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Annual Report

Lower Missouri River Pallid Sturgeon Monitoring and Population Assessment Project

Prepared for the U.S. Army Corps of Engineers
Northwest Division

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Abstract

The Columbia Missouri Fishery Resources Office (CMFRO) began a three-year project funded by the Northwest Division, Kansas City and Omaha Districts, U.S. Army Corps of Engineers (COE) to monitor and evaluate pallid sturgeon populations on the Lower Missouri River. CMFRO targeted six sampling reaches along 170 river miles during the first year of the project. Sampling was conducted from April to September 2001. One site was sampled with hoop and gill nets while all sites were sampled with a slingshot balloon trawl and a beam trawl when possible. Seventy-seven trawl hauls and 12 net nights captured 4,110 fish from 11 families. No pallid or hybrid sturgeon were captured however, 198 shovelnose sturgeon and 2 lake sturgeon were collected. Fourteen young-of-the-year sturgeon were captured, four of which were shovelnose and 10 have currently not been identified to species.

Shovelnose captured in the slingshot balloon trawl over late summer and early fall appeared to prefer habitats with midrange water velocities associated with sand bars. Seventy-one percent of all sturgeon captured were in habitats with velocities less than 0.7m/s. This compares favorably with the need for increased habitat with velocities less than 2 ft/s (0.61m/s) identified in the U.S. Fish and Wildlife Service Biological Opinion. Capture rates of shovelnose were determined for all trawl samples and with the exception of one site, showed that the frequency of capture progressively increased as sampling moved down-river. Trawls were effective in capturing more smaller sturgeon than previous gill net projects, including YOY which were captured in a variety of flows, habitats and depths. Habitat preferences of YOY sturgeon could not be defined with the present data.

Introduction

Pallid sturgeon (*Scaphirhynchus albus)* abundance has declined throughout the Missouri River since dam construction and inception of the Bank Stabilization and Navigation Project in 1912 (Carlson et al. 1985). Loss of habitat, reduced turbidity, increased velocity, loss of natural flows, reduction in forage, increased hybridization and inadequate reproduction and recruitment are some of the factors contributing to the decline of the pallid and other native species (Pflieger and Grace 1987). Surveys conducted throughout the Missouri and Mississippi Rivers since 1996 suggest an increase in hybridization and continued decline of this species (Grady et al. 2001).

In an independent scientific evaluation of the condition and management of the Missouri River, the National Research Council (2002) concluded that altered flow and habitat conditions associated with current management practices on the Missouri River have resulted in an unhealthy river ecosystem. Earlier and similar conclusions presented in the U. S. Fish and Wildlife Service Biological Opinion recommended, in part, that the COE initiate modified flow regimes by 2003 to avoid jeopardizing three listed species (pallid sturgeon, least tern, threatened piping plover) and begin restoring the river's ecological health. The COE is responsible for monitoring and evaluating biotic responses of the pallid sturgeon to operational and habitat changes on the Missouri River (USFWS 2000). Habitat restoration, higher spring and lower summer flows combined with adaptive management are recommended measures to restore pallid sturgeon populations on the Lower Missouri River. Adaptive management is an approach to natural resources management that promotes carefully-designed management actions, monitoring and assessment of impacts and application of results and findings to subsequent policy and management strategies. Monitoring sturgeon populations will provide vital information needed to guide restoration of form and function (habitat and hydrology) in the Lower Missouri River Ecosystem.

In response to the Biological Opinion, the COE is developing monitoring and restoration projects to recover pallid sturgeon populations. As part of their Implementation Plan, COE is working with the Columbia Missouri Fishery Resources Office (CMFRO) and lower basin State resource agencies to develop and conduct a sturgeon monitoring and assessment program. Objectives of this program are to document relative abundance, reproduction, recruitment, distribution and habitat association characteristics of pallid sturgeon and associated fish species in the Lower Missouri River; and to evaluate biotic responses to habitat and hydrologic changes. This report represents CMFRO's first year effort toward those objectives.

Study Design and Locations

Six, ten mile long primary monitoring reaches were sampled. Each study reach either encompassed areas where pallid sturgeon had been collected in the past or where a habitat restoration project of potential benefit to pallid sturgeon was created. These reaches included: St. Charles (River Mile (RM) 20-30), Hermann (RM 95-105), Plowboy Bend (RM 170-180), Lisbon Bottoms/Jameson Island (RM 210-220), Cranberry (RM 275-285) and Overton Bottoms (RM 180-190).

Monitoring and assessment activities were conducted over three temporal periods. The first of these was the November - March (winter/spring) time frame which focuses on overwintering habitat. The second is the March - June (spring/summer) period targeting sturgeon dispersal, migration, staging and spawning activities. The third interval brackets the June-October (summer/fall) time period to evaluate larval and juvenile pallid sturgeon abundance, distribution and habitat associations. Only the second and third time periods were sampled in 2001 due to delays in project approval. Plowboy, Lisbon Bottoms/Jameson Island and Cranberry reaches were sampled in the spring/summer period and all six sites were sampled in the summer/fall period.

Methods

Standard gear and methods were used where possible in accordance with guidelines developed by the Middle Basin Pallid Sturgeon Recovery Work Group (MB-PLS-RWG) in cooperation with COE personnel as described in the draft document Pallid Sturgeon Population and Habitat Monitoring Plan for the Lower Missouri and Kansas Rivers, (Draft), (Drobish et al. 2001). Collection methods conformed with those described in Biological Procedures and Protocol for Collecting, Tagging, Sampling, Holding, Culture, Transporting and Data Recording for Researchers and Managers Handling Pallid Sturgeon (Krentz 2001). Federal Endangered Species Permits and State Wildlife Collecting Permits were obtained and maintained.

An initial experimental effort was made in the spring to compare and evaluate hoop and gill nets in various habitat types in the Plowboy Bend reach. Gill nets used were paired nets 100' long x 6' deep consisting of alternating 25' panels of 1" and 2" bar mesh and 200' long x 6' consisting of alternating 50 foot panels of 3" and 4" bar mesh. These were the standard nets used in the MICRA Pallid Sturgeon Project (Grady et al. 2001). Hoop nets were four feet in diameter by 16 feet long with two throat hoops and 1.5" bar mesh nylon netting. This experimental sampling differs from that in the project proposal, but is included here because relevant data was collected. Future monitoring will focus on selected reaches and methods identified in the above mentioned protocol being jointly developed by Middle Basin Work Group and COE representatives.

Summer/fall sampling in 2001 consisted of a combination of slingshot balloon and beam trawling. The slingshot balloon trawl is 16 feet wide X 15 feet long with 3/4" outer chafing mesh and 1/8" inner cod mesh. It is the standard trawling gear adopted by the Mississippi River Long Term Resources Monitoring Program (Gutreuter et al. 1995). The beam trawl has a 2 meter wide beam and skids 0.5 meters high with 1.5" outer chafing mesh and 1/8" inner cod mesh.

Data Collection and Reporting

Data was collected in accordance with the MICRA Pallid Sturgeon Protocol (Grady et al. 1996) and the Pallid Sturgeon Population and Habitat Monitoring Plan for the Missouri and Kansas Rivers (Draft), (Drobish et al. 2001) and recorded on MICRA standard field data sheets. Parameters include gear number, gear type, set time, pull time, soak time, river stage, discharge rate, habitat type, substrate, depth, turbidity, conductivity, water temperature, water velocity and location. Substrate classifications, gear and habitat codes used in the this study are listed in Table A1 of the appendix. River discharge (cf/s) data were taken from U.S. Geological Survey gauging stations. The gauge referred to was the closest upstream from each sampling reach. GPS coordinates (latitude/longitude) were recorded at each sample site using a Precision Lightweight GPS Receiver (PLGR). Minimum and maximum depths were recorded from the sonar throughout the length of the trawl or net set. Turbidity data (NTU's) were taken with a HACH 2100P turbidimeter. Temperature (°C) and conductivity (uS/cm) data were taken with a HACH sesion5™ meter. Surface 2/10, mid (8/10) and bottom velocities (m/s) were taken using a Marsh-McBirney model 2000 flow meter. Lengths (mm) and weights (g) of fish were recorded for all species collected. Those small fish not identified in the field were fixed in 10% formalin and preserved in 80% ethanol. All data were entered into Columbia FRO's station database. Physio-chemical data, habitat classifications and sturgeon catch per trawling site are presented in the appendix. Statistical Analysis System (SAS 1990) was used to summarize the data as catch-per-unit-effort (CPUE). CPUE was presented as #fish/100m^2 for slingshot balloon trawls and #fish/net-day for gill and hoop nets.

Results

Thirty-four species were represented in our collection of 4,110 fish. Blue catfish (*Ictalurus furcatus*) dominated balloon trawl samples (29%), shovelnose sturgeon (*Scaphirhynchus platorynchus*) dominated gill net samples (82%) and channel catfish (*Ictalurus punctatus*) were most abundant in hoop nets (50%). Catfish (56%) and chub species (35%) were predominant in the beam trawl samples. There were no pallid sturgeon identified in our samples, though ten young-of-the-year (YOY) sturgeon are yet to be identified to species. Verification of suspected pallid sturgeon will be contracted to Darrel Snyder, Ph.D. at the Colorado State University Larval Fish Lab.

Slingshot BalloonTrawls

A diversity of habitats were sampled in an effort to include all possible pallid sturgeon habitat. Bramblett (1996) reported that pallid sturgeon preferred sandy substrate associated with alluvial sandbars. Emergent sandbars make up a small proportion of the overall habitat on the Missouri River, but were sampled more than any other habitat (50%). Remaining trawls were conducted in main channel habitat (31%) and side channels (19%). More sturgeon were collected per trawl in sandbar habitats than in main channel and side channel habitats (Figure 1).

Twenty-eight species represented by 3,775 fish were collected in 65 trawl hauls (Table 1). Shovelnose sturgeon were captured at an average rate of 0.08 (± 0.02) fish per $100m^2$ of trawling in all sampling reaches combined. St. Charles had the highest rate of capture and Lisbon had the lowest rate (Figure 2). Heavy siltation within the Lisbon side channel combined with low water conditions prevented sampling in the side channel itself and likely contributed to the low catch rates observed at the Lisbon Bottoms/Jameson Island reach. High catch rates in the St. Charles reach may be explained by one particularly successful trawl that captured 12 sturgeon. This made up 67% of the total catch for all of St. Charles. The particular trawl covered the tail end of an island consisting of rock and gravel as substrate, with bottom velocities of 0.7 m/s. It was the only sample in 65 trawls where the particular substrate and habitat combination was found and it represented the largest catch of sturgeon over all sampling reaches.

The productivity of the Lisbon Bottoms side chute as a nursery habitat was shown from a trawl at the mouth of the chute that captured almost 900 larval chubs (Table 1). Though these chubs were largely unidentifiable due to their small size, their presence shows the value of the this area for spawning and nursery habitat for potentially declining species such as chubs.

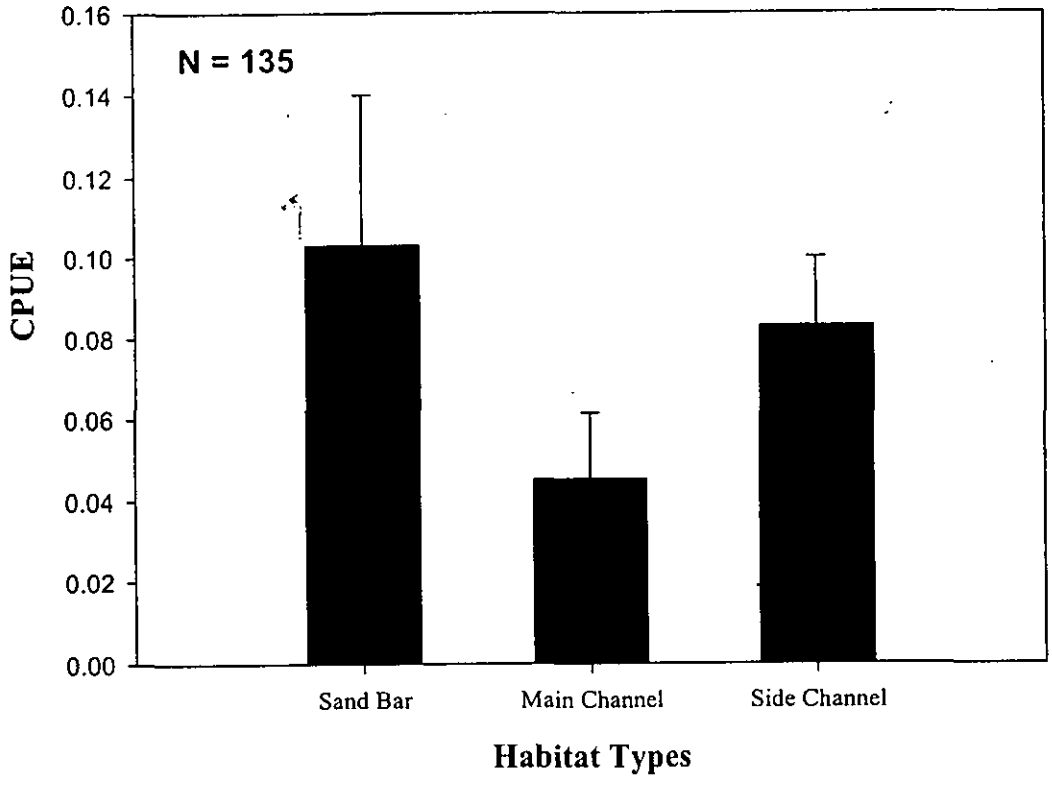

Figure 1. Average capture rate (fish/100 m^2) of shovelnose sturgeon with associated habitat types using a slingshot balloon trawl on the Lower Missouri River in 2001. Catch Per Unit Effort (CPUE) is measured as the number of fish captured per 100 m^2 of trawling.

Table 1. Fish captured in slingshot balloon trawl samples during 2001. Sampling took place in six sampling reaches in the Lower Missouri River (River Miles (RM) 20-285). Species are arranged phylo-genetically by family and species.

	RM 275-285			RM 210-220			RM 180-190		RM 170-180	RM 95-105	RM 20-30	
Species	Cranberry	Cranberry	Cranberry	Lisbon	Lisbon	Lisbon	Overton	Overton	Plowboy	Hermann	St. Charles	Total
	1-Aug	*2-Aug*	*5-Sep*	*17-Jul*	*15-Aug*	*13-Sep*	*9-Aug*	*14-Sep*	*7-Aug*	*8-Aug*	*11-Sep*	
Shovelnose	10	11	12	7	8	14	17	6	16	9	18	[illegible]128
Lake Sturgeon		1										[illegible]1
Shortnose Gar								1	1			[illegible]2
Gizzard Shad					4			1			4	[illegible]9
Goldeye					2					1	2	[illegible]5
Common Carp		2		2					1	1		[illegible]6
Channel Shiner											21	[illegible]21
Emerald Shiner			1			1		260			1	[illegible]263
Red Shiner			1								15	[illegible]16
River Shiner							1					[illegible]1
Bluntnose Minnow								4				[illegible]4
Bullhead Minnow						1		1				[illegible]2
Sicklefin Chub			43	3	2	17	1	37		8	50	[illegible]161
Silver Chub			2		2						1	[illegible]5
Speckled Chub		1	21	1		58		83			96	[illegible]260
Sturgeon Chub			1	1		2		2	1		7	[illegible]14
River Carpsucker				1				1				[illegible]2
Blue Sucker						1	1	1				[illegible]3
Blue Catfish		25	173		104	98	98	89	65	182	252	[illegible]1086
Channel Catfish	20		92	92	2	149	2	134	2	49	81	[illegible]623
Flathead Catfish	1			1						1	1	[illegible]4
White Crappie					2							[illegible]2
Black Crappie					3			1				[illegible]4
Freshwater Drum				37	49	24	2	1	8	56	2	[illegible]179
Unident. Sturgeon						5		4			1	[illegible]10
Unident. Larv.			2		41	891		25				[illegible]959
Unident. Catfish				3					1	1		[illegible]5
Total	[illegible]31	[illegible]40	[illegible]348	[illegible]148	[illegible]219	[illegible]1261	[illegible]122	[illegible]654	[illegible]95	[illegible]308	[illegible]552	[illegible]3776
CPUE	[illegible]0.38	[illegible]0.28	[illegible]1.89	[illegible]0.72	[illegible]1.07	[illegible]5.82	[illegible]0.55	[illegible]3.57	[illegible]0.62	[illegible]1.2	[illegible]3.19	[illegible]1.83

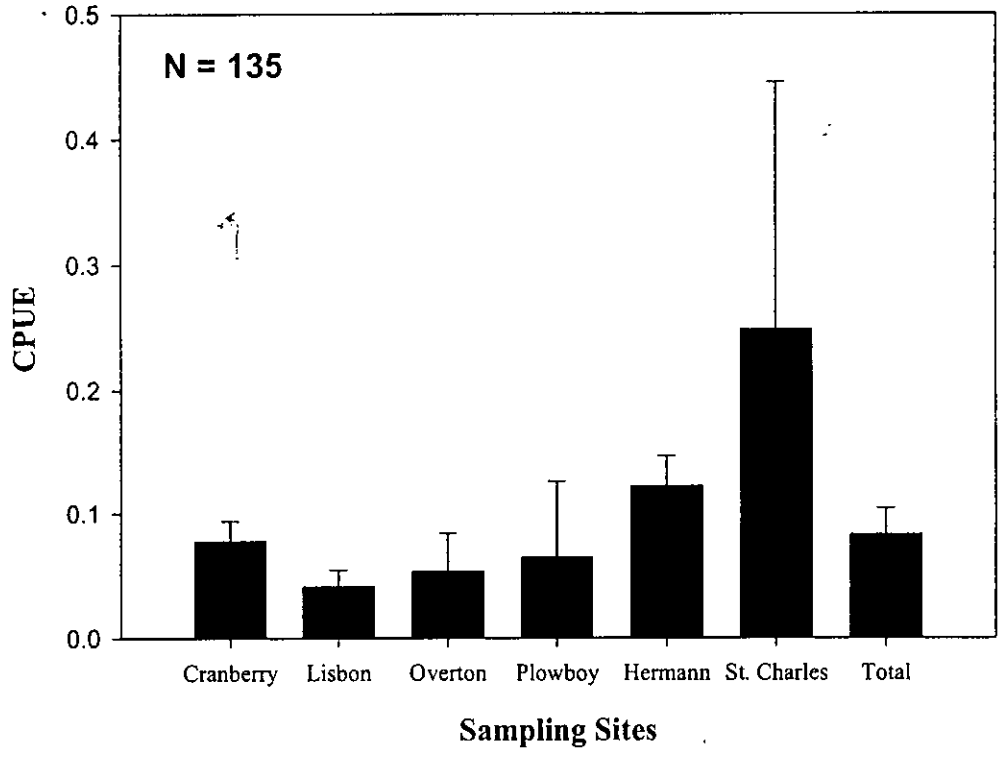

Figure 2. Average capture rate of shovelnose sturgeon among six sampling sites on the Lower Missouri River using slingshot balloon trawls in 2001. Catch Per Unit Effort (CPUE) is measured as the number of fish captured per 100 m^2 of trawling, with catch for all sampling periods combined.

The three basic macro habitat types were separated into more descriptive habitat classifications to determine if shovelnose were selectively using specific habitat types (meso-habitats). Without testing, there did not appear to be an obvious selection for any given habitat (Figure 3). With additional long term data, correlations and selection for specific meso-habitats is expected to become more apparent. YOY sturgeon (yet to be identified) were captured in both sandbar and main channel habitats and one lake sturgeon (*Acipenser fulvescens*) was captured in an area associated with a side channel and sandbar complex.

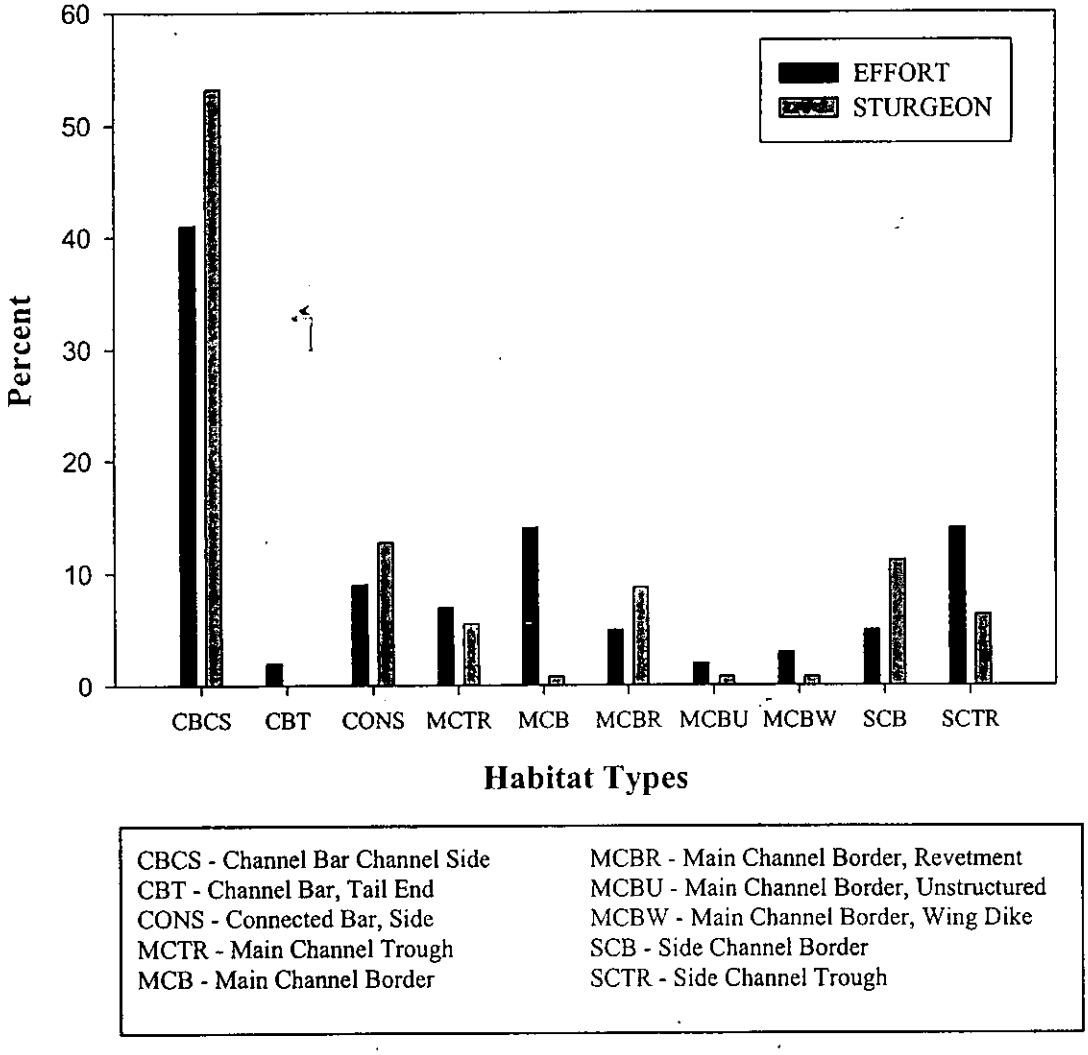

Figure 3. Percent shovelnose sturgeon collected at various habitat types in relation to the sampling effort given to selected habitats. Fish were collected with a slingshot balloon trawl on the Lower Missouri River in 2001.

Water velocities associated with sampling sites were highly variable and dependant on river stage and discharge rates. Bottom velocities were taken at every sampling site and correlated with the number of sturgeon caught at each site. Though untested, it appeared that more shovelnose sturgeon were captured with the least amount of effort in slower velocities (<0.7m/s) (Figure 4). Grady et al. (2001) measured surface velocities in relation to their samples and also showed shovelnose preferred slower water velocities when sampling with gill nets. Availability (Figure 4) is presented as the percent of trawls done in different velocities throughout the range of velocities. A higher availability would mean the velocity was sampled more, thereby increasing the chance of catching fish.

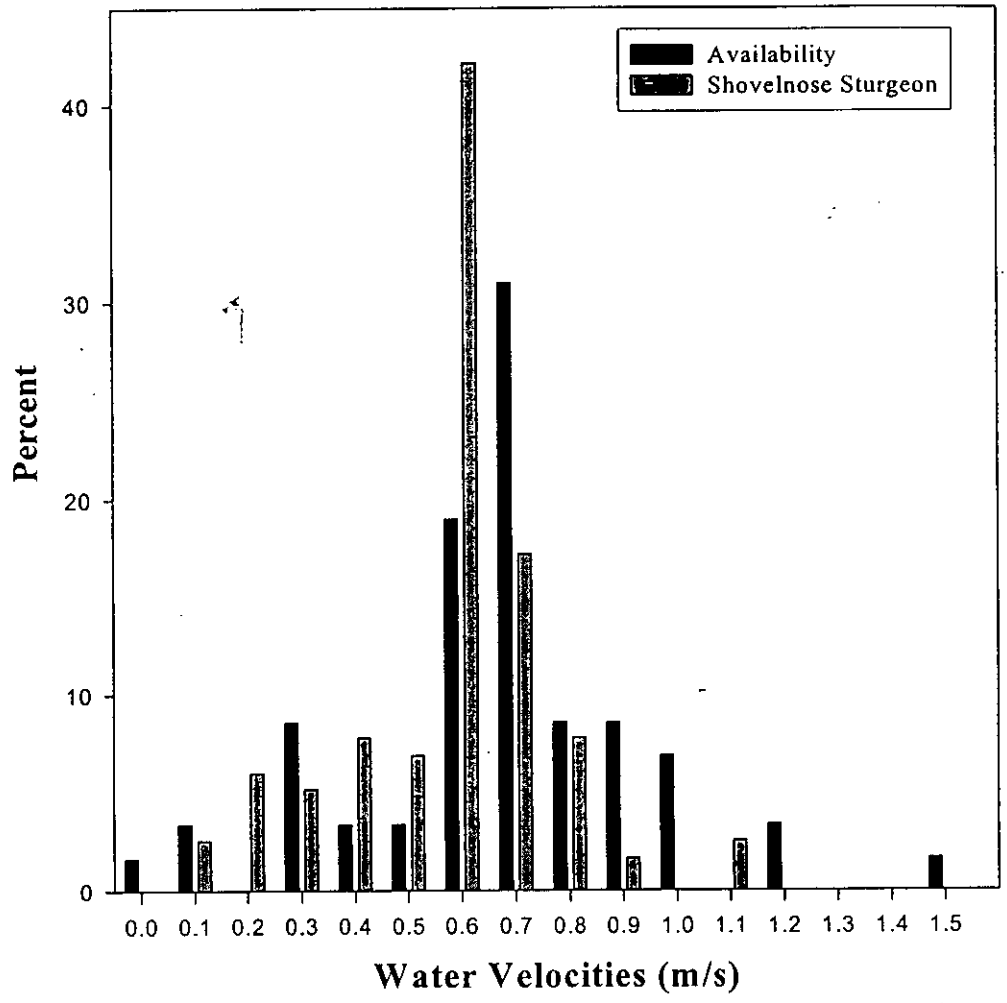

Figure 4. Percent shovelnose sturgeon collected at bottom water velocities. Fish were captured in slingshot balloon trawls on the Lower Missouri River in 2001. Availability represents the proportional amount of effort expended at particular velocities.

In the Biological Opinion, the USFWS (2000) identified flows below 2 f/s (0.61m/s) as a habitat velocity range restoration target needed for sturgeon species. Seventy-one percent of the sturgeon captured occurred in this velocity (Table 2). Almost half of the total sample (49%) were captured between 0.5m/s and 0.7m/s with proportionately less trawling effort (22%), suggesting a possible preference for this range of velocities (Table 2) (Figure 4). This seems to confirm USFWS recommendations for restoration habitat flows.

Table 2. Number of sturgeon captured in slingshot balloon trawls at various velocities on the Lower Missouri River in 2001. Availability represents the proportion velocities were sampled in relation to all velocities sampled.

Velocity (m/s)	% Captured	% Availability
< 0.5	22	17
≥ 1.0	3	5
0.5 - 0.7	49	22
< 0.7	71	39

Length frequency distributions for shovelnose sturgeon ranged from under 40 mm to over 720mm, with proportionately more sturgeon at longer lengths (Figure 5). Previous sampling for the MICRA study also showed a similar distribution of lengths with very few sturgeon under 500mm being captured (Grady et al. 2001). Slingshot balloon trawls seemed to be more effective at capturing smaller sized sturgeon previously not seen in gill net samples. Historically, few smaller sturgeon have been collected and length distributions appear today as they did 20 years ago. At 400 mm, a shovelnose sturgeon may already be 4 years old (Carlson and Pflieger 1981). The potential of four cohorts at large in the river with only a few appearing in samples suggests that the gears do not sample the young fish or that the habitats are not effectively targeted. Alternatively, poor reproduction or recruitment problems at some life history stage could lead to the relative scarcity of small sturgeon. More intensive, long term monitoring in more meso- and micro-habitats will be required to resolve these questions.

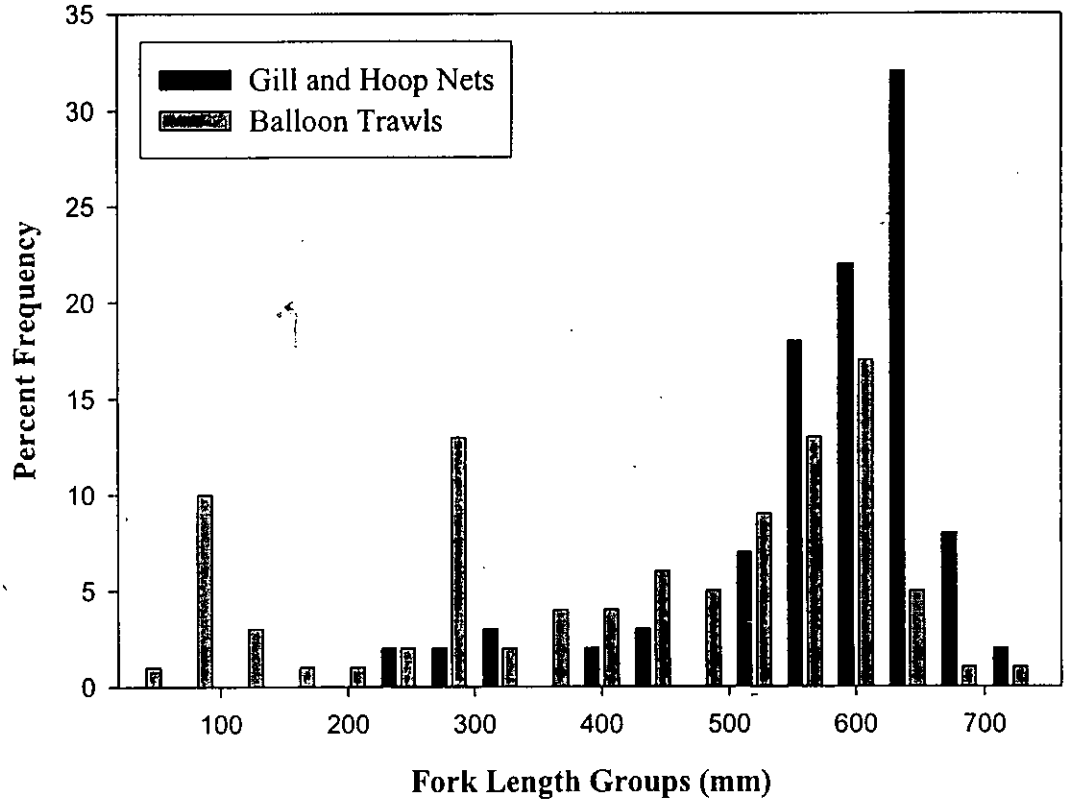

Figure 5. Percent length frequency of shovelnose sturgeon captured in slingshot balloon trawls, gill nets and hoop nets at six sites on the Lower Missouri River in 2001.

YOY shovelnose and unidentified sturgeon were collected in main channel border and sand bar habitats. Depths ranged from 1.2 to 6.1 meters and velocities ranged from 0.33m/s to 1.11m/s with an average of 0.68 m/s (0.31 standard deviation) (Table 3). Because trawls covered a range of depths, velocities and sometimes habitats, it was difficult to conclude the exact spot YOY sturgeon were captured. It was also impossible to draw conclusions from this data since the variables encountered during trawling was so high. A better sampling design based on 2001 data, and new equipment, will help eliminate habitat variability within trawls for the 2002 sampling season.

Table 3. Habitat data associated with YOY sturgeon collected with balloon trawls in September, 2001 in the Lower Missouri River.

Site	# Sturgeon	Habitat Type	Velocity	Depth Range
Lisbon	4	MCBU	0.33	1.2 - 5.0
Lisbon	1	CBCS	0.66	2.0 - 2.5
Lisbon	1	CONS	0.74	3.0 - 4.6
Lisbon	3	CONS	1.11	2.0 - 3.0
St. Charles	1	MCBR	0.59	1.2 - 6.1
Overton	1	CBT	0.55	1.2 - 6.1
Overton	1	MCBW	0.95	5.0 - 6.1
Overton	1	MCBU	0.52	1.5 - 2.2
Overton	1	MCBR	0.90	5.0 - 5.6

Beam Trawls

Fifty fish were collected in 12 beam trawl hauls in three reaches (Table 4). Catfish (62%) and chubs (38%) were the only species in these samples. Past samples have collected pallid sturgeon with the beam trawl and it can be very effective in the right habitat. However, the slingshot balloon trawl is much less labor intensive and capable of sampling more diverse habitats. It was used in lieu of the beam trawl for much of the benthic sampling in 2001. Future trawling will include both types of trawls.

Table 4. Total CPUE and number of fish collected in beam trawl samples at three sampling sites on the Lower Missouri River in 2001 (River Miles (RM) 170-285). Catch Per Unit Effort (CPUE) is measured as the number of fish captured per 100 m^2 of trawling.

	RM 275-285		RM 210-220	RM 170-180	
Species	Cranberry	Cranberry	Lisbon	Plowboy	Totals
	19-Jun	*20-Jun*	*8-May*	*7-Aug*	
Sicklefin Chub	1				1
Speckled Chub		3	11		14
Sturgeon Chub	2				2
Blue Catfish				20	20
Channel Catfish		1	6		7
Flathead Catfish	2				2
Unidentified Catfish				2	2
Totals	3	4	17	2	30
CPUE (100 m^2)	0.17	0.32	0.44	0.54	0.38

Hoop Nets and Gill Nets

Eight species were captured in 8.8 net-days of effort using hoop nets. Channel catfish and shovelnose sturgeon comprised (50%) and (29%) of the catch, respectively. All other species were caught in very low numbers (Table 5). Sturgeon species were captured in hoop nets at the rate of 1.2 (± 0.72) fish/net-day and in gill nets at a rate of 14.4 (± 4.08) fish/net-day. Sturgeon made up 83% of the 60 fish caught in gill nets. Four gill nets were set overnight for a total effort of 3.3 net-days. Comparatively, gill nets were more effective in capturing sturgeon species than hoop nets by 14:1. Hoop nets captured eight species and gill nets captured seven while four of the same species were caught by both nets (Table 5).

Table 5. CPUE and number of fish captured using hoop nets and gill nets at Plowboy Bend on the Lower Missouri River in April 2001. CPUE (Catch Per Unit Effort) is measured as fish/net-day.

Species	Hoop Nets		Gill Nets	
	# Fish	CPUE	# Fish	CPUE
Lake Sturgeon	0	0	1	0.3
Shovelnose Sturgeon	11	1.3	49	14.9
Paddlefish	2	0.2	1	0.3
Shortnose Gar	0	0	0	0
Gizzard Shad	0	0	1	0
Goldeye	1	0.11	1	0
Common Carp	2	0.23	5	1.5
Grass Carp	0	0	0	0
Emerald Shiner	0	0	0	0
Red Shiner	0	0	0	0
River Carpsucker	0	0	0	0
Quillback Carpsucker	0	0	0	0
Blue Sucker	0	0	1	0.3
Smallmouth Buffalo	23	0.3	2	0.6
Bigmouth Buffalo	2	0.2	0	0
Blue Catfish	0	0	0	0
Channel Catfish	29	3.3	0	0
Flathead Catfish	0	0	1	0.3
Striped Bass Hybrid	0	0	0	0
Freshwater Drum	1	0.1	0	0
Unidentified Sturgeon	1	0.1	0	0
Totals	58	6.6	60	17.9

Summary and Discussion

Water velocities, water chemistry, depth and substrate

The length of the trawl sample was based on an average eight minute haul and water velocity and chemistry measurements were taken at some fixed point along the path of the trawl. The length of the haul can encompass a large range of water velocities, depths, and substrates, not knowing the exact point at which fish were captured in the net can make comparisons potentially inaccurate. Substrates are described from one bottom sample or based on knowledge of the river and visible habitat. Depending on the habitat type, the assumption that substrate is uniform throughout the trawl could be arguable. Habitat classifications and velocities are usually indicative of particular substrates and on a macro-habitat level generalizations are probably accurate. Substrate preferences of sturgeon on the meso- or micro- level may be hard to define based on sampling capabilities.

Water chemistry was relatively unchanged throughout the day between habitats in all sites suggesting fish habitat selection based on these parameters is unlikely. However, water chemistry was based on surface samples, not bottom samples, which may be different. A new measuring device will allow bottom samples to be collected in 2002. Differences in water chemistry would be expected in some habitat types during the summer season and 2002 data may show distinctions previously not recognized.

Water velocity was taken at one place along the trawl and not necessarily at the most sampled depth, making distinctions between meso-habitat velocities difficult. However, because habitat classifications generally represented a uniform area throughout the trawl, the measured velocity would not likely be drastically different unless it were affected by debris or a wing dike making most velocities applicable for general comparisons. A specially designed trawling boat provided by the COE in 2002 will make sampling more effective by allowing shorter trawls to be made thereby minimizing the variability within each haul and allowing more precise measurements.

Non-targeted species

YOY blue and channel catfish were abundant in many of the balloon trawl samples. These are important game fishes in the Missouri River. Relatively high abundance indicates good reproduction in both species

Over 800 chubs were collected in one trawl haul in the Lisbon Bottoms chute, suggesting this area provides spawning and nursery habitat for chub species. Several speckled and sicklefin chubs were identified within the sample, however most of the fish were unidentifiable to species due to the small size and common characteristics of the fish.

Habitat parameters

Shovelnose sturgeon were found in greater numbers in velocities less than 0.7m/s and almost half were found in mid-range velocities proposed by the USFWS around 0.5-0.7m/s. Sturgeon were found in greater numbers in sand bar habitats followed by side channel and main channel habitats. Lisbon chute has been cited as a highly productive area for a variety of species including 3 larval pallid sturgeon (Louise Mauldin, Fishery Biologist, USFWS CMFRO, personal communication, January, 2001). The heavy silting and low water conditions in 2001 rendered this area inaccessible and prevented a major portion of side channel sampling. This may have caused side channel use by sturgeon to be underestimated throughout this site and the combined project reaches.

Sampling gears

The most recent report on pallid sturgeon status found a ratio of one pallid per 633 river sturgeon (Grady et al. 2001). Total sampling efforts for this year produced no pallids for 188 shovelnose captured, with 10 YOY yet to be identified. Sampling in 2001 relied mainly on slingshot balloon trawls designed to catch larval and YOY sturgeon. Balloon trawls were effective in this respect and were also capable of capturing adult sturgeon. Smaller sturgeon (<350) were captured in trawls in greater frequency than in hoop or gill nets in past studies, while in contrast larger sturgeon (>600) were few.

Gill nets set at Plowboy Bend were far more effective at catching sturgeon, though hoop nets were shown to be capable of effectively sampling sturgeon and could be used in hard to sample areas such as log jams and revetments. Gill nets will be the primary gear used to collect over-wintering adult sturgeon and will be used in all reaches in winter 2001-2002 sampling. Balloon and beam trawling will be the primary gears used to sample study reaches during the remainder of the year to assess, staying, spawning, dispersal and reproductive success.

Recommendations

Balloon trawls effectively captured YOY sturgeon over a broad range of velocities and habitat types. Based on this diverse dispersal of YOY, 2002 sampling should encompass all habitats types, with varying depths and velocities to better define habitat preference at this stage. Adult shovelnose sturgeon appeared to prefer sand bar habitats over all other habitat types. Specifically sampling head, side and tail ends of sand bars in 2002 may provide better data about meso-habitat preferences. Future monitoring is needed in all facets of this project. Defining sturgeon habitat preferences can only be accomplished by sampling all habitats in the river with a variety of gears. The degree to which these habitats can be classified and sampled will determine the effectiveness of agencies selectively targeting known sturgeon habitats and thereby increasing the likelihood of pallid sturgeon capture.

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Appendix

Physio-chemical and Habitat parameters

Table A1. List of codes for designated gear types, strata, and substrate classes used by Columbia Fishery Resources Office staff for Missouri River monitoring.

Gear type	Strata	Predominant substrate
SN = seine	MCB-U = main channel border, unrestricted	1. Silt
BT = bottom trawl	MCB-R = main channel border, revetment	2. Silt/clay/little sand
DGN = drifting gill net	MCB-W = main channel border, wing dam	3. Sand/some gravel
SGN = stationary gill net	MCTR = main channel trough	4. Gravel/rock
SL = set line	SCB = side channel border	5. FPOM w/ sand & silt
SHN = small hoop net	SCTR = side channel trough	6. Sand
LHN = large hoop net	BWC-O = backwater, offshore	7. CPOM/detritus
EF = electrofishing	BWC-S = backwater, shoreline	8. Silt/some gravel
BP = backpack electrofishing	TWZ = tailwater zone	9. Sand/silt
FN = mini-fyke net	TRIB = tributary confluence	
T = trammel net	CBCS = channel bar, channel side	
WQ = water quality sample	CBBS = channel bar, bank side	
	CBBB=channel bar between bars	
	CBH = channel bar, head end	
	CBT = channel bar, tail end	
	CONS = connected bar, side	
	CONH = connected bar, head end	
	CONT = connected bar, tail end	

Table A1. Physio-chemical data for each day of sampling at six selected sites on the Lower Missouri River in 2001. Values are averages of data taken for samples throughout each day.

SITE	DATE	GEAR	TURBIDITY	TEMP C°	CONDUCTIVITY	RIVER STAGE	DISCHARGE
Cranberry	6/19/2001	BT	>1000	24.7	588	18.22	93300
Cranberry	6/20/2001	BT	>1000	24.9	546	20.49	115000
Cranberry	8/1/2001	OT	>1000	29.1	540	13.86	58900
Cranberry	8/2/2001	OT	211	30.3	711	13.29	54900
Cranberry	9/5/2001	OT	94	27.5	759	11.16	40900
Lisbon	05/08/01	BT	>1000	18.7	504	21.30	170000
Lisbon	7/17/2001	OT	572	29.0	570	11.54	70500
Lisbon	8/15/2001	OT	394	26.9	782	8.29	47400
Lisbon	9/13/2001	OT	82	24.7	791	8.68	50100
Overton	08/09/01	OT	45	31.2	778	9.03	52500
Overton	09/14/01	OT	79	22.7	780	8.31	44700
Plowboy	12/18/01	SGN	50	6.82	793	5.78	N/D
Plowboy	12/19/01	SGN	44	6.55	797	5.67	N/D
Plowboy	4/10/2001	SGN	831	16.8	451	13.04	75400
Plowboy	4/10/2001	LHN	904	16.9	474	13.04	75400
Plowboy	4/11/2001	LHN	531	13.1	494	17.00	116000
Plowboy	08/07/01	OT	84	31.0	702	9.33	47900
Plowboy	08/07/01	BT	108	31.3	702	9.36	48000
Hermann	08/08/01	OT	81	30.3	565	9.83	72100
St. Charles	09/11/01	OT	389	25.4	736	10.05	48400

*N/D- means no data is available

Table A3. Habitat parameters, length-range and number of fish sampled in slingshot-balloon trawls where sturgeon were present. Samples were conducted in six reaches of the Lower Missouri River in 2001.

Sample Site	Date	Habitat	Velocity	Depth Range	Substrate	Length Range	# Fish
Cranberry	08/01/01	SCTR	0.90	1.22 - 3.05	N/D	483 - 597	2
	08/01/01	SCTR	0.67	0.61 - 2.14	N/D	77 - 474	4
	08/01/01	SCTR	0.71	0.92 - 2.44	N/D	499 - 575	4
	08/02/01	MCTR	0.10	3.36 - 7.60	N/D	397	1
	08/02/01	CBCS	0.28	0.61 - 1.83	N/D	70 - 543	2
	08/02/01	CBCS/CBT	0.68	0.61 - 1.83	N/D	69 - 330	5 *
	08/02/01	MCBU	0.62	1.83 - 2.40	N/D	482 - 594	4
	09/05/01	SCTR	0.61	1.52 - 1.52	N/D	244	1
	09/05/01	CBCS	0.21	1.22 - 2.44	Sand	246 - 392	2
	09/05/01	CBCS/CBT	N/D	1.22 - 1.52	Sand	430 - 613	8
	09/05/01	MCBR	0.25	5.49 - 7.62	Gravel/ Rock	690	1
Lisbon	07/17/01	MCBU	0.68	N/D	Sand	559 - 588	2
	07/17/01	CBCS	0.95	1.22 - 4.27	Sand	467	1
	07/17/01	CBCS	0.95	0.61 - 1.83	Sand	532	1
	07/17/01	SCTR	0.22	0.61- 2.44	Silt	267 - 351	2
	07/17/01	SCTR	0.59	2.75 - 3.66	N/D	597	1
	08/15/01	CONS	0.68	0.91 - 1.52	Sand	584	1
	08/15/01	CONS	N/D	1.52 - 2.44	Sand	264 - 586	3
	08/15/01	SCB/CONT	0.05	0.91 - 2.74	Silt	583 - 599	2
	08/15/01	CONS	0.59	1.83 - 2.74	Sand	255 - 493	2
	09/13/01	CBCS	0.66	1.83 - 2.44	Sand	50 - 595	5
	09/13/01	MCBU/CBT	0.33	0.91 - 4.57	Sand	36 - 390	8
	09/13/01	CBCS/CONT	0.74	2.74 - 4.57	N/D	62	1
	09/13/01	CONS/CBT	1.11	2.13 - 2.74	Sand	42 - 145	4
Overton	08/09/01	CBCS	0.44	0.92 - 1.53	N/D	245 - 582	5
	08/09/01	CBCS/CBT	0.64	0.92 - 2.44	N/D	250 - 566	7
	08/09/01	CBCS	0.54	0.61 - 1.53	N/D	225 - 483	5
	09/14/01	CBCS/CONT	0.63	1.22 - 2.44	N/D	250 - 480	2
	09/14/01	CBCS/CBT	0.63	1.83 - 3.97	N/D	420 - 635	3
	09/14/01	MCTR/CBT	0.55	1.22 - 6.10	Silt/Clay/Sand	52 - 615	2
	09/14/01	MCBU	0.52	1.53 - 2.14	Sand	49	1
	09/14/01	MCBR	0.90	4.58 - 5.19	Gravel/Rock	48 - 115	2
Plowboy	08/07/01	MCBR	0.68	3.05 - 3.66	N/D	400 - 669	9
	08/07/01	MCBU	0.73	2.14 - 3.66	N/D	248 - 318	2
	08/07/01	CBCS	0.42	1.22 - 2.75	Sand	490 - 590	4
	08/07/01	CBCS/CBT	0.73	1.83 - 2.75	N/D	249	1
Hermann	08/08/01	MCBU	N/D	2.44 - 3.66	N/D	259	1
	08/08/01	MCBW	0.31	1.83 - 4.58	N/D	350	1
	08/08/01	CBCS	0.69	1.53 - 3.97	N/D	232 - 513	2
	08/08/01	SCB	0.84	1.53 - 3.05	N/D	180 - 644	5
St. Charles	09/11/01	CBCS	0.52	1.53 - 3.36	Sand	580	1
	09/11/01	MCBR	0.59	1.22 - 6.11	N/D	35 - 161	2
	09/11/01	CBCS	0.82	1.22 - 1.83	Rock/Gravel	430 - 485	2
	09/11/01	CBCS/CBT	0.78	1.53 - 3.05	Rock/Gravel	226 - 600	12
	09/12/01	MCBU	0.56	0.92 - 4.58	N/D	425 - 542	2

* Lake sturgeon captured

* N/D means no data is available