.3	5.6	15.9	
Frazer Rapids	North	5/16-10/28	166	12.2	1.8	6.7	14.6	0.460
	South			12.4	2.1	5.8	15.0	
Grand Champs	North	5/16-10/28	166	12.4	2.1	6.0	15.2	0.628
	South			12.5	2.2	5.8	15.5	
Wolf Point	North	5/19-10/20	155	15.0	3.5	4.0	19.4	0.968
	South			15.0	3.4	4.4	19.2	
Poplar	North	5/19-10/20	155	15.6	4.0	2.8	20.7	0.919
	South			15.5	4.0	2.8	20.5	
Culbertson	North	5/19-10/20	155	16.9	4.8	2.7	23.1	0.984
	South			16.9	4.9	2.0	23.2	

Longitudinal water temperature patterns.- Water temperature during the 19 May to 15 October common-date deployment period varied among sites on the mainstem Missouri River, tributaries, and off-channel areas. For mainstem Missouri River sites, water temperature was warmest (mean = 18.4°C, maximum = 25.4°C) at Fred Robinson Bridge in the free-flowing river section upstream from Fort Peck reservoir and coolest at the site downstream from Fort Peck Dam (mean = 11.3°C, maximum = 13.6°C; Table 5, Figure 3). Thus, impoundment and hypolimnetic releases through the dam suppressed mean water temperature by 7.1°C and maximum temperature by 11.8°C. Water temperature warmed gradually in the 280-km reach between the dam and Nohly (most downstream site prior to receiving inputs from the Yellowstone River), but mean (17.5°C) and maximum (23.7°C) temperatures at Nohly remained 0.9°C and 1.7°C cooler, respectively, than temperatures in the river upstream from Fort Peck Dam (Table 5, Figure 3). These results indicate that thermal impacts of hypolimnetic releases through the dam remained evident several hundred km downstream. Warmest temperatures during the deployment period occurred in the Milk River (mean = 18.9°C, maximum = 24.8°C), and the Yellowstone River exhibited mean and maximum temperatures of 18.4°C and 24.9°C, respectively.

Table 5. Summary statistics for daily water temperature (^{o}C; mean, minimum, Min.; maximum, Max.; standard deviation, STD; coefficient of variation, CV; number of days, N) at sites in the mainstem Missouri River, off-channel areas and tributaries during 2009. Inclusive dates span from 19 May to 15 October. See Figure 3 for a graphical representation of mean daily data.

Location	Site	Mean	Min.	Max.	STD	CV	N
Mainstem Missouri River	Robinson Bridge	18.4	3.7	25.4	4.44	24.1	150
	Below Fort Peck Dam	11.3	7.9	13.6	1.4	12.6	150
	Nickels Ferry	12.2	7.8	14.3	1.5	12.3	150
	Nickels Rapids	12.3	6.0	14.4	1.7	14.1	150
	Frazer Pump	12.7	6.2	15.2	2.0	15.4	150
	Frazer Rapids	12.6	6.3	14.8	1.8	14.2	150
	Grand Champs	12.8	5.9	15.3	1.9	15.1	150
	Wolf Point	15.2	4.2	19.3	3.3	21.4	150
	Poplar	15.8	2.8	20.6	3.8	24.1	150
	Culbertson	17.3	2.4	23.2	4.5	26.2	150
	Nohly	17.5	1.7	23.7	4.8	27.4	150
	Below Yellowstone	18.0	2.6	24.7	4.8	26.5	150
	Hwy 85	18.2	3.8	24.6	4.4	24.1	150
Off-channel or tributary	Spillway	17.5	3.1	22.5	4.2	24.1	150
	Milk River	18.9	1.8	24.8	5.3	28.1	150
	Yellowstone River	18.4	3.1	24.9	4.8	26.1	150

Suppression of the thermal regime in association with regulated flows through Fort Peck Dam have been implicated as major factors impeding spawning and recruitment of pallid sturgeon in the Missouri River downstream from the dam (USFWS 2000). To enhance spawning and recruitment success for pallid sturgeon, releases of warm water from Fort Peck Dam through the spillway were proposed as a reasonable and prudent alternative in the Missouri River Biological Opinion (USFWS 2000). Releases of warm water were targeted to increase water temperature at Frazer Rapids to a minimum of 18^{o}C during late May and early June. During 2009, spillway releases were not conducted and water temperature remained cool at Frazer Rapids as mean temperature was 12.6^{o}C and maximum temperature only reached 14.8^{o}C (Table 5; Figure 3).

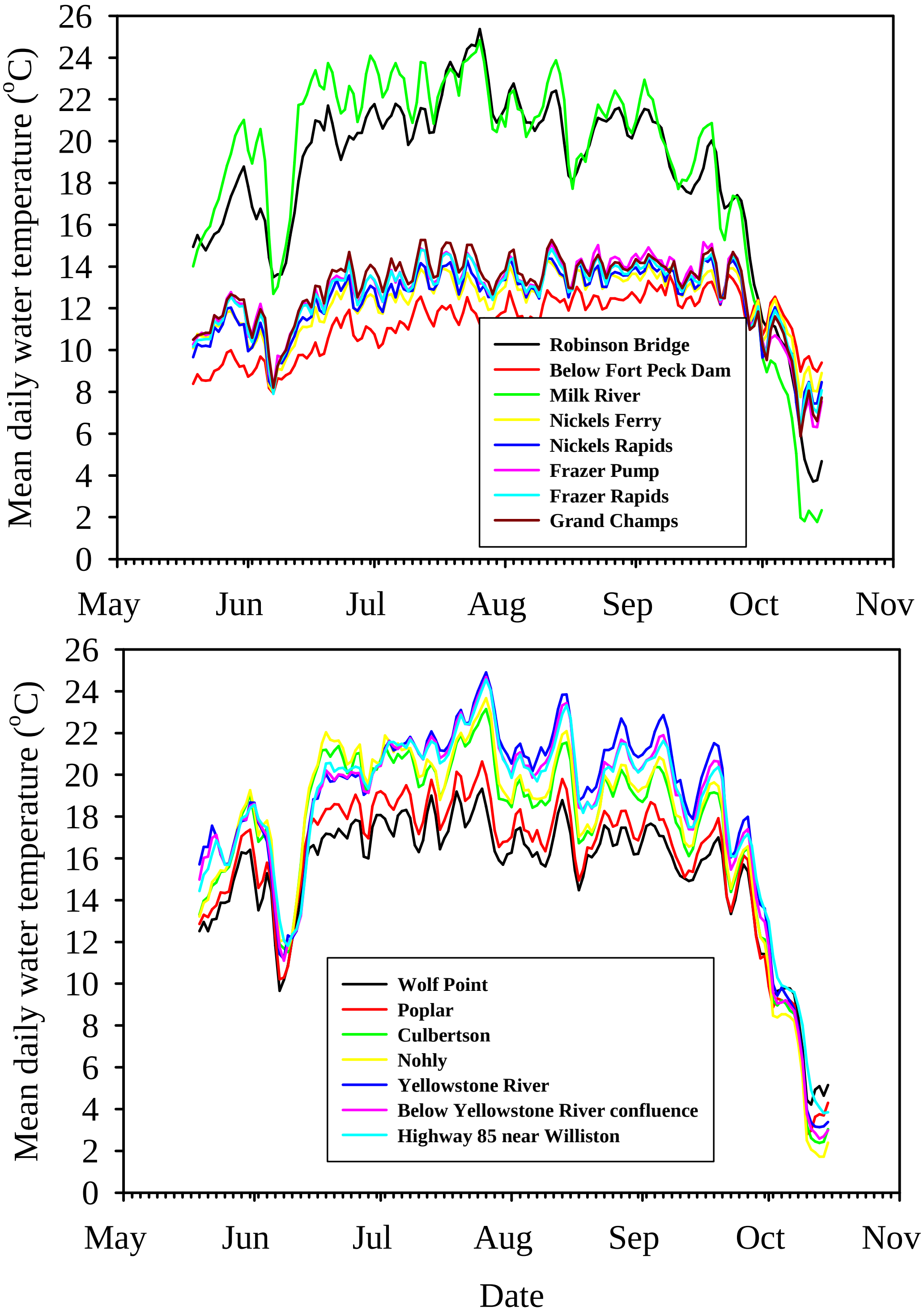

Figure 3. Mean daily water temperature (°C) at site on the mainstem Missouri River, tributaries, and off-channel areas during 2009.

Field measurements of turbidity.- Turbidity loggers deployed in the Missouri River at Frazer Rapids and Poplar malfunctioned during the deployment period and either recorded turbidity for a few days or not at all. Whereas the malfunction resulted in the lack of data for the Poplar site, instantaneous measurements of turbidity recorded at Frazer Rapids in conjunction with larval fish sampling provided data for at least a portion of the season (June – July). Turbidity loggers deployed in the Missouri River at Nohly and in the Yellowstone River recorded hourly turbidity from June through August. At Nohly, the 1000 NTU maximum limit of the logger was exceeded during at least one hourly measurement on two dates (14 July, 23 July). For the Yellowstone River, 1000 NTU was exceeded on 8-9 June, 14 July, and 11-12 August.

Statistical comparisons of turbidity among sites were not conducted due to different collection procedures and because the 1000 NTU limit of the loggers was exceeded at Nohly and in the Yellowstone River. Thus, only general trends in turbidity are summarized. Turbidity during 2009 was lowest at Frazer Rapids (June-July median = 7.8 NTU, minimum = 5.3, lower quartile = 6.6, upper quartile = 9.8, maximum = 14.3, N = 18 days), intermediate in the Missouri River at Nohly (median daily turbidity = 54.5 NTU, minimum = 18.6, lower quartile = 44.8, upper quartile = 97.3, maximum = 488.1, N = 91 days), and greatest in the Yellowstone River (median daily turbidity = 175.3 NTU, minimum = 22.5, lower quartile = 44.6, upper quartile = 321.1, maximum = 942.7, N = 91 days; Figure 4). In the Yellowstone River, periods of elevated turbidity tended to occur on rising limbs of the hydrograph (Figure 4). In early August, turbidity increased substantially as discharge increased only slightly; however, a large rainfall event (~ 2 cm on 7 August as recorded at Miles City, Montana; National Weather Service data) occurred in the lower Yellowstone River basin and runoff from this weather event may have contributed to elevated turbidities. Turbidity increases in the Missouri River at Frazer Rapids and Nohly also tended to follow periods of elevated discharge. Similar to the Yellowstone River, turbidity in the Missouri River at Nohly exhibited an increase during mid-August as rainfall in the Missouri River study area during mid-August 2009 (National Weather Service data) likely accounted for elevated turbidities during this time period.

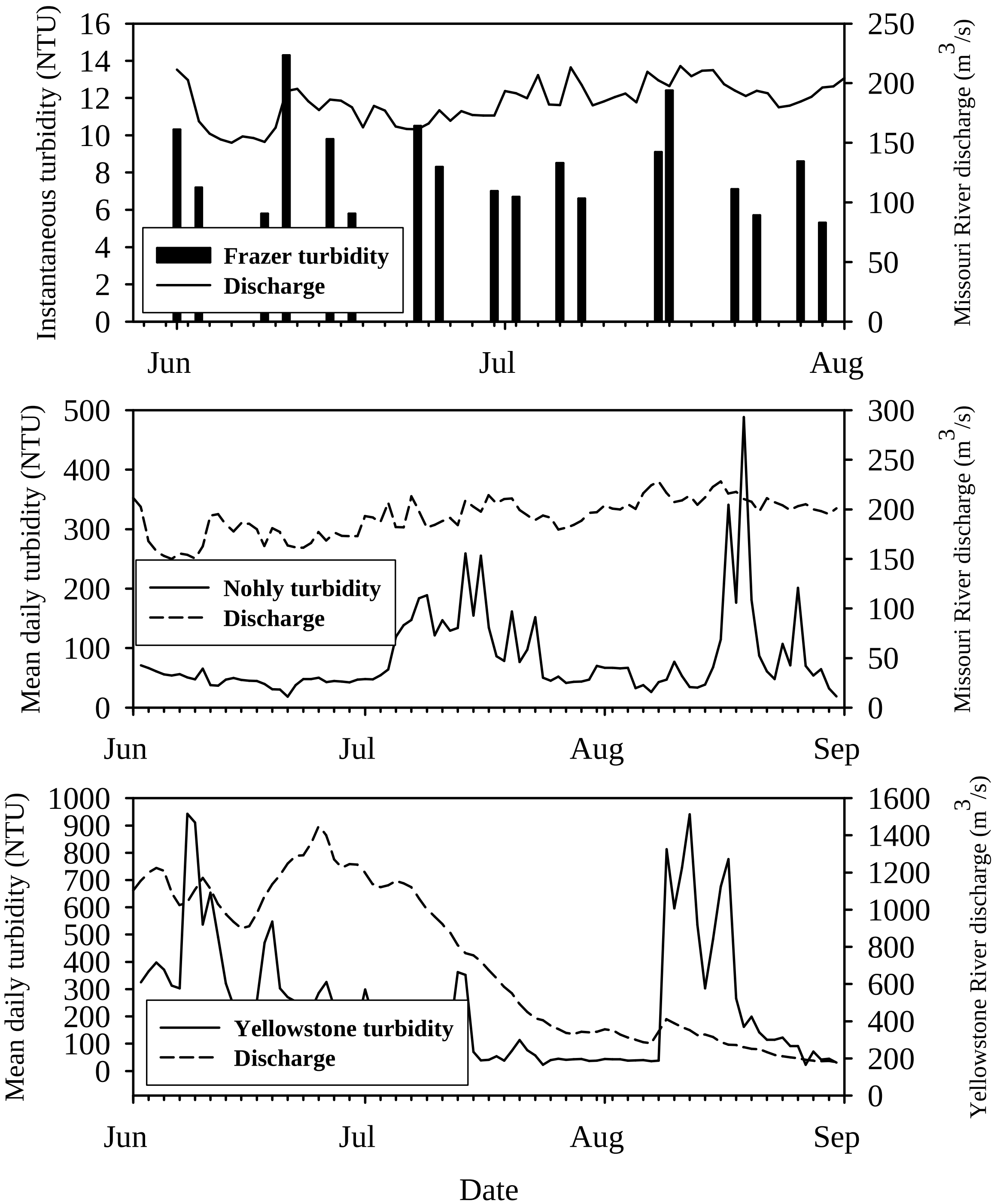

Figure 4. Turbidity (nephelometric turbidity units; NTU) and daily discharge (m^3/s) for sites on the Missouri River near Frazer Rapids (top panel) and Nohly (middle panel), and in the Yellowstone River (bottom panel) during 2009. Note that turbidity measurements for Frazer are instantaneous values (i.e., measured at one point in time); whereas, values for Nohly and the Yellowstone River are daily means (averaged over 24 hourly measurements). Note also that the ordinate and abscissa differ among graphs.

Component 2 – Movements of blue suckers, shovelnose sturgeon, paddlefish, and pallid sturgeon

Blue sucker relocations and movements.

The distribution and relative abundance of blue suckers (N = 28) varied among rivers through time (Figure 5). During April, 96 – 100% of blue suckers used 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 briefly declined to 46% in early May as fish moved from the Missouri River into the Milk River (see below). After numbers rebounded to 96% in early June, relative abundance in the Missouri River gradually declined through early August to 56% and remained stable until early September. Blue suckers gradually reentered the Missouri River through October and 96% of the implanted population was present in the Missouri River before tracking was terminated in November.

The occurrence of blue suckers in the Milk River (Figure 5) was dependant on discharge. From 1 – 9 May, the proportion of implanted blue suckers increased from 4% to 53% as Milk River discharge increased (> 28.3 m^3/s during 2 -15 May; Figure 2). By 19 May, less than 10% of blue suckers were using the Milk River.

Use of the Yellowstone River by radio-tagged blue suckers exhibited a distinct pattern among tracking periods (Figure 5). There were no blue suckers in the Yellowstone River through mid-May, but use steadily increased through June and July. The highest percentage of implanted blue suckers (43%) occurred in the Yellowstone River during August and early September. Individuals began emigrating out of the Yellowstone River in early September and continued their emigration through October. The decrease in relative abundance of blue suckers in the Yellowstone River during September occurred when discharge was low (Figure 2) and water temperature was high (Figure 3).

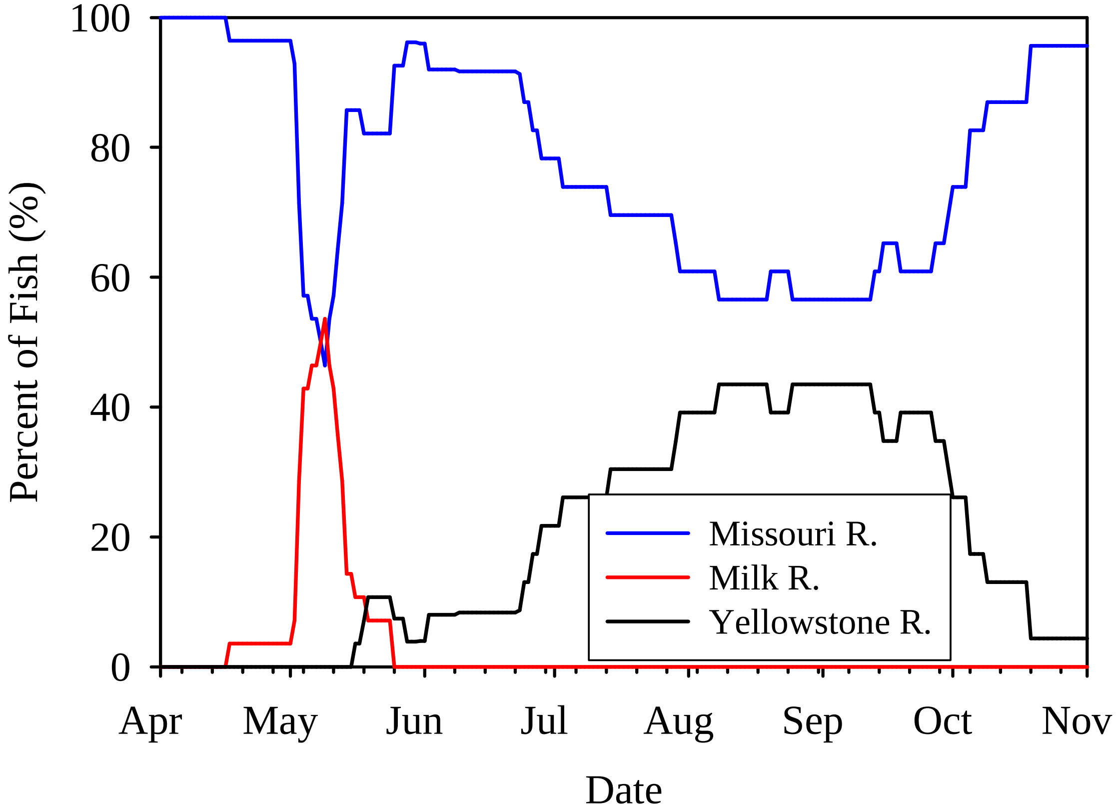

Figure 5. Percent (%) blue suckers relocated in the Missouri, Milk, and Yellowstone rivers in 2009 by date.

Shovelnose sturgeon relocations and movements.

Shovelnose sturgeon (N = 17) use of the upper Missouri River (Fort Peck Dam to Wolf Point) was relatively stable during 2009 (Figure 6). The percentage of relocations occurring in this reach varied between 29 – 35%.

The lower Missouri River (Wolf Point to the headwaters of Lake Sakakawea) is twice as long as the other two reaches. However, this reach tended to exhibit the lowest relative abundance of shovelnose sturgeon (Figure 6). No telemetered shovelnose sturgeon were found in this reach during most of June, July or August. A maximum of 41% of the relocations occurred in early October after several shovelnose sturgeon had emigrated from the Yellowstone River to the lower Missouri River reach.

At the outset of tracking in April, 58% of the implanted shovelnose sturgeon were located in the Yellowstone River (Figure 6). Shovelnose sturgeon relocations in the Yellowstone River increased to 70% in June. Relative abundance remained steady at 70% from June through late August, then declined to 29% for the remainder of the year.

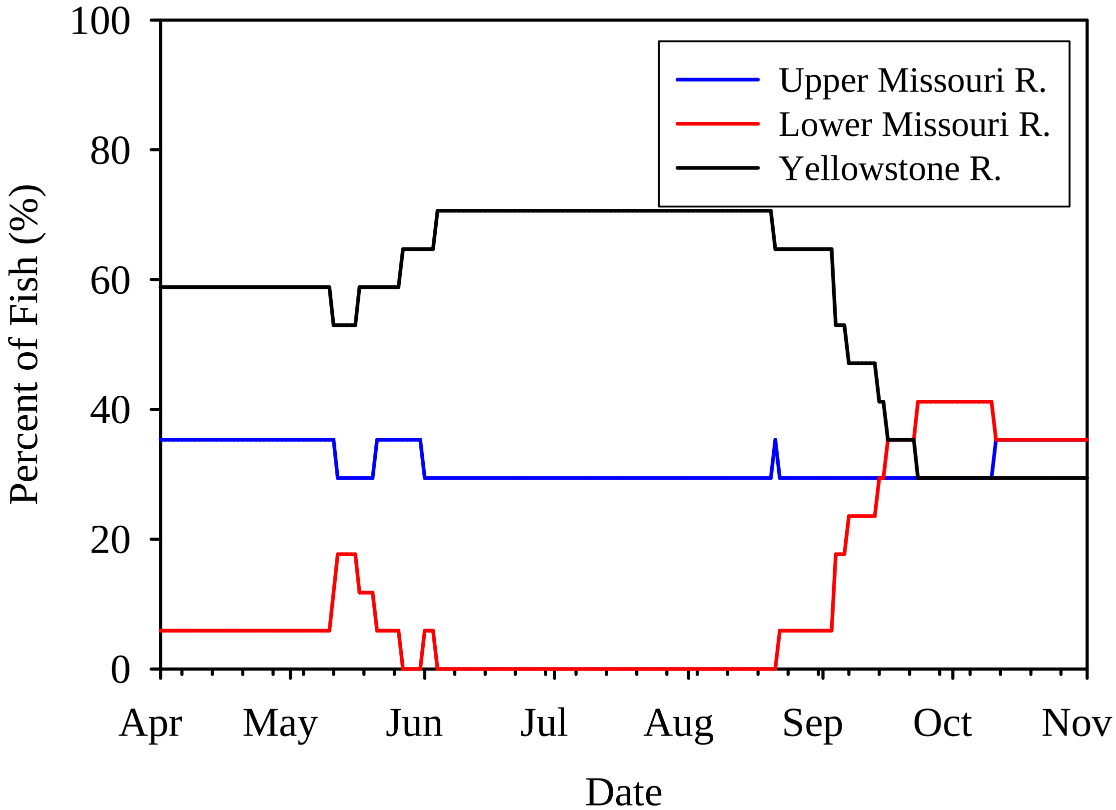

Figure 6. Percent (%) of shovelnose sturgeon relocated in the upper Missouri River (Fort Peck Dam to Wolf Point), lower Missouri River (Wolf Point to Williston), and Yellowstone River in 2009 by date.

Paddlefish relocations and movements

Transmitters that were implanted in paddlefish during the initial years of the Fort Peck project have expired. Therefore, analysis and presentation of paddlefish relocation and movement data will not be reported until the final report of the Fort Peck Flow Modification project.

Pallid Sturgeon relocations and movements

There were 33 pallid sturgeon with active transmitters at the onset of the 2009 field season. Throughout May and early June, 12 pallid sturgeon with transmitters (three gravid females, 9 males) were targeted for capture and removed from the study for propagation purposes. Thus, these fish provided movement information for only the early portion of the tracking season (i.e., migration into the Yellowstone River). Pallid sturgeon removed from the wild and taken to the hatchery they were omitted from the study for the remainder of the year. Although the removed fish were returned to the river, their relocations were not used in the data set due to potential bias associated with handling at the hatchery, transport, and subsequent release location. Thus, 21 pallid sturgeon remained to ascertain immigration and emigration patterns for the entire year. An additional 11 pallid sturgeon were implanted during late April and early May from the lower Yellowstone River, ND. Although these fish could not be used to determine time of immigration into the Yellowstone River during 2009, they did provide information on seasonal movements for the remainder of the year.

Use of the Missouri River above the confluence (ATC) by pallid sturgeon was highest (19%) in early spring (Figure 7). There were no individuals in this reach from late May through early June. Use gradually increased in mid-June and remained around 15% for the remainder of the season.

At the end of the 2008 tracking season, only 5% of the implanted population of pallid sturgeon was using the Yellowstone River (Figure 7). By April 2009, approximately 55% of the population had already migrated into the Yellowstone River. In general, there was inverse pattern for pallid sturgeon between the Yellowstone River and the reach of the Missouri River below the confluence (BTC; Figure 7). Pallid sturgeon use of the Missouri River BTC declined though early May 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 below the confluence through the end of the tracking season.

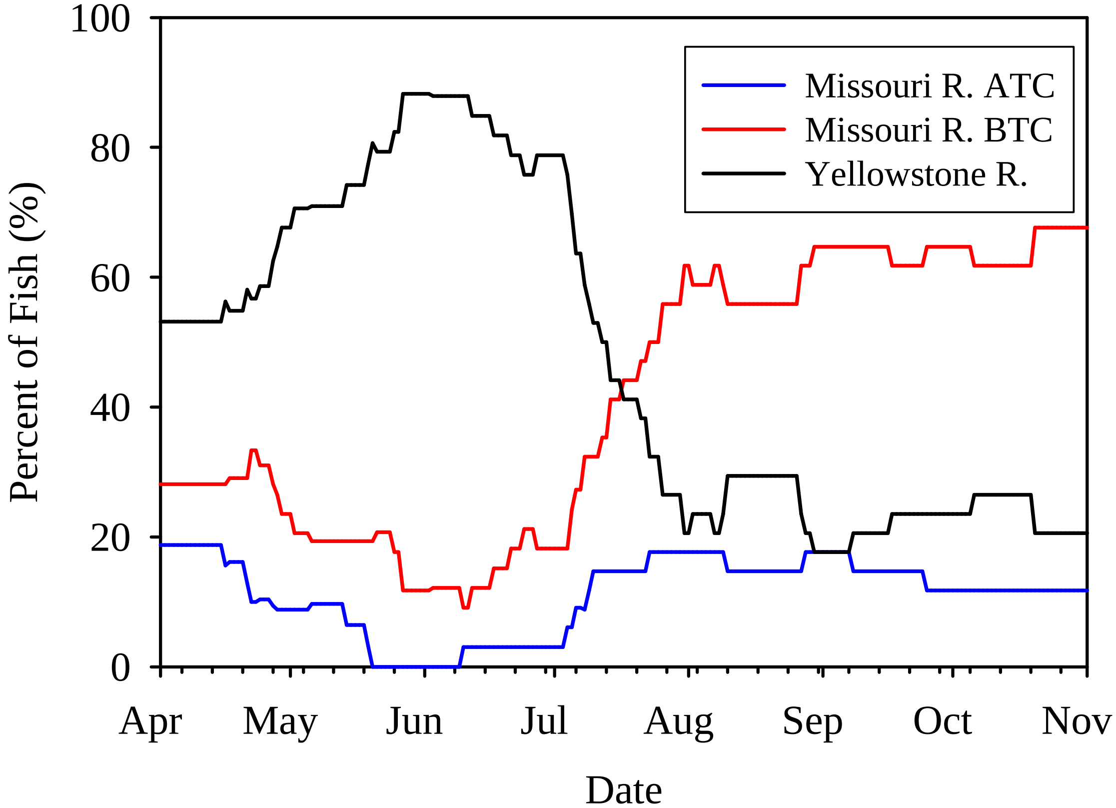

Figure 7. Percent (%) of pallid sturgeon relocated in the Yellowstone River and Missouri River above (ATC) and below (BTC) the Yellowstone River confluence in 2009.

Component 3 – Distribution and Abundance of Larval Fish

A total of 1,100 larval fish samples were collected on 20 (Milk River, Missouri River near Frazer, Yellowstone River) and 21 (Missouri River near Wolf Point) sampling events between 27 May and 5 August 2009. The mean volume of water filtered per subsample was 200 m^3 in the Milk River (total volume = 33,260 m^3, N = 166 samples), 101 m^3 in the Missouri River at Frazer (total volume = 12,101 m^3, N = 120 samples), 162 m^3 in the Missouri River at Wolf Point (total volume = 67,065 m^3, N = 414 samples), and 131 m^3 in the Yellowstone River (total volume = 52,515 m^3, N = 400 samples).

Relative abundance of larval fishes.- Composition of the larval fish catch varied among sampling locations during 2009 (Table 6). Four taxa were identified from nearly 1,300 larvae sampled in the Milk River as cyprinids were numerically dominant (72.4%), followed by catostomids (26.3%), goldeye (family Hiodontidae, 0.2%), and freshwater drum (family Sciaenidae (0.2%). Whereas paddlefish (family Polyodontidae) have been sampled in the Milk River during past years, paddlefish were absent from collections in 2009. Larval sturgeon were not collected in the Milk River during 2009, and this result is similar to all years of the Fort Peck project.

Four taxa were identified from the 111 larvae collected at Frazer Rapids with catostomids composing 82.0% of the catch, cyprinids 10.8%, percids 2.7%, and salmonids 0.9% (Table 6). Although the total number of larvae collected at Frazer Rapids was low in comparison to other sites, sampling effort (replicates and subsamples) was also lower in comparison to other sites.

Sampling in the Missouri River at Wolf Point yielded 368 larvae representative of seven taxa (Table 6). Composition of the catch included catostomids (71.7%), percids (17.1%), salmonids (4.9%), cyprinids (3.8%), paddlefish (1.6%), freshwater drum (0.3%), and sturgeon (0.3%). Differences in the catch composition between the Frazer Rapids and Wolf Point sites yielded important insight into the spawning dynamics of paddlefish and sturgeon. Specifically, the finding that larval paddlefish and sturgeon were not collected at the Frazer Rapids sites but were collected at Wolf Point sites provides evidence that spawning and hatch sites for these species were located downstream from Frazer Rapids in 2009.

In the Yellowstone River, only sturgeon and paddlefish were retained from the larval fish collections. From these efforts, 40 larval sturgeon and 151 larval paddlefish were collected in addition to 203 acipenseriform eggs (Table 6).

Table 6. Number and frequency (%) of larval fishes by taxon, and numbers of juveniles, adults and eggs sampled at four sites during 2009. For the Yellowstone, only larval Acipenseridae, Polyodontidae, and Acipenseriform eggs were extracted from detritus in the field; other taxa were not kept and identified in the laboratory.

	Milk River		Missouri River at Frazer		Missouri River at Wolf Point		Yellowstone River
Taxon	N	%	N	%	N	%	N
Acipenseridae					1	0.3	40
Catostomidae	340	26.3	91	82.0	264	71.7	
Cyprinidae	936	72.4	12	10.8	14	3.8	
Hiodontidae	3	0.2					
Percidae			3	2.7	63	17.1	
Polyodontidae					6	1.6	151
Salmonidae			1	0.9	18	4.9	
Sciaenidae	3	0.2			1	0.3	
Unknown larvae	10	0.8	4	3.6	1	0.3	
Total larvae	1,292		111		368		
Juveniles	1,669						
Adults	60				1		
Acipenseriform eggs							203
Other eggs	450		1,714		5,240		

Spatial and temporal periodicity and densities of larval shovelnose sturgeon and paddlefish.- All larval *Scaphirhynchus* sp. sampled in the Missouri River and Yellowstone River during 2009 were genetically identified as shovelnose sturgeon (Bartron and Kalie 2010). Sampling in the Missouri River at Wolf Point during 2009 yielded few larval shovelnose sturgeon and paddlefish (Table 7). Only one larval shovelnose sturgeon was collected, and this individual was sampled on 16 July. Paddlefish larvae were sampled on four dates as larvae in the drift initially occurred on 13 July (N = 3), and one larvae was collected on each of three dates (20, 23, 27 July).

Table 7. Number (N) of larval shovelnose sturgeon and paddlefish, and mean (median), minimum (min.) and maximum densities (number/100 m^3) sampled by date in the Missouri River at Wolf Point during 2009.

	Shovelnose sturgeon				Paddlefish			
Date	N	Mean (median)	Min.	Max.	N	Mean (median)	Min.	Max.
5/27								
6/2								
6/4								
6/8								
6/10								
6/15								
6/18								
6/22								
6/24								
6/29								
7/1								
7/7								
7/9								
7/13					3	0.09 (0)	0	0.33
7/16	1	0.03 (0)	0	0.34				
7/20					1	0.03 (0)	0	0.29
7/23					1	0.04 (0)	0	0.42
7/27					1	0.03 (0)	0	0.30
7/29								
8/3								
8/5								

In the Yellowstone River, 40 larval shovelnose sturgeon were sampled between 25 June and 4 August 2009 (Table 8). However, 85% (N = 34) of the larval shovelnose sturgeon were collected in about a 1-week time period between 15 July and 23 July and densities were greatest on 23 July (mean = 0.53 larvae/100 m^3). Larval paddlefish (total N = 151) exhibited a protracted period of occurrence in the drift as larvae were collected between 2 June and 23 July. Densities of larval paddlefish were greatest on 16 June (mean = 1.80 larvae/100 m^3), but densities were also elevated in early July (Table 8).

Table 8. Number (N) of larval shovelnose and paddlefish, and mean (median), minimum (min.) and maximum densities (number/100 m^3) sampled by date in the Yellowstone River during 2009.

	Shovelnose sturgeon				Paddlefish			
Date	N	Mean (median)	Min.	Max.	N	Mean (median)	Min.	Max.
5/27								
6/2					5	0.19 (0)	0	0.80
6/4					3	0.12 (0)	0	0.76
6/9					12	0.41 (0)	0	2.53
6/11					3	0.11 (0)	0	0.46
6/16					40	1.80 (1.56)	0	5.84
6/18					11	0.49 (0.47)	0	1.39
6/23					10	0.57 (0.23)	0	2.02
6/25	2	0.12 (0)	0	0.70	6	0.20 (0.10)	0	0.72
6/30	1	0.04 (0)	0	0.35	8	0.30 (0.17)	0	1.43
7/2					14	0.47 (0.52)	0	1.19
7/6					3	0.13 (0)	0	0.66
7/8	1	0.08 (0)	0	0.83	11	0.63 (0.26)	0	2.50
7/15	5	0.19 (0)	0	1.24	4	0.16 (0)	0	0.88
7/16	6	0.14 (0)	0	0.59	8	0.20 (0)	0	1.00
7/21	7	0.25 (0.25)	0	1.18	9	0.39 (0.13)	0	1.87
7/23	16	0.53 (0.30)	0	1.59	4	0.12 (0)	0	0.54
7/28								
7/30								
8/4	2	0.06 (0)	0	0.32				

Temporal periodicity and density of larval fishes exclusive of sturgeons and paddlefish.- The four taxa of larval fishes sampled in the Milk River during 2009 exhibited temporal variability in occurrence and density (Figure 8). Catostomids were collected on 17 sampling events between 29 May and 30 July, but densities were greatest on 29 May when catostomid density (11.16 larvae/100 m^3) composed 97% of the total density. After the initial peak, densities of catostomids remained low through early August with the exception of slight increases in early July. Larval cyprinids were sampled on 14 events between 29 May and 3 August. Densities of cyprinids were low through June then increased to maximum levels on 8 July as cyprinid density (27.17 larvae/100 m^3) composed 99% of all larvae sampled. A secondary period of elevated cyprinid density occurred on 28 July (mean density = 6.30 larvae/100 m^3). Freshwater drum (family Sciaenidae) were sampled on one date (8 July, density = 0.17 larvae/100 m^3). Goldeye (family Hiodontidae) were collected on two dates (29 May, 3 June), but at low densities ($\leq$ 0.05 larvae/100 m^3).

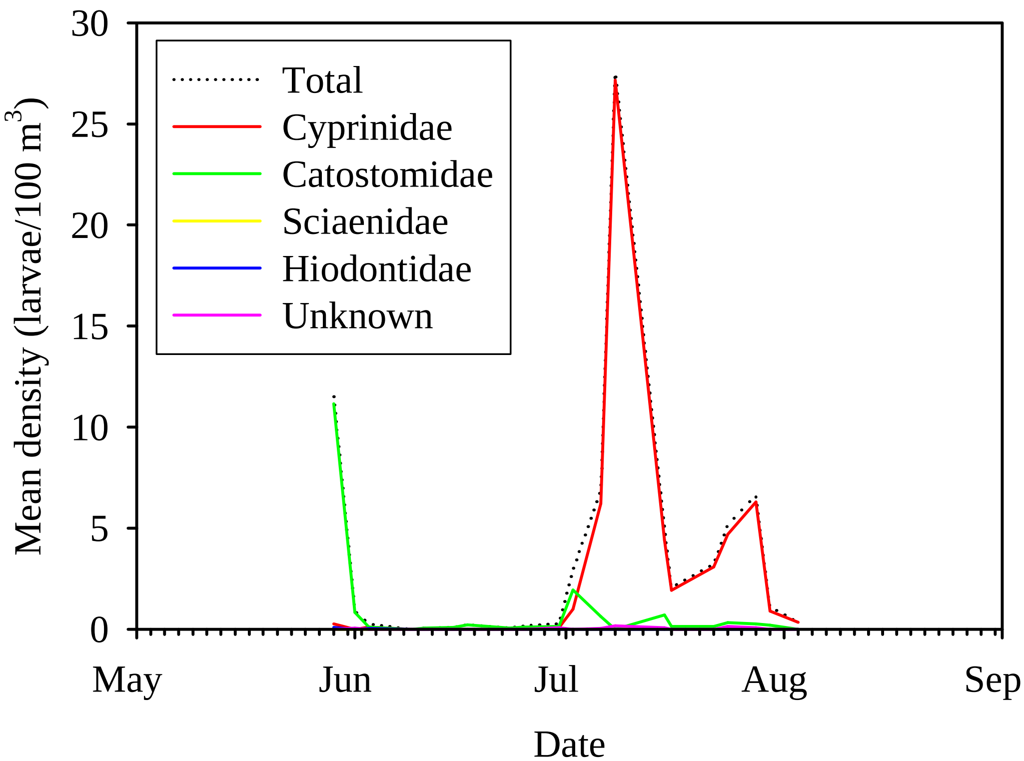

Figure 8. Mean density (larvae/100 m^3) by date of all larval fishes (Total), Cyprinidae, Catostomidae, Sciaenidae, Hiodontidae, and unknown individuals in the Milk River during 2009.

In the Missouri River near Frazer Rapids, two taxa were infrequently collected as percids were sampled on two dates (1 June, 9 June; density ≤ 0.26 larvae/100 m^3) and salmonids on one date (1 June; density = 0.18 larvae/100 m^3; Figure 9). Representatives of Cyprinidae were collected on six dates between 15 June and 15 July and densities were greatest on 6 July (mean = 0.93 larvae/100 m^3). Catostomids were sampled from the drift on 14 events between 29 May and 3 August. Peak densities of larval catostomids occurred on 15 July (mean = 8.15 larvae/100 m^3) as this taxon composed 92% of the total densities of larvae.

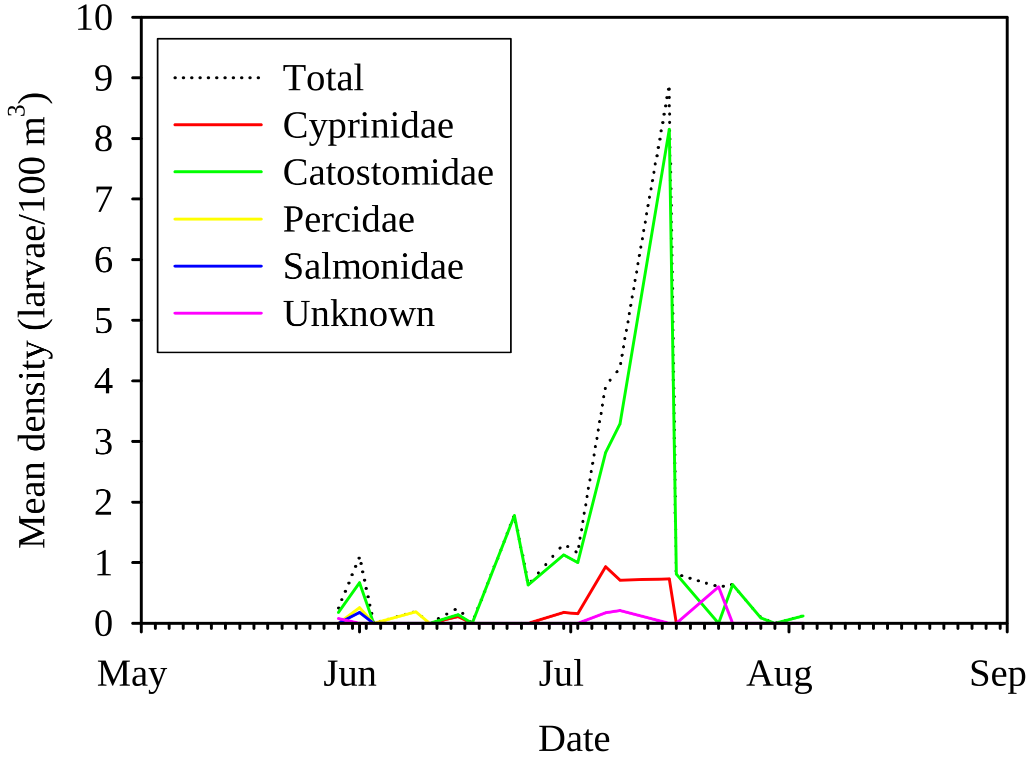

Figure 9. Mean density (larvae/100 m^3) by date of all larval fishes (Total), Cyprinidae, Catostomidae, Percidae, Salmonidae, and unknown individuals in the Missouri River near Frazer Rapids during 2009.

The larval fish community at Wolf Point exhibited substantial temporal variability in the occurrence and density of taxonomic groups (Figure 10). Two taxa were infrequently present in the collections as freshwater drum were sampled on one date (1 July; density = 0.03 larvae/100 m^3) and salmonids on two dates (27 May, 8 June; density ≤ 0.69 larvae/100 m^3). Percids were collected on nine sampling events between 27 May and 7 July, but larval densities were greatest on 4 June (mean = 1.05 larvae/100 m^3) when percid larvae composed 94% of all larvae sampled. Larval cyprinids were sampled at low densities (mean ≤ 0.11 larvae/100 m^3) across nine sampling events between 27 May and 23 July. Representatives of Catostomidae were collected on 17 dates between 27 May and 3 August, and peak densities occurred on 9 July (mean = 2.25 larvae/100 m^3).

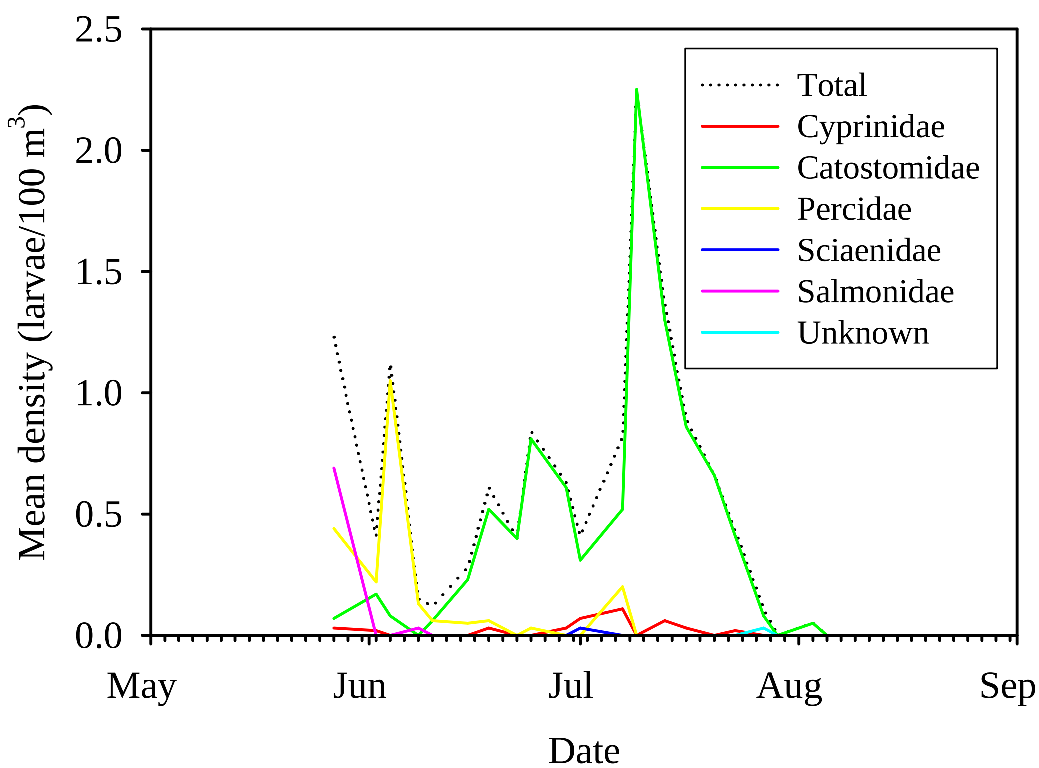

Figure 10. Mean density (larvae/100 m^3) by date of all larval fishes (Total), Cyprinidae, Catostomidae, Percidae, Sciaenidae, Salmonidae, and unknown individuals in the Missouri River near Wolf Point during 2009.

Component 4 – Reproductive success of shovelnose sturgeon and pallid sturgeon

Young-of-year sturgeon sampling.- Beam trawling for young-of-year sturgeon was conducted on eight sampling events between 22 July and 9 September 2009 (Table 9). A total of 358 trawls was conducted as 98 trawls were deployed in the Missouri River ATC (96 standard trawls, 2 targeted trawls), 164 trawls in the Missouri River BTC (144 standard trawls, 20 targeted trawls), and 96 trawls in the Yellowstone River (all were standard trawls).

Trawling efforts resulted in the collection of 11 young-of-year sturgeon. Based on genetic analysis, all young-of-year sturgeon were identified as shovelnose sturgeon (Bartron and Kalie 2010). Thus, similar to past years of the Fort Peck project, no recruitment of pallid sturgeon through the early life stages was observed in 2009. Of the 11 young shovelnose sturgeon collected, one individual was sampled from the Missouri River ATC during the 5-6 August sampling event (Table 9). Ten young-of-year shovelnose sturgeon were sampled in the Missouri River BTC, but the occurrence of young sturgeon was restricted to three sampling events between mid- and late-August. No young shovelnose sturgeon were collected in the Yellowstone River during 2009.

Table 9. Summary of trawling effort and catches of young-of-year sturgeon in the Missouri River above the Yellowstone River confluence (MOR ATC), below the Yellowstone River confluence (MOR BTC) and in the Yellowstone River during 2009.

Site	Sampling protocol	Metric	Jul 22-23	Jul 29-30	Aug 5-6	Aug 11-12	Aug 18-19	Aug 25-26	Aug 31-1	Sep 8-9
MOR ATC	Standard	Sturgeon	0	0	1	0	0	0	0	0
		Trawls	12	12	12	12	12	12	12	12
		Minutes	48	48	48	48.1	47.5	48	48	48
	Targeted	Sturgeon			0					
		Trawls			2					
		Minutes			8					
MOR BTC	Standard	Sturgeon	0	0	0	1	1	1	0	0
		Trawls	18	18	18	18	18	18	18	18
		Minutes	71	71	72	72.3	72.3	72	72	71.5
	Targeted	Sturgeon				3	1	3		
		Trawls				8	4	8		
		Minutes				32	16	32.3		
Yellowstone	Standard	Sturgeon	0	0	0	0	0	0	0	0
		Trawls	12	12	12	12	12	12	12	12
		Minutes	48	48	47	48	48	48	48.1	47
	Targeted	Sturgeon								
		Trawls								
		Minutes								

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

Personnel from the Fort Peck Flow Modification project participated in pallid sturgeon broodstock collection activities during spring 2009. A total of 461 drift trammel nets were deployed over 5 weeks. During this time, the Fort Peck Flow Modification crew contributed 12 of the previously telemetered pallid sturgeon to the propagation program, implanted transmitters in an additional 11 adult pallid sturgeon that were not needed for propagation, and captured an additional 11 pallid sturgeon that were either transported to hatcheries or returned to the river based on sexual state and need. Pallid sturgeon sampled during spring 2009 were sexed and staged by hatchery personnel and reproductive physiology experts. Collection records were submitted to the USFWS Bismarck office for inclusion in the pallid sturgeon database.

Additional activities

Personnel from the Fort Peck Flow Modification project assisted in a study examining survival rates of hatchery-reared juvenile pallid sturgeon (HRJPS) released in the Missouri River downstream from Fort Peck Dam (Recovery Priority Management Area 2). During routine manual tracking events (under Component 2), additional radio frequencies were scanned in an effort to locate 300 juvenile pallid sturgeon that were implanted with transmitters in spring 2008. These frequencies were also added to the ground-based telemetry stations. Information obtained will aid in estimating survival rates of HRJPS that were stocked at three different locations on the Missouri River below Fort Peck Dam.

Acknowledgments

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